PLANNING FOR WATER CONSERVATION

Greater Vancouver Regional District

by

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ABSTRACT

Instances of water scarcity are recurring with greater frequency in urban areas around the globe, yet per capita water consumption continues to increase. Faced with increasing populations and costs associated with urban growth—related to infrastructure, energy, operation, administration, and maintenance—many municipalities are searching for new strategies to cope with expanding water demand. This research investigates the relative advantages and disadvantages of a variety of institutional arrangements in providing sustainable water service for the population of the Greater Vancouver Regional District (GVRD). It is guided by a central research question: what is the relative efficiency of the public and private sectors in providing a supply of high quality urban water?

Best management practices (BMPs) for water conservation are used as evaluative criteria. These BMPs were drawn from California's urban water conservation system. This researched examines 4 case study municipalities from the GVRD. These cases include both public and private, and metered and unmetered utilities. The results of a literature review, document analysis, and interviews with senior utility managers are presented comparatively. An assessment of water conservation initiatives within each of the case studies tests whether the private water utility achieved enhanced water efficiency when compared to its public counterparts. The study concludes with recommendations for institutional arrangements that currently supply water in the GVRD. These include: universal metering, conservation pricing, enhanced education programs, incentives for environmental protection, and improved data collection.

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LIST OF ABBREVIATIONS

BMP	Best management practice
CAD	Canadian dollars
CDWQG	*Canadian Drinking Water Quality Guidelines*
GVRD	Greater Vancouver Regional District
ICI	Industrial, commercial, and institutional
Lpcd	Liters per capita per day
ML / Day	Million liters per day
ML / Year	Million liters per year
UEL	University Endowment Lands

CHAPTER 1 – INTRODUCTION

Instances of water scarcity are recurring with greater frequency in urban areas around the globe, as per capita water consumption continues to rise. Increasing populations and costs associated with urban growth—related to infrastructure, energy, and the operation, administration, and maintenance of municipal services—are motivating many municipalities to find new strategies to cope with these challenges. Increasingly difficult governmental and environmental constraints have spurred a search for innovative and cost effective institutional arrangements to provide urban water planning and management. In response, a number of organizations have suggested, among other recommendations, an expanded role for the private sector in providing drinking water supplies. Recommendations for an enlarged role for the private sector in water and wastewater service provision are based on the assumption that the private sector will attain efficiencies that public utilities are incapable of reaching. This research paper examines this assertion using public and private water utilities as case studies in the Greater Vancouver Regional District (GVRD).

Although GVRD is located in a wet climate, there is growing recognition that regional water supplies are finite and that the era of superabundant, low-cost water has ended. This study investigates the relative advantages and disadvantages of a variety of institutional arrangements in providing sustainable water service for the population of the Greater Vancouver Regional District. Best management practices (BMPs) for water conservation are used as evaluative

criteria. These BMPs were drawn from the California Urban Water Conservation Council's memorandum of understanding regarding urban water conservation. This research examines four case study municipalities from GVRD that include both public and private, and metered and unmetered water utilities. The results of a literature review, document analysis, and interviews undertaken for this research are presented comparatively.

PURPOSE STATEMENT

The research purpose is to ascertain and understand the institutional arrangements that will provide for the most sustainable water service provision for the population of the Greater Vancouver Regional District (GVRD). Private and public water utilities are evaluated to judge their respective performance in implementing urban water conservation initiatives. This study is guided by a central research question:

- What is the relative efficiency of the public and private sectors in providing a supply of high quality urban water?

In an effort to answer the research question, a review of water management arrangements and practices for GVRD was conducted. An understanding of the nature and organization of water planning and management structures and functions is required in order to conduct a critical analysis and assessment of water management activities. The interplay between water planning and management at the municipal and regional levels is analyzed due to their shared responsibility for the resource. Answering the central research question is the main precondition to developing a set of conclusions and recommendations that may indicate opportunities for improvements to the existing institutional system.

An institutional analysis model is used to highlight the fundamental elements that are under investigation in this study (fig. 1.1). A series of research tasks is undertaken to understand the differences in urban water planning and management between private and public water utilities in the region (fig. 1.2). This study also considers the potential role for public-private partnerships in water management. Essentially, the research seeks to evaluate water utilities by comparing the range of best management practices for water conservation undertaken in GVRD and to determine whether detectable differences are linked to public or private operation of the utility. In the effort to achieve sustainable water use, where both human and ecosystem health are ensured, enhancing water efficiency in GVRD will be an essential step.

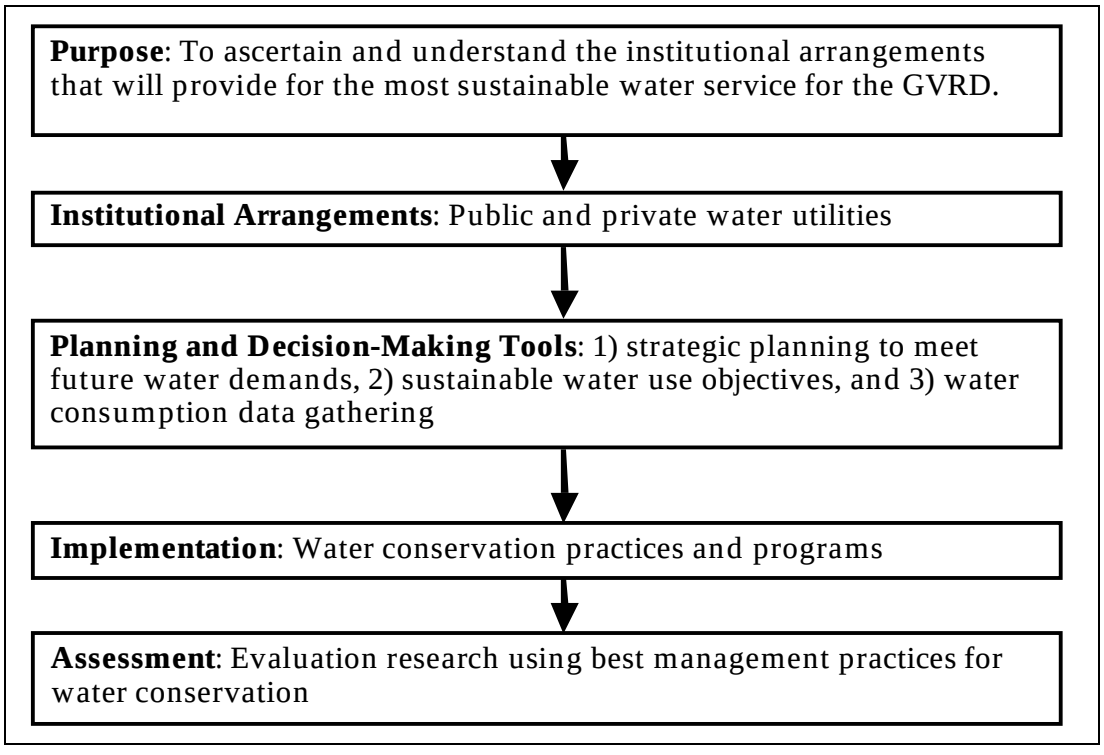

Figure 1.1 Institutional analysis model for water utilities in GVRD

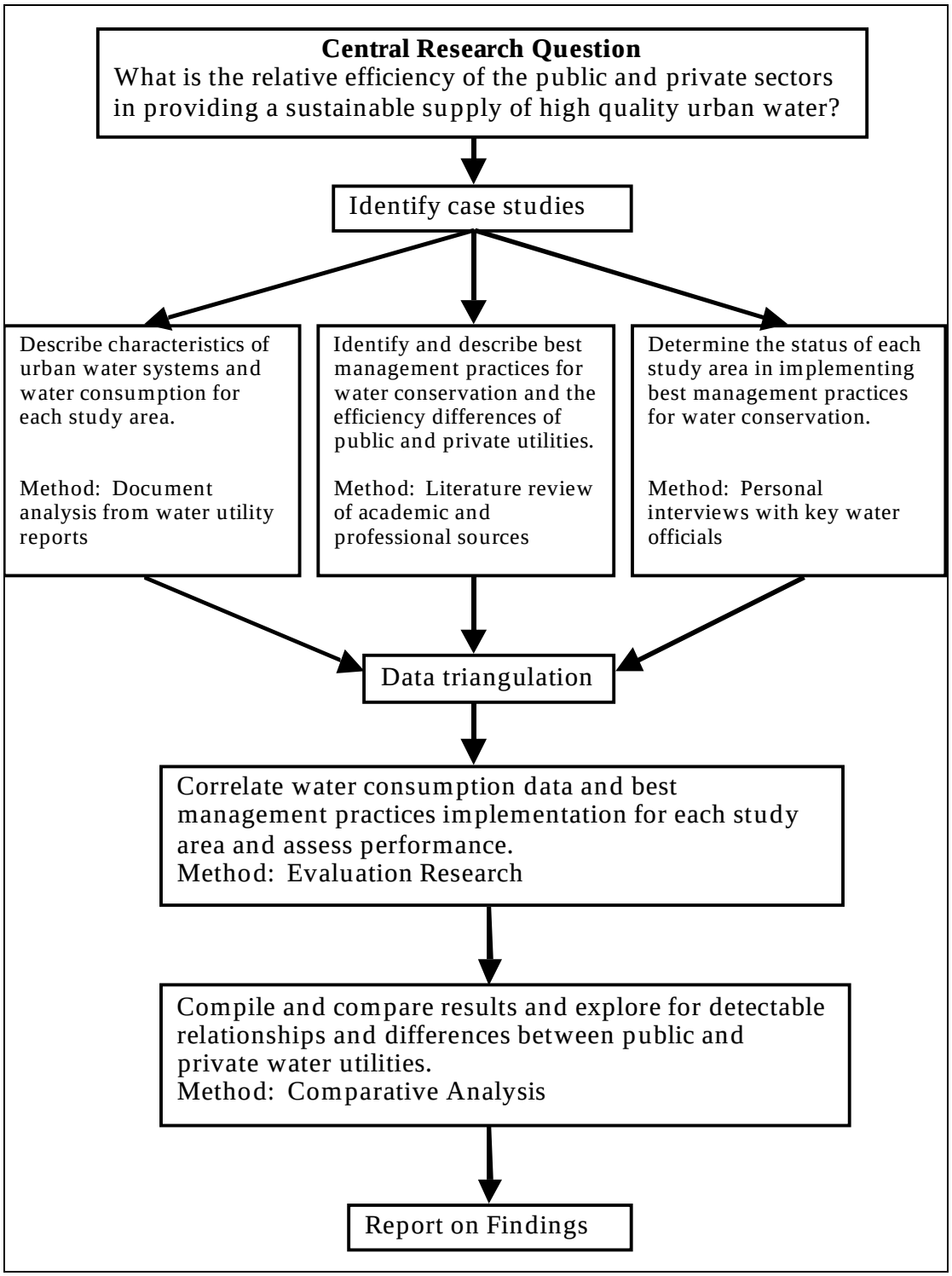

Figure 1.2 Flowchart of research tasks

RESEARCH QUESTIONS

In order to address the central research question with confidence, a series of working research questions are investigated. These questions provide the information needed to complete the research tasks.

- Are there distinguishable differences between private and public water utilities in the Greater Vancouver Regional District?
- How have private and public water utilities performed vis-a-vis best management practices for water conservation?
- What evidence is there that a partnership of public and private water agencies would enhance performance of the water supply system?

KEY TERMS AND CONCEPTS

The definition of key terms and concepts will promote a more complete understanding of this research. Critical terms and concepts used in this report include:

- Water conservation—"The socially beneficial reduction of water use or water loss" (Baumann et al., 1980 as cited in British Columbia 1998b, 18).
- Sustainable water use—"The use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it" (Gleick et al. 1995, ES-3).
- Urban water management—"The total integrated management of waters within the city area to minimize water usage, maximize productivity and cost effectiveness and minimize pollution of the environment" (Milburn n.d., 8).
- Institutional arrangements—"A definable system that provides both opportunities for and constraints upon policy making" (Mitchell 1987 as cited by Smith 1993, 34). Institutional arrangements can be defined "through assessing the interaction of: (1) legislation and regulations, (2) policies and guidelines, (3) administrative structures, (4) economic and financial arrangements, (5) political structures and processes, (6) historical and traditional customs and values, and (7) key participants and actors" (Mitchell

1989, 245). In the context of this research, the definition of institutional arrangements also includes planning systems and education.

- Public-private partnerships—"A cooperative venture between the public and private sectors, built on expertise of each partner, that best meets clearly defined public needs through the appropriate allocation of risks, rewards, and responsibilities" (Canadian Council for Public-Private Partnerships 1998).
- Evaluation research—"The process of assessing whether or not desired or undesired outcomes have been reached, of specifying or explaining the outcomes that were reached and of suggesting new strategies and/or definitions of future problems" (Rich 1979, 11).

SCOPE AND BOUNDARIES OF THE STUDY

Study Variables

The key study variables for this research include: urban water consumption, physical and institutional characteristics of urban water systems, and best management practices for water conservation (appendix I). Data sources that will be analyzed include: legislation, policy statements, government documents, nongovernmental reports, conference proceedings, academic literature, popular literature, and personal interviews with key water officials in the study municipalities.

Study Area

The study area incorporates the Greater Vancouver Regional District (GVRD) and the research was initiated in May and completed in December of 2000. The municipalities were selected to typify the general characteristics of public and private water utilities in the region. White Rock is included as it has the only private water utility in the region. Within the Greater Vancouver Regional District, there are many municipalities that have public water utilities: Vancouver has approximately average water usage (651 Lpcd, 1998), and West

Vancouver has high usage (762 Lpcd, 1998). The University Endowment Lands (UEL) at the University of British Columbia are part of the GVRD water system, but are not associated with an official municipality. The UEL meters and charges volumetrically for water. These areas were selected to provide an indication of the range of water management conditions throughout the region as a whole.

Organization of the Research Report

The literature reviewed for this research supplied the context for this study by providing history and background for the municipal water management problem. Chapter 2 discusses issues associated with the research problem and proposes a framework for considering the study implications. The methodologies used to gather data and information, and guide the analysis and synthesis of this research, are presented in chapter 3. The key research findings are discussed in chapter 4, and chapter 5 presents the implications of these results. Final thoughts, recommendations, and future research needs are included in chapter 6.

CHAPTER 2 – LITERATURE REVIEW

One of the most pressing issues confronting many urban areas throughout the world is water scarcity. If the global demand for water continues to expand at double the rate of population growth, as it has over the past 50 years (OECD 1998), water scarcity will become increasingly common. Uncertainty associated with potential climate change adds another level of complexity to already challenging water planning and management conditions. These conditions along with "the increasing frequency of problems related to water supplies explain[s] the new preoccupation with water consumption and the ability of nations to meet their future water needs within environmental limits" (OECD 1998, 19). Water supply problems involve dimensions of both water quantity, such as shrinking aquifers and reduced surface flows, and water quality, related to pollution and contamination (World Water Council 2000). The result has been greater importance on water planning and management on the public agenda.

There are real environmental limits on the availability of fresh water, creating significant challenges in solving water supply problems. Although environmental conditions are the limiting variable, any successful solution to this water consumption problem must involve human adaptation. The principal reason for this is that water supplies on this planet are fixed; there is no new water entering the ecosphere. Grigg (1999, 527) argued that:

> . . . one prescription for these challenges is to push technical envelopes in areas such as desalting, cloud seeding, and water reuse; but the main challenges will be institutional – to establish correct policies, viable political institutions, workable financing arrangements, self-governing

and self-supporting local systems, and a variety of other institutional arrangements.

Finding institutional arrangements that are participatory, integrative, and comprehensive is critical in effective water management (Kreutzwiser 1995).

In considering innovative institutional arrangements for providing a sustainable supply of high-quality water, it is important to acknowledge that water-related decisions are highly political. Water managers are faced with the considerable challenge of reducing water consumption while avoiding options that may be unacceptable to the public or to politicians (Poyner 1998). In fact "it may be easier for a decision maker to adopt a policy that is socially and politically acceptable but technically unsound than to accept a policy that is technically sound but socially and politically unacceptable" (Letey 1999, 604). In order for water policy to be effective, it must be scientifically sound, economically justified, and socially acceptable (Letey 1999). Clearly, there are institutional and political barriers to sustainable water management (Kreutzwiser 1995).

The broader policy implications associated with innovative institutional arrangements are discussed to provide a context for this study. Sustainability should be the overarching framework guiding natural resource and environmental management policy. Within the framework of sustainability, an integrated approach to water planning and management is preferred. The integrated approach considers a wide range of options to address water supply problems, including both behavioral and technical elements involved with water conservation. Therefore, it is important to have a clear understanding of the

need and justification for water conservation. Once this need is accepted, it is important to examine issues involved with public and private operation of water utilities. Each of these policy implications is discussed in the remainder of this chapter.

Sustainability

With the proliferation of discussion on sustainable development initiated by the World Commission on Environment and Development report, *Our Common Future*, the application of this concept in public policy has been the objective of many governments around the world (Mitchell and Shrubsole 1994). Although the objective of sustainability as a guiding principle appears to be well accepted, there has been limited progress in achieving it in practice. Contributing to this lack of progress has been a legacy of water management institutions designed to encourage the development of water supply projects within a framework of economic efficiency (Kreutzwiser 1995). Within this framework, the main objective was to provide customers with an abundance of water at low cost. Once this framework was identified as inherently unsustainable, attention focused on alternative water management institutions. Greater recognition of ecological integrity and demand management within existing water management institutions initiated a new period of discussion towards achieving sustainable water use (Kreutzwiser 1995).

The first step in reorienting water management institutions toward a new policy focus on sustainability was to identify the critical elements of sustainable water

management. Sustainable use of water resources has been defined as "the use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it" (Gleick et al. 1995, ES-3). Cities need to reduce their ecological footprint on surrounding ecosystems caused by excessive resource consumption. While the objective of sustainable water use is clear, a blueprint or guide to achieve this is missing in practice. In addition to government attention, there is also growing recognition in the professional literature and in the popular media that water consumption in Canada is not sustainable. *The Globe and Mail* (5 August 2000), *The Vancouver Sun* (10 August 2000), and *The Canadian Broadcasting Corporation - Online* (23 March 2000) have all recognized Canadian's propensity to waste water and the inadequacy of water management institutions in responding to the situation.

While water management institutions remain in a state of flux, there have been additional calls for institutional reform to advance progress towards sustainability. Wood et al. (1999, 343) argued that:

> . . . the sustainability agenda, new forms of governance and the demands for greater community involvement in the decision-making process require more novel institutional mechanisms which are able to address a diversity of interests within a new environmental context.

Key among these new forms of governance is the devolution of power from government agencies to both the private and voluntary sectors (Wood et al. 1999). Arguably, managing water resources is a process that has become so complex that neither the public nor the private sector can address it alone (Grigg 1999). The challenge is to find an institutional arrangement that allows public,

private, and voluntary sectors to achieve their respective goals (Wood et al. 1999). This situation has demonstrated "the need for attention to what kinds of institutional structures are best able to accommodate diverse and locally centred aspirations whilst paying heed to the demands of the broader picture" (Wood et al. 1999, 342). A new partnership for providing drinking water services—one that involves the public, private, and voluntary sectors, and provides a mechanism to effectively reconcile economic, environmental, and social sustainability issues—is presented in fig. 2.1. Involving a broad range of stakeholders increases the legitimacy of an institution in making effective decisions (WWC 2000).

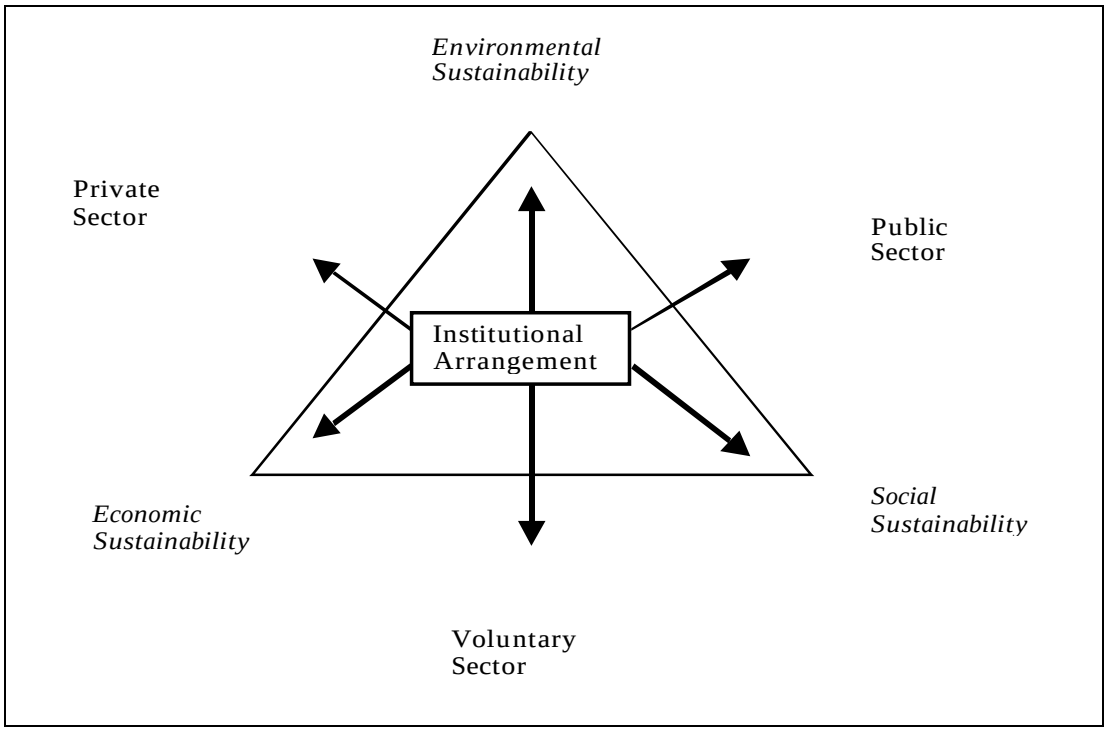

Figure 2.1 Sustainability and partnerships for environmental management
Source: Adapted from Wood et al. 1999, 350.

Within this kind of partnership, some new actors will need to enter the process and some existing actors will need to play new and different roles. It is appropriate to explore some of these changes. Governmental roles include: providing a clear legislative and regulatory framework that is participatory and accountable, protecting the environment, and providing financial assistance to low-income families (WWC 2000). The private sector will bring financing, managerial expertise, and competition to water management, which are anticipated to bring higher levels of efficiency in water consumption (WWC 2000). Roles for the voluntary or community sector include greater participation in the water management processes as well as education and awareness building. Also essential is the inclusion of local knowledge in planning processes and monitoring of private water providers to ensure accountability (WWC 2000). This new kind of partnership outlines water resources management as a process conceived within the framework of sustainability and demonstrates the need for an integrated approach to managing water resources.

Integrated Water Resources Management

An alternative to the traditional, supply-oriented approach to managing water resources, integrated water management, has existed for some time. According to Mitchell (1990a) the roots of an integrated approach to guide the use of water resources in Canada can be traced back to the National Commission of Conservation, early in the 20th century. Given this lengthy experience with the concept of integrated water resources management, it is not surprising that numerous definitions abound in the literature (Grigg 1999). In reviewing these

definitions, Grigg (1999, 528) defined integrated water management as "a framework for planning, organizing and controlling water systems to balance all relevant views and goals of the stakeholders." It is important to recognize that, within integrated water management, one must consider interrelationships between components of the water system, between water and land, and between the hydrological system and the socioeconomic system (Mitchell 1990b). In this way, an integrated approach to managing water integrates the social, economic, and environmental aspects of water management and can act as a precursor to achieving sustainability. As a result of the application of this approach in practice, it is expected that integration will result in cooperation and coordination among stakeholders that will yield improved effectiveness (Mitchell and Pigram 1989).

There is a clear need for integration and interaction among the public, private, and voluntary sectors (fig. 2.1). The main benefit of an integrated approach is that all stakeholders have the opportunity to reach their goals in a cost-effective manner (Grigg 1999). The integrated approach also permits a better appreciation of the nature and types of problems associated with water management, rather than focusing solely on finding solutions to problems (Grigg 1999). Typically, an integrated approach considers a wide variety of potential responses to such water problems.

Although the concept of integration is acknowledged, there has been disappointing progress in implementation (Mitchell 1990b). Part of the reason for this are the barriers to its use, including "lack of congruence of political and

problematic boundaries, disincentives to cooperation, and low perceived need for integration" (Grigg 1999, 533). Additional barriers include a lack of appropriate data and information, lack of clearly defined roles and responsibilities for stakeholders—particularly the role of the public—and lack of successful models (Mitchell 1990b). An effectively designed institution would certainly help overcome some of these barriers.

While the concept of integrated water resources management has received considerable attention, the notion of integrated urban water management is less studied. Integrated urban water management involves the "total integrated management of the waters within the city area to minimise water usage, maximise productivity, and cost effectiveness and minimise pollution of the environment" (Milburn n.d., 8). This approach manages fresh water, storm water, and wastewater in a coordinated manner (Milburn n.d.). In essence, the purposes of integrated urban water management are for resource and financial efficiency (Milburn n.d.). In implementing an integrated approach to urban water management, there are three available options, including: "limiting urban growth; obtaining new supplies; and optimising existing supplies" (Poyner 1998, 39). It is important to recognize that the choice among these options rests with decision makers, those who will consider the costs and public acceptance of each option (Poyner 1998). It seems obvious that the prospect of limiting growth would be unattractive to decision-makers, as would the high costs of developing new water supply infrastructure which, ultimately, would be borne by the taxpayers. Accordingly, the remaining choice to optimize existing supplies,

within which water conservation has a critical role to play, would be the favored option (Poyner 1998).

The Need for Water Conservation

Perhaps it is the myth of superabundance in Canada that has allowed Canadians to become some of the world's largest consumers of water (Kreutzwiser 1995; Pearce and Quinn 1996). It seems reasonable that challenging this myth would make a significant first step in reforming water resources management. Kreutzwiser (1995, 281) argued that:

> . . . perceptions of the abundance of water resources must be tempered by a realization that these resources are finite. Fuller appreciation of the value of water resources is a prerequisite to more effective allocation that minimizes conflict among competing uses and enhances the sustainability of these uses.

Indeed, the need to reform water management has been a widely accepted theme in the literature (Viessman 1990; Postel 1994; Kreutzwiser 1995; Baer 1996; Pearce and Quinn 1996). The major challenge, then, is to curb the demand for water, rather than continuing to search for new supplies (Postel 1994).

While instances of water scarcity are recurring with greater frequency, per capita consumption of water is actually increasing (Baer 1996; Bianchin 1999). To cope with this increasing demand for water, two different approaches may be taken. Under the traditional approach, water management consists of the augmentation of municipal supplies by increasing the water storage capacity through the construction of dams, reservoirs, and diversion channels (Postel 1986). Under an integrated approach, sustainable water management can be achieved through a

combination of demand management, waste reduction and improved water allocation procedures (World Water Council 2000). In an examination of water management at a global scale, the World Water Council (2000, 63) argued that "integrated water resources management should be the philosophical approach, based on participation, full-cost water pricing, private sector involvement, and respect for the integrity of ecosystems." While the implementation of these elements will hasten water efficiency and, thus, more sustainable use of water resources, the completion of this task remains a significant challenge for water management agencies.

In competition for scarce governmental resources, financing for water projects in the future will become increasingly difficult (Shrubsole and Tate 1994). Planning and managing for an increase in demand is essential, yet many municipalities are grappling with the challenges of simply remediating and rehabilitating the existing infrastructure (Pearce and Quinn 1996; Bianchin 1999). In response to the financial stress caused by these large infrastructure projects, "increasingly, municipalities around the world are turning to conservation and other approaches which increase water use efficiencies as integral components of long-term planning" (Postel 1994: 16). Typically, implementing water conservation strategies are less costly than traditional water supply construction projects (Postel 1986; Postel 1994; Waller and Scott 1998; Bianchin 1999). In order to achieve greater water conservation, there is a need for municipalities to reform their management of water. However, this transition will not be easy.

Although responsibility for water management is divided between federal, provincial, regional, and municipal levels in Canada, this report concentrates on the regional and municipal levels. Croockewit (1999) reviewed the roles and responsibilities of senior governments for residential water conservation in British Columbia. The present research focuses instead on the municipal level of analysis as "it is the municipalities that are closest to most water consumers, and it is at this level that most of the opportunities for water conservation exist" (CMHC 1997, 2). Even though municipalities play an essential role in water conservation, the division of responsibilities for water management places some real limitations on the potential of local water conservation initiatives. For example, except for the city of Vancouver, municipalities in British Columbia may not adopt a policy promoting efficient plumbing fixtures that is inconsistent with the standards established in the provincial *Water Conservation Plumbing Regulation*.

Prior to discussing the fundamental elements of a water conservation strategy, it is important to have a sound understanding of the concept. The terms 'water conservation' and 'water efficiency' are often used interchangeably in the literature. Although these terms are very similar in seeking a reduction in water use, there is an important distinction. Trumbo et al. (1999, 1270) found that "the act of water conservation can be seen as socially altruistic . . . a feeling of personal responsibility is a strong factor in this behavior." In essence, water conservation appeals to the personal ethics of the water users while the term water efficiency inspires no such personal commitment. Water efficiency "means decreasing water losses in unproductive directions or increasing supply from lost

resources" (Abu-Taleb and Murad 1999: 94). Thus, these two terms suggest different connotations. Water conservation engages an individual's sense of personal responsibility to consume less water and through the implementation of a variety of water conservation mechanisms to reduce the aggregate demand for water, without the goal of reducing economic costs. Water efficiency seeks to eliminate system waste and inefficiency with the principal objective of achieving an economic benefit (Waller and Scott 1998). To avoid any confusion, this report adopts the following definition: "water conservation is any socially beneficial reduction in water uses or in water loss" (Baumann, Boland, and Sims 1984, as cited by Shrubsole and Tate 1994, 4).

Water conservation has been found to be a cost-effective way of decreasing the cost of the overall water system. When comparing demand and supply approaches, it is important to consider all of the implications associated with each of these approaches. Using the supply approach, financial costs are associated with the construction of a facility, installation of additional infrastructure, and the operation and maintenance costs. By contrast, the demand approach produces reductions in water consumption "to meet existing and projected growth in the demand for water, avoid additional supply acquisition, treatment and system expansion costs and to allocate limited supplies during drought" (Michelsen et al. 1999, 593). Many water conservation mechanisms, as a part of demand management, have been found to have a payback period of two weeks to 10 years (Waller and Scott 1998). This payback period is based on the assumption that these mechanisms will achieve enhanced savings for customers by reducing their water bills.

Although it is obvious that a monetary argument can be made to support water conservation initiatives, there are also environmental and social benefits. Waller and Scott (1998) highlighted a number of nonmonetary benefits which include: decreased pollution, maintenance of aesthetic viewscapes, enhanced habitat for fish and wildlife, and reduced uncertainty about future water supply options. While the environmental and social arguments in favor of water conservation may not be as convincing to decision makers as the monetary argument, integrating all of elements in environmental management decisions is a necessary step on the path toward sustainability.

Even though there must be an initial capital investment in water conservation mechanisms, the construction, infrastructure, and operation and maintenance costs of a new water supply are avoided or deferred. Effectively, the implementation of water conservation acts as a new source of water supply (Morris et al. 1997). Additionally, capital and operational costs associated with wastewater infrastructure and treatment facilities can also be avoided or deferred (Waller and Scott 1998) as there will be no increase in the aggregate volume of water used, unless significant growth in population occurs. Research by McDaniels et al. (1998) indicates that residents of the Lower Fraser Basin, including GVRD, have stated a willingness to undertake activities to further conserve water in the region. Optimism associated with this finding should be tempered as de Oliver (1999) argued that there might be considerable difference between a populations' attitudes and its actions.

Public and Private Water Utilities Issues

The involvement of the private sector in providing water service is not a new occurrence. It was quite common to have a combination of privately and publicly owned water utility networks during the early industrialization period (Marvin et al. 1999). Interestingly, the roots of the GVRD water system originate within the Vancouver Waterworks Company, a private firm that transmitted water from the Capilano River to Vancouver starting in 1889 (GVRD 1997a). As a result of development pressures, and a desire to protect the public interest, many private water companies were taken over by municipalities (Fauconnier 1999). Frequently, public ownership of a water utility has produced "low rates of cost-recovery, low productivity, high debt burdens, . . . and ultimately low service quality and coverage" (Fauconnier 1999, 38). This poor performance has lead to the consideration of innovative institutional arrangements to provide drinking water services for municipalities (Fauconnier 1999).

In particular, a number of global organizations have suggested, among other recommendations, an expanded role for the private sector in providing drinking water supplies. These agencies include: the United Nations, the World Water Council, the World Bank, and the Organization for Economic Cooperation and Development. Presently, there is a worldwide trend towards privatizing water utilities (Milburn n.d.). However, an important distinction between this renewed interest in private sector involvement and its predecessor must be made. The original private companies were entirely locally oriented and had a strong

interest in the community's wellbeing, whereas the current companies are global in orientation and likely have little interest in the wellbeing of local communities.

Recently, a rich debate on the issue of privatization of public utilities has developed. The privatization of water utilities in the United Kingdom (Marvin et al. 1999), Australia (King and Pitchford 1998), and France (Fauconnier 1999) has produced a rich record of privatization experience. Some of these experiences have achieved positive results such as in France, while others have produced few positive results as in the United Kingdom, yet customers have encountered rate increases. Although engaging in the debate surrounding privatization of public utilities exceeds the scope of this study, it is essential to have at least some understanding of the advantages and disadvantages associated with private sector involvement in water services. It is important to review the types of institutional arrangements involving private sector participation. The various types of institutional arrangements are presented in figure 2.2.

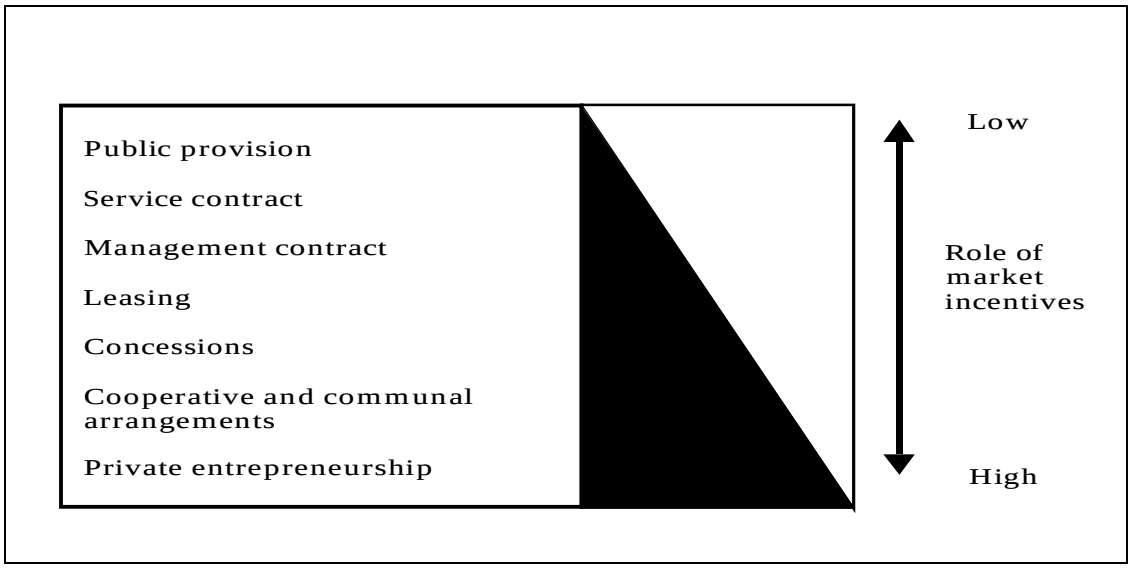

Figure 2.2 Institutional arrangements by degree of public and private sector responsibility (Source: Kessides 1993 as cited by Lee and Jouravlev 1997).

Involving the private sector in providing an essential service, such as water, is seen as a highly political issue and has produced a polarized debate. The principal advantages and disadvantages of private sector participation in this sector are presented in Table 2.1. It is important to realize that many advantages of private sector involvement correspond to criticisms of the public sector which has been seen "as inefficient and overstaffed, unaccountable, union-dominated, stagnant, uncompetitive, and failing to innovate" (Marvin et al. 1999, 102). In Canada, most water utilities are publicly owned. Thus they never face bankruptcy or competition, reducing the pressure for efficient operation (MacLaren 1997). As this statement indicates, there are problems with public ownership of water utilities. However, there are potential problems with private

Table 2.1 Advantages and disadvantages of private sector involvement in municipal water services

Advantages	Disadvantages
Construction cost savings	Loss of local control
Procurement and scheduling efficiencies	Lack of social or environmental objectives
Liberation of public funds for other purposes (health, education, etc)	Cherry-picking (providing only profitable services)
Operational savings	No public interest ethic
Tax benefits	Loss of democratic participation
Debt capacity	Inflexibility of long-term contracts
Greater access to capital in the private markets	Potentially negative impacts on social equity
Performance guarantees	
Efficiency gains from streamlined, profit-driven operations	
Better cost-recovery	
Increased interaction with customers	
Increased entrepreneurial activity	
Increased competition	

(Sources: Milburn, n.d., 3; Grigg 1996, 187; Fauconnier 1999, 56; King and Pitchford 1999, 316; Marvin et al. 1999, 102; and World Water Council 2000)

ownership as well. While private water utilities may achieve enhanced efficiencies in operation and financing, there is no evidence to show that they enhance social equity (Fauconnier 1999).

The bulk of academic literature produced on the topic of privatization has researched econometric or regulatory elements of the process (Marvin et al. 1999). Recently, theories have emerged that try to explain the variance in performance achieved by public and private utilities; however, these difference are not yet fully understood (King and Pitchford 1998). Nevertheless, much of the present research examines the economic impacts of privatization, such as: water rate increases, rising utility profits, and decreasing levels of customer service. While many such studies exist, there is a paucity of research investigating the environmental, social, and spatial effects of privatization (Marvin et al. 1999). The omission of these elements is curious, as "all aspects of the functioning of cities and regions rely intensely and continuously on such [utility] networks at every stage, [yet] they are largely invisible and ignored in debates about contemporary urban and regional development" (Marvin et al. 1999, 101). The infrastructure provided by these utility networks is the basic foundation upon which cities are constructed and operate (Marvin et al. 1999). Perhaps these elements have not been sufficiently studied because the social, environmental, and spatial impacts of privatization had not be predicted and problems are only now beginning to manifest themselves.

CHAPTER 3 - METHODOLOGY

Evaluation research provides the main methodological framework for this study. Within this framework, specific methodologies were used to provide the data and information necessary to answer the research questions. This research utilizes a case study approach to organize and analyze the data from the study areas. A literature search was undertaken as an essential step in tracing the history and background of the research problem and to provide a context for the results of this study. Protocols of survey research were used in dialogue development and applied to the personal interviews initiated for the study. Analysis of documentation from each of the case studies produced data related to key water system characteristics and water consumption. Once the interviews were completed, comparative analysis was applied to the results of the personal interviews, document analysis, and the literature review that jointly comprise the study. These three sources of data were used to 'triangulate', or cross check, the research results. To gain an understanding of the procedures involved with these methodologies it is appropriate to explore their respective applications.

Research Framework

Evaluation is an activity that is closely tied to the monitoring of performance for a wide variety of policies, programs, and projects. While monitoring is a practice that describes conditions and explains relationships, evaluation often involves an assessment of efficiency, effectiveness, or equity (Mitchell 1997). In essence, evaluation is "the process of assessing whether or not desired or undesired

outcomes have been reached, of specifying or explaining the outcomes that were reached, and of suggesting new strategies and definitions of future problems" (Rich 1979, 11). In conducting evaluation research, the aim is to detect weaknesses in the activity under study through systematic and empirical data collection and analysis (Patton 1990), with the aim of rectifying the deficiency in future activities or decisions (Mitchell 1989).

Evaluation research assesses the progress of a particular policy, program, or project in achieving goals or objectives and determines the variables responsible for the success or failure of the initiative (Weiss 1975a). In this sense, evaluation research is inherently applied research as "the purpose of the research is to contribute to knowledge that will help people understand the nature of a problem so that human beings can more effectively control their environment" (Patton 1990, 153). As applied research, it aims to find innovative solutions to real-world problems (Patton 1990). In order to accomplish this, an assessment of the current state of affairs is necessary, thus creating the fundamental link between evaluation and applied research. For this evaluative study, the goal or objective is an effective water conservation initiative and the variables used to judge success or failure are best management practices for water conservation.

At the core of most evaluation research is the examination of how effective a given policy, program, or project is in achieving its goals and objectives. This goals-based evaluation is the classic model for evaluation research (Patton 1990). While this goals-based model has guided much evaluation research, "often program objectives are far too generally stated to permit accurate assessment,

conflicting goals exist, and different staff members have yet other ideas about the objectives" (Twain 1975, 38). Despite these challenges, outcome criteria can be identified that are operationally defined and have the requisite specificity to measure performance and operationalize an evaluation (Twain 1975). In this study, the outcome criteria used to conduct the evaluation are best management practices for water conservation. Best management practices (BMPs) are activities that have been demonstrated to decrease water consumption and reflect the best available measures that are economically feasible for most water utilities to adopt. Additionally, these BMPs are operationally defined, specific criteria that enable an accurate evaluation of urban water management. These BMPs can serve as proxies for goals and objectives, which may be different for each water utility, and provide a standardized measure for this evaluation.

With an understanding of the definition and purposes of evaluation research, it is appropriate to consider evaluation within a broader policy framework. The principal outcome of evaluation research is to improve or enhance decision making (Weiss 1975a; Patton 1990). While the purpose of evaluation research is to improve decision making, this process does not occur in a political vacuum. The policies, programs, and projects that are being evaluated have "emerged from the rough-and-tumble of political support, opposition, and bargaining; and attached to them are the reputations of legislative sponsors, the careers of administrators, the jobs of program staff, and the expectations of clients" (Weiss 1975a, 14). Clearly, evaluation research can be viewed as a threat to the status quo, which may produce resistance on behalf of the participants.

The connection of evaluation research to the policy making process is based upon two important assumptions. These are "(1) that reforms in current policies and programs will serve to improve government performance without drastic restructuring and (2) that decision-makers will heed the evidence and respond by improving programming" (Weiss 1975a, 22). If these assumptions are correct, then the conclusions and recommendations outlined in evaluation studies should stand a legitimate expectation of receiving due consideration in the policy-making process (Weiss 1975a). Thus, the results of evaluation research should ideally influence the adjustment, modification, or alteration of policy decisions (Rich 1979). However, given the highly political context of this type of research, these expectations may be unwarranted.

Within the framework of evaluation research, the case study approach has a distinctive role in providing guidance in the design of an inquiry (Yin 1989). In particular, case studies are valuable in evaluations where the purpose of the assessment is to highlight distinct differences between case studies (Patton 1990). The appropriate conditions for employing a case study approach have been outlined in the following passage by Yin (1989, 23):

> A case study is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when—the boundaries between phenomenon and context are not clearly evident; and in which—multiple sources of evidence are used.

As an approach to social research, case studies offer significant flexibility and adaptability in the research process (Rose 1991). Case studies produce detailed information that can be particularly useful for researchers, managers, and policy makers and may develop into an exemplar of the research topic (Patton 1990).

This information can also be informative as to potential barriers to effective, efficient or equitable management.

Unlike the traditional quantitative approach to social research that seeks a large random sample to generalize about a population, the case study approach adopts a deliberate implement for selecting cases. The choice of a case study can be based on the presence of unique characteristics associated with a particular case. While this may inhibit statistical generalization, it will produce enhanced explanatory value (Rose 1991). The case studies selected for this research (University Endowment Lands, Vancouver, West Vancouver and White Rock) were chosen based on a number of criteria. Within the 22 GVRD municipalities (see appendix II) there are a variety of land-uses, including single-family residential, multifamily residential, commercial, institutional, industrial, large landscapes (parks and golf courses), and agriculture. Agricultural water usage is quite distinct from each of the other types of land uses in scale and water volume consumed. Agricultural water uses have characteristics that are unique and have an associated literature. Since the research interest in water use in GVRD is primarily urban water conservation, municipalities with significant agricultural land uses were eliminated. Using the GVRD municipalities as the boundaries for this research, case studies were deliberately selected to ensure representation of public and private water utilities and metered and unmetered customers.

The comparison of public and private water utilities is the core of this study. Thus a multiple-case study design was selected. In this way, a logic of comparison is incorporated into the research design. In order to ensure that this

comparison is just, it is important to define units of analysis that are common to all of the case studies. The units of analysis for this research are the water conservation initiatives undertaken within each of the case study jurisdictions. By defining the case studies and units of analysis at these levels, it will be possible to compare the results of this study with the findings of previous research in other jurisdictions.

Research Methods

In conducting evaluation research, personal interviews supply much of the required information (Weiss 1975b) and are an appropriate research technique for this study. A personal interview is valuable when a researcher is seeking general information about a region, or when an interview is directed to key contacts who possess specialized information that may not be known to others (Loundsbury and Aldrich 1986). In this study, key contacts were assumed to have data and commentary that were unavailable from general sources and to be able to provide unique insights into the research topic. The personal interview provides greater flexibility than self-administered survey instruments, as the researcher may probe for clarification and elaboration of responses. Normally this method produces more useful information (Singleton and Straits 1999). Although the purpose of a personal interview is to gather new knowledge, the researcher should be adequately informed on the subject so as to be able to discuss the topic knowledgeably and have some means of recording important data and information (Loundsbury and Aldrich 1986). In this research project, a tape recorder was used to keep a record of the discussions, thus permitting a

more complete and accurate account of the interaction. The participation of the researcher in an interview is an important issue, as the results of an interview are derived from the interaction between a respondent and the researcher (Moser and Kalton 1972).

To conduct this research, the semistructured interview was used. A semistructured approach is preferred "when the [research] purpose is to acquire preliminary data in an area in which little research has been done, in order to generate hypotheses" (Singleton and Straits 1999, 252). A semistructured approach sets out specific objectives for an interview and allows the discussion to flow around issues in a free manner rather than being rigidly structured (Patton 1990; Singleton and Straits 1999). The interview is guided by questions or comments that are intended to elicit free discussion on selected topics and provide a broad perspective on the issues in question (Moser and Kalton 1972). This type of interviewing is more flexible than the formal method, yet still covers the essential research elements and collects common information from multiple respondents (Moser and Kalton 1972; Singleton and Straits 1999).

Since there is a general rather than specific focus in semistructured interviews, there are some drawbacks to the use of data and information obtained. Differences in responses, or in the way questions were posed, might make it difficult to compare or aggregate the results (Moser and Kalton 1972). The qualitative, descriptive nature of the interviews inhibits the use of statistical analysis (Moser and Kalton 1972), as does the small sample size. It is also important to note that the results of the personal interviews are filtered through

perspectives, perceptions, and biases of the respondents, who are operating with varying levels of information and understanding of, and interest in, the research topic (Patton 1990). Despite these potential drawbacks, the semistructured interview was adopted as the most appropriate for this research.

In order to fulfill the research objectives, an interview guide was used to focus the discussions. In essence, "an interview guide is a list of questions or issues that are to be explored in the course of an interview" (Patton 1990, 283). The advantage of an interview guide is that common data and information will emerge from interviews with a variety of people, while maintaining significant flexibility throughout the discussion (Patton 1990). The preparation of an interview guide forces a researcher to carefully consider issues to be explored in a study and to decide the best use of limited interview time (Patton 1990). The interview guide used for this research is presented in appendix III.

The interview guide used in this study employed both open and closed questions. Open questions were selected to allow the respondent freedom in discussing issues spontaneously, rather than using preconceived options for answering the question (Nachmias and Nachmias 1976). Such open questions may produce a "veritable gold mine of information, revealing respondents' logic or thought processes, the amount of information they possess, and the strength of their opinions or feelings" (Singleton and Straits 1999, 281). While this characteristic of open questions can be advantageous, it does create a challenge in coding responses and inhibits cross-comparison. To rectify this problem, some closed questions were also included in the interview guide. The response

options supplied to the respondents in closed questions enable a mechanism for coding and standardizing interview responses (Singleton and Straits 1999). While closed questions are effective for cross-comparisons, they are not effective in incorporating serendipitous or spontaneous responses. In considering the advantages and disadvantages of both open and closed questions, a combination of both question types was selected to carry out this research.

In addition to the personal interview, two other research methods were used in this study. Although the procedures associated with these methods are not as involved and rigorous as a personal interview, the data and information generated are just as useful. The first of these additional sources of data and information is the documentation associated with the phenomenon of interest. The collection of documentation should be foregrounded in the research process to ensure that relevant documents are collected (Yin 1989). The analysis of documentation can provide a source of basic information to a researcher (Patton 1990), but also provides a mechanism "to corroborate and augment evidence from other sources" (Yin 1989, 86). In this sense, documentation can be used to support or refute the findings of other data collection methods, such as interviewing (Yin 1989). Documentation analysis may reveal insights that a researcher may not have been aware of prior to examining such documents (Patton 1990). While documentation may be a particularly useful source of data, it is important to be cognizant of biases, measurement errors, omissions, and inaccuracies implicit within the documents (Patton 1990). These drawbacks can be overcome if the documents are examined critically and are not readily accepted as the final and true accounting of events (Yin 1989).

The literature review is another method of data and information collection that is valuable to the researcher. A literature is useful in establishing the status of knowledge on a particular research topic. However, a more mature use of a literature review will examine "previous research to develop sharper and more insightful *questions* about the topic" (Yin 1989, 20 emphasis in original). The literature review provides history and insight into a research topic. A thorough review of the literature will allow a researcher to formulate expected results based on the findings of previous research. These expected results are useful in comparing the results of the present findings with previous findings to determine if there is consistency between the research findings.

Data Analysis

This section deals with the sources of data, the data analysis, and the data presentation. There were two principal sources of data used in this study. Specifically, the sources of data included key officials (see appendix IV for listing of contacts) and documentation originating from water utilities within the case study areas, and the academic and professional literatures for urban water planning and management. Dangers associated with bias in a data set and a narrow perspective introduced by relying on a single source of data can be reduced by including multiple data sources thereby strengthening a study's robustness (Patton 1990).

Each respondent who participated in this research received a consent form and interview guide prior to the interview. The consent form and interview guide

are displayed in appendix III. The purpose of the consent form was to ensure the respondents were aware of the nature of their participation in the research and were provided a formal mechanism to accept or decline participation. The personal interviews supplied detailed data and information about the BMPs for water conservation that had been implemented in each case study. These interviews were also useful in providing a context for the challenges of undertaking water conservation initiatives in a wet climate, such as GVRD. In addition to the interviews, important quantitative data were needed for each of the study areas. In order to collect these data, without taking up important interview time, a separate inquiry sheet was sent prior to the interviews so that these data could be compiled and organized by the respondents. The quantitative data, relating to water consumption in the case studies, originated in both formal documents and informal information sheets and printouts. The number of documents available for analysis was lower than was anticipated.

The analysis of the data involved three main steps. First, units of analysis were identified from the documents and personal communication that took place. The units of analysis for this study were the California Urban Water Conservation Council's 14 best management practices (BMPs) for water conservation (see appendix I). BMPs have been defined as:

> . . . a policy, program, practice, rule, regulation, ordinance or the use of devices, equipment of facilities which meets either of the following criteria:
> a) An established and generally accepted practice among water suppliers that results in more efficient use of conservation of water;
> b) A practice for which sufficient data are available from existing water conservation projects to indicate that significant conservation or conservation related benefits can be achieved;

> that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water suppliers to carry out (CUWCC 1999, 5).

Second, the results of the best management practices analysis were grouped with the water consumption figures for each study area to indicate whether a link exists between BMP implementation performance and the relative water efficiency achieved. Third, the results were compared, based on the private or public nature of the water utility, and considered together with the results of the literature review. The data analysis provides the necessary information to answer the central research question.

Conducting a comparative analysis is a manner of presenting and analyzing the results of the research which groups the results of different cases to answer common questions (Patton 1990, 376). In essence, a "comparison in its broadest sense is the process of discovering similarities and differences among phenomena" (Warwick and Osherson 1973, 7). Comparative research allows a researcher to draw conclusions about system-level traits. That is, only by comparing two or more municipal systems can the effects of the system type be assessed (Manheim and Rich 1991). In the context of this study, elements and characteristics of both public and private water utilities were compared to reveal key differences and similarities.

Using a cross-comparison analytic approach offers an opportunity to use both quantitative and qualitative data. In conducting evaluation research that "requires gathering data from several local sites, quantitative measures may be

appropriate for comparing local programs along standardized dimensions, but qualitative methods are necessary to capture the unique diversities and contrasts that emerge as local programs adapt to local needs and circumstances" (Patton 1990, 102). Essentially, the quantitative data facilitate comparisons between different areas, whereas qualitative data allow for the extraction of the characteristics that are particular to one or another local site (Patton 1990). Thus, the use of both qualitative and quantitative data is desirable and necessary.

In this study, three sources—personal interviewing, documentation analysis and literature review—were used to cross-check, or triangulate, the data in a corroboratory manner. Triangulation is one means of strengthening the research. Through triangulation, "any finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information" (Yin 1989, 97). As there are strengths and weaknesses associated with each of these data origins, using a variety of sources will permit the strengths of one data source to counterbalance the weaknesses of others (Patton 1990). In this sense, one source of data can be used to validate another by confirming or rejecting the results (Yin 1989; Patton 1990; Rose 1991). The key element in this activity is not necessarily to confirm the uniformity of the results, rather to understand why and when differences are manifested (Patton 1990). The results of this research are presented in the following chapter and implications of these findings are discussed in chapter 5.

CHAPTER 4 –STUDY RESULTS

The research findings provide the evidence required to answer the central research question. In order to assess the comparative efficiencies associated with public and private water utilities in the Greater Vancouver Regional District, the research results must identify the characteristics of the water systems and judge performance in implementing best management practices for water conservation. The discussion of each case study is organized around these elements. These results originate from the personal interviews, document analysis, and literature review conducted for this research, and address the supporting research questions. Providing evidence with which to answer the supporting research questions allows the central research question to be addressed with confidence.

Characteristics of the Water Utilities

The main research purpose was to determine the relative efficiency of public and private utilities in providing a sustainable supply of high quality water. In conducting a comparison between public and private water utilities, and to ensure that this comparison is just, the characteristics of each of the study areas, and the characteristics of their water systems, were collected. These characteristics are displayed in Table 4.1 below. This table facilitates the detection of distinguishable differences and permits comparisons between the study areas. Some of the differences detected within this table require further elaboration, and are discussed and explained in the remainder of this section. These differences relate to water system networks, business practices, and water treatment.

Table 4.1 Water system characteristics of the study municipalities

Characteristic	GVRD			White Rock
	UEL	Vancouver	West Vancouver	
Population (1998)	7253	554 062	42 785	17 738
Water Source	Surface	Surface	Surface	Ground
Utility	Public	Public	Public	Private
Water Use: Lpcd (1998)	439	651	771	303
Water Use: ML / Day (1998)	3.2	345	33	6.6
Water Use: ML / year (1998)	1168	125 925	12 045	2392
Water Consumption: Residential	7%	50%	N / A	78%
Water Consumption: ICI	87%	35%	N / A	22%
Water Consumption: Parks	0%	5%	N / A	0%
Water Consumption: Other	6%	10%	N / A	0%
Metering: Single-Family Residential	Yes	No	Some (9%)	Yes
Metering: Multifamily Residential	Yes	Yes	Some(9%)	Yes
Metering: ICI	Yes	Yes	Yes	Yes
Percentage of Metered Connections	100%	56%	N / A	100%
Wholesale Cost	$\$0.178 / m^3$	$\$0.178 / m^3$	$\$0.178 / m^3$	N / A
Retail Pricing: Single-Family Residential	Uniform Commodity Rate	Flat Fee	Flat Fee or Inverted-Block Rate	Base-Excess Use Rate
Retail Pricing: Multifamily Residential	Uniform Commodity Rate	Uniform Commodity Rate	Flat Fee or Inverted-Block Rate	Base-Excess Use Rate
Retail Pricing: ICI	Uniform Commodity Rate	Uniform Commodity Rate	Inverted Block Rate	Base-Excess Use Rate
Testing: Chemical	Weekly / Annually	Weekly / Annually	Weekly / Annually	Annually
Testing: Bacteria	Daily	Daily	Daily	Monthly
Treatment-Disinfection	Chlorination or Ozonation	Chlorination or Ozonation	Chlorination or Ozonation	None Required
Violations of CDWQG	Yes	Yes	Yes	No
Water Shut-off Policy	No	No	No	Yes

Water System Networks

There are two different approaches to the provision of water services that exist in GVRD. One approach involves public ownership of the water supply system, transmission system, and distribution system while the other approach places these systems within private utilities regulated by the provincial government. Assessing the relative performance of these two types of institutional arrangements is the focus of this study. Prior to discussing differences among the study areas, it is important to have a good understanding of the context of these two institutional systems.

In the public system, drinking water is managed by both the regional and municipal governments. There is a very clear distinction between the responsibilities of each level of government. The regional government is responsible for the source water supply areas and for the transmission system to each of the municipalities serviced. It is GVRD's role to transmit water from the three reservoirs in the North Shore mountains to the boundaries of each of the member municipalities. Once the water is received from the regional government, the member municipal government distributes it to each residential, commercial, institutional, industrial, agricultural and other consumers within its boundaries. Each municipality is responsible for servicing its distribution system and is responsible for the rate setting and billing policies for each kind of client. Municipalities also determine when to adopt water meters, which water conservation practices will be undertaken, and for which sectors. In contrast with the public water systems, the private water company, White Rock Utilities

Limited, is responsible for all aspects of its operations: the water supply system, the transmission system, and the distribution system in White Rock.

The source water for 99% of GVRD's 2 million residents is supplied from the Capilano, Coquitlam, and Seymour Watersheds in the mountains north of the Greater Vancouver Regional District (fig. 4.1). These watersheds encompass more than 58 500 hectares of mountainous forest which supply three reservoirs (GVRD 1997a). Rain and snowfall from these watersheds provide the principal water inputs into the reservoirs. To prevent the risk of human-associated contamination of these surface waters, all of these watersheds are closed to the public and access is carefully controlled to protect water quality. Given that GVRD is located in a wet climate, there is an abundance of source water available during the winter, the season with the greatest amount of precipitation; the water supply depletes as precipitation drops and consumption rises during

Figure 4.1 Coquitlam Reservoir of the GVRD water system

summer. The GVRD water utility network includes: six dams, 22 distribution reservoirs, 15 pumping stations, and over 500 kilometers of piping (GVRD 1997a).

The system operated by White Rock Utilities Limited, which serves approximately 18 000 residents, is miniscule in comparison with the GVRD water system. White Rock Utilities was established in 1913, as a drinking water service provider, and predates the incorporation of the City of White Rock by 44 years. White Rock Utilities serves the municipality by pumping a series of six wells located throughout White Rock. These wells, ranging in depth from 60 to 150 meters, were drilled between 1946 and 1991 and supply concrete reservoirs on the surface (fig. 4.2). The utility has over 70 kilometers of piping to transmit and distribute water directly from the wells to residential and commercial customers.

Figure 4.2 A concrete reservoir of the White Rock Utilities water system

Business Practices

The GVRD water system must operate on a not-for-profit basis, in order to comply with provincial regulations, and accordingly water is delivered to the municipalities at a rate that covers the costs associated with the water supply system. The municipalities, in turn, establish rates and billing policies for their clients. The types of billing practices are listed in table 4.1. Exact rates charged to consumers are dealt with in detail under BMP 11 in the best management practices section of this study. Just as the GVRD water system is regulated, White Rock Utilities is regulated by the BC *Water Utility Act* and the *Utility Commission Act* administered by the Utility Regulation Section of the British Columbia Ministry of Environment, Lands and Parks. White Rock Utilities is permitted a maximum 12 percent return on equity on an annual basis and has its water rates set by the regulator. White Rock Utilities is the only case study that has the authority to shut-off water service for nonpayment or water wastage, although all of the case studies have mechanisms to achieve this result. Practices such as reducing water pressure, withdrawal of nonessential services such as garbage collection, or installation of water meters may be undertaken by public water utilities to encourage payment of overdue accounts.

Water Treatment

Prior to deliveries to member municipalities, GVRD uses a combination of ozonation and chlorination to disinfect the water and ensure its quality for domestic consumption. GVRD tests for a variety of chemical, physical, and microbiological properties that may take place daily, weekly, or annually

depending on the parameter. For example, turbidity and coliform are tested daily, iron and ammonia levels are tested weekly, and organic compounds, volatile organic compounds, and radiological characteristics are tested annually (GVRD 1998). While GVRD water is generally reliable, "Greater Vancouver is the only major centre in Canada whose water does not consistently meet the Canadian Drinking Water Quality Guidelines" (GVRD 1997b). GVRD has initiated a number of projects to address this problem, including: source water filtration plants, new transmission facilities, and the use of ozone for primary disinfection (GVRD 1997a).

White Rock Utilities tests for coliform levels on a monthly basis and conducts a full chemical, physical, and microbacterial analysis annually. The groundwater supplied by White Rock Utilities is of such high quality that no treatment is required to meet the Canadian Drinking Water Quality Guidelines. While GVRD has closed access to its watersheds to protect the quality of the water, recently White Rock Utilities began to improve the aesthetic appearance of its grounds—by landscaping and creating public art—and by increasing public access to its facilities.

Water Consumption

Just as there are significant differences in the institutions governing public and private water systems, there are also differences in water consumption. To provide a broader context for the water consumption figures for GVRD, it is useful to compare results with other large urban centers, on the west-coast of

North America, that share similar climates. The highest average water consumer is Vancouver (615 Lpcd), followed by Victoria (545 Lpcd), Portland (513 Lpcd), Seattle (428 Lpcd), and San Francisco (393 Lpcd). Each of these cities are comprised of public water providers, similar to GVRD; however, all of these other jurisdictions meter universally and charge volumetrically.

In comparing water consumption between the water utilities within GVRD, there are two important elements that must be considered. First, as was highlighted in chapter 2, global demand for water over the last 50 years has increased more rapidly than growth in population. The population growth rates and water consumption rates for the four case studies are presented in figures 4.3-4.6 on the following pages. What is important to recognize in each of these graphs is that the increase in water consumption is approximately the same rate as the increase in population. Second, there is a wide range in per capita water consumption among the public water utility jurisdictions.

A comparison of water consumed in each of the case studies, one of the key indicators for effective urban water management, is presented graphically in figure 4.7. An effort was made to collect data for each of the study areas for the same period. However, reliable data sets for water consumption were not available. Accordingly, the data sets in figure 4.7 display the amount of water consumed per capita per day for each of the study areas over different time periods. In examining the comparative water consumption figures, it is important to consider both the comparison between public and private utilities and the comparison between metered and unmetered utilities.

All four of the study areas use these aggregate and per capita water consumption figures to assess performance in water conservation. As one respondent noted "it is the easiest and most universal statistic when you are trying to compare yourself with other jurisdictions." Lack of universal metering also complicates the collection of water consumption data, resulting in a significant amount of guesswork associated with allocating water usage by sector, by season, or by time of day. Indeed, "this aggregate figure hides numerous factors and needs careful analysis" (Poyner 1998, 42). Researchers have found that the lack of accurate data and substandard documentation surrounding the implementation of the water conservation initiatives hinder the ability to test for the effectiveness of specific programs (Michelsen et al. 1999, Poyner 1998).

In addition to program-related variables, the recording of other demand conditions—such as price, temperature and precipitation—is an important component of studying effectiveness (Michelsen et al. 1999). Perhaps the clearest message received from reviewing the literature is that researchers have long lamented the inability to conduct proper effectiveness studies that evaluate various water conservation mechanisms due to the absence of accurate data collection and record keeping activities.

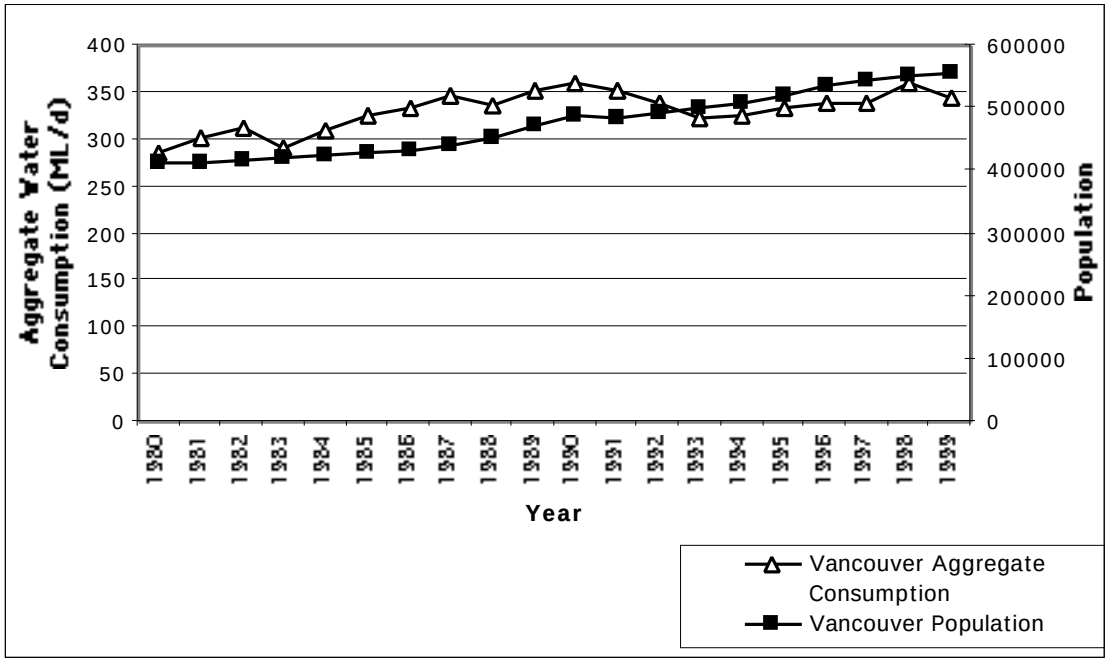

Figure 4.3 Water consumption and population in Vancouver

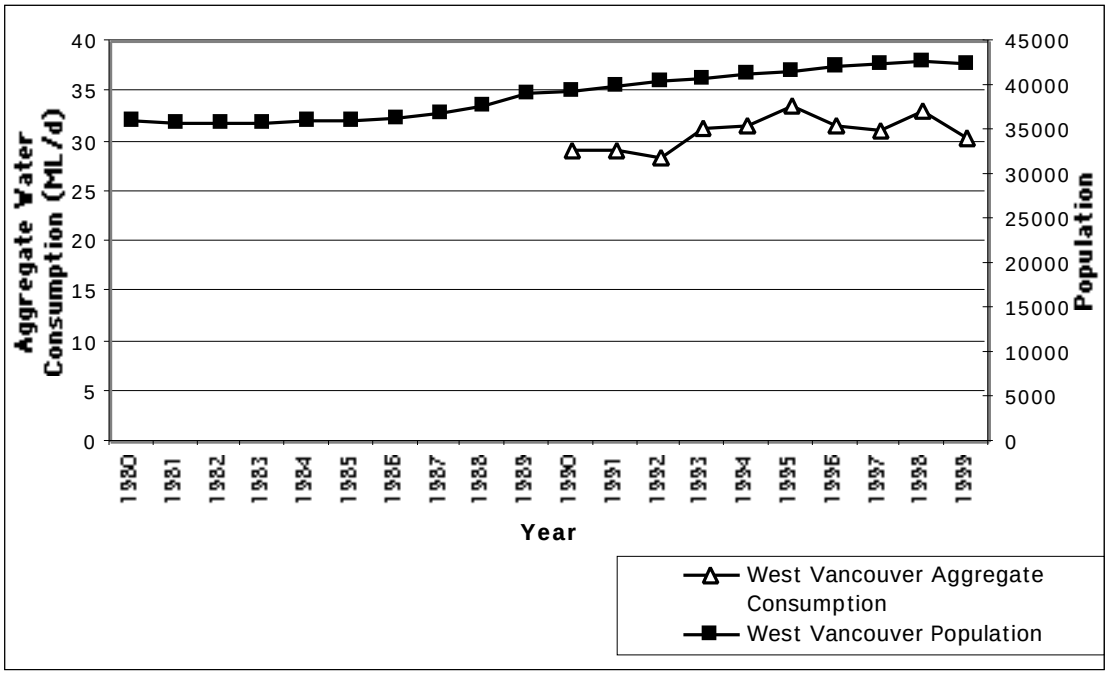

Figure 4.4 Water consumption and population in West Vancouver

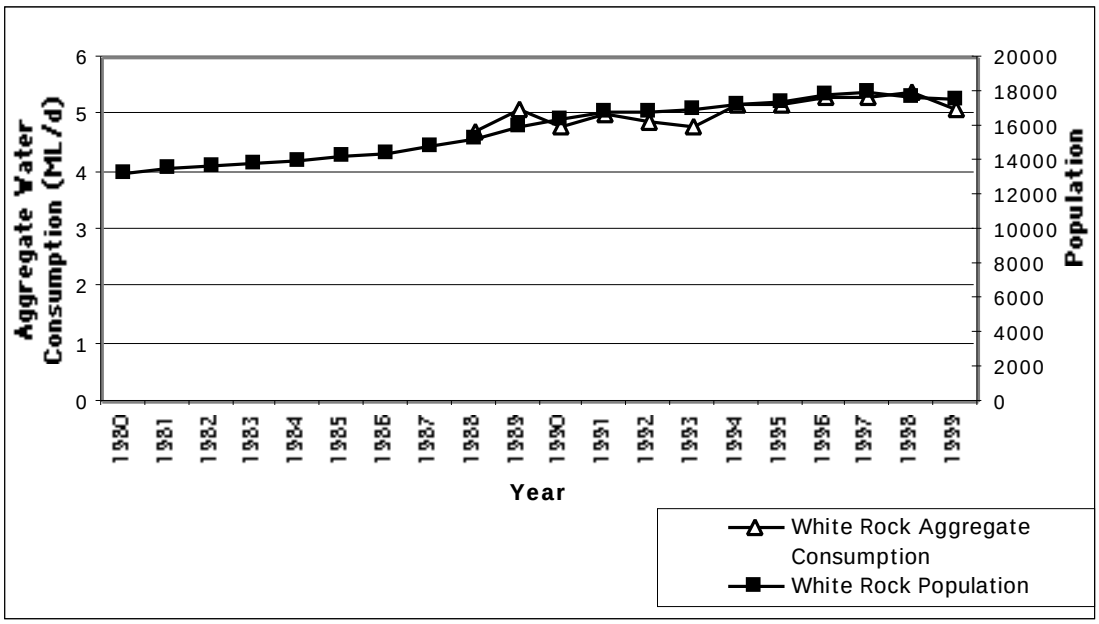

Figure 4.5 Water consumption and population in White Rock

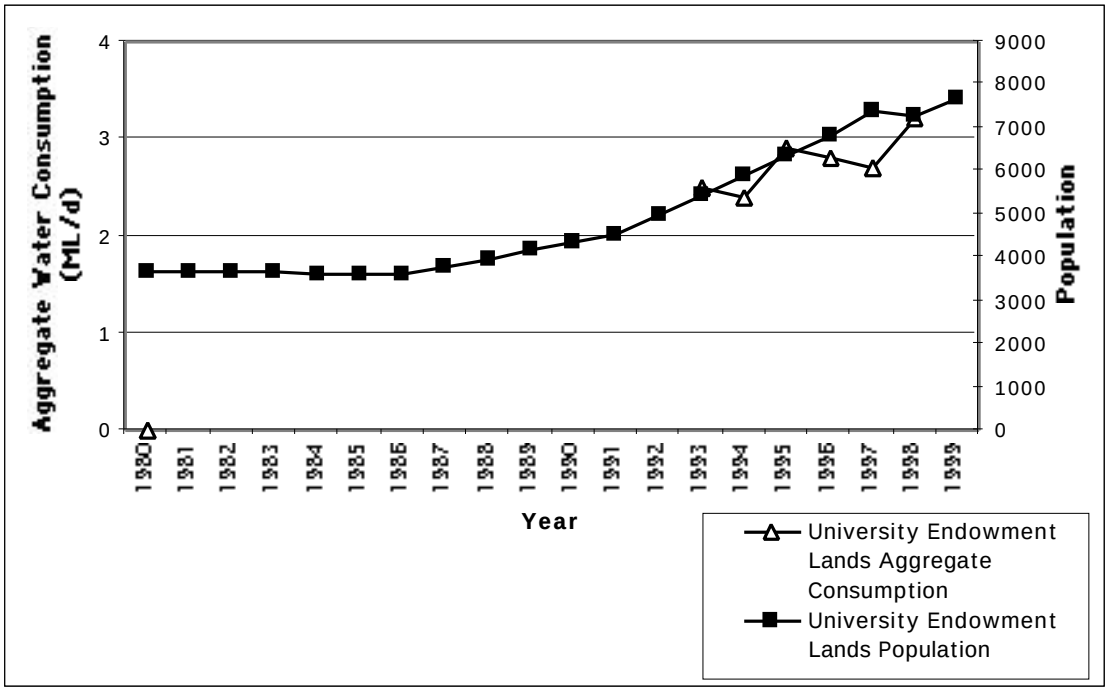

Figure 4.6 Water consumption and population in University Endowment Lands

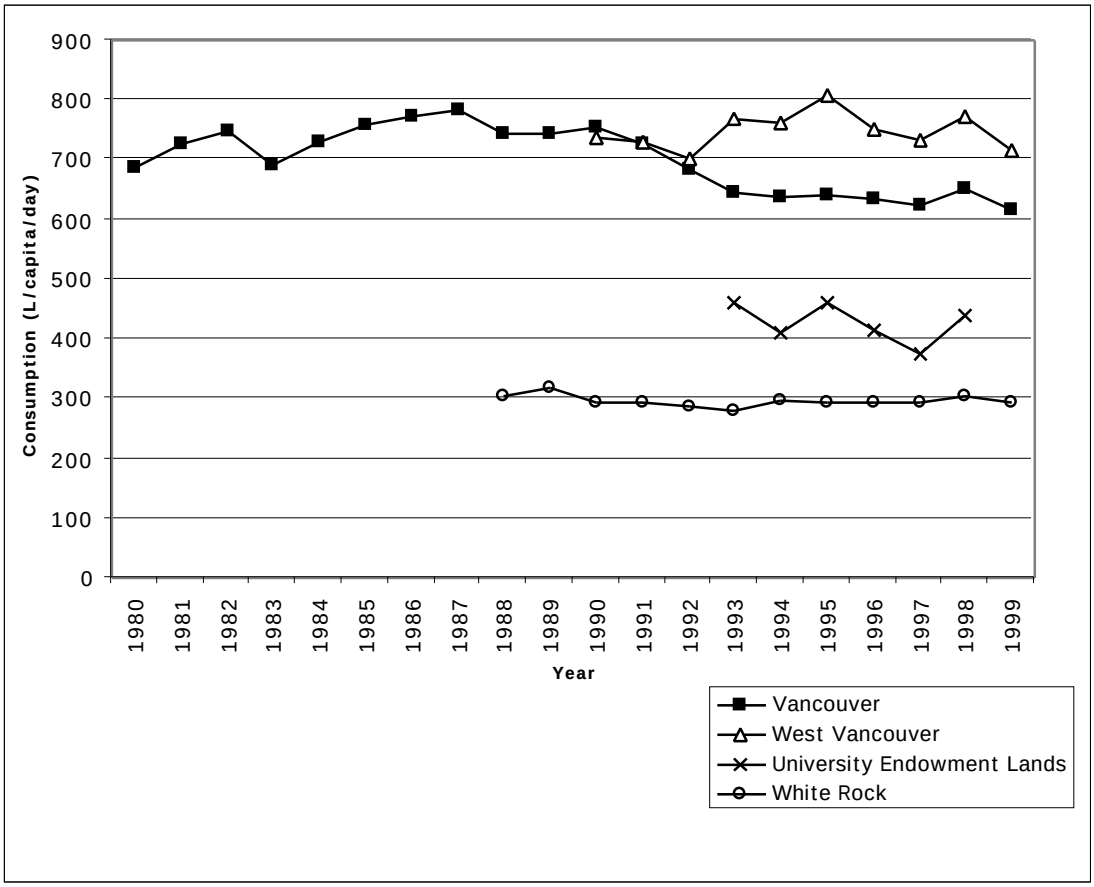

Figure 4.7 Per capita water consumption in the case studies

Best Management Practices

The principal focus of this research was to determine which best management practices for water conservation have been implemented in the case studies. The California Urban Water Conservation Council (1999) established a series of best management practices and potential best management practices for water conservation as part of its memorandum of understanding regarding urban water conservation. The full list of best management practices is presented in appendix I. Although this listing offers a comprehensive suite of best management practices, institutional and physical differences between California and British Columbia render some of these BMPs inappropriate in British Columbia.

In discussing of the results of each case study in implementing BMPs, it is important to note the rationale for excluding some of the council's best management practices from this evaluation. The water conservation mechanisms currently employed by each case study are listed in table 4.2 according to the appropriate BMP. The results for each BMP are presented in the discussion below. All of this discussion relates to case study activities for water conservation that have been extracted from the personal interviews conducted with water staff in each of the study areas. The details on individual case study water conservation programs emanated from these interviews.

Table 4.2 Best management practices implemented by case study municipalities

Best Management Practice, by number (see appendix I)	GVRD			White Rock
	UEL	Vancouver	West Vancouver	
1 Water survey programs for single-family and multifamily residential customers	None	None	None	None
2 Residential plumbing retrofit	None	Voluntary	None	Voluntary
3 System water audits, leak detection, and repair	All programs	All programs	All programs	All programs
4 Metering with commodity rate for all new connections and retrofits of existing single-family residential connections	All	None	Some (9%)	All
4-Multifamily residential	All	All	Some (9%)	All
4-ICI	All	All	All	All
5 Large landscape conservation programs and incentives	None	Storm water retention Groundwater source	None	None
6 High-efficiency washing machine rebates	N / A	N / A	N / A	N / A
7 Public information programs	Pamphlets	Film previews TV commercials Posters Pamphlets Internet Workshops Community events Landscape and garden demos Rain barrels	Bill inserts Pamphlets	Bill inserts Landscape and garden demos Publications Pamphlets

Continued on next page

Table 4.2—*Continued*

Best Management Practice, by number (see appendix I)	GVRD			White Rock
	UEL	Vancouver	West Vancouver	
8 School education programs	Train the trainer packages	School presentations Train the trainer packages Publications	Train the trainer packages	School presentations Utility tours Curriculum guides
9 Conservation programs for commercial, industrial, and institutional accounts	None	Water conservation programs and audits	None	None
10 Wholesale agency assistance programs	N/A	N/A	N/A	N/A
11 Conservation pricing	No	No	Increasing block rate	Base plus excess rate
12 Conservation coordinator	No	Water Conservation Analyst	No	No
13 Water waste prohibition	No	No	No	No
14 Residential ULFT replacement program	N/A	Mandates ULFTs in new construction	N/A	N/A

BMP 1: *Water Survey Programs for Single-family Residential and Multifamily Residential Customers*

This service, provided by water utilities to their clients, would involve home visits to audit residential water use and highlight the ways that customers may save water (CUWCC 1999). Such residential water audits examine both indoor and outdoor water uses—verifying flow rates, checking for leaks, and developing a watering schedule—to determine where efficiencies can be gained. In GVRD, none of the case studies have implemented a water survey program that audits residential water use.

BMP 2: *Residential Plumbing Retrofit*

In an effort to reduce residential indoor water use, this BMP involves providing mechanisms that reduce the amount of water used by showerheads, toilets, and faucets (CUWCC 1999). The issue of ultra-low-flush toilets will be excluded as it is discussed in BMP 14; however, other toilet displacement mechanisms are included. In the case studies, both Vancouver and White Rock sponsored programs in the past few years that promoted the use of low-flow showerheads, toilet displacement devices, and faucet aerators that water customers could purchase on a voluntary basis. Due to lack of public interest and participation, both of these programs were discontinued.

BMP 3: *System Water Audits, Leak Detection, and Repair*

Using meters on the water distribution network, system water audits are undertaken by water utilities once every three years to locate system losses (Pekelney et al. 1996). Where individual connections are metered, the utility informs the client when losses are occurring on the customer's side of the meter (Pekelney et al.1996). All four case studies have adopted system water audits, leak detection, and repair programs although the installation of water meters is variable. Metering is discussed in BMP 4. In White Rock and University Endowment Lands, where metering is universal, leak detection for all connections is possible and water losses by consumers can be minimized. As either the water utility or the customer will be financially responsible for unaccounted water use, leaks are normally detected and repaired quickly. For

Vancouver and West Vancouver, leaks on unmetered connections are difficult to detect and can go unnoticed by both a customer and the utility.

BMP 4: *Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections*

Universal metering and volumetric commodity rates for water consumption are widely recommended as standard management tools by water utilities (CUWCC 1999). Commodity rates are charges based on the volume of water consumed, an improvement on the annual flat fee system used for many single-family residences in GVRD. Although metering and volumetric billing are used in all four case study jurisdictions, application varies by consumer sector. White Rock and University Endowment Lands meter universally so all consumer sectors are charged by the volume of water used. In Vancouver, industrial, commercial, institutional, and multifamily residential sectors are metered and billed by volume. Single-family homes are not metered, however, and pay an annual flat fee. In West Vancouver, industrial, commercial, and institutional clients are metered and charged volumetrically. However, only new residential clients, and those undertaking approved renovations, are metered and charged by volume. Metering of existing connections is not currently planned.

BMP 5: *Large Landscape Conservation Programs and Incentives*

BMP 5 applies to outdoor irrigation efficiency initiatives undertaken by industrial, commercial, institutional, and mutlifamily residential clients (Whitcomb et al. 1999). Activities associated with this BMP include: landscape

water use surveys, water use budgets, dedicated landscape meters, training, financial incentives, and follow-up reviews. Outdoor water use for single-family residential customers is covered in BMP 1 and is not repeated here. Only Vancouver has developed a large landscape conservation program, but this program applies only at municipal golf courses. For City of Vancouver golf courses, the sources of irrigation water are groundwater wells or stormwater retention ponds. By using these alternative sources, rather than drinking water, golf courses do not deplete the treated GVRD mountain watershed reservoirs.

BMP 6: *High-Efficiency Washing Machine Rebate Programs*

High-efficiency washing machines have a horizontal-axis and presently cost a minimum of CAD $300 more than conventional washing machines. Unlike conventional machines, the horizontal-axis machines consume 50-70% less energy, 30-60% less water, and produce less wear on clothes (RMI, n. d.). Their higher initial cost is recovered rapidly. Normally, this program is implemented when washing machine rebates are provided by a local water utility to support the replacement of appliances. This subsidy helps to offset the cost of installing a water efficient appliance in existing homes. The main benefits generally accrue to clients who are charged for water volumetrically, as they have an economic incentive to increase efficiency in water consumption without experiencing a lifestyle change. None of the case studies have implemented a rebate program for domestic appliances. As product availability is limited, and financial cost can be prohibitive, a champion will be needed to educate the public and politicians about the potential benefits of such a program before it will be widely adopted.

BMP 7: *Public Information Programs*

The promotion of water conservation is an important component in ensuring positive results of water conservation initiatives. In essence, "education is crucial to gain support for conservation and to make people aware of the easy and cost-effective ways they can save water" (Postel, 1986: 20). If the public does not understand or agree with the need to conserve water, implementation of most water conservation mechanisms is bound to fail. To implement such initiatives, water utilities can undertake public education through: speaking engagements, public demonstrations, bill inserts, web sites, and radio and television public service announcements.

As a baseline, GVRD public water utilities are able to take advantage of the information pamphlets and booklets produced by the district, thus providing a minimum level of water conservation information to the public. University Endowment Lands has taken advantage of this public information. West Vancouver has also used this information and recently began using bill inserts to remind customers of the need for water conservation. Vancouver adopted the GVRD information but has supplemented this with innovative materials to convey the conservation message. It has used a variety of media including film vignettes, television programs, posters, demonstrations, the internet, and community workshops. Because White Rock is not part of the GVRD water system, it developed an information program based on material from the American Water Works Association. Most of this information is supplied as

pamphlets and bill inserts, but public demonstrations of water efficient plumbing fixtures and efficient garden watering techniques have also been used.

BMP 8: *School Education Programs*

Engaging students with the message of water conservation will permit a generation of new citizens with greater awareness and concern regarding the excessive level of pressure on this resource. Through school visits, information sheets, and tours of water facilities, students gain a better understanding of the need to reduce the amount of water consumed in urban areas. As with its public information programs, GVRD has developed school education materials that are distributed to member municipalities. These materials include 'train the trainer' packages which provide hints and guides for teachers in integrating the message of water conservation into the classroom. Watershed tours are also provided for school children. In addition to GVRD materials, Vancouver conducts school presentations and distributes information packages to the schools. White Rock has been active in involving school children in water conservation education. Like Vancouver, White Rock conducts school presentations and distributes information packages. White Rock also conducts tours of the water utility and has developed curriculum guides to assist teachers. Additionally, White Rock attempted a series of related education programs, with students taking an active role; sufficient support was not received from schools to continue this program.

BMP 9: *Conservation Programs for Commercial, Industrial, and Institutional Accounts*

Conservation programs for industrial, commercial, and institutional (ICI) clients are similar to programs offered in BMP 1 for residential clients. Water use surveys and incentives are used to show ICI customers how they can become more water efficient and demonstrate incentives for conserving water (CUWCC 1999). Performance targets can be established which will serve as benchmarks for ICI clients to measure their progress towards water efficiency. In examining the case studies, the only municipality that has a significant ICI presence is Vancouver and it is the only case study to have an ICI program. Although University Endowment Lands does supply water to the University of British Columbia, UEL effectively acts as a wholesaler, as the university manages its own water distribution and consumption.

BMP 10: *Wholesale Agency Assistance Programs*

This BMP was exempted from this research because there are, effectively, only two water wholesalers in GVRD. When a greater number of water wholesalers are present, assistance programs consisting of financial support, technical support, program management, and water shortage allocation planning are provided. White Rock Utilities can be considered a water wholesaler to itself. This utility can be assumed to have no need for an assistance program as all functions and responsibilities are performed by one organization. The major water wholesaler is the Greater Vancouver Regional District that has a legislated responsibility to provide water to member municipalities at zero profit. At

present, no program resources or financial incentives are being used to encourage municipalities, the water retailers, to implement water conservation initiatives. Seasonal pricing, a financial incentive that increases water prices during periods of low water storage with a corresponding decrease in prices during periods of high water storage, is an option that GVRD is investigating.

BMP11: *Conservation Pricing*

Implementing a conservation-based price structure, rather than nonconserving pricing, is a minimum step (CUWCC 1999). Although conservation pricing does signal the importance of conserving water to customers, lifeline rates must be available to low-income customers. Lemoine and Cuthbert (1995) identified the following conservation-oriented rates: flat seasonal rates, inverted-block rates, and base-excess use rates (fig. 4.9). These rate structures provide the customer with a financial motivation to consume less water and eliminate waste (Shrubsole and Tate 1994). The rate structures in the case study areas are presented in the table below. According to the Lemoine and Cuthbert (1995) definition, only White Rock and West Vancouver use conservation-based pricing.

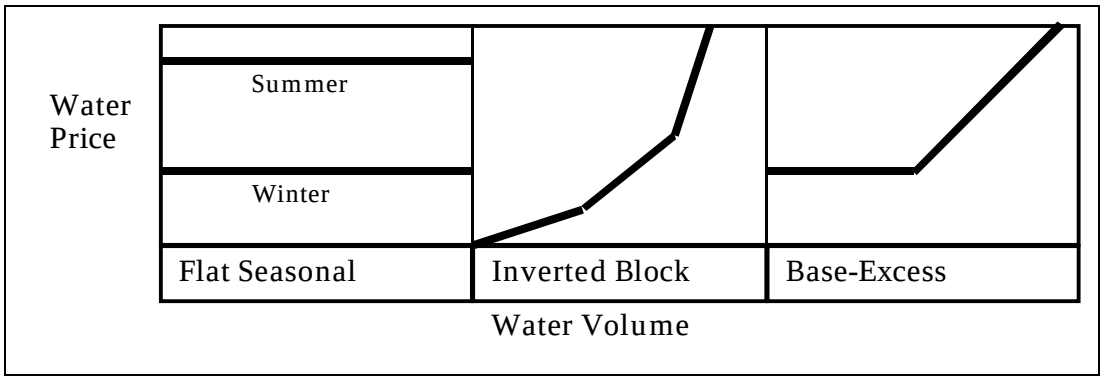

Figure 4.8 Conservation-based rate structures

Table 4.3 Water pricing structures in the study area

Water User Categories	University Endowment Lands	Vancouver	West Vancouver	White Rock
Single-Family Residential	$0.424 / m^3	$256 / year	· $251 / year · $0.25 / m^3 for 1st 100m^3, then $0.34 / m^3 (min $7 / month)	$12.75 / month for 1st 14$m^3$ + $0.424 / m^3 excess
Multifamily Residential	$0.424 / m^3	$0.4384 / m^3	· $251 / year · $0.25 / m^3 for 1st 100m^3, then $0.34 / m^3 (min $7 / month)	$4.07 / unit / month for 1st 7m^3 + $0.424 / m^3 excess
Industrial, Commercial, & Institutional (ICI)	$0.424 / m^3	$0.4384 / m^3	$0.25 / m^3 for 1st 100m^3, then $0.34 / m^3 (min $7 / month)	Variable based on meter size + $0.424 / m^3 excess

BMP 12: *Conservation Coordinator*

Implementing this BMP involves the designation of a conservation coordinator and possibly additional staff. Having a conservation coordinator provides a single contact person for residents or businesses seeking information on water conservation. Other responsibilities of the conservation coordinator are: oversight of water conservation activity implementation, communication of progress to senior management, and coordination of conservation programs. Only the City of Vancouver has officially designated a water conservation coordinator. In the other municipalities, the functions of a water coordinator are performed by staff who have many other responsibilities. Within GVRD, the Demand Side Management Division is responsible for water conservation and also reducing demand for solid waste disposal and sewage treatment.

BMP 13: *Water Waste Prohibition*

Essentially, this BMP involves regulating businesses by prohibiting single pass cooling systems and nonrecirculating systems in car washes, commercial laundries, and decorative water fountains (CUWCC 1999). Although not a full prohibition, the City of Vancouver limits the amount of water available to businesses which have not installed recirculating systems. The other case studies have not regulated businesses for this purpose.

BMP 14: *Residential Ultra-low-flush Toilet (ULFT) Replacement Programs*

This BMP can be exempted, as the only GVRD municipality that has the ability to implement an ultra-low-flush toilet program is the City of Vancouver. Through the *Vancouver Charter* (British Columbia 1997), the City of Vancouver mandated the use of ULFTs. All other municipalities in GVRD are governed by the Province of British Columbia under the *Water Conservation Plumbing Regulation* (British Columbia 1998a), which requires the use of low-flush toilets (13L / flush) rather than the ULFTs (6L / flush). Except in the City of Vancouver, a water customer would be out of compliance in installing an ULFT in his or her home or office according to the current plumbing regulation (British Columbia 1998a). The Ministry of Municipal Affairs is considering changing the plumbing regulation to accept ULFTs (Croockewit 1999).

A Role for Water Conservation in GVRD

In order to gain an appreciation of the role of water conservation in a wet climate, such as GVRD, it is important to understand the context of urban water

management. There are benefits associated with the use of water conservation mechanisms, including delaying costly water system expansion projects and postponing environmentally destructive water infrastructure construction (Postel 1994, 16). Using water conservation also avoids wastewater treatment costs. In fact, the cost savings and enhanced environmental protection provide justification for expanding water conservation initiatives throughout GVRD.

Although each study municipality has implemented a water conservation program, however rudimentary, none of them has established specific goals or objectives to gauge their performance. A potential explanation for this may be that it is "only through actual implementation of conservation measures and evaluation of their effectiveness that reliable goals can be set (and also reset) for the long term" (Vicker 1994, 94). In this sense, realistic goals can only be established by implementing water conservation measures and observing reductions in water consumption. Considering that none of the case studies have been carefully monitoring water consumption data, it is difficult to imagine realistic goals being set in the near future. Without specific goals or objectives, it is difficult to conduct a typical goals-based evaluation. Thus, in the absence of these, the use of BMPs as evaluative criteria to measure performance is the only justifiable method available.

While convincing economic and environmental arguments can be made in favor of water conservation, there is a significant barrier that has resulted in decision-makers being reluctant to do more. This reluctance is based on the popular perception that water conservation is unnecessary in GVRD due to the high

precipitation. Although this perception is correct, it does not address the core issue, which is an excessive level of water use per capita compared to other jurisdictions in western North America (see table 4.4), as well as a shortage of water storage capacity. This perception must be overcome before any real progress can be made in becoming water efficient.

Table 4.4 Comparative water systems and consumption for west-coast cities

Jurisdiction	Type of System	Metering	Consumption (Lpcd)
San Francisco	Public	Universal	393
Seattle	Public	Universal	423
Portland	Public	Universal	513
Victoria	Public	Universal	545
Vancouver	Public	Selective	615

An essential tool to help the publics become aware of their excessive level of water consumption is the installation of water meters. In conjunction with volumetric pricing, meters provide a direct financial incentive for consumers to become water efficient and also provide users with a mechanism to gauge their own performance in reducing water consumption. There are implications associated with the use of meters, volumetric pricing, and education in supporting water conservation initiatives. These implications—public resistance, capital expenditure increases, and public involvement in decision-making—are discussed in more detail in the following chapter. Based on the findings presented in this chapter, the next chapter will discuss the implications of the research findings and answer the supporting and central research questions.

CHAPTER 5 – DISCUSSION

The answer to the central research question must be based on the results and evidence from the supporting research questions. Accordingly, these supporting research questions are discussed prior to addressing the central research question. By organizing the discussion in this manner, the central research question can be answered with a greater degree of confidence. In addressing the supporting research questions, it is important incorporate the three sources of data used in this research: literature review, documentation analysis, and personal interviews. Using these three data sources will help answer the supporting research questions with greater insight and reliability.

Distinct Differences

The literature indicates that there should be notable differences between public and private utilities. Most of these distinctions relate to the financial efficiency with which private water utilities are able to operate in comparison to public utilities (chapter 2). Given the scarcity of financial resources, which are currently constraining government activities, the issue of financial efficiency is critical. Despite the importance of economic efficiency, this study is principally interested in the efficiency of resource use, another critical issue. The efficiency of water use is a measure that has significant environmental implications, as destructive supply projects can be deferred as long as possible. The delay or elimination of the need to develop new water supply projects avoids significant environmental losses and large capital costs. Accordingly, efficient water management for a

private utility "is driven not so much by commercial competition between utility companies, but rather by the desire to maximise profitability" (Marvin et al. 1999, 135). Although the incentive to be water efficient is mediated through financial goals, the outcome is that private water utilities seek efficient resource uses. On the other hand, public utilities should be striving for water efficiency in an effort to preserve the environment, as a public policy objective. While the motivations or incentives for public and private water utilities may be different, the result should be the same. Capital expenditures in the form of water supply augmentation projects—and the deleterious environmental impacts associated with them—should be avoided for as long as possible.

Within this framework, distinctions between the case studies are highlighted. There are variations among the case studies on a number of characteristics related to water system networks, business practices, water treatment, and water consumption. Although each of these differences help to understand the water management regimes in GVRD, the difference in per capita water consumption is the most interesting result and provides the most meaningful insight for this research. As mentioned above, the literature indicates an expectation of greater water efficiency with private water utilities than with public utilities, because of the incentive of profitability. This study cautiously supports that conclusion.

Examining the results solely on the basis of water use efficiency is misleading, however. The relative efficiencies of the case study examples need to be discussed. Although the results for University Endowment Lands are variable, and the data record is short, the data reveal that water consumption is

significantly less than the other two public water utilities. In fact, water consumption in UEL is closer to the private utility than the other public utilities. While the difference in water consumption is the key finding, the explanation for this finding is found by examining the second supporting research question regarding implementation of best management practices.

Performance in Best Management Practices Implementation

Using the same rationale as in the previous section, it seems logical that private utilities would have a greater incentive to implement best management practices for water conservation than their public counterparts. The literature indicates a number of examples where implementing a water conservation program has been more cost-effective than developing new water supplies. Thus, a profit-driven private water utility—one responsible for water supply in addition to water distribution—would normally choose water conservation over new supply development, as this is the cheaper of the two options. Accordingly, in the context of this research one could expect that the private case study would have employed a greater number of best management practices than the public utilities. Relating water consumption to best management practice implementation also seems logical. Water utilities with relatively lower water consumption would be expected to have implemented a greater number of best management practices than those with higher water consumption. The results of this research do not support these expectations.

There is a striking incongruency between water consumption and performance in implementing best management practices for water conservation. As expected, the private water utility has relatively low water consumption and a fair number of best management practices have been implemented. However, University Endowment Lands, which also has relatively low water consumption, has implemented few best management practices. On the other hand, Vancouver has been innovative in its water conservation program and a greater number of best management practices were implemented—more than in the other case studies. But in comparison to the University Endowment Lands, Vancouver has not achieved the same reduction in water consumption. This result suggests that perhaps not all best management practices are equal in their effect.

In reviewing the best management practices that have been implemented, the key difference is that the University Endowment Lands and White Rock meter universally and Vancouver and West Vancouver do not. The findings of this research clearly indicate that there is a greater difference in water consumption per capita between water utilities that meter universally and those that do not than there is between public and private water utilities.

Although the installation of meters on all water connections can result in a permanent reduction in water consumption (Brooks et al. 1990), without an economic incentive to reinforce this behavioral adaptation, the reduction may not remain at a significant level. Universal metering, combined with volumetric charges, provide an economic incentive to all water customers that they should become as water efficient as possible (Canadian Water and Wastewater

Association 1997). Such changes demonstrate the potential to conserve water; however, such a decision would be highly controversial and would likely result in public backlash. Thus, in combination with metering and pricing, education is also an important element of a water conservation initiative. As a critic of municipal water management in Canada noted "we need a commitment now to a public information and awareness program directed to enforcing conservation including full cost pricing on a metered bases…no [more] studies – action!" (MacLaren 1997, 49). Prior to exploring the role of the private sector in providing water services further, it is appropriate to examine these three strategies for water conservation in further detail.

Meters

The installation of meters provides the infrastructure that allows water users to record their own water usage. While the ability to track their water usage is an important element for water users, they must also have a cost incentive that reinforces the desired modifications in behavior. Therefore, "an appropriate rate structure for residential use, along with universal metering [are] important, if not essential, part[s] of a water conservation program" (Waller and Scott, 1998: 374). Establishing a conservation-based rate structure and metering will help ensure that water users assume more of the true costs of providing water and wastewater service, in addition to discouraging the overuse of water that occurs with flat fees (Waller and Scott, 1998). The intention is to have water users assume a greater responsibility to paying the actual cost of the resource they use;

however, the tools necessary for achieving this should be provided at the lowest financial cost to the consumer to encourage this activity to take place.

The installation of meters would also serve an important role in detecting leaks. Metering individual units would help locate leaks in the system, as there will be significant differences between adjacent meters. Having meters installed on every water connection also permit greater detail in data and information gathering. While metering can provide detailed water consumption data, commitment from the water utility to record and analyze this data is necessary for monitoring to improve.

Pricing

Pricing of water services can be a contentious political issue. Affordability and access to high quality drinking water are serious social issues that must be balanced against the economic viability of organizations to provide this service and against the environmental impacts of continuing to provide access to the resource. In re-examining the other large west-coast cities, it is clear that these areas decided that conservation-based rate structures were appropriate pricing tools. For example, the City of Portland implemented an inverted block rate structure for all customers and the City of Seattle adopted a combination of seasonal pricing and an inverted block structure. In effect, both of these jurisdictions have taken a serious approach to water pricing, which has not yet been undertaken in GVRD.

An interesting finding emerges from the study related to the two case studies that have implemented conservation-based rate structures. White Rock uses a base-plus-excess rate system while West Vancouver has increasing block rate pricing. Although both of these case studies have conservation-based rates structures, there is a dramatic difference in the water consumption (fig. 4.7). Water consumption per capita in West Vancouver is double the consumption of White Rock. In fact, water consumption in West Vancouver is higher than the other two public case studies, neither of which has incorporated conservation-based rate structures. Clearly the charges for initial water consumption associated with West Vancouver's rate structure are significantly less than the uniform rate charge in Vancouver and University Endowment Lands, and far below the rate in White Rock (see table 5.1). This finding demonstrates that, although implementing a conservation-based rate structure is important, the actual price of the per-meter rate has greater impact on the customer than the type of pricing structure.

Table 5.1 Comparison of water rates in the case study municipalities

	1m^3	10 m^3	50 m^3	100 m^3	200 m^3	500 m^3
University Endowment Lands	$0.42	$4.24	$21.20	$42.40	$84.80	$212.00
Vancouver–Metered	$0.44	$4.38	$21.92	$43.84	$87.68	$219.20
Vancouver–Unmetered	$256.00	▸	▸	▸	▸	▸
West Vancouver-Metered	$0.25	$2.50	$12.50	$25.00	$59.00	$161.00
West Vancouver-Unmetered	$251.00	▸	▸	▸	▸	▸
White Rock-Residential	$0.91	$9.10	$28.91	$50.11	$92.51	$219.71
White Rock-Commercial	$0.42	$4.24	$21.20	$42.40	$84.80	$212.00

The political nature of water pricing makes it critical to set the correct price when a volume-based pricing system is adopted. In setting the correct price, there are two interrelated concepts that must be explored: full-cost pricing and conservation-based pricing. The reality is that the present price of water rarely covers the full cost of providing the service (Poyner 1998), indicating a need to increase water prices. Full-cost pricing is a policy that ensures water and wastewater charges are set so that customers pay all costs of the service provided (CWWA 1997). Costs associated with environmental degradation, energy consumption, and future development, although difficult to quantify, must also be incorporated into the final price (British Columbia 1998b). Waller and Scott (1998, 402) identified the following elements as being key in the evolution towards full-cost pricing:

- strong public education and involvement in the rate setting process;
- basing rates on actual costs of providing water service to each customer class;
- avoiding punitive rates that exceed actual costs in an effort to achieve conservation; and
- gradual implementation of increased rates over time.

A key aspect of pricing is involvement of the public. Consulting and informing the public on the need and rationale for increasing prices will help in securing public acceptance and cooperation (Poyner 1998).

This research reveals a variety of pricing mechanisms are currently in use in GVRD. These include: flat fee, uniform commodity rate, increasing block rate, and base-plus-excess rate. The literature review reveals that customers are much more receptive to water conservation when metering and volumetric charges convey price signals that encourage water conservation (Lemoine and Cuthbert

1995; CWWA 1997). Particular attention must be given to these price signals. If they are set too low, customers will soon habituate to the new price and revert to their previous consumption pattern (CWWA 1997). Perhaps this explains why West Vancouver has a conservation-based price structure yet has the highest water consumption among the case studies and indeed among all urban GVRD municipalities.

Education

Given that GVRD has such a wet climate, the public perception is that water supplies are unlimited. While there is a tremendous amount of precipitation in the region, there are narrow limitations on the regional capacity to store drinking water. As with other regions, the consumption of water increases during summer, the period when temperatures are high and precipitation is slight. These conditions put a tremendous strain on the GVRD water system. It will be important to design and implement an effective public education and communication strategy to narrow the gap in understanding, between water managers and the public, on the nature of water problems (Shrubsole and Tate 1994). Such a program should "focus on conveying methods and the importance of water conservation to consumers" (Michelsen et al., 1999: 597). There are two key messages that must be transmitted to the public. Current water consumption rates are unsustainable and infrastructure costs associated with establishing new water supplies will be borne by the taxpayer, either directly or indirectly. It is important to persuade the public that many water conservation mechanisms would help reduce water usage without a noticeable lifestyle

change for water customers, and over the long-term would be less costly than developing new water supplies. Once the public agrees with this strategy, implementation of water conservation mechanisms will go much more smoothly.

As with the need for broad-scale public education, there is an urgent necessity to educate school-aged children on the importance of conserving this precious resource. Perhaps water conservation education could be bundled with lessons on sustainability, providing a practical message that kids may take home and act on to help 'do their part'. The message that present consumption is not sustainable could be impressed upon children and they could be empowered to help make changes in the future. These children may also convince other family members of the importance of such action, as occurred with recycling education.

Communication and public education are essential to the success of any water conservation strategy. In essence, "education is crucial to gain support for conservation and to make people aware of the easy and cost-effective ways they can save water" (Postel, 1986: 20). Public awareness of water management issues must be enhanced for the public to become sensitive to the potential fragility of this resource (Waller and Scott, 1998), and the social, economic, and environmental implications of water management decisions (Shrubsole and Tate 1994). In addition to increasing public awareness and education on water conservation, innovative partnerships and collaborations should be sought with members of the public to further advance education, program delivery and consideration of creative alternatives. The sharing of human, financial and other

resources amongst the partners will be key to the smooth functioning of these collaborations (Waller and Scott, 1998).

Public-Private Partnerships

In defining an appropriate role for the private sector, particularly in an area where a private sector presence has been limited, questions arise as to how this can best be achieved. The situation in Canada dictates that some form of partnering between the public and private sector is necessary to sustain municipal water infrastructure as municipalities can no longer afford to continue alone (MacLaren 1997). Some smaller communities in Ontario, such as Goderich, have already partnered with the private sector to share the costs of providing drinking water service. MacLaren (1997) found growing interest in British Columbia in public-private partnering for municipal water services. Although private utilities have been shown in the literature, and in this research, to have achieved greater efficiency than their public counterparts, it is important to be aware of differential circumstances that can influence their respective performance. For example, private water utilities, often using groundwater, have inherent economic efficiencies when compared to public utilities which bear a greater cost for transporting and treating surface water (Fauconnier 1999).

Creating roles that can be filled by the private sector has generally involved the unbundling of services from the current monopolies held by public water utilities (Fauconnier 1999). In general, public-private partnerships identify a particular component of water service that can be provided, or identify a

particular area where water services are provided (Lee and Jouravlev 1997). In fact, the idea of involving the private sector in water planning and management within GVRD is not unprecedented. A previous study investigating water and wastewater services in GVRD by Jeyachandran (1998) proposed unbundling specific services that represented appropriate roles for the private sector. In September 2000, GVRD requested proposals for a public-private partnership for a filtration plant on the Seymour Reservoir and is presently investigating the implications of undertaking this initiative.

The unbundling of water utilities can have a significant influence on the urban geography of the region. In effect, a new involvement of the private sector could result in "a process of spatial, institutional and social 'splintering' in the delivery, development and management of utility networks" (Marvin et al. 1999, 97). This process of splintering means that there may be uneven distribution and quality of services being delivered depending on who is providing the services, where the service in being provided, and the customer type (Marvin et al. 1999). This uneven distribution of services may increase the level of social polarization, as profitable markets will normally receive a higher level of service than less profitable markets (Marvin et al. 1999). While private water utilities may place less emphasis on localities that are less profitable, there is an incentive to promote regional development as a means of generating new business (Marvin et al. 1999). Thus, the potential spatial impacts of private water utility policies have major implications for urban development strategies and regional planning.

King and Pitchford (1998) found that the separation of public water companies in Australia, to permit private sector involvement, resulted in a number of problems. To illustrate some of these problems, King and Pitchford (1998, 322) examined the following scenario:

> Suppose consumers notice an increase in water turbidity. To whom do they complain? The water distributor is likely to blame the transmission company, claiming that they receive dirty water. The transmission company will blame the distributor, arguing that the turbidity is due to a broken pipe or high leakage levels. It will be difficult for the customer or a regulator to correctly allocate liability for a reduction in water quality.

Ultimately, the customer will be better served by keeping water companies intact and privatizing the entire water utility, rather than carving off specific services to the private sector (King and Pitchford 1998). In considering a private sector role in providing water services, it is important to acknowledge that implementation has not always met expectations (Grigg 1996). Therefore a strong monitoring role needs to be undertaken by a third party. Issues of social equity—decreasing levels of customer service and dumping of low-income households—and the need for surveillance, suggest that community organizations, with the public's interest at heart, may need to perform a monitoring role (Marvin et al. 1999).

While the private sector may be taking on new roles, the public sector will also need to do the same. Redefining roles in water services will result in:

> . . . freeing the public sector to focus on what only it can do better—make decisions on welfare and the provision of public goods—and freeing the private sector to do what it does better—provide cost-effective services in an accountable and transparent way and mobilize investment (WWC 2000, 22).

An important new task for the public sector will be to provide targeted subsidies to low-income families, thereby fulfilling the requirement of providing for public

welfare while simultaneously signaling to private utilities that each connection provides an equal stream of income (Fauconnier 1999; WWC 2000). This type of system would improve upon the current mechanism of cross-subsidies, which hides the true costs of water and may lead to water wastage (Fauconnier 1999).

A key advantage of private sector involvement in water service provision, noted in the literature, is the introduction of competition. At the operational level, however, this expected increase in competition has not been realized. The characteristics of water infrastructure lead to management of a utility as a natural monopoly where "it is difficult to introduce the sort of competition which might bring innovation" (Milburn, n.d.). There is little sense in duplicating water network infrastructure and an owner may be reluctant to allow a competitor access to one's infrastructure, which has limited opportunities for meaningful competition (Marvin et al. 1999). Although increased competition is possible at a conceptual level, in practice such competition is seldom operationalized. This example demonstrates the need to share experiences with privatizing water utilities, to narrow the gap between conceptualization and implementation.

Efficiencies of Public and Private Water Utilities

In addressing the central research question, it is appropriate to review the outcomes of the three supporting research questions. Distinguishable differences were detected between the characteristics of public and private water utilities in GVRD. The key difference was in water consumption. However, when comparing universal metering versus nonuniversal metering municipalities, a

much more striking difference emerged—namely that metering appeared to account for an even greater difference in consumption patterns than public versus private. Re-examining the water consumption data for the study areas (fig. 5.1) reveals that the difference based on metering is 212 liters whereas the difference based on public or private ownership of the utilities is only 132 liters. Clearly, there is a greater efficiency gain by installing meters and volumetric pricing than by public or private ownership of the water utility.

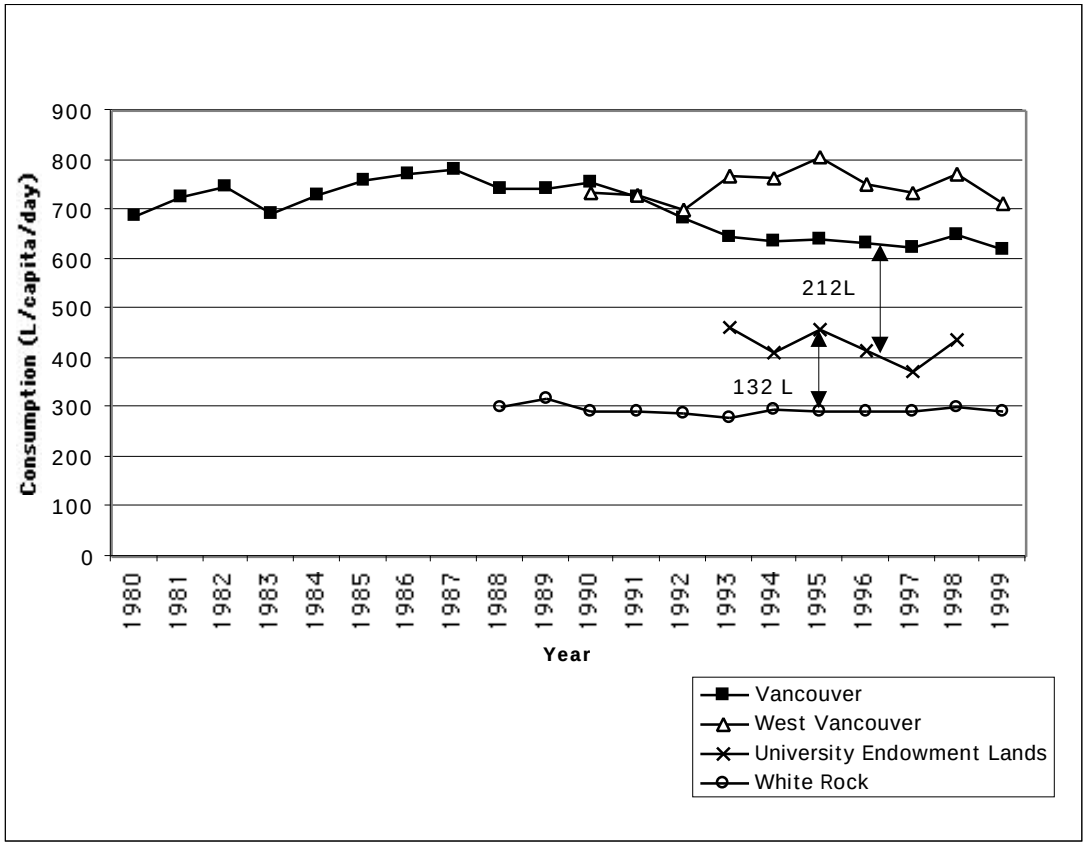

Figure 5.1 Water consumption differences in the study area municipalities

In comparing the relative performance of public and private water utilities in the implementation of best management practices, these results are much less clear. White Rock, the private water utility, implemented a number of BMPs, whereas

University Endowment Lands, a public water utility, implemented few BMPs. Despite this difference, water consumption for UEL is only marginally higher than White Rock. Vancouver also implemented a number of BMPs and has not seen a corresponding reduction in water consumption. These results indicate that while BMPs are a useful tool in measuring the performance of water conservation programs, some BMPs are far more effective than others.

Based on these results, and the answers to these supporting research questions, it is appropriate to answer the central research question. Examining water consumption in water utilities in GVRD indicates that the private water utility has achieved greater water consumption efficiency than public utilities. In using best management practices for water conservation as evaluative criteria, there is evidence that the private utility implemented a number of these, but some public utilities have also made progress. In determining whether public or private water utilities are more efficient at providing a supply of high-quality drinking water, answers can be given at two different levels. The simple answer to this question is that the private utility achieved greater water efficiency; however, there are qualifications associated with this answer. White Rock Utilities Limited has achieved the lowest water consumption and a high number of water conservation BMPs in comparison to the other case study municipalities.

At a more critical level, while the private water utility achieved greater progress in water conservation, it is questionable whether this is the key variable in determining water consumption. The difference in water consumption between the private utility and the other municipality with universal metering is less

substantial. The new drinking water management planning process—being undertaken by GVRD to provide strategic direction on drinking water supplies, water conservation strategies, and to establish goals and objectives for water conservation—may provide a degree of optimism that public utilities have begun planning for water conservation. This optimism must be tempered by the expectation that significant changes to the status quo may not occur. Regardless of the aggressiveness of this specific plan, public utilities have the potential to achieve a similar level of water efficiency as private utilities. The claim that private utilities can achieve levels of economic efficiency that are unattainable for public water utilities does not necessarily reflect itself in water use efficiency.

Monitoring and Data Gathering

Perhaps the clearest message received from reviewing the literature is that researchers have lamented the difficulty of conducting proper effectiveness studies to evaluate the variety of potential water conservation programs. This finding indicates that more sophisticated monitoring and evaluation frameworks need to be adopted. Michelsen et al. (1999: 597) found that "activities were often aggregated in reports without descriptions of individual program efforts, specific dates of implementation or quantitative measure of individual program efforts." The lack of accurate data and information, and substandard documentation surrounding the implementation of the water conservation programs hinder the ability to test for the effectiveness of individual programs (Michelsen et al. 1999). In addition to program-related variables, the recording of other demand conditions such as price, ambient temperature, and antecedent precipitation is an

important component of studying effectiveness (Michelsen et al. 1999). The lack of reliable data sets for the case studies indicates a variable commitment to monitoring water use in GVRD. Since such data provide the principal mechanism for assessing water conservation, as well as evaluating water conservation initiatives, consumption statistics should be recorded with greater accuracy. Without reliable data, it is difficult to ascertain the performance of water utilities in achieving sustainable water use.

In an effort to address some of these challenges noted above, a more rigorous monitoring and evaluation framework should be implemented. Bianchin (1999) proposed that the following elements be included in a monitoring and evaluation framework:

- Review what each initiative is expected to contribute to water efficiency, and what its specific goal is. Concentrate on measurable benefits.
- Define the information necessary for measuring costs and benefits of each initiative and its contribution to overall efficiency. Identify sources where this information may be found and design tools for gathering it.
- Gather information in a timely manner and maintain functional and durable databases.
- Analyze periodically the success, cost, and other relevant characteristics of each initiative, such as the effect on customers' lifestyles or the natural environment.
- Report on progress made, costs incurred, customer participation and response, and other effects, both expected and unforeseen.

Although this monitoring and evaluation framework is demanding, there is an identified need for better recording of information and effectiveness studies to guide future research and innovation. Undertaking such a program provides an excellent feedback loop to refine the water conservation strategy to ensure continual improvement.

CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

As urban areas around the globe face greater environmental and financial limitations in providing water services, the demand for water continues to increase. Finding institutional arrangements that can effectively cope with this situation and lead us towards sustainable water use is a challenge that must be overcome. Achieving a sustainable supply of high-quality water is a necessary step in ensuring the future of cities. If an area adopts an institutional arrangements that can effectively resolve water management problems, "more people might by attracted to live there on the assumption that water supplies would be safeguarded in future" (Poyner 1998, 45). Population growth may be an enduring concern for areas that have demonstrated a capability to deal with water supply problems. As a consequence, water utilities need to remain vigilant in ensuring that water resources are used as efficiently as possible. Water conservation has a critical role to play in such an effort.

An assessment of water conservation initiatives within each of the case studies was undertaken to test whether public or private water utilities achieved enhanced water efficiency when compared to their public counterparts. In an attempt to isolate critical success variables in conserving water, characteristics of four municipal water systems and their implementation of various BMPs for water conservation were compared to highlight key distinctions among these case studies. The analysis of water consumption data showed important differences in the amount of water consumed in each of the case studies. These

data also demonstrated the variation in commitment to data collection and monitoring undertaken by the water utilities. In most cases, reliable data sets cover the past several years, but are insufficient for long-term water consumption analysis. Vancouver has a comprehensive data set, one that dates from 1965 to the present, and is the only reliable long-term data set. White Rock also has a reliable data set; however, these data only date from 1988. Data prior to that date is unavailable. West Vancouver has a long-term data set for the water it acquires from GVRD, but it approximates water consumption from additional sources. The accuracy of this additional data is questionable. Data for UEL are impossible to obtain from UEL as it does not record water consumption data. The UEL water consumption included in this study was derived from GVRD data and University of British Columbia data.

Assessing the implementation of BMPs through personal interviews was much more successful. For BMPs that had been undertaken in the case studies, details were readily available and comprised the majority of the results chapter of this report. Considering issues related to performance measurement, indicators, and goals and objectives of water conservation programs, however, this research found that little or no progress had been made by any of the case study municipalities. This finding, combined with suspect data collection procedures, indicates challenging barriers to conducting efficiency, effectiveness, or equity evaluations of water conservation activities throughout GVRD. Without the ability to evaluate present activities, it will be difficult to ascertain whether any progress is being made towards sustainable water use.

While there were challenges in conducting an evaluation in this research, the results do permit a key conclusion to be drawn. The study indicates a wide range in water consumption patterns amongst the case studies. In particular, there is a dramatic difference in water use between municipalities that meter universally and those that do not. Although there are differences among the utilities when public water utilities are compared with private water utilities, the comparison based on metering and charging volumetrically is much more striking. This research suggests that metering and volumetric pricing may have a greater impact on water efficiency than does public or private ownership of a utility. Despite the potential of public utilities for significant gains in water efficiency, on a comparative basis the only private water utility is the most water efficient in GVRD. Clearly, ownership can influence water efficiency; however, the relative impact appears to be less than metering and pricing. Based on these findings, the study concludes with a series of recommendations for the institutional arrangements that currently provide the most sustainable supply of high quality water.

Recommendations

- **Meters, conservation pricing, and education for all water customers.** – Although there was a difference detected between public and private water utilities in water consumption, a greater difference was detected when comparing universally metered utilities and nonuniversally metered utilities. While this result does not diminish the finding that the sole private water utility in GVRD is the most efficient, it does raise doubts as to whether public

or private management is the key success variables. The key to success in achieving efficient water consumption is likely related to metering, conservation pricing, and education, rather than the ownership of the institution that delivers the service.

- **BMPs are the standards for efficient water utilities.** – The use of BMPs in this report provides an effective and standardized mechanism to evaluate water conservation programs of each case study municipality. None of the case studies has formal conservation goals or objectives; thus it is impossible to conduct a traditional goals-based evaluation of current conservation practices. As discussed in chapter 4, not all of the BMPs examined in this study are presently appropriate for GVRD. Institutional differences between California and British Columbia make some of the BMPs, such as wholesale agency assistance programs and ULFT replacement programs, inappropriate at the present time. While these BMPs cannot be implemented with the current institutional system, it is important to consider all of these BMPs as future standards of practice that every water utility should undertake.
- **Ensure private utilities have incentives for environmental protection.** – Private utilities have an inherent incentive to encourage water efficiency. That is, minimization of capital expenditures. One outcome of resource efficiency is that environmental impacts are lessened because large, capital-intensive water supply projects are avoided as long as possible. Although private water utilities may produce a positive result for ecosystems providing the urban water, these utilities may also have significant negative implications for the built environment. The environmental impacts of private utilities will not be manifested as quickly through new supply projects, but

rather by increasing pressure for regional development to create a larger customer base as a means of increasing profit. Thus a private sector firm providing water service may have a significant interest in promoting urban growth and development to ensure a stable, growing customer base. If a sufficient number of additional customers can be attracted to a municipality, the capital expenditures required to develop new supplies may be economically logical. Ultimately, serious environmental destruction may result from the need to construct new water supply sources if the customer base is permitted to increase.

- **Improve the monitoring and collection of water consumption data.** – It is critical to establish a monitoring and evaluation framework that carefully records water and wastewater use, ambient environmental conditions, and demand conditions. With enhanced data collection, future evaluations could be conducted with greater confidence and reliability. Water utilities would also be better able to use these data for water planning as well as assessment and evaluation purposes.

Future Research

While best management practices for water conservation are accepted in California, additional experience with these activities in other areas needs to be shared. As BMPs are implemented and tested in other areas, collaboration among water utilities to find innovative solutions to common problems must be publicized. With the trend to increasing private sector involvement in the provision of public services, academic research has focused on economic and

regulatory issues. There is a paucity of research investigating other key aspects of the trend to privatization. Privatization of water utilities may have significant impacts on regional development pressures, social polarization related to the discarding of low-income customers, and effects of more infrastructural demands on already stressed ecosystems. These and many other, perhaps yet unpredicted, impacts have not been sufficiently studied. It is essential to consider these spatial, environmental, social, and economic implications of both public and private water service provision before an informed debate on sustainable institutional arrangements can take place.

APPENDIX I – BEST MANAGEMENT PRACTICES

FOR WATER CONSERVATION

1. Water survey programs for single-family residential and multi-family residential customers. This is basically an audit of individual customers residential water use.
2. Residential plumbing retrofit. This targets replacement of showerheads, toilets, and faucets.
3. System water audits, leak detection and repair. This is an audit starting with metered usage to determine where losses are occurring in the system.
4. Metering with commodity rates for all new connections and retrofit of existing connections. This is to require all water use to be metered and to bill by volume used.
5. Large landscape conservation programs and incentives. This is to target large non-residential customers and may include dedicated landscape meters.
6. High-efficiency washing machine rebate programs. This is in the process of being adopted based on widespread product availability and financial viability.
7. Public information programs. This consists of a variety of programs that promotes water conservation and water conservation related benefits.
8. School education programs. This consists of implementing a school education program that promotes water conservation and water conservation related benefits.
9. Conservation programs for commercial, industrial, and institutional accounts. This includes identifying and ranking these customers according to water use; offering water use surveys, customer incentives, and water conservation performance targets.
10. Wholesale agency assistance programs. This consists of the wholesale water supplier providing financial incentives or equivalent resources to the retail water agencies to implement water conservation efforts that are cost effective to the wholesale agency.
11. Conservation pricing. This consists of moving from non-conserving pricing to conservation pricing as a minimum.
12. Conservation coordinator. This consists of designating a water conservation coordinator and possible support staff.
13. Water waste prohibition. This consists of enacting and enforcing measures to prohibit single pass cooling systems and non-recirculating systems in new car wash and commercial laundry systems and non-recycling decorative water fountains.
14. Residential ultra-low-flush toilet (ULFT) replacement programs. This involves implementing a program to replace existing high-water-using toilets.

Source: CUWCC, 1999

APPENDIX II – GREATER VANCOUVER REGIONAL DISTRICT MEMBERS

City Members

- Burnaby
- Coquitlam
- Langley City
- New Westminster
- North Vancouver City
- Port Coquitlam
- Port Moody
- Richmond
- Surrey
- Vancouver
- White Rock

District Members

- Delta
- Langley Township
- Maple Ridge
- North Vancouver District
- Pitt Meadows
- West Vancouver

Village Members

- Anmore
- Belcarra
- Lions Bay

Electoral Area Members

- A (University Endowment Lands)
- C (Bowen Island, Howe Sound, Barnston Island, Indian Arm, west of Pitt Lake)

APPENDIX III – INTERVIEW GUIDE AND CONSENT FORM

Themes For Discussion

- What is the current status of the municipal water system, in terms of the following characteristics? Are data available for previous years?
  - Average water use (L / capita / day)
  - Aggregate water use (L / day or L / year)
  - Source water capacity (L / year)
  - Water quality delivered to customers
  - Total volume (m^3 / year)
  - Average, Peak, and Max day demand (L / s)
  - Water rates ($ / L) (operation costs & costs to customers - by sector)
  - Industrial, residential, commercial, agricultural usage
  - Usage of water meters - by sector

- Please tell me about the goals and objectives that your organization / agency / department has for its water conservation initiatives.

- What water conservation activities have been undertaken by your organization / agency / department?

- In your opinion, which of these activities are essential to a successful water conservation initiative?

- Do you have a measure of how effective these activities have been? What indicators are being used to gauge progress?

- How does your utility benefit from water conservation initiatives? How will the water customers benefit from these initiatives?

- Is it important to undertake water conservation in Greater Vancouver / your municipality? Is there a justification for enhancing water conservation?

- Why has there not been more done for water conservation?

- Do you have a water shut-off policy? If yes, please describe the policy.

Interview Consent Form

To:
Fax:
Researcher: Andrew Doi
Research Group: Water Planning and Management
School of Resource and Environmental Management
Simon Fraser University
Contact Telephone: 604-275-3070 Fax: 604-291-4968
Email akdoi@sfu.ca

The purpose of this form is to request your consent in participating in a personal interview related to your experience in urban water management in Greater Vancouver. Your involvement in municipal water management has given you first-hand experience in water planning. My research depends on the perspectives and opinions of individuals such as you.

Interviews are being conducted with representatives from a number of GVRD municipalities to gain an appreciation of water management in the region as a whole. Information generated from the interviews will be used in a major research paper for a graduate program in natural resource and environmental management and will be made available to the public. The paper will focus on the range of activities currently being undertaken by municipalities in GVRD for water conservation and efficiency. I have included some themes for discussion on the following page for our meeting on_____, 2000. Please take this agenda strictly as a starting point and advise me of additional insights or directions that you feel would enhance my research. I would be happy to hear any additional comments that you feel may be relevant.

The interview will take about 30 minutes. Your participation is voluntary and you may terminate the interview at any time. Your personal responses will not be disclosed in the study, and should you have any concerns or complaints in this regard, you may contact my supervisor, Dr. Chad Day, Professor at the School of Resource and Environmental Management at Simon Fraser University, Burnaby, B.C. , V5A 1S6 Tel: 604-291-3067 Fax: 604-291-4968 Email: jday@sfu.ca.

Your signature below will serve as acknowledgement that you have received a copy of this consent form and have agreed to participate in this research. When signed, please return this form to me by fax (if possible) to 604-291-4968 or by mail. If you have any questions regarding the interview or research, please call me at 604-275-3070. If you would like to obtain a copy of this study, upon its completion, please indicate below.

Thank You.

Subject consent:_____Date:_____

Yes, send me the study _____ No thanks _____

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