Disaster Debris Management

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Abstract

Major disasters during the last decade have raised questions regarding response delays and significant environmental impacts due to the debris generated. The environmental and financial costs of debris management have been devastating.

Canada is subject to potential hazards that may exacerbate existing solid waste management problems, cause environmental pollution, and disrupt local economies.

The purpose of the present work is to promote the local development of a debris management plan as one of the most effective strategies to mitigate disaster impacts. The paper addresses major topics including allocation of responsibilities, policy making, human factors, debris management, cost reduction and administrative procedures. It is intended as a discussion paper to develop guidelines for emergency planners, municipal engineers and others with decision making or front-line authority who would be responsible for debris management. Local professional judgment is essential for realistic assessment of contingencies and resources. Experience and information gained through the planning process will potentially increase the efficiency of the response.

Emergency Preparedness Canada has sponsored the research and writing of this paper as part of its ongoing efforts to mitigate the consequences of disasters and improve preparedness nationally by supporting good planning at local levels of government.

DISASTER DEBRIS MANAGEMENT

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1. INTRODUCTION

Major disasters during the last decade have raised questions regarding response delays and significant environmental impacts due to the debris generated. Medical care, transportation of victims or relief teams, fire fighting, provision of shelter, food, clothing, and water supplies were all delayed due to transportation difficulties as a result of debris blocked roads.

The amount of debris generated by some disasters was equivalent in volume to years, if not decades, of normal solid waste production in the affected jurisdictions. Thus, landfill

capacities were overwhelmed; roads were damaged by trucks hauling debris; dust produced by clearance operations annoyed the population for several months; tons of waste were burned; and some disposal sites were established without adequate environmental consideration (including the disposal of hazardous wastes). The financial and environmental costs were devastating.

Debris management was not considered a serious issue, relative to the emergency plans regarding people's safety and well-being. The lesson learned is that, in order to protect people, planning should be based on a systems approach, whereby every component is functional in itself and is coordinated into a cohesive working response.

The purpose of the present work is to promote the local development of a debris management plan, as one of the most effective strategies to mitigate disaster impacts. It is intended as a discussion paper to develop guidelines for emergency planners, municipal engineers and others with decision making or front-line authority who would be responsible for debris management.

Emergency Preparedness Canada has sponsored the research and writing of this work, as a part of its ongoing efforts to mitigate the consequences of disasters and improve preparedness nationally by supporting good planning at local levels of government.

This paper is based on a review of reported experiences with disaster-generated debris in Canada and elsewhere in order to develop lessons that may be applied to Canadian practices. It provides and recommends planning actions and procedures for use by emergency planners and those responsible for debris to avoid or mitigate problems (should a similar situation arise in their jurisdictions). The recommended actions and procedures may be utilized in both response and recovery phase. They are designed as guidelines for municipalities of all sizes with different government structures, administrative complexities, levels of planning, infrastructures, and resources. Rather than a constraining structure, the guidelines are intended to be more a source of information and motivation from which municipal engineers could depart to develop a plan suitable to their community, their government, and their own environment.

The criteria used to develop the guidelines are:

- Reduction of impacts on people, the environment, resources and local economies.

- Promotion of an organized and prompt response.

- Fast restoration to normalcy.
- Effective use of local resources already available, such as human, organizational, infrastructural, etc.
- Planning rather than reacting during the response.

This discussion paper is organized under the eight major headings outlined below. Each heading addresses specific questions that may arise during the development of the plan.

- Allocation of Responsibilities
  Impacts do not recognize jurisdictional boundaries. Planning to respond to impacts must involve the jurisdictions that are likely to be affected, and/or have resources in common.
- Policy Definition
  What policies would be needed to develop and organize support, to coordinate efforts, and protect human life, the environment and property?
- Human Factors
  How can a department's response be increased in terms of efficiency and staff protection?
- Debris Management
  How is debris to be collected, transported, and disposed of; how should hazardous waste be managed; what are the environmental implications related to debris management?
- Cost Reduction
  How can overall debris management expenditures be reduced?
- Administrative Procedures
  What administrative procedures can be developed to facilitate the management of contractors, the issuing of permits, the signing of contracts, the work of supervisors and coordinators, and the control of expenses with respect to audits and reimbursements?
- Data Organization
  What information is needed for prompt and efficient response; where is it; who should be contacted; what will happen if all the response information is lost during the disaster?

·. Post-Disaster Evaluation
How can lessons learned be recorded and shared to benefit other jurisdictions?

The guidelines presented in this discussion paper could be used in various ways:

·. As background information.

·. As a hand-out source for use in meetings; to focus planning efforts; to generate ideas on specific topics; for individual and collective brainstorming; and/or obtaining comments from experts, colleagues, other decision makers, staff, etc.

·. As a tool for evaluating existing plans.

·. As a checklist or information resource during response and recovery.

2. ALLOCATION OF RESPONSIBILITIES

During a disaster, complications related to multi-jurisdictional allocation of responsibilities **(Table 1)** arise, mainly due to the following causes:

I. Different levels of government: ownership, legal rights and provision of services fall under different levels of government.

·. Regional solid waste management: a centralized organism provides services to adjacent jurisdictions.

Area	**Regional Solid Waste Management Operation**
Agreements	There is no single corporate body, therefore all participants must agree each time a new issue arises.
Autonomy	Lack of autonomy in defining collection contractors, setting charges, and other decisions.

Compensation	Compensation may be inadequate for communities hosting facilities.
Decision making	Lack of presence of Board members to make decisions.
Finances	Might rely on special charges requiring approval.
Logistic response	Political issues may complicate the selection of transportation routes, temporary accumulation and disposal sites.
Power	Powers might be limited by Provincial statutes.

Table 1: Examples of Multi-jurisdictional Debris Management Complications

Issues related to the allocation of responsibility for debris management can be crucial in a disaster. Planned actions and agreements between all those involved are required to ensure a rapid and coordinated response. Various strategies may be used to reduce multi-jurisdictional problems. Examples include:

·.Transfer of functions whereby one level of government delegates to another level or jurisdiction.

·.Detailed negotiations to define all aspects involved in the allocation of responsibilities, such as:
- Levels of authority, e.g., statutory, decision making, over-riding;
- Identifying who is responsible for actions and payments;
- The circumstances under which responsibilities apply.

·.Formalized agreements through a contract or other mechanism to avoid later misunderstandings, e.g., financial assurance to host community.

·.Establish criteria to allocate responsibilities, such as:
- Debris type, e.g., special, hazardous, general.
- Property ownership, e.g., Federal, Provincial, Local, Aboriginal, private.

The strategies will ensure that processes are in place to address anticipated inter-jurisdictional issues, and more importantly, will ensure that understandings are in place to identify which agency and/or jurisdiction is responsible for key activities and related costs.

3. POLICY DEFINITION

3.1. External Participation

In the event of a major disaster, local government resources could be insufficient to rapidly mitigate the impact. The support received by different levels of government (federal, provincial, municipal, or local) could substantially accelerate the recovery within the disaster area. In the following pages, different levels of external participation are analysed.

3.1.1. Plan Development

External participation should be encouraged during the development of the plan. Some advantages of decentralizing the planning process are:

- The diversity of strategy innovation will increase, therefore enriching the plan.
- The plan will include points of view and experience based on local capabilities and limitations, and not on government expectations, thereby increasing the chances of successful coordination during a disaster.
- The process of planning is likely to promote the active cooperation of the participants during a disaster.
- During the planning process, important disaster information will be acquired by the participants. The cooperation will become goal oriented, and the information could be transmitted to other non-participants.

3.1.2. Disaster Preparedness Directory

A Disaster Preparedness Directory would be a useful tool for organizing information related to individuals and organizations that may be required for response. The directory should include all relevant data related to the potential service or support, including:

- Primary and alternative contact
- Addresses
- Telephone numbers
- Methods of communication
- Response criteria
- Type of agreement (verbal, contract, advanced payment)
- Type of resource available

3.1.3. Inter-Governmental Collaboration Plan

Adjacent municipalities usually play an important role in providing accelerated response assistance due to proximity, equipment, staff, resources and volunteers that can be available in a short period of time. The establishment of an intergovernmental debris management plan may facilitate and organize the flow of aid.

3.2. Access to Debris

Debris salvage may interfere with the overall debris clearance. Affected individuals may claim their right to recover their possessions, to retrieve documents and inventories, or to salvage building materials and appliances. Contractors may demand right-of-way and space for debris collection.

A planning strategy is required to provide a framework for all of those likely to be involved. An access-to-debris policy should specify procedures to:

- Prioritize and define management responsibilities, e.g., debris (including abandoned objects) becomes a City "donation" as soon as contractors pick it up .
- Prioritize debris access, e.g., owners first, contractors second, pickers third.
- Identify debris ownership, e.g., witnesses, identifications.

3.3. Public Information

It is important to include the media in the planning process in order to ensure processes are in place to facilitate the distribution of debris information during the disaster phase. There may be a need to post general information messages that provide the public with debris

clearance status, or health and safety information related to the debris (e.g. debris piles are unstable and may, if disturbed, fall causing injury.)

3.4. Management Policies and Clean-up Standards

The establishment of management policies and clean-up standards **(Table 2)** are required to:

- Guide actions by owners and contractors.
- Reduce the interference between private and public clean-up programs.
- Protect health and safety of crews and population.
- Protect wildlife.
- Protect the environment, e.g., assure resumption of debris disposal at proper sites.
- Accelerate recovery and resume normal activities.

Policy Goal	***Example***
Accelerate clearance	*Define a date to end private clean-up and debrisremoval, and dispose of debris without charges.*

	Free collection period, after which charges are made.
Meet demolition guidelines	*Maintain retaining walls and protect lot workers.* *Protect adjacent properties.* *Prevent disturbance of property.*
Meet regulatory guidelines	*Demolition permits.* *Health and safety standards for workers.* *Local, provincial, and federal environmental*
Protect the environment	*Apply anti-erosion measures.* *Minimize disturbance to wildlife.* *Wet debris before removal to minimize dust.*
Protect people	*Provide protective equipment to individuals hired to* *Wet debris to reduce dust aspiration.*
Reduce impacts due to hazardous materials	*Use hot-line to report asbestos and household chemicals.*
Traffic clearance	*Place containers off the right-of-way.*

Table 2: Examples of Disaster Debris Management and Clean-Up Standards Policies

4. HUMAN FACTORS

Successful debris removal depends on getting the right equipment and human resources into the affected areas of the disaster as quickly as possible. A timely response can only be achieved with proper coordination of effective human resources. In this chapter, ways to improve staff response and safety are presented.

4.1. Staff Protection

During a disaster, stress may rise to unmanageable levels, especially during the response stage when overwork, decision making and heavy responsibilities lead to an overwhelmed and tired staff. As well, proper nourishment and water provision may not be available on a regular basis. Being away from home may also aggravate the working situation. At this point, human errors increase and may create a negative feedback mechanism that delays response, increases the stress level and reduces effectiveness.

Managers must be flexible and promote rest periods as well as change performance expectations when visible signs of stress and fatigue such as repetitive mistakes, decreasing physical coordination, poor posture, and diminished responsiveness appear.

4.2. Health and Safety

Disaster debris management imposes a greater health and safety risk than in normal waste management situations. The main reasons include:

- Time constraints demand a faster work pace which can reduce risk awareness.

- A higher risk of dangerous materials mixed with the debris, e.g., nails, glass, sharp objects, asbestos dust, and chemicals.

4.3. Communications

Response timeliness is directly correlated to the speed at which information is available; information is also vital to coordinate response efforts **(Table 3)**.

Level of Communication Failure	**Examples**
Infrastructure damage	Commercial communication not available Cellular base stations impaired Computer systems down
Communication overload	Demand outstrips availability causing access
Modes of transmission and reception not compatible	Responders using different radio frequencies and computer programs Decoding systems not available
Unknown sources of information	Spontaneous radio transmissions without identification code.
Information media or presentation unfamiliar to staff	Geographic digital mapping Satellite communication and video
Information lost due to lack of systematic recording	Information regarding policies and practices not in place

Table 3: Examples of Communication Failure During Disasters

5. DEBRIS MANAGEMENT

Debris management deals with debris collection, transportion, and disposal. It must take into account the special treatment of hazardous waste, as well as the environmental implications related to debris management.

5.1. Types of Debris

Three types of debris are associated with a disaster:

- Debris generated *directly* by the disaster, e.g., rubble, roofing, insulation.
- Debris generated *indirectly* by the disaster, e.g., spoiled food due to power failure or excessive donations.
- Debris generated by *abnormal patterns of life*, e.g., greatly increased consumption of bottled water and canned food.

To facilitate decision making concerning debris collection and disposal priorities, it is important to classify and group debris into categories.

The criteria used to establish debris categories will depend on local variables, for example:
- Amount of debris generated.
- Type of region, e.g., urban, rural, coastal.
- Land use, e.g., agricultural, residential, industrial.
- Types of wastes, e.g., non-hazardous, special.
- Recycling infrastructure and programs.

Examples of debris that might be generated by a disaster include the following:

A. Debris Subject to Putrefaction
- Animal corpses: Cattle, pets and wild animals
- Food remnants: Meal leftovers or food spoiled as a result of power failure

B. Vegetation
- Leaves
- Branches
- Uprooted shrubs and trees

C. Inert Environmental Debris
- Dirt
- Mud
- Rocks
- Sand

D. Construction Debris
- Acrylic

- Asphalt
- Blinds
- Brick
- Carpet
- Concrete
- Drywall
- Electrical wires, lamps, bulbs
- Glass and mirror
- Insulation materials (fibreglass, Styrofoam, etc.)
- Masonry
- Metals (steel, iron, aluminum, copper, brass, etc.):
- Tiles
- Pipes
- Plastic
- Rubble
- Vinyl
- Wood

E. Appliances, Household Equipment and Furniture.

- Beds and mattresses
- Upholstered furniture
- Computer equipment, telephones, typewriters
- Desks, chairs, chests
- Lamps
- Sofas
- Washing and drying machines, refrigerators, dishwashers, stoves, hot water tanks, furnaces

F. Personal Items and Objects

- Art work
- Books and papers
- Clothing
- Cooking utensils, china, glassware

G. Hazardous Wastes

- Asbestos
- Biomedical wastes

- Cleaning agents
- Combustibles
- Explosives
- Fertilizers
- Oils
- Paints
- Pesticides
- Radioactive substances
- Solvents
- Other toxic substances or materials

5.1.1. Debris and Risk Estimate

Reasonable estimates of the amount of debris by type will improve the overall clearance efficiency, for example:

- Define resource needs
- Adequate resource allocation
- Evaluate disposal capacity of existing sites
- Estimate hauling time

The level and variety of methods and technologies required to estimate the amount of debris generated will depend on the type, magnitude and extent of the disaster, for example:

- Visual Inspection:
  - Aquatic
  - Terrestrial: vehicular and pedestrian
  - Aerial: aircraft and helicopters

- Photography:
  - Common
  - Aerial: aircraft and helicopters with photo/video capability
  - Satellite

Debris estimation should be presented in easily understood terms, e.g., “150 tons”, or “a pile 100 x 200 x 10 m”, instead of subjective assessments such as “a lot of rubble”. Risk

evaluations should also define priorities, e.g., hazardous materials will be collected first, organic and perishable wastes second, and rubble third.

5.2. Collection

The identification of a debris collection method will depend on the following criteria:

- Amount of debris generated
- Type of debris
- Urgency of site clearance
- Disaster site characteristics
- Debris recycling possibilities
- Geographic complications

Debris collection tools and equipment are mainly for collecting, segmenting, and lifting. The same equipment is used by the construction and heavy duty industry, e.g., bulldozers, front-end loaders, cables, cranes, cutting torches, hand tools (shovels, picks, hammers, handcarts, etc.), mechanical shovels, saws, and vacuum equipment. Debris collection equipment should also include protective clothing and equipment for workers.

5.3. Transportation

The efficiency of debris transportation will depend on the hauling time, i.e., time expended to travel between the debris clearance areas and the disposal sites.

Some strategies to increase the transportation efficiency include:

- First consolidate a transportation network, and then clear whole sectors. Transportation corridors progress from primary routes to secondary feeder roads to residential streets.

- Establish a transportation network with well-defined uses. Classify roads according to their:
    a. Use (general public, debris transportation)
    b. Vehicle Speed (emergency vehicles)

c. Destination Linkage (highways, disposal sites)

- Contractors are assigned to sectors. Sectors are prioritized so that access to essential service buildings are cleared first.

- Purchasing departments establish prior claim on contractors through 'Letters of Agreement'. Procedures and practices developed in advance to ensure speedy procurement of services.

- Vehicles used in the transportation of debris (government, contractors and others) could be identified by an easily identifiable permit to ensure unimpeded access to disaster areas.

- Debris is accumulated at temporary accumulation sites. (Please refer to section: 5.4)

- Debris volume is reduced before hauling.

- Multiple disposal sites are established. (Please refer to section 5.4. and 5.5).

- Volunteers and the general public are separated from contractors at disposal sites.

- Access to disposal sites is restricted and controlled.

- Small vehicles may be needed where access is limited.

- Maps showing designated zones, contractors, debris concentration points and other relevant information are published through the media ('recovery information' newsletter).

5.4. Temporary Accumulation

In a disaster situation the establishment of temporary debris accumulation sites may be required. This could be due to significant problems such as: disposal site congestion; excessive queuing at permanent disposal sites, and insufficient collection and/or transportation equipment.

The use of temporary accumulation sites substantially increases the overall debris clearance

costs, since debris is essentially managed twice, i.e., from the generation point to the temporary accumulation site, and from there to final disposal. Strategies to reduce the costs might involve the location of temporary accumulation sites:

- On or near primary roads, with in-out access, maneuvering space, and where obstructions are not likely to occur.
- In areas not affecting other response activities, e.g., avoid garbage near temporary accommodation.
- In places not to be used by any other disaster response component, such as tent shelters, ambulatory hospital, etc.

5.5. Disposal

Debris disposal could be one of the major challenges of the overall debris management during a disaster, not only because the volumes generated could be overwhelming, but also due to potential hazards to the environment. In major disasters total clearance may take months or years.

Some strategies that could be used when faced with debris disposal problems include:

·. Increase number of disposal sites, e.g., gullies, natural or artificial cavities, etc.
·. Increase disposal methods, e.g., incineration, composting, etc.
·. Reduce debris volume, e.g., grinding, chipping, crushing, granulating, mulching, etc.

5.6. Hazardous Wastes

Hazardous substances may be released in an area affected by a disaster. Examples are retail supplies of fuels, pesticides, paints and solvents, cleaning materials and dry cleaning solvents found in almost every jurisdiction. PCBs and bio-medical wastes are also very common. College and university science and engineering labs, and similar labs in secondary schools, have a variety of dangerous materials that may be released or spilled in a disaster. Most localities also have rail and road transport routes which may at any given time have dangerous goods in transit. As well, in many jurisdictions there are specialized industrial or terminal facilities that store and handle some significant amounts of dangerous goods.

Managing hazardous wastes requires prompt action in identifying:

- Sources of hazardous substances
- Potential risks
- Isolation measures
- Handling and disposal requirements

Hazardous wastes are not usually managed by local governments but by hazardous waste management corporations. However, definition of roles, coordinated actions, and responsibilities should be clarified prior to a disaster.

5.7. Environmental Concerns

While environmental issues should be a concern of debris managers, planning should pay consideration to the extent to which normal environmental codes, practices, and regulations may be relaxed during a disaster to facilitate the removal of debris. Health and safety should be paramount where any flexibility of regulations is exercised.

5.8. Evaluation

Estimating the amount of debris that will be generated by a disaster is a very complex task since a great number of variables must be taken into consideration. The appraisal range could vary from a very small amount of debris to thousands of tons: a range of uncertainty that makes such estimates of very limited use for planning. The only planning that can be done in this matter, is to estimate in advance the actual availability of the municipalities personnel and emergency debris management capability. These, together with an assessment of the amount of debris generated during the disaster, will allow municipalities to estimate:

- External support required
- Expected removal time
- Working schedule
- Costs

6. COSTS REDUCTION

The amount of economic resources invested as a consequence of a disaster is often immense. Costs involved may include hiring external contractors, paying overtime, collecting, hauling and disposing of large amounts of wastes, etc. Disasters may even disrupt the financial stability of local government. For this reason, the prospect of reducing the overall expenditure becomes an important issue. Ways to facilitate this process are presented in this section.

6.1. Reduce Transportation Costs

The transportation of disaster debris will account for a great percentage of the entire debris management costs; developing strategies for this area can result in significant savings. Transportation cost reductions may be achieved at different levels, these include:

Contractor Level

During a disaster the demand for transportation services will increase; as a consequence, service costs may rise to inconceivable levels. Costs may be reduced by negotiating in advance with local waste management, demolition and hauler contractors. Cooperation agreements could be signed based on bids, fixed prices, shares, payments in advance for future services.

Processor or Marketer Level

Recyclers, manufacturers and marketing dealers interested in debris by-products could carry out the collection and transportation of certain types of debris, thus diminishing the amount of debris to be transported by the local government.

6.2. Re-use and Recycling

A decrease in disaster debris management costs could be achieved by increasing re-use and recycling efforts. Re-use and recycling are already becoming a priority for many governments as a tool to address the rising costs and environmental impact of waste disposal. Re-use and recycling are very complex issues and cannot be relied on as the sole means of addressing a disaster debris problem; however, they can reduce adverse impacts by diverting significant portions of debris away from more expensive disposal options.

6.2.1. Viability and Feasibility

The viability of diverting disaster debris for its re-use or recycling will depend on:

- Existence of established local debris processors and infrastructure.
- Existing recycling programs and reduction strategies.
- Distance between the disaster area and debris processors and/or infrastructure.
- Market demand for debris by-products.
- Debris by-product quality (depends upon demolition technology and handling).
- Local re-use and recycling policies (especially those concerned with material specifications).
- Sorting facilities or separated collection and transportation. Separation at source is required in order to obtain materials in their cleanest form, prevent contamination and improve end quality.

Factor	**Effect**
Administrative measures:	Free or low-cost debris disposal may not encourage separation
Communication failure:	Lack information network for advertising availability of materials
Environmental conditions:	Debris may be damaged by the elements and be unsuitable for re-use or recycling
Political Considerations:	Factors that call for fast debris clearance
Quality of debris:	Lack of demolition experts and technology
Sanitation policies:	Debris covered with lime or earth to reduce epidemic risks
Social and cultural barriers:	Reusing materials from locations where people died
Urgency of site clearance:	No time for slow salvage due to rescue of buried victims

Table 4: Factors influencing the feasibility of re-use and recycling in disaster debris management.

6.3. Savings on Future Expenditures

Savings on future expenditures could be achieved by identifying areas within the jurisdiction where debris could be used as a substitute for other materials. Some examples are:

- Using rubble as a sanitary landfill cover or to reinforce embankments.
- Using debris for land reclamation.
- Using organic materials to make compost for nurseries, or, wood chipping for soil cover and erosion protection in public parks.

7. ADMINISTRATIVE PROCEDURES

Administrative procedures have to be developed to facilitate the management of contractors, the issuing of permits, the signing of contracts, the work of supervisors and coordinators, and the control of expenses with respect to audits and reimbursements.

7.1. Contractors

The main problems associated with hiring contractors during a disaster include:

- Reduced contractor availability due to increased services demands.
- Undefined work load due to debris amounts based on estimates.
- Incapability of assessing contractors' previous experience, i.e. choosing the right contractor to do the job.
- Lengthy and bureaucratic administrative procedures at a time when prompt action is required.

Contractors work should be defined, coordinated, supervised, administered, inspected and reviewed.

7.2. Permits and Contracts

Issuing permits and establishing contracts promptly are important aspects of accelerating the recovery process. Procedures should be simple and expeditious in order to start large-scale debris removal as soon as possible.

Permits and contracts are required to:
- Control debris management, e.g., collection, transport, disposal.
- Direct actions based on priorities.
- Reduce the interference between private clean-up and municipal programs.
- Protect property.

Permits and contracts could be issued to different recipients, for example:
- Builders
- Contractors
- General public
- Manufacturers
- Recyclers

7.3. Supervision and Coordination

Organized supervision and coordination are required to control and evaluate response during a disaster, especially since unpredictable events are likely to occur. Both supervisors and coordinators should be qualified in debris estimation, logistics, and strategic management.

7.4. Expenditure Control

Before a disaster strikes, planning is required to establish a strategy for controlling expenses. Expenditures such as overtime, equipment acquisition, supplies and materials, should be controlled and tracked immediately after the disaster.

8. DATA ORGANIZATION

Obviously, government buildings are also subject to damage during disasters, resulting in lack of access and/or destroyed documents. A debris management delay could slow the activities of other disaster responders (police, fire, ambulance). Therefore, it is crucial that backup copies of debris response plans, documents, and procedures be stored off-site.

9. POST-DISASTER EVALUATION

Disaster debris management is a relatively new concern for municipalities, especially in Canada. Therefore, useful data is very scarce and it is only possible to gain a partial sense of what might occur by reviewing past disasters. Post-disaster debris management evaluations could provide an important source of feedback for debris managers. Better reporting of disaster debris management experience will promote better preparedness planning, thus facilitating faster and less costly response and recovery operations during future disasters.

Evaluations should include:

- Problems associated with debris management.
- Ways in which problems were addressed.
- Elements of successful outcomes.
- Specific strategies recommended to reproduce successful outcomes.

FURTHER READING