Environmental Protocols

Demand Management

This document is the third in a series of best practices that focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. For titles of other best practices in this and other series, please refer to ***<www.infraguide.ca>.***

National Guide to Sustainable Municipal Infrastructure

NRC·CNRC Federation of Canadian Municipalities Canada

Demand Management

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InfraGuide® – Innovations and Best Practices

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Canadian municipalities spend $12 to $15 billion annually on infrastructure but it never seems to be enough. Existing infrastructure is ageing while demand grows for more and better roads, and improved water and sewer systems responding both to higher standards of safety, health and environmental protection as well as population growth. The solution is to change the way we plan, design and manage infrastructure. Only by doing so can municipalities meet new demands within a fiscally responsible and environmentally sustainable framework, while preserving our quality of life.

This is what the *National Guide to Sustainable Municipal Infrastructure (InfraGuide®)* seeks to accomplish.

In 2001, the federal government, through its Infrastructure Canada Program (IC) and the National Research Council (NRC), joined forces with the Federation of Canadian Municipalities (FCM) to create the National Guide to Sustainable Municipal Infrastructure (InfraGuide®). InfraGuide® is both a new, national network of people and a growing collection of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research, the reports set out the best practices to support sustainable municipal infrastructure decisions and actions in six key areas: decision making and investment planning, potable water, storm and wastewater, municipal roads and sidewalks, environmental protocols, and transit. The best practices are available on-line and in hard copy.

A Knowledge Network of Excellence

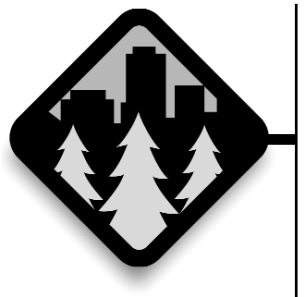
InfraGuide®´s creation is made possible through $12.5 million from Infrastructure Canada, in-kind contributions from various facets of the industry, technical resources, the collaborative effort of municipal practitioners, researchers and other experts, and a host of volunteers throughout the country. By gathering and synthesizing the best Canadian experience and knowledge, InfraGuide® helps municipalities get the maximum return on every dollar they spend on infrastructure — while being mindful of the social and environmental implications of their decisions.

Volunteer technical committees and working groups — with the assistance of consultants and other stakeholders — are responsible for the research and publication of the best practices. This is a system of shared knowledge, shared responsibility and shared benefits. We urge you to become a part of the InfraGuide® Network of Excellence. Whether you are a municipal plant operator, a planner or a municipal councillor, your input is critical to the quality of our work.

Please join us.

Contact InfraGuide® toll-free at **1-866-330-3350** or visit our Web site at <***www.infraguide.ca***> for more information. We look forward to working with you.

The InfraGuide® Best Practices Focus



Environmental Protocols

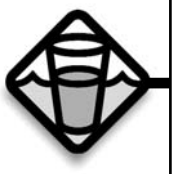
Municipal infrastructure decisions, particularly those related to potable water, municipal roads, and storm and wastewater can have a significant impact on the natural environment. Environmental protocols focus on the interaction of natural systems and their effects on human quality of life in relation to municipal infrastructure delivery. Environmental elements and systems include land (including flora), water, air (including noise and light) and soil. Example practices include how to factor in environmental considerations in establishing the desired level of municipal infrastructure service; and definition of local environmental conditions, challenges and opportunities with respect to municipal infrastructure.

Decision Making and Investment Planning

Elected officials and senior municipal administrators need a framework for articulating the value of infrastructure planning and maintenance, while balancing social, environmental and economic factors. Decision-making and investment planning best practices transform complex and technical material into non-technical principles and guidelines for decision making, and facilitate the realization of adequate funding over the life cycle of the infrastructure. Examples include protocols for determining costs and benefits associated with desired levels of service; and strategic benchmarks, indicators or reference points for investment policy and planning decisions.

Municipal Roads and Sidewalks

Sound decision making and preventive maintenance are essential to managing municipal pavement infrastructure cost effectively. Municipal roads and sidewalks best practices address two priorities: front-end planning and decision making to identify and manage pavement infrastructures as a component of the infrastructure system; and a preventive approach to slow the deterioration of existing roadways. Example topics include timely preventative maintenance of municipal roads; construction and rehabilitation of utility boxes; and progressive improvement of asphalt and concrete pavement repair practices.



Potable Water

Potable water best practices address various approaches to enhance a municipality's or water utility's ability to manage drinking water delivery in a way that ensures public health and safety at best value and on a sustainable basis. Issues such as water accountability, water use and loss, deterioration and inspection of distribution systems, renewal planning and technologies for rehabilitation of potable water systems and water quality in the distribution systems are examined.

Transit

Urbanization places pressure on an eroding, ageing infrastructure, and raises concerns about declining air and water quality. Transit systems contribute to reducing traffic gridlock and improving road safety. Transit best practices address the need to improve supply, influence demand and make operational improvements with the least environmental impact, while meeting social and business needs.

Storm and Wastewater

Ageing buried infrastructure, diminishing financial resources, stricter legislation for effluents, increasing public awareness of environmental impacts due to wastewater and contaminated stormwater are challenges that municipalities have to deal with. Storm and wastewater best practices deal with buried linear infrastructure as well as end of pipe treatment and management issues. Examples include ways to control and reduce inflow and infiltration; how to secure relevant and consistent data sets; how to inspect and assess condition and performance of collections systems; treatment plant optimization; and management of biosolids.

TABLE OF CONTENTS

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EXECUTIVE SUMMARY

This document describes the best practice for developing a Demand Management strategy. It is based on a literature review, surveys of selected municipalities across Canada, and input from Demand Management experts.

Demand management (DM) is a key tool for sustainable community development. Economic, environmental, and social pressures have necessitated a re-evaluation of community demands, service needs, and infrastructure assets. To provide sustainable municipal infrastructure services, the demands of the community must match the service capabilities of the municipality. These capabilities are determined by the environmental, economic, and social characteristics of the community itself, as well as by national and international factors (such as Canada's commitment to reduce greenhouse gas emissions). Thus, DM is essential for the sustainability of municipal infrastructure services.

Demand management is the active promotion of behaviours and alternatives designed to harmonize community demands for resources and infrastructure services with the municipality's capacity to deliver these services in a sustainable manner to:

- live today with future generations in mind;
- reduce environmental degradation, such as water and air pollution, climate change, and biodiversity decline;
- preserve or enhance the quality of life in the community, including public health and safety;
- maximize service from existing infrastructure and enhance its service life;
- minimize the need for new infrastructure; and
- maintain or increase affordability of, and access to, services.

Demand management programs influence the amount, composition, or timing of demand for a commodity or service through the use of a collection of tools and approaches. Over the long term, a desired effect of DM is to inspire a cultural shift to create greater appreciation of the costs and implications of consuming a commodity, or accessing a service or resource. Such a cultural shift can result in demand reductions, reduced environmental impacts, deferred or reduced capital expenditures, design innovations, market changes, and new opportunities and partnerships.

This best practice provides senior municipal officials with guidance on the concepts behind DM, current best practices, and information needs and tools for initiating and implementing DM programs.

Rationale

Supply of a service tends to foster increased demand for the service, because new expectations arise for similar improvements elsewhere. Demand is not a fixed quantity since it involves humans and is, therefore, influenced by perceptions of equity, affordability, suitability, availability, convenience, safety, benefits, and impacts. Increased knowledge can change these perceptions and expectations.

Demand for services has historically led to the creation of assets to meet the demand. Demand management challenges this approach by looking for alternate ways to meet the underlying need and manage demand to match available services or resources. It challenges the service-asset relationship: Can the underlying needs and desires of the community be met in a way that does not require new or expanded infrastructure assets? It also challenges the expectations and perceptions of the public and businesses regarding the value and appropriate use of services. Demand management challenges the public to value a service in a new way.

Demand management programs influence the amount, composition, or timing of demand for a commodity or service through the use of a collection of tools and approaches.

Benefits and Challenges

The benefits of DM accrue to the infrastructure service directly through improved infrastructure affordability. In addition, benefits accrue to the community more broadly through improved quality of life. The primary benefit is that DM enables sustainable community development. The risks of not undertaking DM are the persistence of unrealistic public expectations, unaffordable levels of service, continued environmental degradation, and increasing social costs.

A key ingredient is the long-term commitment and leadership of senior decision makers who understand the essential nature of DM.

Many of the challenges of undertaking DM pertain to management of DM by a municipal organization. There must be a long-term commitment to DM that is reflected through realistic, yet challenging, targets and that can be evaluated with the numerous benefits in mind. Public acceptance is another challenge. Mitigation of the challenges requires senior leadership, consistent and open communication with the public and stakeholders, and a program designed to offer options and flexibility suitable to the community.

Framework for Demand Management

A DM strategy, as outlined in this best practice, includes:

- policy and planning;
- technical practices;
- corporate capacity; and
- implementation and evaluation.

A key ingredient is the long-term commitment and leadership of senior decision makers who understand the essential nature of DM. They must initiate, enable, and plan; DM must become entrenched in the policy and planning documents of communities.

Current practices can be grouped into seven types of technical practices (refer to Table 3–5 in the body of the report), each with its strengths and weaknesses. Emerging practices that will broaden the scope and effectiveness of DM include integrated resource planning, greater consideration for substitutions of municipal services and the interrelationships between services provided, and the application of broader criteria to assess the cost benefits of DM, including factors such as health improvements, environmental quality and climate change mitigation.

Many leading municipalities started their DM programs with little corporate or community support, but, using the practices outlined in this document, they are now experiencing the benefits of DM. Senior decision makers must ensure that resources and processes are in place to plan and implement the DM program successfully.

Implementation and evaluation of DM programs for infrastructure services require common practices of good management and some specific considerations to ensure good communication with partners, an inclusive communications plan and close communication with political champions. Pilot programs and program phasing can be effective implementation measures to build DM momentum. Evaluation of DM is most effectively initiated in the planning stage, with identification of targets and their associated performance indicators, and gathering baseline information before DM is implemented.

Significant shifts in the public perception of consumption and resource use can be anticipated as the impacts and costs of local and global environment and health issues continue to be felt, or even accelerate, such as poor air quality and climate change. Municipalities that undertake DM as a proactive strategy, will be better positioned to accommodate the inevitable changes in public opinion and public demand for more efficient practices and reduced resource use to mitigate negative public health and environmental impacts.

1. General

1.1 Introduction

The need to manage demand for infrastructure has arisen, partly due to the high quality of service provided by municipalities. Businesses, private citizens, and non-government organizations have come to expect progressive improvement and expansion of the services provided. The benefits of infrastructure use are expected, even taken for granted. Quick commute times, abundant drinking water for all applications, and efficient land drainage during any storm, are just a few examples. With the provision of improvements to municipal services, new expectations arise and new needs are identified.

Many pressures have necessitated a re-evaluation of community demands, service needs and infrastructure assets. The nature of these pressures varies from one community to another, but generally includes:

- economic pressures, such as budget constraints or the need for capital investments (e.g., wider roads or increased water purification capacity);
- environmental constraints, such as water supply limitations, river and lake ecosystem degradation, air quality concerns, toxics releases, loss of greenspace, or the threat of climate change;
- social pressures, such as population growth, community resistance to construction or location of infrastructure, time lost to traffic congestion, noise complaints, community values for quality of life and environment; and
- targets and requirements from other governmental or international agencies, including the Kyoto Protocol commitments, U.S.–Canada bilateral air quality agreements, the *Canadian Environmental Protection Act* (CEPA), and the *Fisheries Act.*

To provide sustainable municipal infrastructure services, demands need to match the service capabilities of the municipality. Service capabilities are determined by the environmental, economic, and social characteristics of the community itself, as well as by national and international factors. Without an alignment of demand with service capability, the negative social and environmental impacts continue or increase, and public satisfaction with the municipal service declines, while affordability and access to services are jeopardized. Thus, demand management (DM) is essential for the sustainability of municipal infrastructure services and, therefore, for sustainable communities.

To provide sustainable municipal infrastructure services, demands need to match the service capabilities of the municipality.

1.2 Definition

Demand management is the active promotion of behaviour and alternatives designed to harmonize community demands for resources and infrastructure services with the municipality's capacity to deliver services in a sustainable manner to:

- live today with future generations in mind;
- reduce environmental degradation, such as water and air pollution, climate change, and biodiversity decline;
- preserve or enhance the quality of life in the community, including public health and safety;
- maximize service from existing infrastructure;
- minimize the need for new infrastructure; and
- maintain or increase affordability of, and access to, services.

Over the long term, the goal is to inspire a cultural shift to create a greater appreciation of the costs and implications of consuming a commodity, or accessing a service or resource.

To be successful, senior leadership of the municipal corporation must support and implement DM with a long-term commitment to the approach.

Demand management programs influence the amount, composition, and timing of demand for a commodity or service through the use of a collection of tools and approaches. Over the long term, the goal is to inspire a cultural shift to create a greater appreciation of the costs and implications of consuming a commodity, or accessing a service or resource. Such a cultural shift can result in demand reductions, reduced environmental impacts, deferred or reduced capital expenditures, design innovations, market changes, new opportunities and partnerships.

1.3 Purpose and Scope

This best practice explains DM as an essential strategy for municipal infrastructure management. It provides senior municipal officials with guidance on the concepts behind DM, current best practices, and information needs and tools for initiating and implementing DM programs.

This document is written for generic application to any type of municipal infrastructure, including transportation, water, wastewater, and storm water services. The scope is broad since the specific needs and conditions of each municipality vary. Also, the concepts of DM are common to all services of interest and, therefore, senior municipal decision makers can apply them at multiple levels to the planning and operational functions of the municipality.

The emphasis is on managing demand through promotion of behavioural changes and alternatives for residents and businesses. However, it is also important to include other aspects of infrastructure use and capacity loss to match demand to capacity in the most efficient manner. Specifically, holistic infrastructure management also requires analysis and management of capacity loss resulting from supply-side conditions (see Table 1–1). Integrated resource planning, which balances demand-side and supply-side measures, is an emerging approach for municipal infrastructure (see Appendix A).

Table 1–1: Influence of Supply-Side Management on Service Capacity

Supply-side conditions that affect capacity result from infrastructure design, operation and management. Examples of capacity loss due to supply-side conditions include:

- water losses in a distribution system due to water main leaks;
- infiltration of groundwater into a sewer system due to cracks;
- rough road surface conditions due to the lack of resurfacing; and
- reducing traffic capacity due to the snow-clearing policy during severe winter weather events.

(Best practices are available on many supply-side topics of relevance to demand management at *<www.infraguide.ca>*.)

To be successful, senior leadership of the municipal corporation must support and implement DM with a long-term commitment to the approach. This requires good management practices applied to planning, implementing, evaluating, and adjusting DM programs. The municipalities should ensure that the goals for DM and resource use efficiency support broader community goals for sustainability and quality of life. They should also use DM programs to learn and improve continuously.

1.4 How to Use This Document

This best practice introduces InfraGuide® and DM, with guidance and examples for successful DM strategies. Sections 2 and 3 provide the "what, why, and how" of DM for transportation, water, wastewater and storm water infrastructure. The information provided is also applicable to solid waste services, and many of the techniques discussed have already been successfully applied to reduce solid waste in Canadian municipalities.

Section 1 provides an introduction to the best practice, a definition of DM and the scope of the best practice. It can be used as a quick reference for DM.

Section 2 provides an overview of why it is important for municipalities to establish DM strategies for municipal infrastructure. Municipal decision makers can draw on this section to develop an understanding of their own municipality's need for the practice, including the benefits and challenges of undertaking a DM strategy.

Section 3 outlines a framework for DM in municipalities, including policy and planning development, technical practices, corporate capacity, implementation, and evaluation. Section 3 can be used to guide the establishment or enhancement of DM strategies for a range of infrastructure services, or as a unified approach to all infrastructure services.

Section 4 provides case studies of three infrastructure DM programs in three unidentified Canadian municipalities. The targets and successful application of DM strategies serve as examples of the successes achieved by the municipalities and validate the essential nature of DM strategies for sustainable communities.

Section 5 provides a summary of the DM framework and key success factors.

Appendix A includes an expanded definition of integrated resource planning, while **Appendix B** outlines the water conservation guidelines developed by the U.S. Environmental Protection Agency. Although the guidelines were written specifically for potable water DM programs, the sequence of steps is more broadly applicable to all municipal infrastructure services.

A list of **references** is provided at the end of this document.

1.5 Glossary

3Rs — The 3Rs, in order of preference, are reduce, reuse, and recycle. The term is used in solid waste management and refers to use/consumption of materials.

Base use or consumption — Base use/consumption is the demand for a service that is present continuously during a given time period.

Capital costs — Typically, the costs applying to the purchase, construction, or significant rehabilitation of physical assets of an organization. Capital costs for fixed assets are also referred to as "one-off" costs. Capital costs for projects typically span more than one fiscal year.

Climate change — Climate includes temperature, atmospheric pressure, precipitation, wind, humidity, and sunshine (Kemp, 1998). Climate change is "attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UN FCCC in Kemp). For information see the International Panel on Climate Change (IPCC). Web site <www.ipcc.ch>.

Demand — Demand includes needs, wants, expectations, and aspirations of individuals, businesses, and organizations. Demand is not a fixed quantity and is influenced by perceptions of equity, affordability, suitability, availability, convenience, safety, benefits, and impacts.

Demand management — The active promotion of behaviours and alternatives designed to harmonize community demands for resources and infrastructure services with the municipality's capacity to deliver services in a sustainable manner.

Eco-industrial parks — Industrial parks designed to turn waste flows from one facility within the park into resource flows for a receiving facility located nearby (i.e., in the park).

Greenhouse gases — A group of 20 gases, including carbon dioxide, that are responsible for the greenhouse effect through their ability to absorb long-wave terrestrial radiation (heat).

Integrated resource planning — An approach to planning utility or other services through both demand-side management and supply-side management techniques in balance to develop least-cost plans and accomplish specified social and environmental goals (see Appendix A).

Leading or successful municipalities — The term is used in examples throughout this document. Leading municipalities come in all sizes—small, medium, and large—with a variety of issues, approaches, and goals for their infrastructure DM programs. The term is intended to apply to any municipality demonstrating best practices.

Municipality — A legally incorporated or duly authorized association of inhabitants of limited area for local governmental or other public purposes.

Operating costs (variable and fixed) — The day-to-day expenses incurred in running a facility, such as staff and administration; also termed operating expenses. Variable operating costs are incurred on the basis of units produced/treated (e.g., energy, chemicals), whereas fixed operating costs are incurred with or without production of a product or use of a service.

Peak use — Demand during the highest demand period for a given time period.

Social marketing — Social marketing strives to create conditions in the social structure that facilitate the behavioural changes promoted through marketing concepts. Social marketing involves increasing the public knowledge and appreciation for a service while simultaneously providing incentives or motivation to use alternatives.

Supply and supply-side management measures — Activities conducted by a municipal service to expand supply or to alter supply approaches to meet demand in the municipality. For example, water metering and high-occupancy vehicle lanes are supply-side measures. The meters manage water demand while the high-occupancy lanes improve the efficiency of road network use.

Sustainability — Conditions that meet current needs without compromising the needs of future generations. Sustainability considers environmental, social, and economic factors together. The terms sustainability and sustainable development can have varying interpretations, depending on perceptions, values, priorities, and perspectives of individuals and organizations.

Telework — Working from a location other than the work site (e.g., from home) through the use of technology, including Internet connections or cell phones. One advantage of telework is that transportation demand can decrease since fewer commuters are using the infrastructure. Another advantage is increased employee satisfaction through more flexible work arrangements.

2. Rationale

2.1 Background

Demand management is essential for comprehensive infrastructure management. In the past, it was perceived as an option that provided fringe benefits and good public relations. Now, most municipalities understand the essential nature of DM. Having invested in comprehensive DM programs, they now realize the returns and benefits for infrastructure management. (See the case studies outlined in Section 4 for examples of three such programs.)

2.1.1 Breaking the Demand-Service-Asset Spiral

To appreciate why DM is essential, decision makers need to understand the nature of public demands for infrastructure services, and the relationship of these demands with municipal services and capital assets. Supply of a service tends to foster increased demand for the service, because new expectations arise within the serviced area as well as the broader community for similar improvements elsewhere. A newly paved road surface, for example, attracts users due to a higher standard of service, and creates expectations for resurfacing of similar or adjacent roads.

Demand includes needs, wants, expectations, and aspirations of individuals, businesses, and organizations. In this best practice, "demand" includes all of these types of demand. Demand is not a fixed quantity; it involves humans and is, therefore, influenced by perceptions of equity, affordability, suitability, availability, convenience, safety, benefits, and impacts. The perceptions and expectations of individuals can change with increased knowledge of costs, impacts, benefits, or alternatives.

Demand for services has historically led to the creation of assets to meet the demand. Demand management challenges this approach by looking for alternate ways to meet the underlying need and manage demand to match available services or resources. Needs are examined to determine if they can be met in ways other than through infrastructure assets. In other words, the service needs are distinct from the asset used to deliver the service. For example, access to community services and employment does not need to be provided exclusively by transportation infrastructure; the Internet also provides access to banking, shopping, and employer intranets. Similarly, the desire for an attractive yard does not need to rely on the potable water service if water-resistant plants and rain barrels are used.

Demand management challenges the service-asset relationship.

Can the underlying needs and desires of the community be met in a way that does not require new or expanded infrastructure assets? Demand management also challenges the expectations and perceptions of the public and businesses regarding the value of services and the appropriate use of services. Changing expectations and perceptions of a service or asset can change behaviour, because the service becomes more highly valued.

Demand management challenges the public to value a service in a new way.

What are the social, environmental, and economic costs of using the service? Public behaviour can change with a change in knowledge, coupled with a community capacity to provide alternatives. The municipality, the private sector, or other organizations can provide alternatives.

Demand for services has historically led to the creation of assets to meet the demand. Demand management challenges this approach by looking for alternate ways to meet the underlying need and manage demand to match available services or resources.

More contemporary and emerging approaches to education and outreach for municipal services involve increasing the public's knowledge and appreciation for a service while providing incentives to use alternatives. For example, a municipality with a need to reduce traffic congestion and smog may launch an information campaign on air quality and transit use and, at the same time, provide discounts for transit passes provided by local employers to employees through payroll deduction. Thus, the employees become aware of the social and environmental costs of vehicle use (lost time and air pollution), while receiving an incentive to use alternative transportation services and encouragement at their workplace to use the alternative.

2.1.2 Scope and Power of Demand Management Approaches

The scope of potential DM approaches is broad, encompassing individual behaviours through to the community design. A comprehensive DM program creates opportunities within all levels of the hierarchy to change the nature of demand. The hierarchy has four nested levels as shown in Table 2–1.

Table 2–1: Scope and Power of Demand Management Approaches

Increasing Time for Results ↓		Increasing Magnitude of Effect ↓
	Individuals: Individual choices of people and businesses are influenced by knowledge, perceptions, attitude, values, incentives/disincentives, and access to alternatives. Together, these individual choices create the culture of demand in the community. However, even individuals eager to reduce reliance on, or use of, municipal infrastructure services are constrained by conditions resulting from building/infrastructure/community design, because these determine the alternatives available.	
	Buildings and Technologies: The need for municipal services to and from buildings depends on location (e.g., proximity to transit services), external characteristics (landscaping, parking area, roof design), and internal characteristics (type and number of plumbing fixtures, industrial processes and appliances using water and discharging wastewater). Vehicle technologies also fall within this level, including innovative mass transit systems.	
	Infrastructure: The design of infrastructure, standards, range of services offered, operation and maintenance practices, and condition influences land use and, therefore, sets the direction for building location and individual choices in use of infrastructure services.	
	Community Design and Municipal Policies: Planning and policies for land use have a fundamental influence on demand for municipal services since they shape the community itself. Urban sprawl versus compact urban boundaries, for example, determine the physical extent of the transportation, water, wastewater and stormwater infrastructure required. Reducing the need for traditional infrastructure asset expansion is contingent, ultimately, on the development of solid community official plans that optimize the use of existing infrastructure through land use policies and regulations. Municipal pricing policies and legislation are also key tools available to the municipalities to complement planning measures. Individuals in the community influence planning decisions through the culture of demand within the community.	

The time scale for changing each level within the hierarchy is long, since it involves cultural shifts in the community as well as a slow, physical evolution of the building stock, infrastructure, and community shape. As indicated by the arrow in Table 2–1, the time needed to see results increases with each level. The potential magnitude and permanence of effect can increase with actions at higher positions in the hierarchy. However, it is important to include all levels of the hierarchy in a DM strategy, especially campaigns to educate and motivate individuals. It is individuals in the community who support and inspire changes at the fourth level (community design and municipal policies); therefore, motivated individuals create positive feedback and momentum for changes at all levels.

Successful DM requires long-term decision making and ongoing commitment. With this commitment, however, the power of DM can be vast. (See Table 2–2 for a profile of DM in the solid waste reduction experience.)

Table 2–2: The Power of Demand Management—The 3Rs Experience

The 3Rs programs have shifted perceptions and practices of materials use, thereby inspiring fundamental change in the economy that is still unfolding.

- Materials, such as plastics and paper, are being recycled back into the economy for use at a lower cost than new materials.
- "Design for environment" is inspiring less material use in products and products that can be easily disassembled for material reuse (chairs for example).
- Companies are redefining their businesses around services rather than products. For example, Interface, Inc. leases carpets to building owners as a service, then, at the end of the lease, replaces the carpet and recycles the old carpet material to make new carpet.
- Business parks are being developed using industrial ecology practices so the waste materials (including heat) from one company's process can be readily used as inputs to the product, or production line, of another business.

As a result, leading municipalities have been successful in extending the life of landfill sites. In addition, broader quality of life goals have been realized, such as lower greenhouse gas emissions, and more competitive business communities through innovation, increased market potential, and reduced cost/need of materials.

Motivated individuals create positive feedback and momentum for changes at all levels.

2.1.3 Understanding Types of Demand Management Goals

All infrastructure services have demand patterns associated with their use. These patterns reflect the daily or seasonal use of the services. Community characteristics that affect infrastructure demand include population, economic profile of the community, and weather. Less tangible community characteristics that make up the culture of demand also play a significant role in the demand profile for services.

Base use is the demand present constantly during a given time period. Peak use is the demand present during the highest demand period for a given time period.

During lower demand periods, the infrastructure is available, but is not used to its full capacity; it is the peak demand that often drives the need for infrastructure expansions.

The demand profile for a service has two components: base use and peak use. Base use is the demand present constantly during a given time period. Peak use is the demand present during the highest demand period for a given time period. Demand management aims to change one or both of these components. Three types of DM goals can be identified that are relevant for infrastructure management: reduce peak demand, reduce average demand, and shift demand.

Reduce Peak Demand

This goal aims to reduce the demand for a service during peak usage periods. Also known as peak shaving, peak demand is a prime factor in establishing the design capacity of a system: the higher the peak demand, the greater the design capacity (and higher the capital costs). During lower demand periods, the infrastructure is available, but is not used to its full capacity; it is the peak demand that often drives the need for infrastructure expansions. Municipalities of all sizes in North America have successfully reduced peak demands to defer or eliminate the need for infrastructure expansions.

Example A

Water use in Canada peaks during the summer, especially in hot, dry weather. This is attributable to landscape watering. Peak water reduction programs, therefore, focus on outdoor use. Examples include reducing the need for potable water during this period (through water-resistant plantings or rain barrels), increasing the efficiency of watering (through sprinkler timers) or eliminating the option for watering (through sprinkling bans or alternate day watering rules).

Example B

Road congestion increases in the morning and evening as commuters travel to and from work. Peak use reduction programs include increasing efficiency of road use (through high-occupancy vehicle lanes) or encouraging telework, cycling, or transit use during this period.

Reduce Average Demand

This goal aims to reduce the overall (base and peak) demand for service. Both base and peak demands contribute to resource consumption, pollution impacts, operating costs and, eventually, capital costs. Substitution through alternatives and increased efficiency of use are two common approaches to reducing average demand. Again, municipalities of all types and sizes have successfully reduced average demand to achieve financial and environmental goals for infrastructure services.

Example A

The types of fixtures in residences or businesses and the types of industrial processes in use determine base demand for water and wastewater services. Base flow water/wastewater reduction programs, therefore, focus on fixture replacements (low-flow toilets and shower heads) and industrial process efficiency, or water reuse. Peak use programs, as described above, would also be used in a campaign to reduce average water use.

Example B

Base demand for transportation is determined by the need for residents and businesses to access services or activities not in proximity to their locations. Base demand reduction, therefore, focuses on eliminating the need for travel (through high-quality Internet access, telework campaigns, or communities designed with compact, mixed land uses). Base demand reduction may also focus on alternatives for mobility (walking and cycling routes).

Example C

Base demand for stormwater infrastructure is determined by the impervious area (i.e. road surfaces and roof areas) in the community. Base reduction in storm water infrastructure, therefore, focuses on reducing the impervious area (through green roofs, or increased use of ditches) (2002a) and on retention of storm water for other uses. (InfraGuide®, SWW3)

Shift Demand

This goal is similar to peak reduction, although it does not necessarily aim to reduce overall demand for a service. Rather, the goal is to even out demand by shifting peak period demand to off-peak periods. It is a suitable goal where existing infrastructure capacity is sufficient to meet foreseeable demands and where the community does not have environmental targets for reduced resource use or pollution impacts. By achieving this goal, some municipalities have been able to avoid infrastructure expansion and increase the efficiency of infrastructure use.

Example A

Demand for water can be shifted from peak periods during the day to off-peak periods by encouraging landscape watering in the early morning or late evening, or by encouraging residents to run appliances during the night.

Example B

Demand for transportation can be shifted by encouraging employers to offer employees flexible or staggered work hours that shift their commutes out of peak periods.

Table 2–3
Lessons Learned—Energy and Solid Waste

2.1.4 Lessons Learned from Energy and Solid Waste Programs

The electricity generation and solid waste management sectors pioneered DM. Many useful techniques have been developed in an effort to reduce energy consumption and optimize the use of the electricity grid.

Similarly, social pressures to restrict landfill site size and location have spurred the introduction of successful, cost-effective measures to reduce solid waste, while creating new economic opportunities. See Table 2–3 for a summary of lessons learned through these services.

Table 2–3: Lessons Learned—Energy and Solid Waste

In Canada, DM programs have developed in the energy sector and municipal solid waste services (through 3Rs campaigns) ahead of other services. Some lessons from the experience of these services include the following:

The Nature of Demand

- Demand for services should not be considered uncontrollable and uninfluenced by price, culture, or perceptions of availability and impact of the service.
- Payback is generated through changing behaviours; therefore, long-term commitment, vision, and planning are needed.
- Demand characteristics and patterns, such as peak demand (in the case of energy) and waste stream volume (in the case of solid waste) can be altered through demand-side management to increase efficiency of asset and resource use and the cost effectiveness of services.

Responsibility for Demand

- Analysis of the players and their interests in the service is needed to identify appropriate roles, responsibilities, potential partners, and target sectors/markets. In solid waste diversion programs, the private sector was identified as a key player responsible for DM, resulting in a gradual shift to extended producer responsibility.
- Partnerships to undertake the various aspects of DM programs are very important for success; this includes the private sector, all government levels, and non-profit groups.
- Senior government-level policy and targets can play a key role in the success of DM programs.

Approaches to Demand Management

- A wide range of tools and approaches should be used to appeal to the needs or interests of various user groups.
- Infrastructure and services to support alternatives are needed for success (e.g., recycling facilities for solid waste streams diverted from landfill).
- Pricing systems that reflect the cost of service use to the user (or cost of waste generation to the generator) are an effective component of DM.
- Supply-side measures can be used in balance with demand-side measures to optimize the approach with a suite of measures. (See Appendix A for integrated resource planning.)

Benefits of Demand Management

- Multiple benefits can be identified from actions initially developed for a single purpose. Energy demand side management has prompted increased energy efficiency (resulting in lowered air emissions, decreased costs for businesses and households), utility load management (improving asset use efficiency, capital asset investment effectiveness), delay of major capital investments, and increased public awareness of energy sources and impacts of use.
- Demand management has enabled recognition of opportunities to improve community design and redefine service needs. Solid waste management is evolving into resource management (For example, eco-industrial parks are designed to turn waste flows from one facility into resource flows for a receiving facility). Energy DM is leading to community energy systems.

2.2 Benefits of Demand Management

The benefits of DM accrue to the infrastructure service directly, and more importantly, to the broader community through improved quality of life. The risks of not undertaking DM are the persistence of unrealistic public expectations, unaffordable levels of service, continued environmental degradation, and increasing social costs.

The direct benefits possible from DM strategies include:

- maximizing the service from existing infrastructure by using built assets more efficiently and effectively;
- minimizing the need for new infrastructure, thereby avoiding, postponing, or reducing capital costs and associated operating costs; and
- potentially reducing the net capital and operating costs over the long term.

Broader community goals for maintaining a high quality of life can also be derived from DM through:

- maintaining or increasing the affordability of, and access to, services by residents and businesses by reducing waste and pollution, and increasing resource use efficiency (resources include water and energy);
- preserving or enhancing public health and safety through access to affordable services and reduced air pollution;
- increasing competitiveness of local businesses through affordability of infrastructure services, more efficient use of resources, increased economic efficiency, and opportunities for innovation;
- increasing the public sense of system equity or fairness as the benefits of DM are realized and the costs reflect recognized community needs; and
- reducing degradation of water resources, air quality, climate stability, biodiversity, and natural spaces such as forests, wetlands, and meadows.

The long-term benefit of DM is the cultural shift created by:

- increasing public awareness of impacts of excess resource and service use;
- engaging public, private, and non-profit sectors in community issues; and
- aligning responsibilities for reducing use of infrastructure services with those that use, or benefit from, the service.

This cultural shift can result in communities that live with future generations in mind, use resources wisely, reduce the environmental impacts of the community, and create vibrant economic bases within the community.

In summary, the primary benefit of DM is that it enables and contributes to sustainable community development.

Table 2–4: Benefits of DM—Lessons from Successful Municipalities

Identify the multiple benefits of DM, making important linkages among the multiple goals for sustainable communities. For example, the use of boulevards on roads as a storm water infrastructure DM technique also increases greenspace, provides a corridor for buried utilities, takes up greenhouse gases and air pollutants, provides traffic calming, improves the aesthetic qualities of the community, and can provide pilot demonstration sites for low maintenance landscape practices. Demand management techniques cut across social, economic, and environmental issues.

Table 2–4
Benefits of DM—Lessons from Successful Municipalities

This cultural shift can result in communities that live with future generations in mind, use resources wisely, reduce the environmental impacts of the community, and create vibrant economic bases within the community.

2.3 Challenges of Undertaking Demand Management

The challenges of undertaking DM pertain to management of DM by municipal organizations and obtaining public buy-in. Management challenges include the need for a long-term commitment and senior-level involvement, setting realistic targets, evaluation, and predicting the effects of demand reduction.

2.3.1 Long-Term Commitment and Senior-Level Involvement

Demand management requires long-term commitment by the municipality to achieve the goals and benefits of the strategies. The commitment of senior decision makers is essential for successful, effective DM that is recognized as a fundamental component of infrastructure management. Senior decision makers approve budgets for long-term infrastructure plans and, therefore, they are best positioned to understand the multiple benefits of DM.

To meet this challenge, proponents for DM must incorporate DM principles into the municipal policy and planning documents, within the existing decision-making processes and structures, so DM becomes a way of doing business. Opportunities to engage, educate, and challenge senior decision makers who are unfamiliar with the essential nature of DM should be identified and taken up to build involvement and commitment to the concept and actions. (InfraGuide®, 2002a)

2.3.2 Setting Realistic Targets

Since targets will form the basis for service demand projections, they must be realistic and achievable, yet challenge community demand norms. At the same time, the targets cannot be too modest, if they are to inspire a shift in the culture of demand within the community.

Meeting this challenge requires strong senior leadership to maintain stretch targets for DM while providing the framework for alternatives, partnerships, and target adjustments if necessary. The targets are not simply municipal targets, but community targets, so the private sector also has an important role in the success of DM strategies. Engaging the private sector in target setting and identifying solutions can be a challenge, but will greatly assist in establishing any buy-in.

2.3.3 Evaluation

There can be multiple variables involved in assessing the effectiveness of DM and the change taking place over time. This challenge can be met by planning for the evaluation phase during DM strategy development and ensuring a range of measures are included to give an overview of public response, cost benefits, qualitative considerations of broader benefits, and demand profile changes. Meeting the challenge of evaluation is important to sustain the support for DM strategies.

2.3.4 Predicting the Effects of Demand Reductions

Predicting the effects of demand reductions on costs to residents and businesses is not simple. Demand management has been used successfully to defer capital costs, and it is an important part of the long-term strategy for affordable infrastructure. However, the fixed operating costs of many infrastructure services are a larger proportion of the operating budget than the variable operating costs. Similarly capital budget support may comprise a larger portion of rates than the operating costs. While the average demand for a service may decrease, the costs of providing the service may not decrease proportionately, because of the fixed operating and capital support costs. A clear understanding of fixed operating costs, variable operating costs, and the annualized cost of capital investments is needed before promises regarding cost reductions in the traditional accounting can be made to the public. (InfraGuide®, 2003b)

A key challenge of obtaining public buy-in pertains to addressing negative perceptions or reactions, such as:

- a perception of inequity in fees or services;
- resistance to new measures (such as paying a fee for service);
- a perception that DM is intrusive, which can occur if the public perceives the role of government to be one of being at arm's length from community and/or individual decision making; and
- a perception that DM efforts are designed primarily to support a hidden agenda of accommodating population growth by providing less service to each taxpayer. (This issue arises when there is a perception that services are available in abundance, such as potable water. Interestingly, communities with long-standing water DM programs do not face this issue as frequently, because the communities have developed a conservation ethic.)

To mitigate the potential for public suspicion about the motivation for DM, it is essential to be clear and open about all objectives and to engage in public consultation during the development of DM measures. Effective communications campaigns and provision of a range of choices to meet the various service needs are other useful program elements for public buy-in. Where growth in community population is expected, it is important to develop a DM strategy early so the multiple benefits can be identified and results achieved before growth becomes a potential criticism associated with the strategy. It is important to report progress toward DM goals back to the public to validate the program and reinforce public support for the measures. Consistency of messages to the public regarding the DM strategy is important and, again, it requires long-term planning and commitment.

A clear understanding of fixed operating costs, variable operating costs, and the annualized cost of capital investments is needed before promises regarding cost reductions in the traditional accounting can be made to the public.

3. Methodology

3.1 Framework for Demand Management

The goal of DM is to harmonize community demands for resources and infrastructure services with the municipality's capacity to deliver services in a sustainable manner. This is accomplished through the active promotion of behaviour and alternatives, with the potential for multiple benefits (refer to sections 1.2 and 2.2) when using an explicit DM strategy that includes the following components (See Appendix B: Outline of the EPA Water Conservation Plan Guidelines):

- policy and planning;
- technical practices;
- corporate capacity; and
- implementation and evaluation.

3.1.1 Policy and Planning

Leadership entails taking steps to initiate DM and enable it to happen, as well as the development of plans to guide the implementation.

- Develop a policy to authorize and enable a DM strategy.
- Review existing policies to assess their alignment with DM approaches.
- Set goals and plan the DM strategy, based on priorities of the community and the municipal corporation.

Initiate DM

Each municipality is unique in terms of its community vision and corporate culture. Identify how DM will contribute to meeting that vision and the community's goals. There is no single best community vision statement. However, a good vision will draw on DM contributions to the quality of life, environmental protection, economic viability, and social equity within the community. Such outcomes are usually implied, or even explicitly stated, in municipal visions across the country. In initiating a DM strategy, decision makers can ask several questions.

- What are the benefits delivered by DM that will support the community vision?
- What high-level community goals need a DM strategy if the goals are to be achieved?
- Who, within the community, is interested in, or already promoting DM? Political champion? Community leaders? Municipal staff members?
- Should the DM strategy apply as a broad-based approach for all infrastructure, or is there a higher priority for one or more specific infrastructure services (transportation, water, wastewater, storm water, solid waste)?

There is no single best community vision statement. However, a good vision will draw on DM contributions to the quality of life, environmental protection, economic viability, and social equity within the community.

Table 3–1: Initiate DM—Tips from Successful Municipalities

Other Program Goals and DM

Take a holistic view of DM strategies and leverage DM investments to meet goals identified through other environmental, social, and economic commitments. For example:

- Water DM has been linked to operational budget savings, energy use reductions, greenhouse gas emission reductions, biodiversity protection, source water protection, reduced wastewater discharge, watershed management, and more engaged citizens.
- Transportation DM has been linked to reductions in road congestion, improved goods movement, reduced lost time, improved air quality, reduced greenhouse gas emissions, and improved community competitiveness to attract and retain employers and employees.

A Broad Strategy

While detailed plans for DM focus on specific infrastructure needs, leading municipalities do not limit their DM strategy to one infrastructure service. Instead, they adopt an approach designed to change corporate and community cultures of demand and consumption to work toward sustainable community living goals.

Champion

High-profile political champions for DM have assisted leading municipalities in developing broad-based political support. Municipalities with effective and successful DM strategies also have broad-based political support and a culture of conservation in the community, but it was not always that way. Each of them started with a handful of voices and ideas, perseverance, vision, and leadership.

Enable DM

The policies and plans of municipalities encompass a wide range of community and corporate activities. Community plans and policies include official plans for land development, infrastructure plans, rates and charges for services, bylaws and permits for building, effluent discharge, water use and other activities, public participation, and outreach. Corporate plans and policies cover the activities of the municipality as a corporation, such as purchasing, facilities maintenance and operations, staff levels, locations, deployment, and benefits.

For the DM concept to be successful, it must be entrenched in both community and corporate planning documents. It is probable that municipalities already have a policy and planning framework in place that can support a DM strategy, since they already have policies and plans that support the day-to-day business of corporate and community affairs (i.e. official/master plans). The work to implement a DM strategy pertains to adjusting plans and policies within the municipal jurisdiction to recognize explicitly a DM strategy, its goals and activities, and anticipated outcomes. Incorporation of DM into official plans is particularly important, since these plans have legal status and are a key tool in defining the community's vision and values.

A strategic DM policy can be a powerful tool to enable and encourage DM thinking within the municipal corporation. Note that enabling and planning a DM strategy may be iterative; as more information is available on the strategy, and plan as it develops, more steps to enable DM actions may be taken.

In enabling a DM strategy, municipal decision makers can ask some key questions.

- What community plans and infrastructure plans should support the DM strategy? Do they?
- Would a policy to support a DM strategy assist in providing profile and validity to DM for developing, implementing, and managing a strategy?
- How can the corporation demonstrate leadership in undertaking DM actions?

Table 3–2: Enable DM—Tips from Successful Municipalities

Community Design

These municipalities make changes in land use policies and infrastructure design as part of a DM strategy. For example, limiting sprawl and encouraging land development close to transit nodes spurs the evolution of the community form to support the most efficient use of existing infrastructure and a reduced need for auto travel.

DM Policy

They have a policy of examining DM options first for all infrastructure services, before considering any supply-side initiatives, such as infrastructure expansion.

Plan for DM

While the DM policy and the vision for a strategic approach to DM may be broad and applicable to all infrastructure services, municipalities must also plan activities that are achievable within specified time frames and resources. Therefore, at the planning stage, it will be important to set priorities and targets, and identify linkages to the necessary resources. The results of effective first steps validate the long-term vision for demand management.

Many municipalities initially established goals and objectives for their DM plans on the basis of a specific driving issue, such as traffic congestion or to defer the capital expansion of a major facility. Later, as successes were achieved and benefits realized, DM plans were developed for a range of infrastructure services, and additional program goals were established.

In the long term, it is important to plan for DM approaches well before crisis management is needed. For example, it is better to reduce demand for potable water before a capital expansion is imminent since it takes time for behaviours to change and for technologies to be implemented that will reduce water consumption. Similarly, it is important to start putting transportation DM measures in place before congestion negatively impacts air quality and the employment attractiveness of the community.

In planning the scope of a DM strategy and its goals, municipal decision makers can ask several questions:

- How can municipal, strategic and official plans support DM goals and objectives?
- Who should be involved in establishing priorities and targets?
- What infrastructure services should be examined first for detailed planning?
- What opportunities are there for partnerships in developing and implementing the plan? Do they include:
  - municipal departments;
  - private sector or non-profit groups or stakeholders;
  - senior levels of government and other municipalities; and
  - the public?
- What is the role of senior government levels in setting targets and policy or contributing resources?
- Is there a community of practice to draw on so that reinventing of approaches and tools can be avoided?

Table 3–3: Plan Elements for DM—Tips from Successful Municipalities

Setting Priorities, Targets, and Developing the Plan

Successful Municipalities:

- develop objectives and targets for DM through active consultation with the public and other stakeholders. (Although more time consuming, the consultation process is also a tool to inform and engage the public in issues faced by infrastructure decision makers and, therefore, to build support for a DM strategy.)
- design flexible plans to respond to community input and the results of pilot projects or demonstration sites (i.e., the plan is implemented in the context of continuous improvement).
- form advisory committees to discuss ideas for the plan and technical practices. One effective committee was a mix of political councillors, academics, partner organizations, and public representatives. It reported to council and provided a less formal venue for plan development and implementation, and developed political support prior to council meetings.

Leveraging Community Interest and Resources

- Successful municipalities form partnerships early in DM development to maximize participation and buy-in of the community's stakeholders. For example, non-government groups involved in setting targets have later delivered education, training and audit services under contract to municipalities.

Leveraging Other Resources and Skills

- They look for available research funding from other governments, and work with associations or other partners to instigate changes in codes, standards, or senior-level regulations and policy.

Numerical Targets and Evaluation

- They set numerical targets, or percentage targets, for specific aspects of the DM goals and anticipate their future needs for measuring, evaluating, and reporting on progress toward the targets (see Section 3.5). In other words, parameters, measurement, and frequency of reporting are established before implementation.

In developing the specifics of the plan, several aspects of the current and desired situation need to be understood, including:

- current and projected future demand and the "business as usual" demand profile now and for the projected future (i.e., base and peak demand) based on population, or other influences (e.g., economic activity);
- constraints (asset condition or expansion costs, resource or land use limitations), broader environmental, social, and economic conditions (e.g., air pollution, road congestion, watershed health);
- sources of demand, including residential, business, and other types of demand resulting from supply-side issues (e.g., infiltration/inflow in sewers is a demand on the system, water loss places a demand on potable water systems, physical asset deterioration places a demand on road systems); and
- the cost of providing the service (e.g., cost per cubic metre of water supply, cost per lane-kilometre of road).

Once a profile of current and projected demand is developed, a comparative analysis of targets, potential technical approaches (see Section 3.2), expected change in demand profile, and costs is undertaken. This analysis is comparative, because the cost benefit of the demand management measures implemented depends on the expected change in demand for the projected cost of reaching the target groups of the population, and needs to be compared with a business as usual baseline. The scope of the groups targeted, the degree of incentive or the cost of enforcing deterrents, and the cost per unit of service will all influence the cost-benefit ratio. (InfraGuide®, 2002b)

(Municipalities should consider whether they wish to develop this analysis expertise in-house or contract services for undertaking the analysis.) (InfraGuide®, 2003b)

The outcome of this analysis results in the DM plan for the infrastructure service(s). The plan can then be rounded out with details of the resources required (budget, staff, materials), responsibilities, partners and their roles, timelines, and benefits (specific and broader) anticipated.

An overview of the U.S. Environmental Protection Service (EPA) guidance document for development of water conservation plans for intermediate size water systems is provided in Appendix B. (This is available on-line from the EPA Web site, along with companion guidance documents for small and large systems.) Although this outline was developed for water specifically, it provides insights to the steps to plan a DM strategy and an integrated resource management approach (see Appendix A).

Table 3–4
Plan Approaches for DM—Tips from Successful Municipalities

Table 3–4: Plan Approaches for DM—Tips from Successful Municipalities

Choice and Tailored Approaches

Successful municipalities:

- found that a suite of tools and approaches is best to reach a full range of target groups and to provide choice while enabling change in behaviour.
- develop tailored programs, as required, for each target sector (residential, industrial, commercial, industrial, institutional).
- found that the industrial sector responds well to programs tailored to meet individual needs of each site, such as technology transfer and incentive programs (e.g., process water treatment techniques for reuse, tailored employer programs to encourage alternate transportation modes of their employees).
- include outreach and education as part of every DM plan. This may include combinations of multimedia information sources, workshops, consultation, door-to-door campaigns, site audits/assessments, and reporting back.

Policy for Cost Benefit

- Successful municipalities know the cost of providing services in a "business as usual" scenario and establish a willingness to invest in DM based on that cost.

Demonstration and Pilot Programs for Corporate Leadership

Demand management strategies of these municipalities recognize the need for the municipal corporation to adopt DM activities for their own operations to demonstrate leadership and the effectiveness of the measures, and to pilot specific approaches where required. For example, municipalities have adopted measures as an employer or facility owner to accomplish the following:

- Meet transportation DM goals, by enabling staff to work from home; by proximity assignments of staff to locations close to their residence; by subsidizing transit passes, by providing bicycle racks and shower facilities; by informing and educating staff on DM goals and rationale.
- Meet storm water management goals through green roofs on city facilities (e.g., fire stations), installing rain storage capacity at city facilities (i.e., cisterns), creating swales to drain city parking lots, greening road boulevards to reduce runoff.
- Meet water DM goals through water-efficient plumbing fixtures in city facilities, drought-resistant landscaping, observing watering bans, recycling process water.

Table 3–5
Types of Demand Management Measures

3.2 Technical Practices

There could be best practices written for each of the potential technical practices for DM. This section provides information on the scope of current practices, the strengths and weaknesses of each measure, and emerging practices in the application of the various types of measures.

3.2.1 Current Practices

The literature provides three different ways of grouping or categorizing DM techniques:

- socio-political measures (e.g., education or bylaws);
- economic strategies (e.g., pricing or financial incentives); and
- structural measures (e.g., land use plans).

These three categories can be further divided, as identified in Table 3–5, which profiles seven types of technical practices.

- communication and education;
- technical assistance;
- pricing;
- financial incentives/disincentives;
- regulation;
- market transformation; and
- structural change.

Table 3–5: Types of Demand Management Measures

DM Measure	Strengths	Weaknesses
Communication and Education		
■ School-based programs ■ Information (potentially multimedia) ■ Social marketing (i.e., communication in combination with other measures) ■ Demonstration projects	■ Political and public acceptance ■ Creates informed and supportive public ■ Initiates value change ■ Can simultaneously target multiple sectors	■ Savings difficult to validate ■ Uncertainty regarding persistence of savings ■ Behaviour constrained by available alternatives ■ Substantial opportunity for "free riders"*
Technical Assistance		
■ Audits/process review ■ Retrofit assistance ■ Technical training workshops ■ Codes of practice	■ Savings are more predictable and reliable ■ Synergies with communications and education	■ Requires technical expertise and resources (staff, possibly other) ■ Requires monitoring to document savings ■ Programs are typically very customer- and sector-specific ■ Substantial opportunity for "free riders"
Pricing		
■ User pay systems ■ Conservation-oriented rate structures (e.g., increasing the block rate for water use)	■ Very direct and efficient means to affect demand ■ Perceived fairness of user pay systems ■ Required minimal intervention in markets	■ Need information on response of markets to prices ■ May require structural change (e.g., metering, road toll systems) ■ Market barriers may persist (e.g., lack of alternatives or information)

Source : adapted from GVRD (1995)

Cont'd on p. 31

*Note : This refers to a situation where some people incur costs to alter their behaviour, but the benefits accrue to all users. Individuals who benefit from programs, which alter other people's behaviour, but do not alter their own behaviour are known as "free riders".

Table 3–5 Types of Demand Management Measures (Continued)

Table 3–5: Types of Demand Management Measures (Continued)

DM Measure	Strengths	Weaknesses
Financial Incentives/Disincentives		
■ Rebates/low-cost loans ■ Deposit/refund schemes ■ Tradable permits/pollution taxes ■ Targeted tax reductions (e.g., for employers that subsidize transit passes for employees)	■ Encourages cost-effective savings ■ May remove financial market barriers ■ Creates markets for services that cannot be directly priced (e.g., air emissions)	■ High administrative workload ■ May require funding (e.g., low-cost loans) ■ Risks associated with recovering investments ■ Perception of unfair subsidies or punitive pricing
Regulation		
■ Technology or emission standards ■ Codes of practice ■ Building codes ■ Use restrictions/disposal bans (e.g., sewer use bylaws)	■ Predictable and measurable results ■ Most direct means of influencing demand	■ Need enforcement mechanisms ■ No incentive to go beyond minimum standards ■ May not capture most cost-effective DM ■ Political/public resistance to regulation
Market Transformation		
■ Product development ■ Technology demos ■ Manufacturer, distributor, developer, and retailer programs	■ Achieves permanent change in markets ■ Changes in markets can be easily monitored ■ Political and public acceptance ■ Contributes to economic development	■ Requires economies of scale (i.e., large market) ■ Requires understanding of markets and technologies
Structural Change		
■ Land use planning ■ Infrastructure development ■ Policy	■ Produces systemic, long-term change ■ Removes barriers to behavioural change ■ Provides savings in multiple sectors	■ Requires partnerships among many organizations ■ Requires long-term focus ■ Immediate savings difficult to validate

3.2.2 Emerging Practices

One of the key trends in developing DM strategies is the incorporation of supply-side measures in balance. This approach is called integrated resource planning and is described in more detail in Appendix A. By integrating supply-side measures in balance with demand-side measures, optimum results can be obtained through changes to:

- the level of service;
- efficiency of use; and
- structure of the service, including alternatives.

By considering supply-side measures, municipalities can also assess programs to alter infrastructure design, conditions, usage, or operations to maximize demand pattern changes. For example, reducing lost water in potable water systems reduces base demand; changing single occupant vehicle access to parts of a city's transportation grid changes the structure of the transportation service and can increase the efficiency of transit services.

In principle, each of the seven types of measures identified in Table 3–5 could also be important in supporting supply-side measures.

A second emerging approach is one of greater consideration for substitutions of services provided and the interrelationships between them. This trend is especially prevalent for water resources as the perceived barriers between water, wastewater, and storm water services break down. Storm water, for example, is seen by successful municipalities as a resource to be retained and used as a substitute for many current potable water uses. Similarly, municipalities in drought-stricken areas are considering dual pipe systems to deliver potable water and water treated to a lower standard for other purposes (irrigation and fire fighting, for example). In the same spirit, wastewater is being categorized for purposes of potential use and reuse, including domestic greywater and industrial process water. Some municipalities and technologies are challenging the fundamental assumption that water should be used for domestic waste disposal, collected centrally for treatment then discharged to surface waters; this challenge is spurred by the potential risk that pharmaceuticals, personal care products, and/or endocrine disruptors will find their way into potable water systems.

A third emerging trend is in the area of financial and economic calculations. The cost of supplying a service is being approached with broader criteria than the conventional estimate of "low-bid" price versus return on demand. External factors, such as reduced greenhouse gas emissions, improved air and water quality, and reduced hospital emergency visits, are factored into municipal decision-making systems. Various tools may assist in this approach, such as matrices of social, economic, and environmental progress indicators and very long-term decision-making horizons (e.g., a 100-year horizon was used by Cities Plus).[1]

1 cities PLUS (or Cities Planning for Long-term Urban Sustainability) developed the 100 year sustainability plan for Vancouver, Canada, in a project that involved 500 experts and participants from 30 cities across Canada. This 2-year long exercise, culminated in Team Canada being awarded the Grand Prix at the International Sustainable Urban Systems Design competition in Tokyo, June 2003.

Table 3–6: Emerging Practices—Tips from Successful Municipalities

Integrated Resource Planning

Potable water services are fully metered, including master meters for supply metering and service line meters for end use metering. Metering assists in both supply- and demand-side management. For example, through metering, the municipality can understand system demand and can realistically estimate water loss. It can therefore assess the cost benefits of leak detection programs. Meters can assist with demand-side management by informing customers of their actual water consumption volumes. Water meters are an integrated resource planning tool.

Making Connections between Infrastructure Services

Take a systems approach to infrastructure, breaking down perceived barriers among infrastructure types. Potable water use can be altered to reduce wastewater impacts; storm water can be used to reduce potable water consumption; transportation infrastructure can be designed to improve storm water runoff; use of all municipal infrastructure can be altered to reduce greenhouse gas emissions contributing to climate change. Inherent in this approach is the recognition that resources or products from one service can support or substitute for demand in other municipal service areas.

Costs of Service

Take non-fiscal factors into account in estimating the costs of providing services. Non-fiscal factors include health, environment, and other quality of life considerations. For example, the environmental impact of water withdrawals from aquifers, or wastewater discharges to water bodies, are included in the considerations for the "cost" of providing water and wastewater services. It is difficult to link some of these types of impacts directly to individual capital projects, so many municipalities are developing sustainability report cards, or other reporting mechanisms, that measure success in terms of a balance of social, economic, and environmental factors. Municipalities of all sizes are working to identify suitable indicators for their particular community priorities that reflect a balanced set of sustainability factors, and to report to the public on progress toward sustainability. It is anticipated that the municipality will adjust its decision-making processes if trends in the indicators do not match the goals of the community.

3.3 Corporate Capacity

A solid vision, proactive planning, and sound technical measures are essential aspects of a successful DM strategy. However, there is also a very important element that is less easily quantified and may take some time to acquire: corporate capacity for undertaking DM. Corporate capacity comprises the culture and resources within the municipal organization. The culture and resources of a municipality can carry a limited DM strategy to great success; on the other hand, they can stymie even the most sophisticated DM strategy.

In assessing the corporate capacity for a DM strategy and plan development, senior decision makers and leaders can ask the following questions:

- Where does responsibility for DM fit within the municipal organization?
- Are there leaders on staff who can assume responsibility for developing DM?
- Are they positioned within the organization for such a role?
- Is the current organization sufficient to support DM strategy development and implementation (including job descriptions, responsibilities matched to required authorities, resource levels, expertise)?
- Is there a culture of conservation among municipal departments or is a corporate cultural shift required with the development of community measures? Is there a practice of long-term decision making? What are the typical horizons for planning and programs?

A solid vision, proactive planning, and sound technical measures are essential aspects of a successful DM strategy.

It is important not to become discouraged by potential timelines and barriers at the outset.

- Does the decision-making process and rapport with council engender continuous improvement and learning as an organization?
- What are the specific process steps and who are the key players in achieving internal commitment and approval for a DM strategy?
- Are there programs already underway with DM successes that can be leveraged for corporate profile (such as solid waste, health care programs, energy efficiency programs)?

The answers will influence the time required to initiate, plan, and implement DM in the community. It is important not to become discouraged by potential timelines and barriers at the outset. Many leading municipalities started their DM programs with little corporate or community support, but are now experiencing returns on the investments in corporate and community measures.

Table 3–7: Corporate Capacity—Tips from Successful Municipalities

Successful municipalities:

- Leverage the DM aspects of existing programs to give momentum to a broader DM.
- Organize so DM is a formal part of a senior municipal official's responsibility and an identifiable organizational unit in the corporation.
- Ensure that political leaders and senior officials are recognized for their contributions during local, national, and international reward or recognition ceremonies.
- Bring political councils on board by providing incentives to them in pilot programs (such as installing water-efficient fixtures in their homes).

3.4 Implementation and Evaluation

Implementation of DM plans for infrastructure services requires the same common practices of good management as any other municipal business area, including clear responsibilities with matching authorities, well-communicated targets, known timelines, and sufficient resources. These will not be covered in this document, as there is abundant literature on good management practices. However, there are a few specific considerations for decision makers that are important for implementation of DM.

- Ensure good communication with partners, through written agreements on responsibilities and deliverables, regular progress meetings or reporting, and by demonstrating the flexibility to accommodate or adjust plans to meet their needs.
- Develop a communications plan that includes all groups or sectors targeted by the DM measures and monitor the effectiveness of the communications techniques and plan as a whole.
- Keep in close communication with political champions to ensure they have the information needed to communicate with their peers and constituents.
- Consider pilot programs as a way of introducing DM to the community as well as to provide opportunities to validate expectations, or adjust plans prior to a full rollout.
- Consider phasing implementation to match available resources and build momentum and profile within the community.

Evaluation of DM is most effectively initiated in the planning stage with identification of targets and their associated performance indicators. (InfraGuide®, 2002c and 2003a)

Performance indicators may pertain to performance results (e.g., in terms of demand changes and public acceptance of the measures), management measures (e.g., the effectiveness and consistency of corporate policies), or condition assessments (e.g., water or air quality). Monitoring performance will involve data collection and, usually, a baseline monitoring assessment against which future monitoring results will be evaluated. Reporting is an important part of the evaluation phase, and timing of reports to council and the public should be established during the planning phase. Reporting is an important element of building and maintaining a commitment to a DM strategy by councils, partners, and the public.

Evaluations should be undertaken with the goal of continuous improvement and learning from successes and missed targets.

Table 3–8: Implement and Evaluate DM—Tips from Successful Municipalities

Building Momentum
Implement a combination of measures that can engage a variety of citizens and sectors in the community. This includes short-term measures for early successes, along with longer-term measures that will take time to return results. Measures for short-term results, such as the number of participants at a promotional event, are used to build interest in longer-term results. Long-term results include affordable infrastructure, high rates of community participation and measurable changes in demand.
Keeping Momentum
Ensure that successes of the DM program are well publicized within the community and more broadly. Opportunities for awards or other forms of recognition, such as making presentations at conferences, are taken up. In addition, opportunities for new partnership arrangements with the private sector, the non-governmental sector, or with other governmental organizations are continuously sought to support and enhance the DM program.

4. Case Study Applications

4.1 Case Study 1: Water Demand Management

Target: Reduce 1990 water consumption level by one-eighth by 2020.

4.1.1 Success of the Program

- Between 1990 and 2003, the population in the service area grew by 17 percent; however, water use in 2003, a year with near-normal rainfall, was virtually the same as in 1990.
- In the municipality, water conservation measures are expected to reduce total urban demand by about 12 percent by 2020, with an estimated savings of 13.1 million cubic meters per year (13,126,000 cubic meters).

4.1.2 Program Elements

Maximum conservation measures are implemented before looking at other measures to provide water to the municipality. The program relies on a combination of approaches including the following:

- Board policy specifies the acceptable cost of DM (up to about 65 percent of the overall cost of supply).
- A suite of measures targets each water consumer group.
- Incentive programs are in place for ultra low-flush toilets, water-saving shower heads, residential high-efficiency clothes washers, and commercial-industrial-institutional hardware. For example, water customers received a voucher of up to $75 per toilet replaced, and hospitals were supplied with new X-ray machines that did not use flow-through water for X-ray development ($3,000 per machine, provided free of charge based on cost benefit of supply/demand reduction).
- Residential home water use surveys were conducted along with audits of large landscape areas, and an agricultural irrigation program.
- The program was tailored for each large industry employer to understand their needs and cost competitive issues; technology transfer is a major element for process water reuse. Industry did not want site audits for confidentiality reasons, but responded well to opportunities to discuss treatment and reuse options.
- Education programs included workshops and school education and participation activities.

4.1.3 Greater Benefits

Benefits to the greater community include the following:

- **Affordability:** The cost of clothes washers with water-efficient features decreased by 40 percent in part attributable to the municipal programs (also because of state and national programs). Also, industry sectors are saving money and their capacity to implement further measures is increasing as a result of the transfer of technology on wastewater treatment.
- **Culture:** A water conservation ethic has developed in the municipality, enabling additional DM measures.
- **Senior government partners:** The program inspired legislation at a higher government level for residential clothes washer efficiency standards.
- **Environment:** The public recognizes that reduced water consumption also reduces the quantity of wastewater discharged, resulting in water quality benefits.

4.2 Case Study 2: Storm Water

Target: Eliminate combined sewer overflows.

4.2.1 Success of the Program

- The municipality eliminated combined sewer overflows to one of two rivers in 2000, and will eliminate 94 percent of the overflows to the other by 2011.
- The program is on target to reduce the costs of new storm sewer mains due to the reduced size required.
- More than 41,000 homeowners have disconnected downspouts, removing more than 835 million gallons of storm water per year from the combined sewer system (about 30 percent of the flow).
- Outreach activities resulted in the monetary incentive only being required in half the cases.

4.2.2 Program Elements

The program uses a suite of measures.

- Downspout disconnection of residential areas in the combined sewer overflows was mandatory.
- Downspout disconnection of residential areas in the separated flows that drain to local streams was voluntary.
- Commercial and multi-family roofs were disconnected from dry wells, roof-only sumps, or landscaped on-site storage.
- Eco-roof or rooftop gardens were built on municipal properties and private buildings.
- Inlet controls store peak flows on side streets and parking lots.
- Detention ponds were built upstream of the locations where storm water discharged into streams.

4.2.3 Greater Benefits

Other benefits of the program include the following.

- Waterways are cleaner for fish, wildlife, and people.
- Reduced energy consumption lowers greenhouse gas emissions due to reduced wastewater requiring transportation and treatment.
- Reduced energy used in facilities with green roofs.
- More efficient use of road systems.

4.3 Case Study 3: Transportation

Target: Reduce car trips by 46 percent by 2029, increasing the modal share of trips made walking, cycling, and by public transport; achieve an average trip length of 7.2 km by 2029, and increase car occupancy to 1.25 people per car by 2029.

4.3.1 Success of the Program

- The program managed a 14 percent reduction in car kilometres travelled in an initial trial with improved results the following year.
- In relation to this decrease, the program increased the use of other modes of transport such as walking by 16 percent and cycling by about 91 percent while public transit use increased by about 21 percent.
- These results were maintained in the two years following the intervention.
- Bus companies collected enough extra fares to recoup their program costs within three years.
- The benefit-cost ratio of the program is 30:1 which is worth over $1 billion in savings to the community over 15 years.

4.3.2 Program Elements

The transport strategy centres on an individualized marketing approach.

- Individuals likely to change their behaviour are identified.
- The individuals are then personally contacted and asked about their preferences regarding walking, cycling, and public transport.
- Personalized packages of information specific to their situation (e.g., local bus service timetables and local cycling and walking maps) are delivered; home visits are available as well as free trial tickets and vouchers from local cycling shops.
- The program encourages people to set a goal to change two or three of their 19 average car trips per week.

4.3.3 Greater Benefits

- Air pollution and greenhouse gas emissions declined.
- Public safety increased through fewer road crashes.
- Further health benefits from increased walking and cycling.
- Economic benefits for both individuals (savings in car operation and maintenance costs) and governments (reduced public transport subsidiaries).

5. Evaluation

5.1 Summary and Conclusions

Demand management strategies by municipalities require several elements:

- long-term commitment to achieving the community vision for sustainability;
- strong leadership by senior decision makers to ensure resources and processes are in place to implement DM successfully;
- alignment of municipal policies and programs with DM approaches (e.g., the official plan should reflect land use policies that support demand management principles);
- development of corporate capacity to undertake a sustained DM strategy;
- analysis and evaluation of technical measures and costs to achieve the desired demand profile; and
- implementation and evaluation of DM plans, usually with a suite of measures targeted at various residential and private sector infrastructure service users.

The benefits of DM are many, including increased affordability of infrastructure services, reduced negative environmental impact and improved health and equity for current and future municipal populations. The risks of not undertaking DM are the persistence of unrealistic public expectations, unaffordable levels of service, continued environmental degradation and increasing social costs. In short, DM is essential for maintaining or improving the quality of life in municipalities.

Significant shifts in public perceptions of consumption and resource use can be anticipated as the impact and costs of local and global environment and health issues continue to be felt, or even accelerate, such as poor air quality and climate change. Municipalities that undertake DM now as a proactive strategy will be better positioned to accommodate the inevitable changes in public opinion and public demand for more efficient practices and reduced resource use to mitigate negative public health and environment impacts.

5.2 Limitations of This Best Practice

This document provides an introduction and overview of DM for municipal decision makers. The framework provides guidance to senior municipal decision makers on the components of a DM strategy and program (policy and planning; technical practices, corporate capacity, implementation, and evaluation). The information presented will not address all of the information needs of municipalities to undertake DM. Additional references, or resources, will be required to develop and implement a DM strategy fully. For example, resources will be needed to gather demand data, analyze demand profiles, and estimate the cost benefits of various measures for the municipality. While DM measures are implemented in many municipalities, the cost-benefit result will be unique to each municipality due to service conditions, levels, resources available, public perceptions, and culture.

Information in this document was drawn from about 20 municipalities with recognized best practices for municipal infrastructure DM. Other best practice tips may be employed in other municipalities that are not captured in this document. Municipal decision makers are encouraged to contact their peers in other municipalities and to work through industry associations to broaden their knowledge of potential DM practices and approaches. Similarly, municipalities that have successfully implemented measures are encouraged to share their experience by dissemination of knowledge through presentations and papers for the municipal audience.

Municipalities that undertake DM now as a proactive strategy will be better positioned to accommodate the inevitable changes in public opinion and public demand for more efficient practices and reduced resource use to mitigate negative public health and environment impacts.

Appendix A:
Integrated Resource Planning

Integrated resource planning or **IRP** considers the direct and indirect costs and benefits of demand-side management and supply-side management by using

> alternative planning scenarios, analyses across disciplines, community involvement in the planning, decision making and implementation process, and consideration of other societal and environmental benefits (AWWA, 1993).

Integrated resource planning aims to define a least-cost scenario that considers the economic analysis, but also environmental impact analysis, and reliability analysis. Integrated resource planning is different from supply-side management in a number of ways:

- The focus of planning is on underlying services rather than intermediate commodities.
- Multiple objectives are considered, including financial, technical, and environmental objectives.
- All options including demand-side and supply-side options are treated consistently and fairly in the planning process.
- Direct financial and social costs are included in the analysis of each option.
- Risk and uncertainty are treated explicitly in selecting a preferred plan.
- The public is involved throughout the planning process.

Through IRP, the planning issue is redefined from service and assets of a municipality to the need of the customers. For example, IRP differentiates between the service of electricity and the need for heating and lighting; it differentiates the transportation service from the need for mobility. This perspective offers many more options to the municipality when trying to meet the needs of customers in a cost-effective manner (financial, social, and environmental costs).

Key components of IRP include:

- clear goals and policy objectives adopted by the utility/service management;
- a defined planning horizon for future design year;
- an interdisciplinary process, considering not just engineering details but also a range of key policy objectives;
- equal treatment of supply-side and demand-side options (a level playing field);
- consideration of supply reliability;
- explicit consideration of uncertainty; and
- an open process with good public participation.

This perspective offers many more options to the municipality when trying to meet the needs of customers in a cost-effective manner.

Appendix B:
Outline of the EPA Water Conservation Plan Guidelines

Guideline Steps (for intermediate systems)

(A number of worksheets are provided to simplify and guide the process.)

Specify conservation planning goals:

- planning goals; and
- community involvement.

Develop a water system profile:

- system profile (service characteristics, annual water supply, service connections, water demand, average peak demand, pricing, planning);
- system conditions (climate and water availability, infrastructure conditions, system demographics, etc.); and
- current conservation efforts.

Prepare a demand forecast:

- demand forecasting (anticipated demand for a selected time period);
- forecasting method (residential demand, non-residential demand, non-accounted water, water system total demand, average-daily and maximum-daily demand);
- describe planned facilities;
- supply forecasting;
- cost analysis;
- estimating incremental supply cost; and
- preliminary supply-capacity forecast.

Identify water conservation measures:

- levels and measures (supply- and demand-side); and
- identifying conservation measures (Level 1: universal metering, water accounting and loss control, costing and pricing, information and education; Level 2: water-use audits, retrofits, pressure management, landscape efficiency; Level 3: replacement and promotions, reuse and recycling, water-use regulation, integrated resource management).

Analyze benefits and costs:

- purpose;
- water savings;
- implementation costs;
- cost effectiveness;
- net benefits; and
- comparison of measures.

Select conservation measures:

- selection criteria; and
- selecting the measures.

Integrate resources and modify forecast:

- integrating options;
- modifying demand forecasts;
- project-specific savings (from project elimination, downsizing, or postponement, or from a reduction/elimination of water purchases);
- modifying supply forecasts; and
- revenue effects (variable and fixed costs, short- and long-term).

Present implementation and evaluation strategy:

- implementation;
- implementation of measures (schedule); and
- implementation and evaluation (public involvement, monitoring and evaluation, updates and revisions).

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Web Sites

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American Water Works Association
(Water Wiser Information Clearing House)
<*www.awwa.org/waterwiser/*>

Atlantic Canada Water Works Association
(Division of the AWWA)
<*http://www.acwwa.ns.ca/awwa/index.html*>

Canada Mortgage and Housing Centre
<*http://www.cmhc-schl.gc.ca/en/contact/contacten_001.cfm*>

Canadian Water and Wastewater Association (CWWA)
<*http://www.cwwa.ca/*>

Cities Plus
<*http://www.citiesplus.ca/*>

Economic and Social Research Council, U.K.
<*http://www.esrc.ac.uk/*>

Environment Canada
<*http://www.ec.gc.ca/*>

FCM / CH2M Hill Sustainable Community Best Practice Awards
<*http://www.fcm.ca/scep/awards/awards_judges.htm*>

Global Urban Research Unit, University of Newcastle, U.K.
<*http://www.ncl.ac.uk/guru/*>

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<*http://www.gvrd.bc.ca*>

Institute for Sustainable Futures, Australia
<*http://www.isf.uts.edu.au/*>

Interface, Inc.
<*http://www.interfaceinc.com/flash/flash_C.html*>

International Council for Local Environmental Initiatives (ICLEI)
<*http://www.iclei.org/*>

International Directory of Solid Waste Management
<*http://www.jxj.com/yearbook/iswa/1999/inegratedapproachwaste.html*>

International Water Resources Association
<*http://www.iwra.siu.edu/*>

Internet Guide to Financing Stormwater Management
<*http://stormwaterfinance.urbancenter.iupui.edu/*>

King County, Seattle, Washington, U.S.
<*http://www.metrokc.gov/*>

Local Sustainability – European Good Practice Information Service
<*http://www3.iclei.org/egpis/*>

Nanaimo, British Columbia
<*http://www.city.nanaimo.bc.ca/*>

National Water Demand Centre, U.K
<*http://www.fwr.org/nwdmc.htm*>

Ontario Centre for Municipal Best Practices (Ontario Ministry of Municipal Affairs and Housing, and the Association of Municipalities of Ontario)
<*http://municipalbestpractices.ca/home.asp*>

Oregon Department of Water Resources
<*http://www.wrd.state.or.us/*>

Ottawa, Ontario
<*http://www.city.ottawa.on.ca/*>

Perth, Australia
<*http://www.cityofperth.wa.gov.au/*>

Portland, Oregon
<*http://www.portlandonline.com/*>

Regina, Saskatchewan
<*http://www.regina.com/*>

Resources for the Future
<*http://www.rff.org/*>

San Diego, California
<*http://www.sannet.gov/*>

Southern Illinois University
<*http://www.siu.edu/*>

State of Oregon, U.S.
<*http://www.oregon.gov/*>

Surrey, British Columbia
<*http://www.city.surrey.bc.ca/default.htm*>

Sydney, Australia
<*http://www.cityofsydney.nsw.gov.au/*>

Transport Canada
<*http://www.tc.gc.ca/*>

Travel Smart Australia (National Guidance Web site)
<*http://www.dpi.wa.gov.au/travelsmart/*>

United States Environmental Protection Agency (EPA)
<*http://www.epa.gov/*>

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<*http://www.polisproject.org/*>

Victoria Transport Policy Institute, Victoria, British Columbia
<*http://www.vtpi.org/*>

Victoria, British Columbia
<*http://www.city.victoria.bc.ca/common/index.shtml*>

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<*www.watereuse.org/*>

Waterloo, Ontario
<*http://www.city.waterloo.on.ca/*>

Other Sources

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