Managing Green Stormwater Infrastructure on Single Lot Developments

A Guide for Local Governments in British Columbia

Photo Credit: Capital Regional District - BC

Kendra Ferguson
McGill University
Montreal, Quebec
December 2008

ACKNOWLEDGEMENTS

First I would like to thank my parents, Karen and Don who can always be counted on for support and perspective. I am grateful to my mom for passing on her love of reading and sense of humour, without which, life would not be nearly as interesting.

I would also like to thank my supervisor at McGill, Dr. David Brown, who has provided guidance and support for this project while encouraging me to set goals and helping me stick to them.

Finally I wish to acknowledge the Planners at Urban Systems who introduced me to the field of stormwater management and to Urban Planning as a profession. Sara Stevens, Andrew Baigent and Brian Patterson have shown me the highest level of professionalism and knowledge in the planning field, which I will aspire to demonstrate throughout my own career.

ABSTRACT

The trend for greener stormwater management has been to move away from traditional infrastructure such as piping, and towards an approach which uses the filtration capabilities of plants and soil. The green approach helps to protect water quality, reduces runoff volumes and recharges groundwater. On-lot best management strategies (BMPs) aid in this process, however they pose a unique problem of management for local governments. As key components of a green stormwater infrastructure system are located on private property, local governments must explore ways in which they can ensure the maintenance and upkeep of this green infrastructure takes place.

Local governments in BC have a responsibility to provide a management strategy for on-lot green stormwater infrastructure which will inherently involve consequences for neglecting to perform maintenance duties. It is not possible to propose one management strategy for all local governments in BC, as any successful solution must be tailored to local conditions which include: topography, climate, the management capacity of the planning department, public support and interest in green developments, budgets and of course, the support of local councils. Six possible strategies for on-lot maintenance are identified in this report, some of which will need to be considered in conjunction with one another, while some have proven effective as stand-alone management strategies.

Maintenance agreements are necessary in almost every case to ensure that the landowner understands their responsibility and the consequences for "failure to maintain." Maintenance agreements should be the foundation of any on-lot green stormwater maintenance program. Other strategies that have proven successful are the establishment of **statutory rights-of-way** and **conservation covenants**. A **security or bond** can also be used as a financial tool to ensure that green infrastructure is constructed to the standards set by the local government and to ensure that the infrastructure is properly maintained over a set period of time. Local governments may choose to implement performance bonds or maintenance bonds. However the difficulty lies in the inherent "temporary" nature of the bond. Any of the above mentioned strategies will likely require the implementation of a **stormwater management bylaw**. Finally, local governments may consider formalizing **voluntary programs**, if such support from the community exists. Neighbourhood organizations, homeowner associations, environmental groups and NGOs have proven to be valuable resources in educating homeowners, encouraging homeowner maintenance and taking on the management tasks themselves.

Before a local government develops a maintenance strategy, certain considerations must be undertaken. The local government should determine the most suitable on-lot stormwater BMPs for homeowners and developers to adopt, BMP design standards, performance standards and finally the enforcement tools so that the performance standards are maintained. If a local government is to encourage green infrastructure practices, it must also establish a maintenance strategy. If maintenance is neglected, the installation of green stormwater infrastructure will become a detriment to ecosystems, watersheds and property values.

TABLE OF CONTENTS

PART 1: INTRODUCTION

In British Columbia, there has been a recent push for the implementation of green infrastructure both at the policy level and from public demand for green developments. One aspect of green development that municipalities in BC are having difficulty managing is on-lot green stormwater infrastructure. While it is less complicated to manage and maintain stormwater infrastructure that has been installed on public lands, it is difficult to ensure that on-lot green stormwater infrastructure on private land is preserved and maintained as the upkeep of the infrastructure is the responsibility of the individual private landowner.

This is a particularly challenging situation because if green stormwater infrastructure, including on-lot stormwater infrastructure, is not maintained, there can be drastic consequences for entire watersheds. These consequences include the loss of land, environmental degradation, flooding, loss of wildlife habitat, financial costs for remediation and severe changes in local stream and river levels.

Many municipalities and local governments in BC would like to know how they could ensure that new developments incorporate on-lot green stormwater infrastructure in their design (where appropriate), while being sure that the infrastructure will be preserved and maintained for the lifespan of the development.

This report examines a number of case studies that demonstrate how other governments have overcome this challenge. The report also identifies the current legislation in BC that enables local governments to regulate on-lot green stormwater infrastructure.

One of the reasons that municipalities in BC have been slow to tackle this issue is because in many regions, stormwater management is under the exclusive jurisdiction of a specific department (usually Engineering). The issue in question cannot be resolved by planners or engineers alone as it requires the knowledge and experience of both professions. The need for planners in BC to have a cooperative working relationship with other city departments will also be exemplified in this report. Additionally, the report will identify green stormwater BMPs for on-lot developments, from which local governments in BC can draw from, when determining the most appropriate practices for private developments.

Along with the above mentioned reasons, there are two other related reasons why there has been a hesitation for local governments to encourage the use of on-lot BMPs. The first is that local governments are generally risk adverse and this is new territory in the field of stormwater management. A fully piped stormwater system is known as "safe." Secondly, some of the risk that local governments are assuming is because of the perceived inability to guarantee the maintenance of the on-lot BMPs.[1] This report will help bring some clarity to these issues and show that green on-lot BMPs should be encouraged and can be managed by local governments in BC.

[1] Stevens, Sara. (2008). Personal Communication.

PART 2: BACKGROUND

2.1 Stormwater Management in British Columbia

According to the 2006 census, 49% of the population of BC lives within the regional agglomeration of Metro Vancouver. Metro Vancouver comprises 22 member municipalities and one electoral area.[2] Aside from establishing a program of sustainability targets and measures as well as a collaborative governance outreach program, Metro Vancouver has established an integrated system of management plans. In terms of stormwater management, Metro Vancouver has established *Stormwater Source Control Design Guidelines*, a *Stormwater Best Management Practices Guide* and several of its municipalities have adopted area-specific Integrated Stormwater Management Plans (ISMPs) (See section 2.3). Metro Vancouver recognizes that ISMPs are a best practice for stormwater management as they take into account land use planning, environmental factors and the engineering related aspects of stormwater management. Integrating land use planning with stormwater management ensures that private property and water quality will be best preserved and that the levels of runoff that flow into streams will remain as stable as possible.

In 2002 the British Columbia Ministry of Water, Land and Air Protection published a *Stormwater Planning Guidebook for British Columbia*. The Guidebook is a useful tool for municipalities and regional districts in BC that fall both within and outside the boundaries of Metro Vancouver. In BC, the *Local Government Act (LGA)* and the *Community Charter (CC)* enable local governments to be proactive in implementing innovative stormwater management solutions. This support for innovation has been at the root of the development of green stormwater management practices and will be critical to the future of effective stormwater planning in BC.

---

[2] City of Abbotsford, Village of Anmore, Village of Belcarra, Bowen Island Municipality, City of Burnaby, City of Coquitlam, Corporation of Delta, City of Langley, Township of Langley, Village of Lions Bay, District of Maple Ridge, City of New Westminster, City of North Vancouver, District of North Vancouver, City of Pitt Meadows, City of Port Coquitlam, City of Port Moody, City of Richmond, City of Surrey, City of Vancouver, District of West Vancouver, City of White Rock, Electoral Area A.

2.2 Planning for Growth

Regional district population growth projections predict that although there are substantial disparities in growth projections in the 28 Regional Districts in British Columbia, the southern regions of the province will experience considerable population growth over the next couple of decades. It is predicted that population averages amongst all municipalities will increase by 35.5% by 2031, and in certain districts, such as the Squamish-Lilooet District it is predicted that the population will nearly double in size. Furthermore, it is estimated that the Central Okanagan, the Sunshine Coast and the Fraser Valley will all grow by 65-70%.[4]

What is most significant about these numbers is that in many areas throughout BC, single-family homes are the dwelling choice for most residents. Single-family homes comprised 60% of all housing starts in Kelowna and 93% of starts in Prince George in 2004.[5] Single-family homes on large lots require extensive amounts of stormwater servicing infrastructure and lead to a significant reduction in pervious pavement as roads, sidewalks and driveways are built on the land.

The recent and projected future increase of the population of British Columbia has created intense land development pressures which have led to a significant strain on the natural environment. Unless current landuse, development and stormwater management practices are reformed, it is expected that watershed degradation will accelerate throughout Greater Vancouver[6] and the entire province of BC.

---

[4] BC Statistics, Ministry of Management Services. (2004). *British Columbia Population Projections*.

[5] Smart Growth BC. (2005). *Affordable Housing Policy*.

[6] Greater Vancouver Regional District (GVRD). (2005). *Template for Integrated Stormwater Management Planning*.

2.3 Integrated Stormwater Management

Over recent years, there has been a consistent shift from traditional stormwater management practices to an integrated approach. ISMPs have gained widespread acceptance by local governments as a comprehensive approach to stormwater planning because they take into account land use planning and environmental considerations in addition to engineering aspects of stormwater management. Integrating land use planning with stormwater management ensures that private property and water quality will be best preserved and that runoff that flows into streams will remain as stable as possible. The purpose of an ISMP is to protect the natural characteristics of the region while accommodating land development and growth.

The goal of traditional stormwater management practices is to remove stormwater run-off from the land as quickly as possible through a system of storm sewers (pipes). The run-off typically contains higher concentrations of fertilizers, heavy metals, oil from roadways, and other pollutants. This polluted water is typically collected in centralized locations—stormwater treatment ponds—where some of the pollutants are separated out before the stormwater is released, generally into local streams and rivers. As undeveloped land becomes urbanized, the volume of surface water run-off increases proportionately to the percentage of impervious ground cover constructed (concrete, asphalt, rooftops etc). If a pipe system is installed to drain these areas, all of the water collected on these surfaces vacates the land through pipes. This approach to managing surface run-off does not allow rainfall to soak into shallow ground, percolate vertically into deep groundwater or be returned back into the air through evapotranspiration. The traditional approach only allows water to flow over the ground as surface run-off.

An integrated approach to stormwater management ensures that all natural movements of water as described above, are facilitated in order to preserve as much as possible, the natural water balance. An integrated approach also considers different filtration schemes for different types of runoff, which will contain different levels of pollutants.

There is still a clear divide between the planning and engineering profession when making development and infrastructure plans for a region. While Official Community Plans (OCPs) are primarily prepared by planners, Liquid Waste Management Plans (LWMPs) are designed almost exclusively by engineering professionals. In BC, municipalities are recognizing the need to integrate stormwater management with OCPs and LWMPs. To do this however, there must be continuity between perspectives and responsibilities of both planners and engineers. Stormwater planning requires both the technical knowledge that engineers can provide, as well as the knowledge of land development, municipal finance, legal frameworks and growth pressures that planners provide.

Municipalities in BC are now faced with the challenge of encouraging and sometimes requiring developers to implement green stormwater infrastructure on private, typically single-family lots. The challenge lies in how municipalities can encourage green stormwater infrastructure while ensuring that the infrastructure will be properly maintained by individual owners. Without this assurance, a back-up, traditional drainage system would be required, largely defeating the purpose and reducing the economic advantage of an on-lot “green” stormwater system.

PART 3: RATIONALE FOR GREEN INFRASTRUCTURE

In British Columbia, there has been a recent push for the implementation of green infrastructure both at the policy level and from the public demand for green developments. The shift towards "green" policies can be exemplified in recent policy and legislative initiatives in BC. The primary rationale behind this policy shift in terms of stormwater is the growing urgency to protect the watersheds in BC from irrevocable degradation. The following section highlights the convincing body of knowledge that focuses on the processes that threaten the health of BC's watersheds and dependent ecosystems. Finally, this section considers the financial case for green infrastructure as the costs associated with the implementation of green infrastructure have often been misconceived and have therefore acted as a barrier to implementation. The purpose of this section is to dispel this misconception through the review of case studies and relevant literature.

Amongst the municipalities and the BC Provincial Government, we are seeing a consistent policy and legislative shift towards implementing and encouraging green infrastructure practices; a transition that is gaining momentum and will be a continuous presence throughout the Province.

3.1 Policy Shift - Green Development

3.1.1 *Climate Action Charter*[7]

The Province of BC along with many local governments, made a commitment to environmental practices when they signed the *Climate Action Charter* in 2007. The *Charter* focuses on reducing greenhouse gas emissions (GHGs) in order to slow and prevent climate change. The *Charter* also identifies the need for infrastructure and a

[7] British Columbia Ministry of Community Development. (2007). *B.C. Climate Action Charter.*

built environment that supports the economic and social needs of the community while minimizing environmental impacts. The *Charter* supports the fast tracking of green development projects that encourage land use patterns that increase density and reduce sprawl. The *Charter* focuses on developing a range of actions that can affect climate change naturally, which also affect how stormwater will be managed in the future (community gardens, urban forestry, regulatory reforms or incentives to encourage land use patterns that promote smaller lot sizes).

3.1.2 Bill 27 LGA[8]

In June 2008, the Provincial Government passed Bill 27 – Local Government (Green Communities) Statutes Amendment Act. The amendment identifies developments that are eligible to have development cost charges waived. Bill 27 now permits the waiving or reducing of DCCs for developments that are designed to result in a low environmental impact. This is a meaningful statement for developers and municipalities alike as local governments now have the authority to reduce or waive development costs to encourage green development practices.

3.1.3 Living Water Smart: A Plan for Water Sustainability[9]

The Province of BC published a vision and plan entitled *Living Water Smart: A Plan for Water Sustainability* in June 2008. The *Plan* proposes over 40 actions and targets to help keep the Province's water healthy and secure. The *Plan* draws on a variety of policy measures (planning, regulatory change, education and incentives) while committing to new actions and building on existing efforts. The strength of this document is that it recognizes that the actions and targets for water protection and conservation must be addressed at every level of action.

---

[8] Legislative Assembly of British Columbia. (2008). *Bill 27- 2008, Local Government.* Green Communities Statutes Amendment Act.

[9] Government of British Columbia. (2008). *Living Water Smart – British Columbia's Water Plan.*

3.1.4 Green BC Building Code[10]

On April 15, 2008, new Building Code requirements, to increase energy and water efficiency were introduced in BC. The first steps in *Greening the BC Building Code* were in support of the Province's commitment to reduce greenhouse gas emissions related to building and construction. A summary of these new requirements is as follows:

1. Energy Efficiency Requirements for Single Family Houses and Smaller Multi-Family Residential, Commercial and Industrial Buildings, mainly in the form of insulation standards.
2. Energy Efficiency Requirements for High-Rise Multi-Family Residential Buildings and Larger Industrial, Commercial and Institutional Buildings. They must meet the American Society of Heating, Refrigeration and Air Conditioning Engineers standard.
3. Water Efficiency Requirements have been introduced which mandate that ultra low-flow toilets and other water-saving plumbing fixtures and fittings are mandatory in new construction and renovations.

3.2 Impacts of Growth on Stormwater

Population growth results in more land development, redevelopment and densification of existing urban areas. In many rural areas, as the population grows, the municipality becomes suburban and in suburban areas, the trend is to become increasingly urban. In most regions, an increase in population results in a greater amount of non-porous surface area. This inherently increases the stormwater run-off volume and the levels of polluted run-off, for which local governments must plan.

---

[10] British Columbia Office of Housing and Construction Standards. (2008, September). *Greening the BC Building Code: First Steps.*

3.3 Need to Integrate Stormwater Planning with Land Use Planning

The benefits from green stormwater infrastructure are maximized when green practices are used as a tool for conservation and development planning. The integration of green stormwater management planning with land use planning enables conservation to occur in harmony with both of these tasks; integrated planning also provides developers and local governments with predictable development expectations and security in the value and desirability of the land.

Professionals who traditionally engage in stormwater management do not often have the opportunity to engage in land use decisions. Over the past few decades, the practice of stormwater management has focused on hard infrastructure engineering and end-of-pipe practices to come up with control and treatment strategies that are primarily concerned with peak flow rates and pollutant control.[11]

Various factors at the site, neighbourhood or regional levels can drive the spread of impervious cover that increases levels of run-off. These factors are embedded in land use policies and bylaws. The following are common land use regulations and policies that impact impervious land cover:

- Zoning and OCP land use designations
- Road design guidelines
- Parking requirements
- Minimum setback requirements
- Site coverage maximums
- Floor to area ratios (F.A.R.)
- Urban containment boundaries

Any stormwater management plan must take into account land development regulations, policies and bylaws so that they can be integrated with water quality, protection and conservation goals.

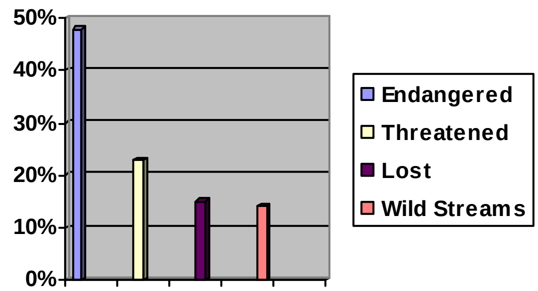
---

[11] Center for Watershed Protection. (2008, July). *Managing Stormwater in Your Community – A Guide for Building an Effective Post-Construction Program*.

3.4 Protecting our Watersheds

The watersheds in the Lower Fraser Valley have been subjected to intense urban and rural development pressures for many decades. The great majority of pre-settlement streams in the Vancouver area have been buried or culverted, and many have been effectively lost. [12]

Percentage of streams classified as wild, threatened, endangered or lost within the Lower Fraser Valley



At one time, there were as many as 50 streams that fed into English Bay, Burrard Inlet and the Fraser River from wetland and swamp areas within Greater Vancouver. Over the years, many of these creeks and streams have disappeared, an estimated total of 550-600 km in length. These streams have disappeared because of the impacts of urbanization in Greater Vancouver while many were simply filled-in to accommodate development.[13]

Over the last few decades, there has been an increased awareness and stewardship aimed at identifying and protecting aquatic and riparian habitats however these intentions are coupled with increasing populations, urbanization and development pressures. In BC, the trend for new residential development has been to build on low-lying valleys where the soil is fertile, the climate is moderate and water supplies

[12] Fisheries & Oceans Canada. (1997). *Wild, Threatened, Endangered and Lost Streams of the Lower Fraser Valley – Summary Report*. Lower Fraser Valley Stream Review, Vol. 3.

[13] Ibid.

are abundant. Unfortunately, these are also the types of areas where many fish bearing streams and creeks exist. A study completed in 2000 on salmon populations in the Thompson River confirmed that the rate at which individual Coho populations declined between 1988 and 1998 was related to the extent of agricultural and urban land use and the density of roads in the watershed.[14] As many similar studies have shown, without careful management, the cumulative impacts of housing subdivisions, golf courses, shopping malls and industrial development result in the permanent loss of fish and wildlife populations, much of which occurs through the loss of their supporting habitats.[15]

In urban watersheds, impermeability causes some of the most serious impacts to the ecology of a stream. Once more than 10% of an urban area becomes impermeable the changes become irreversible.[16] Salmonids, for example require a complex set of factors to survive the lifecycle. They require clean water that is free from turbidity and within a specific temperature and oxygen level range. The stream bed must comprise substrate materials such as gravel and rocks to support the spawning beds and to provide food. Finally, salmon bearing streams must be free from obstacles that could prevent the fish from returning to the spawning beds to reproduce. Urban growth and development must proceed with assurance that the riparian zones are not infringed upon, as even a minor disturbance to a stream may offset the precise conditions that are required for the reproduction of the species.

The conversion of permeable lands (forests, farmlands, wetlands etc.) to what are generally impermeable zones (residential areas and commercial and industrial developments) directly impacts stream and riparian zones by: [17]

---

[14] Bradford, J. Michael., Irvine, R. James. (2000). *Land Use, Fishing, Climate Change, and the Decline of Thompson River, British Columbia, Coho Salmon.* Canadian journal of Fisheries and Aquatic Sciences. 57(1).

[15] Dovetail Consulting Inc. (1996, November). *Urban Stream Stewardship: From Bylaws to Partnerships – An Assessment of Mechanisms for the Protection of Aquatic and Riparian Resources in the Lower Mainland.* Canadian journal of Fisheries and Aquatic Sciences. Prepared for Fisheries and Oceans Canada and Environment Canada.

[16] Ibid.

[17] Fischenich, J. Craig. (2001, May). *Technologies for Urban Stream Restoration and Watershed Management.* Technology News from the Ecosystem Management and Restoration Research Program.

- altering stream channels through straightening, lining, or placement culverts
- reducing riparian corridor width through floodplain encroachments
- increasing sediment yield during development and increasing pollutant loading following development and;
- displacing native riparian plant communities by invasive non-natives.

In addition to these direct impacts, urbanization affects a watershed by changing the level of runoff flows and the sediment yield. The changes in a stream's sediment load and water levels can disrupt the stream's equilibrium, resulting in rapid channel enlargement through the process of incision. Incision occurs when the streambed degrades, due to increased runoff from urbanization to a point which the streambank fails which then increases the width of the stream and its sediment load.

In urban watersheds, impervious surfaces increase runoff and are the primary contributor to the incision process.[19] The increase in impervious urban areas also decreases the base level of water flow in a stream since less rainwater is able to infiltrate the soil. During a rainstorm however, there is a surge in stream flows as the rainwater is quickly transported to streams by flowing over impervious grounds or by being directed through pipes. Impervious surfaces also accumulate pollutants from sources such as vehicles which are then washed off and quickly delivered to aquatic systems. It is for this reason that urban streams often contain high levels of heavy metals, bacteria, fecal coliforms and other pollutants.

[19] Fischenich, J. Craig. (2001, May). *Technologies for Urban Stream Restoration and Watershed Management.* Technology News from the Ecosystem Management and Restoration Research Program.

3.5 Financial Case for Green Infrastructure

The "shift" towards green infrastructure is not only occurring because of the responsibility local governments and citizens have to care for the environment; green infrastructure is also often less costly than "hard" or traditional stormwater infrastructure (pipes) and can offer aesthetic and recreational benefits. Green stormwater infrastructure such as street trees, greenways and rooftop gardens are seen as amenities and increase property values and desirability of neighbourhoods for both residential and commercial purposes.

The costs and benefits of utilizing green stormwater infrastructure are site specific and will vary depending on the methods used and on local physical conditions such as soil, climate and topography. Integrating the knowledge of developers, engineers, architects and landscape architects early in the decision making and design process can help to minimize the long-term maintenance and construction costs of green infrastructure. Another point to consider is that green BMPs are still relatively new and costs for installation, infrastructure and engineering will likely decline as we learn more about the technology available and as the number of suppliers and trained professionals expands.

3.5.1 COST OF STORMWATER DAMAGE IN PUGET SOUND[20]

A report written in 2006 summarizes the major impacts of damage due to stormwater runoff in the Puget Sound region. This study reports that the financial costs of the damage incurred, was largely attributable to traditional stormwater management practices. The types of damage reported are prevalent in many communities throughout North America. The major impacts that can be quantified in economic terms are as follows:

---

[20] Booth, B, D., Visitacion, B. and Steinemann, C. Anne. (2006, August). *Damages and Costs of Stormwater Runoff in the Puget Sound Region.* The Water Center, Department of Civil and Environmental Engineering, University of Washington.

Estimates of the Cost of Stormwater Damage in Puget Sound

TYPES OF COSTS	REPORTED COSTS
Flooding, Landsliding, and Property Damage	
Property damage and financial losses	Flood insurance claim payments to the Puget Sound region have totaled $56 million since 1978. Although significant, it still underestimates the total flood losses borne by property owners.
Expense of stormwater facilities	Capital improvement plans of Puget Sound jurisdictions reviewed in this study indicated annual expenditures of $115,333 to $5 million; however, many millions of dollars in shortfalls exist across the Puget Sound region beyond this reported value.
Expense of stormwater programs	Annual stormwater program budgets within the Puget Sound region range from hundreds of thousands to millions of dollars, with typical annual costs of approximately $100/person within a stormwater utility district.
Degradation of Water Quality	
Clean-up of polluted water resources	A review of expenditures within the Puget Sound region revealed that water-quality improvement in a single watershed due to a single stormwater-related contaminant can cost as much as $1.5 million.
Protecting water resources from additional contamination	Various Puget Sound jurisdictions report treatment costs for stormwater discharges ranging from $172,000 to $6.8 million.
Loss of Fish and Wildlife Habitat	
Habitat restoration and protection efforts	Individual restoration projects associated with stormwater discharges have cost individual Puget Sound jurisdictions $100,000 to as much as $100 million. Efforts in one jurisdiction to restore and prevent continued degradation of critical fish and wildlife habitat cost $25.8 million in 2005 alone.
Closure of Shellfish Growing Areas	
Shellfish harvest area protection and clean-up	Pollution-prevention and clean-up measures cost $160,000 to $200,000 annually for Drayton Harbor, for example, which was once a valuable Puget Sound shellfish harvest area.
Lost revenues and lost jobs	One Puget Sound harvest area alone experienced a loss of over $3 million in shellfish sales due to closed shellfish harvest areas.
Lost recreation opportunities	The state generated $16.9 million in sales for fishing and shellfishing licenses with over 700,000 customers indicating the popularity of fishing and shellfishing. With the majority of shellfish harvest areas located in the Puget Sound, closed beaches in the region result in lost opportunities for recreational revenue and shellfishing.

The above table shows only quantifiable damages which do not include the social, cultural, and quality-of-life changes; lost recreational opportunities due to degraded water quality; reductions in consumer confidence; decreased tourism; and loss of fish and wildlife.

3.5.2 GREEN ROOFS IN TORONTO[21]

In 2005 a report entitled *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto,* a method was used to compute the monetary value of green roof infrastructure. While there are many benefits a green roof can provide a community, the ones that had the most quantifiable monetary value based on current data were the benefits of stormwater flow reduction, the reduced impact on combined sewer overflow, improvements in air quality, reduction in direct energy use, and the reduction in the urban heat island effect. The following is a chart from the report summarizing the municipal level cost savings for factors that were able to be quantified.

Cost-Saving Analysis for Toronto Green Roof Case Study[22]

Summary of Municipal Level Environmental Benefits of Green Roof Implementation in the City of Toronto (Assuming green roof coverage of approx. 5,000 hectares)		
Category of Benefit	**Initial Cost Savings**	**Annual Cost Saving**
Stormwater		
Alternate BMP cost avoidance	$79,000,000	
Pollutant control cost avoidance	$14,000,000	
Erosion control cost avoidance	$25,000,000	
Combined Sewer Overflow (CSO)		
Storage cost avoidance	$46,600,000	
Reduced beach closures		$750,000
Air Quality		
Impacts of reduction in CO, NO2, O3, PM10 and SO2		$21,000,000
Cost avoidance due to peak demand reduction	$68,700,000	
Savings from CO2 reduction		$563,000
Urban Heat Island		
Savings in annual energy use		$12,000,000
Cost avoidance due to peak demand reduction	$79,800,000	
Savings from CO2 reduction		$322,000

[21] Banting et al. (2005, October). *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto.*

[22] Ibid.

This study acknowledges the annual cost savings that occur in addition to the upfront savings. While this study was specific to green roofs in Toronto, the cost savings due to the environmental benefits a green roof provides could be conducted for any green infrastructure project and would likely yield similar savings.

3.5.3 RESIDENTIAL DEVELOPMENT COST SAVINGS – MARYLAND AND ILLINOIS[23]

A study completed in 2005 showed that installation of new green on-lot stormwater infrastructure in residential developments in Maryland and Illinois saved the developer $3500 to $4500 per lot. The cost savings in this case resulted from not having to purchase the traditional infrastructure and lower paving and site preparation costs. In addition to the economic benefits that the green infrastructure provided, each of the residential sites in this case study contributed less stormwater runoff than comparable traditional developments.[24] While this case showed that developers are able to save money by implementing green stormwater infrastructure, they are also able to yield more lots for sale by eliminating land-consuming conventional stormwater infrastructure. Green developments may be sold at a higher price because of the value that consumers put on the vegetated landscape and because of the growing concern for environmental responsibility.[25]

3.5.4 COST SAVINGS FOR RETROFITTING – VANCOUVER

As stormwater infrastructure in BC ages, local governments have to spend money retrofitting existing infrastructure. Retrofitting traditional urban stormwater infrastructure is generally expensive, inconvenient and often complicated by space constraints. In a 'green streets' pilot program undertaken by the City of Vancouver, it was believed that the costs of installing green infrastructure would be

---

[23] Haugland, John. (2005, February). *Changing Cost Perceptions: An Analysis of Conservation Development.* Conservation Research Institute.

[24] Kloss, Christopher., Low Impact Development Center (2006, June). *Rooftops to Rivers – Green Strategies for Controlling Stormwater and Combined Sewer Overflows*. Natural Resources Defense Council.

[25] Ibid.

approximately the same as installing traditional stormwater infrastructure. Because this was a pilot project, the costs were higher than expected, however the City also undertook extensive background research for this project and multiple public consultation sessions. The City of Vancouver has indicated that retrofitting green infrastructure into locations with existing traditional infrastructure will cost only marginally more than rehabilitating the conventional system, but introducing green infrastructure into new development will cost less.[26]

The report issued by the City of Vancouver identifies that many of the benefits of the retrofitted infrastructure are indirect and difficult to cost quantify.[27] The retrofitting has entirely changed the character and aesthetic value of the street. The report also notes that with replication, the process will become more affordable and widespread implementation could produce additional cost savings through pipe reduction, water treatment costs and the avoidance of stormwater related environmental damage.

[26] Kloss, Christopher., Low Impact Development Center (2006, June). *Rooftops to Rivers – Green Strategies for Controlling Stormwater and Combined Sewer Overflows*. Natural Resources Defense Council.

[27] City of Vancouver. (2006). *Crown Street – Sustainable Streetscapes and Fish Habitat Enhancement Project.*

PART 4: ON-LOT STORMWATER MANAGEMENT ISSUES

4.1 What is On-lot Management?

The term on-lot treatment refers to a series of practices that are designed to treat runoff from individual residential lots. The primary purpose of most on-lot practices is to manage runoff from impervious surfaces on the individual lot such as rooftop runoff and paved area runoff. Runoff that has low pollutant concentrations, such as rooftop runoff are best directed to infiltrate into the ground, by disconnecting impervious surfaces and reducing the overall percentage of impervious cover on an individual lot.

The objective of on-lot green stormwater infrastructure is to minimize the post development volume of stormwater runoff, so that runoff is as close as possible to predevelopment hydrologic functions and runoff volumes. Both runoff volumes and peak runoff rates are considerations for measuring the success of green infrastructure and determining BMPs.

There are three categories of on-lot treatment options: [28]

1. **Practices that infiltrate runoff (rooftop and pavement)**
   - The technique most often used to infiltrate rooftop runoff is the drywell. In this case, a rooftop storm drain is directed to an underground rock-filled trench or alternatively into a perforated pipe that runs the length of a gravel bed, can be used to distribute rainwater flow throughout the length of the trench. Through these

[28] Stormwater Manager's Resource Center. *Stormwater Management Fact Sheet: On-Lot Treatment*. Retrieved December 5th 2008 from http://www.stormwatercenter.net/

methods, rooftop runoff can be directed to a pervious area using site grading.

- Non-pervious pavement runoff that is infiltration oriented can be directed through landscaping and siting to rain gardens, infiltration basins, and porous pavement areas.
- Practices that divert low-pollutant runoff (such as rooftop runoff) should then be diverted to pervious lawn areas rather than onto the street and into the storm drain system.

2. **Practices that are non-infiltration oriented**
   - These practices can be extremely simple in design and can generally be applied regardless of site conditions or existing landscaping. For water that contains low levels of pollutant, rainbarrels are particularly valuable in arid regions where the water can be reused for irrigation. Water can also be directed to wetlands and retention basins, depending on the site characteristics and runoff levels.
   - Green roofs are another example as they absorb the rainwater without having the water leach into the groundwater.
3. **Runoff quality control that is non-infiltration oriented**
   - Alternatively, for water that is not suitable for infiltration either because of a high pollutant content or a high debris content, the flow can be directed to a variety of filters such as wetlands or retention basins.

Depending on the site, the best solution may be a combination of treatment options although site specific feasibility and maintenance preferences of the homeowner should be primary considerations.

Many on-lot stormwater management practices are inherently “green” in design as they often involve simple landscaping techniques, alterations to existing infrastructure (such as downspout disconnection), and the installation of water collection facilities such as rain barrels and cisterns. On-lot management techniques can be applied to almost all single lot developments.

4.2 Why On-Lot?

On-lot stormwater management techniques help to mitigate the impacts of urbanization on the natural water balance. Instead of stormwater becoming runoff and treated like a waste product, water is treated as a resource that supports the natural environment, recharges groundwater and eventually flows into local streams. On-lot management techniques are also able to improve water quality by removing certain pollutants and solid particles through the infiltration process. By reducing the volume of runoff, on-lot techniques also prevent erosion and loss of property while reducing the likelihood of flooding.

PART 5: ON-LOT BEST MANAGEMENT PRACTICES

5.1 Introduction

There is a wide variety of green on-lot stormwater infrastructure that local governments could require developers to implement. While the infrastructure to be implemented is extremely site specific, there are some practices that are widely accepted and commonly used for individual lot (usually residential) developments. The different types of infrastructure range in complexity, maintenance requirements and financial costs. This section will identify the on-lot green infrastructure BMPs and provide a summary of which types of sites are best suited for each management practice.

The ultimate goal is to use green management practices so efficiently that the traditional stormwater infrastructure is no longer needed. The ability to achieve this goal is dependant on the success of the maintenance program as well as local climates. There should always also be an emergency system in place which may be relied upon during extreme whether conditions or in case of first-response infrastructure failure.

This chapter contains a description of on-lot green stormwater BMPs and general maintenance requirements. It must be stressed, however, that each individual local government must specify design and engineering requirements for each element that are appropriate for their jurisdiction. These specifications will depend on existing standards and localized conditions.

The US state of Maryland has one of the most progressive stormwater management programs. In their guide for selecting the BMPs for a site, six factors are considered when selecting the best BMP or group of BMPs for a development site: [29]

[29] City of Maryland, Department of the Environment. (2000, October). *Maryland Stormwater Design Manual.* Sec. 4.1.

- Watershed factors
- Terrain factors
- Stormwater treatment suitability
- Physical feasibility factors
- Community and Environmental Factors
- Locational and Permitting Factors

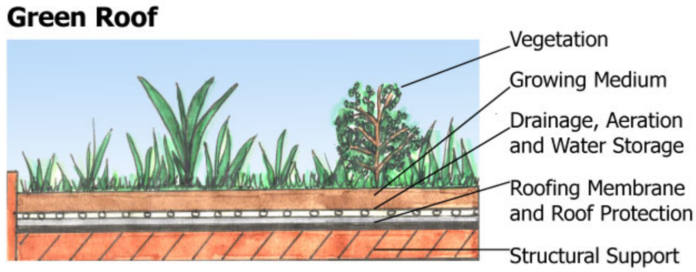
The on-lot BMPs identified in this section can be divided into three categories:

1. Techniques that reduce impervious area
    - Green roofs
    - Pervious pavement
2. Vegetation to facilitate absorption and infiltration
    - Swales
    - Planters
3. Hard infrastructure practices
    - Soakage trench
    - Rainwater harvesting
    - Drywell

5.1.1 Green Roofs

Description

A green roof is a lightweight vegetated roof system consisting of waterproofing material, growing medium, and specially selected plants. A green roof can be used in place of a traditional roof as a way to limit impervious site area and manage stormwater runoff. While also reducing post-development peak runoff rates to near pre-developed rates and reducing annual runoff volume by around 50 percent, greenroofs also save on building heating and cooling costs (as shown in section 3.5.2).



Green roofs can be implemented on existing traditional roofs as long as the structural roof support is sufficient to hold the additional weight of the vegetation. For this reason, there are greater options for green roofs for new buildings than for retrofitting existing buildings with green roofs.

Simple alterations to existing roofs, in order to make them structurally sound so as to support a green roof may include: additional decking, roof trusses, joists, columns, and/or foundations.[31] Generally, the building structure must be adequate to hold an additional 15 to 30 pounds per square-foot of saturated weight, including the vegetation and growing medium that will be used.[32]

<u>Benefits and Effectiveness</u>

The benefits of green roof technology go beyond the reduction of stormwater roof runoff and have been proven to be highly effective in reducing greenhouse gas emissions related to residential heating and cooling costs.

- A 4 inch green roof can retain 50% of total rainfall over a series of storm events.[33]
- Green roofs reduce peak discharge rates by retaining runoff and creating long paths through which the stormwater must

---

[31] Portland Bureau of Environmental Services. (2008, October). *Stormwater Management Manual.* 2-37.

[32] Ibid.

[33] Boston Metropolitan Area Planning Council. *Massachusetts Low Impact Development Toolkit.* Retrieved December 5th 2008 from http://www.mapc.org/LID.html

flow. Peak flow rates are reduced by 50-90% compared to conventional roofs, while delaying the discharge at the same time.[34]

- Roofs that are green have a longer lifespan than traditional roofs as they shield roof membranes from intense heat and direct sunlight.[35]
- Green roofs help to reduce air temperatures around the building by reducing the "heat island" effect. The vegetation on green roofs also consumes carbon dioxide and increases local levels of oxygen and humidity.

<u>Maintenance</u>

For a properly installed green roof, once the vegetation is established, the maintenance requirements should be minimal. The more intensive the roof however, the higher the maintenance requirements will be. For a standard green roof, the most important maintenance requirements will include inspection of the roof membrane, routine inspection and maintenance of drainage flow paths and the general upkeep of the vegetation. The most appropriate plants for green roofs are light in weight, low lying succulents. The plants will generally require watering and fertilization until they have fully established themselves. Depending on natural precipitation levels, supplemental irrigation may be required for the first six months or so, however; the careful selection of the types of rooftop plants can ensure that the roof will have low maintenance needs.

5.1.2 Pervious Pavement

Pervious pavement is designed to allow percolation or infiltration of stormwater through the surface into the soil below where the water is naturally filtered and pollutants are removed. In contrast, traditional pavement is an impervious surface

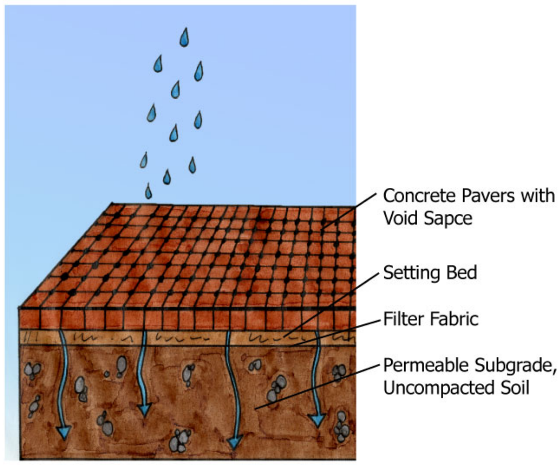
---

[34] Boston Metropolitan Area Planning Council. *Massachusetts Low Impact Development Toolkit.* Retrieved December 5th 2008 from http://www.mapc.org/LID.html

[35] Ibid.

across which rainfall flows, directly into nearby storm drains and then into local streams and lakes.

Pervious Pavement



Benefits and Effectiveness

There are two main types of pervious pavements: pervious concrete or pervious asphalt, which is poured in place and permeable pavers, which are discrete units set in the ground. Both of these materials can allow stormwater to infiltrate into the ground while providing a stable, load-bearing surface. Using pervious pavement reduces the obligation of other stormwater management techniques on the site.

Pervious pavement can be used on almost all residential driveways, pool decks, patios and commercial parking lots and is very similar to conventional asphalt and concrete except that the sand and finer materials have been removed and the top lifts are thicker to provide stability. [36]

[36] Portland Bureau of Environmental Services. (2008, October). *Stormwater Management Manual.* 2-40.

Maintenance

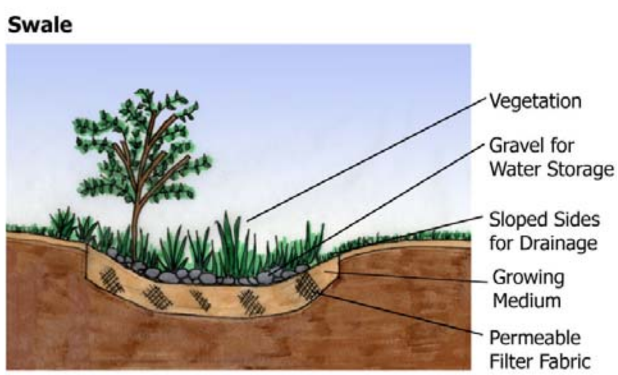
Landowners who install pervious pavement must be aware of necessary maintenance practices that may not be pertinent to traditional paving practices. These maintenance practices include:

- ensuring that paving area is clear of debris
- ensuring that paving dewaters between storms
- mowing upland and adjacent areas, and seeding bare areas
- inspecting the surface for deterioration or spalling

These maintenance measures must be taken to protect pervious pavement from over-compaction. Pervious pavement may require specialized vacuuming once a year to remove fine particles from the infiltration spaces. This maintenance is done with a high-powered, specialized vacuum. Without this maintenance, the pervious pavement will become impervious over time.[37]

5.1.3 Swales

While swales can vary in size and shape, they are generally long, narrow, gently sloped, landscaped depressions that collect and infiltrate stormwater runoff. As they are generally planted with dense vegetation they help filter contaminated stormwater runoff from rooftops, parking lots, driveways and streets.



[37] Portland Bureau of Environmental Services. (2008, October). *Stormwater Management Manual.* 2-43.

Benefits and Effectiveness

Because of the dense vegetation, swales can also reduce the flow velocity of stormwater runoff and can potentially replace curbs, gutters and storm sewer systems.

For swales to maintain their effectiveness, the amount of impervious cover in the contributing area to each swale should be no more than a few acres. Also, swales should not be used in areas where pollutant spills are likely. Swales function best when their design follows natural topography and drainage patterns to the highest extent possible. Swales work best in sandy loams because this type of soil allows for adequate infiltration. However if the soil is too sandy, it may be prone to erosion when runoff flow levels are high. On sites with denser soils, swales may be designed with a 2-4 feet bed of loamy sand which may let the water flow into a perforated underdrain to ensure adequate drainage of the swale if the groundwater is slow. In such applications, the water enters the traditional piping system, however, the flow rates will be much lower and the water quality better because, of the natural filtration process.

Maintenance

If vegetated swales are properly maintained, they will last indefinitely. Swales should be regularly inspected and assessed for slope integrity, soil moisture, vegetative health, soil stability, compaction, erosion, ponding and sedimentation.[38] Other regular maintenance activities include:

- Mowing when needed, however the grass must not be cut shorter than the designed flow depth
- Removing accumulated sediment
- Irrigating when necessary to prevent vegetation from dying

---

[38] Boston Metropolitan Area Planning Council. *Massachusetts Low Impact Development Toolkit.* Retrieved December 5th 2008 from http://www.mapc.org/LID.html

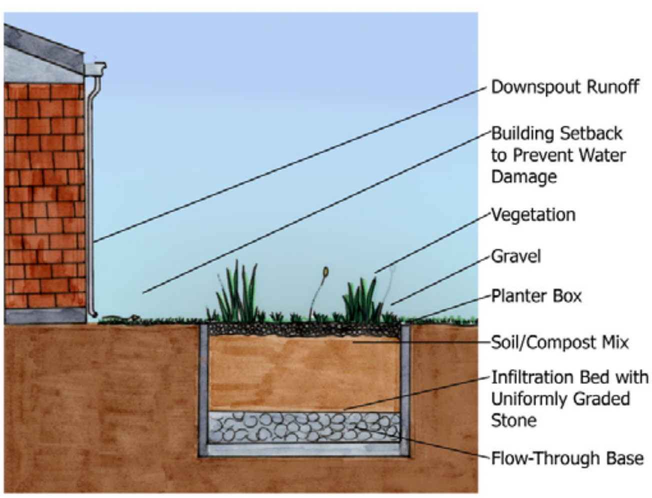
- Reseeding when necessary to maintain dense turf
- Removing obstructions that cause standing water

5.1.4 Planters

Stormwater planters are small, contained areas, planted with vegetation that collect and treat stormwater through bioretention. Bioretention collects and filters stomwater as the water makes its way through layers of mulch, soil and plant root systems. Through the process of bioretention, pollutants including heavy metals, oil and grease are retained, degraded and absorbed.

Treated stormwater is then infiltrated into the ground as groundwater (infiltration planter) or, if infiltration is not appropriate, discharged into a traditional stormwater drainage system (flow-through planter). Stormwater planters do not require a large amount of space and can add an aesthetic appeal and wildlife habitat to city streets, parking lots, and to commercial and residential properties. Stormwater planters typically contain native, hydrophilic flowers, grasses, shrubs and trees.

Planter Box



Benefits and Effectiveness

While planters can effectively treat stormwater before it is infiltrated into the ground as groundwater, planters are an easy way to add aesthetic value to the land. They can be designed to fit in any amount of space and can be planted with a diverse range of plants and flowers. Planters that allow stormwater to flow through can be constructed directly adjacent to a building, as long as the building foundation is impermeable. For this reason, they are ideal for sites with setback requirements, poorly draining soils or other constraints. [39]

Maintenance

Depending on how quickly the stormwater is able to flow through the planter, the landscaping may require a subsurface infiltration facility, or the overflow water should be directed to an approved discharge point to avoid flooding of the planter.

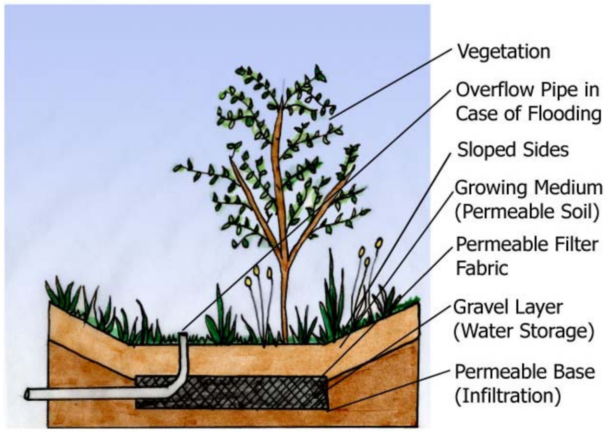
The soil in a planter should be maintained as a sandy loam, mixed with compost. The compost will help to support the plant growth as the entire planter should be planted with vegetation. Regular maintenance will be required to ensure that the plants remain healthy and viable.

5.1.5 Soakage Trench

Soakage trenches are shallow trenches usually lined with filter fabric and backfilled with stone. Water enters the trench through a perforated pipe that allows water to slowly be absorbed by the underlying soil. Soakage trenches can collect water from most types of impervious surfaces such as roofs and parking lots and can be placed under any ground-level, permeable surface. Soakage trenches are most appropriate in areas where native soils infiltrate effectively.

[39] Portland Bureau of Environmental Services. (2008, October). *Stormwater Management Manual.* 2-53.

Soakage Trench



Benefits and Effectiveness

Soakage trenches can be very effective at reducing the runoff flow rate and volume, while recharging the groundwater. While they are not usually able to treat water with high levels of pollution, with a sufficient amount of sand or soil for filtration, they can help reduce pollutants in water before flowing into the groundwater. However, if the soakage trench is not properly sited, designed, and maintained, they can pollute the groundwater.

While it depends on soil permeability, climate and size of the soakage trench, a soakage trench sized to the City of Portland's standards, can serve a maximum of 15,000 square feet of impervious area.[40]

Maintenance

In order to ensure that a soakage trench is not polluting the groundwater, inspections should take place on a regular basis, as well as after any major storm event. While inspections should make sure that the infrastructure is maintained and properly sited, other maintenance tasks involve controlling erosion and debris accumulation, replacing the piping and filter as needed, removing sediment from the

[40] Environmental Services – City of Portland. (2006, July). *Soakage Trenches (Infiltration Trenches).*

collection box and replacing clogged aggregate. With proper construction and maintenance, a soakage trench can last up to 30 years.[41]

5.1.6 Rainwater Harvesting

Rainwater harvesting refers to the collection and storage of rainwater. Rainwater is usually collected from non-contaminated surfaces such as rooftops, and is stored in catchment tanks. Before the creation of public utilities, rainwater harvesting was very popular across North America as it was a primary water source for many homes.

The complexity of rainwater harvesting systems can vary from a simple collection barrel at the bottom of a residential downspout, to a system with multiple pipes, tanks and controls. Single rain barrels have become extremely popular for single-family residential lots and many municipalities throughout Canada have programs through which they can be purchased for residential use.

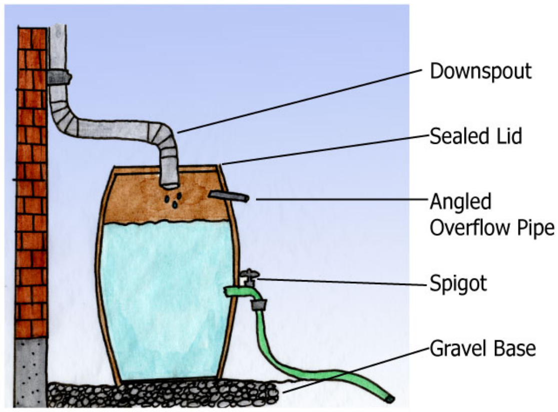
Of all the green on-lot stormwater BMPs, rain barrels have the fewest site constraints. In order for the practice to be effective, however, homeowners need to have a use for the water collected.[42]

---

[41] Environmental Services – City of Portland. (2006, July). *Soakage Trenches (Infiltration Trenches).*

[42] Coffman, S. Larry., Clar, L. Michael and Weinstein, Neil. (1998). *New Low Impact Design: Site Planning and Design Techniques for Stormwater Management.* Proceedings of the 1998 National Planning Conference. AICP Press.

Rain Barrel



Benefits and Effectiveness

The amount of rainwater collected is a direct function of the amount of precipitation and the area of the roof used to collect the precipitation. The water collected can be used for non-potable purposes such as lawn irrigation, washing cars, laundry or toilet flushing. While some precipitation is lost to evaporation as it runs off the roof, generally, collection systems are estimated to be 75-90% efficient. Steel roofs are more efficient than asphalt or tile roofs.[43]

Rainwater that is collected and reused for landscape irrigation or in buildings connected to onsite wastewater systems, infiltrates back into the ground and replenishes the groundwater. These benefits could also translate into financial savings for residential landowners if the demand on municipal water systems is reduced.

Maintenance

Rain barrels must be drained during the winter to prevent ice damage and cracking. If the rain barrel is connected to a downspout, it should be disconnected and the downspout elbow should be removed and stored during the winter. It is essential

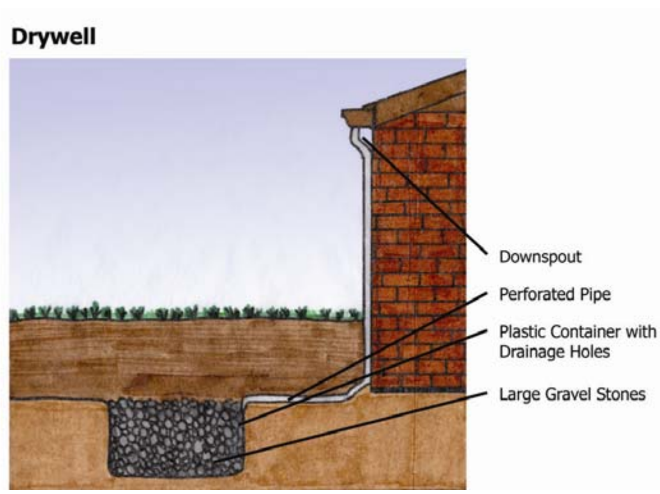
[43] Capital Regional District, Water Services. (2007, February). *Rainwater Harvesting in Greater Victoria.*

that a fine mesh screen be installed and maintained over any openings in the rain barrel to prevent mosquitoes from breeding in the stagnant water.

5.1.7 Drywell (Infiltration Trenches)

A drywell is a subsurface storage facility in which stormwater runoff is stored before it infiltrates into the groundwater. A drywell can receive water from a pipe or channel such as a roof downspout pipe that collects rooftop stormwater. The water is then led through the pipe to the well which is usually an excavated pit filled with gravel. The water can be stored in the space between the gravel before it is discharged into the groundwater.

Dry wells should not receive stormwater from contaminated surfaces and they must be installed at a distance from building foundations. Drywells should be designed to store the water and infiltrate it into the ground within 72 hours.[44] Dry wells are best suited for infiltrating runoff from small drainage areas, usually less than 5 acres.[45] They must be installed carefully to avoid groundwater contamination and to maximize soil infiltration capacity.



[44] Boston Metropolitan Area Planning Council. *Massachusetts Low Impact Development Toolkit.* Retrieved December 5th 2008 from http://www.mapc.org/LID.html

[45] Ibid.

Benefits and Effectiveness

Aside from reducing the volume of stomwater runoff and reducing peak discharge rates, drywells are unobtrusive on a landscape and are suitable for most residential lots.

Maintenance

Drywells need to be inspected at least four times a year and after every major storm. Sediment and debris should also be removed, as they accumulate. Routine inspection should also ensure that the drain-down time of the dry well does not exceed 72 hours.

PART 6: REGULATORY AND POLICY TOOLS – STEERING TOWARDS GREEN

Local governments are regulators and policy makers in the implementation and development of green infrastructure. There is a range of tools available to local governments in BC to encourage green development practices and to regulate the installation of green infrastructure. This section explores regulatory and policy tools that can be used in conjunction with a green on-lot stormwater management plan.

6.1.1 Official Community Plans

Official Community Plans (OCPs) are mandated under section 875 of the *Local Government Act (LGA).* OCPs can be developed by both municipalities and regional districts to set the planning direction for the region's growth and land use management. Local governments are able to instill smart growth principles and can encourage green development practices through their OCPs. OCPs derive their power through their policy direction but also because capital expenditure as well as any bylaws, must be consistent with the OCP.[46]

In section 884 (2) of the *LGA,*[47] it is stated that all bylaws and works must be consistent with the relevant plan; however, the OCP does not commit or authorize a municipality, regional district or improvement district to proceed with any project that is specified in the Plan. If a local government wants to amend a zoning bylaw

---

[46] Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law. 2.1.1.

[47] *Local Government Act*, R.S.B.C. 1996, s. 884.

that is not consistent with the OCP, the OCP and the zoning bylaw will have to be amended at the same time.[48]

While a community's OCP will not usually mandate that private sector development be of a specific "green" standard, they may encourage that current and future development practices are consistent with the vision expressed in the OCP. Proposed developments will be evaluated according to the vision and statements made in the OCP.

6.1.2 Development Permit Guidelines

Local governments in British Columbia are able to mitigate the impacts of development on the environment by establishing development permit areas (DPAs). Development may not take place on land within a DPA without first obtaining a development permit. The authority for municipalities to establish DPAs falls under section 919.1 of the *LGA*. DPAs must be identified in the local government's OCP along with a description of the objectives that justify the DPA designation. The guidelines that must be followed in order for the local government to grant a DPA permit must also be included in the OCP.[49]

Recently, new legislation passed in BC (Bill 27) amends section 920 of the *LGA* to allow local governments to establish 'described requirements in relation to development permits.'[50] While local governments have always been able to create DPAs for the protection of the natural environment, local governments may now designate DPAs for the purposes of:

- Reducing greenhouse gas emissions;
- Energy conservation; and
- Water conservation.

These development permits may now include requirements for:

[48] Nowlan, Linda., Rolfe, Chris and Grant, Kathy. (2001). *The Smart Growth Guide to Local Government Law and Advocacy.* West Coast Environmental Law.
[49] *Local Government Act*, R.S.B.C. 1996, s. 920.
[50] Ibid.

- Landscaping (for example, using drought resistant plants);
- Siting of buildings (which may encourage solar orientation); and
- Specific features in development (such as permeable surfaces).[51]

Many municipalities in BC designate environmentally sensitive areas (ESAs) as DPAs in order to protect the natural environment. Generally, a stringent set of development restrictions will be applied to land within an ESA, or development may be restricted altogether.

6.1.3 Subdivision and Development Servicing Bylaw

A Subdivision Servicing Bylaw can be used by a local government to set the requirements and standards for servicing. Such a bylaw is one of the most direct ways that a local government can require that green on-lot infrastructure be incorporated into a subdivision plan and in the development of land. In most cases, the developer is responsible for the undertaking and must bear the cost of all design, inspection, testing, construction and installation of the works required under the bylaw. Unlike development permit guidelines and OCPs, a Subdivision and Development Servicing Bylaw will require by law that the developer implement the infrastructure specified within the bylaw.

6.1.4 Zoning

Another tool available to local governments is zoning. Zoning bylaw powers generally cover land use, siting, size and dimensions of buildings and can require that certain land use design features such as minimum setbacks are in place. These land use design features can provide important protection for sensitive natural environments. A zoning bylaw can also be used to legislate the management of the green on-lot infrastructure, as shown in section 8.1.5.

As the general principle of green development aims to mimic the natural processes of pre-development levels, municipalities may consider restricting the amount of impermeable surface areas that can be constructed on a parcel of land. This can be

[51] Robertson, Tatiana. (2008). *Overview of Bill 27 (Powerpoint Presentation).* Ministry of Community Services.

done through a zoning bylaw which addresses rain permeability. The City of Vancouver has implemented such a bylaw for land zoned RS (one family dwelling). The following is an example of Vancouver's RS-1 Zoning Bylaw:[52]

The area of impermeable materials, including building coverage, shall not exceed 60 percent of the total site area except that where developed secondary vehicular access to a site is not available, the Director of Planning may exclude from the area of impermeable materials an amount not exceeding:

(a) for the first parking space, the product of the distance, in metres as measured along the driveway centre line, from the point where the driveway crosses the property boundary to the point where it meets the nearest side of the approvable parking space times 3.1 m; and
(b) for each additional parking space, 67 m² to accommodate vehicular access and manoeuvring.

The following materials shall be considered impermeable: the projected area of the outside of the outermost walls of all buildings, including carports, covered porches and entries; asphalt; concrete; brick; stone; and wood.

Parking requirements within a zoning bylaw can also influence site permeability. By establishing parking "maximums" instead of minimum requirements for parking, local governments can reduce the amount of paved surface area.

6.1.5 Other Regulatory Bylaws

Landscaping and Land Use Bylaws

Section 909 of the *LGA* permits a local government to set standards for and regulate the provision of screening or landscaping for one or more of the following purposes:[53]

a. masking or separating uses;
b. preserving, protecting, restoring and enhancing the natural environment;
c. preventing hazardous conditions.

Local governments are able to develop bylaws that help ensure that landscaping will work towards achieving green objectives instead of allowing developments to shift away from these principles. Landscaping and land use bylaws have been around for

[52] City of Vancouver. (2008). *RS-1 District Schedule.* Zoning and Development Bylaw. Bylaw No. 3575.
[53] *Local Government Act*, R.S.B.C. 1996, s. 909.

decades and they continue to be powerful tools in controlling the shape of development, determining use, density, setbacks, height, parking, fencing and landscaping requirements,[54] all of which influence the flow of stormwater.

Topsoil Bylaw

The Community Charter (Section 8.3.m) gives local governments the authority to pass bylaws which impose requirements regarding the deposit of topsoil. Topsoil is fundamental to a soil's retention of rainwater and a proper topsoil layer will increase stormwater infiltration rates and also therefore, decrease the need for lawns and gardens irrigated with freshwater.

The *Community Charter* authorizes local governments to require the deposit of topsoil or to prohibit the removal of topsoil. Bylaws however, prohibiting soil removal are subject to concurrent jurisdiction with the Province and require approval of the minister.[55]

Water Conservation Bylaw

A water conservation bylaw may place restrictions on outdoor watering activities such as watering lawns and gardens, filling swimming pools and car washing. Such a bylaw indirectly encourages green landscaping practices such as water conserving mowing and fertilizing techniques, mulching and rainwater collection. [57]

The Town of Comox, BC has implemented a Water Conservation Bylaw (no. 2867) which applies to all areas that receive water service from the Regional District. The bylaw allows the Council to prohibit the use of water for the purposes of conserving the water supply.

---

[54] Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law. 2.1.1.

[55] Ibid.

[57] Town of Comox. (2006). *Comox Water Rates and Regulations Bylaw.* Zoning and Development Bylaw. Bylaw No. 2867.

Comox has established a three-stage water conservation program, stemming from the bylaw, in which the stage enforced is dependent on the Regional District's water supply and reservoir levels.[58]

Stage 1 – Seven Days a Week Watering

- *People living at an even numbered address can use a sprinkler to water a lawn from midnight (12:01 a.m.) to 7:00 a.m., and 7:00 p.m. to midnight (11:59 p.m.) on an even numbered day.*
- *People at an odd numbered address can water from midnight (12:01 a.m.) to 7:00 a.m. and 7:00 p.m. to midnight (11:59 p.m.) on an odd numbered day.*

Stage 2 – Four Days a Week Watering

- *People living at an even numbered address can use a sprinkler to water a lawn on Tuesday and Saturday from 4:00 a.m. to 7:00 a.m. and from 7:00 p.m. to 10:00 p.m.;*
- *People at an odd numbered address can water on Wednesday and Sunday from 4:00 a.m. to 7:00 a.m. and from 7:00 p.m. to 10:00 p.m.;*
- *No washing of sidewalks, driveways, parking lots, exterior windows, or exterior building surfaces.*

Stage 3 – No Days a Week Watering

- *No one can water a lawn or boulevard; fill or add water to a swimming pool, hot tub, or garden pond; fill or add water to or operate a decorative fountain at any time; or wash a vehicle or a boat with water.*

6.1.6 Financial Incentives – DCC Reduction

Development cost charges (DCCs) are collected by local governments from developers in order to offset the costs that the municipality must incur to service the developer's land. The charges are paid by developers for subdivision approvals and building permits related to construction, alteration or extension of existing buildings.[59] The purpose of DCCs is to recover the capital costs of providing, constructing, altering or expanding of:

- Roads, (other than off-street parking)
- Sewer trunks, treatment plants and related infrastructure;

---

[58] Town of Comox. (2006). *Comox Water Rates and Regulations Bylaw.* Zoning and Development Bylaw. Bylaw No. 2867.

[59] Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law.

- Waterworks; and, drainage works.[60]

DCCs can also be collected for the acquisition and development of parkland as long as the parkland directly serves the new development.[61] DCCs operate under the "user pay" principle and should be similar for all developments that impose similar capital cost burdens on a local government.[62]

DCCs could be influenced by green stormwater management practices because by design, these green practices reduce the amount of hard infrastructure that is required and environmental rehabilitation that traditional stormwater systems contribute to. If green stormwater management practices impose a lower burden on municipal infrastructure, the DCCs paid by the developer should also be lower than for developments that exclusively use traditional practices in their design. Additionally, the demand for water can be reduced through the reuse of non-potable water from rainwater collection barrels and by using native plants to reduce irrigation needs.

New legislation was recently passed in BC (May 2008), which gives local governments the right to waive or reduce DCCs for:

- Development with a low environmental impact;
- For-profit affordable rental housing; and
- For small lot subdivisions.

This new legislation forces local governments to examine how low impact development may affect the cost of municipal infrastructure and servicing.

Local governments may also fast-track the building permit approval process for green developments, which creates an indirect financial incentive.

---

[60] BC Ministry of Community Services. (2005). *Development Cost Charge Guide for Elected Officials.*

[61] Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law.

[62] *Local Government Act*, R.S.B.C. 1996, s. 943.

PART 7: MANAGEMENT AND MAINTENANCE STRATEGIES

7.1 Maintenance Requirements

In communities that have successful green stormwater management plans, a great deal of effort has gone into establishing maintenance programs that correspond to the management plan. Establishing the drive to implement green infrastructure is a major accomplishment in itself, however an effective maintenance program is needed to see the success of the program into the future. An effective maintenance program that ensures that the infrastructure will continue to perform as designed, should be of utmost priority. Maintenance requirements will serve to protect water quality, improve the longevity of the infrastructure, maximize the effectiveness of the infrastructure and make sure the facilities remain attractive and functional. The lack of an adequate maintenance program is the primary shortcoming for most local stormwater programs.[63] Proper planning will ensure that post-construction green stormwater infrastructure will be an amenity rather than a chronic problem.

7.2 Common Maintenance Issues

While there are numerous types of maintenance issues that relate specifically to the type of infrastructure installed, there are some common issues that will need to be addressed in all maintenance programs.

Inherent to the function of water flow, most stormwater infrastructure easily traps litter, foliage, silt and other debris. This debris must be removed at regular intervals and after any significant storm event. If this maintenance is not performed, the performance of the infrastructure will decline.

---

[63] Center for Watershed Protection. (2008, July). *Managing Stormwater in Your Community – A Guide for Building an Effective Post-Construction Program*.

One major public health concern is the spread of West Nile Virus by mosquitoes. If the infrastructure is well designed and maintained, such problems should not arise. If the site and infrastructure is not maintained, the pooling of stagnant water as well as overgrowth of vegetation will create a habitat for mosquitoes. In many municipalities it is prohibited to have any stagnant water on private property.

While these are perhaps two of the most prevalent problems, there are many other maintenance issues that may need to be continuously addressed such as structural repairs, erosion and safety concerns.

The maintenance issues identified apply most specifically to BMPs on private lots. These challenges include:

- The lack of knowledge of maintenance practices and the importance of these maintenance practices on the part of the homeowner.
- The financial burden that the management of BMPs and remediation from poorly managed BMPs may impose on the homeowner.
- The potential lack of adherence to maintenance practices; and

  The burden and costs associated with the enforcement of maintenance practices on the part of the local government.

7.3 Strategies for On-lot Management

The long-term performance of stormwater BMPs is reliant on ongoing and proper maintenance. Ideally, the issue of maintenance of on-lot green stormwater infrastructure would be sufficiently resolved so that it is not a barrier to enforcing green development practices.

7.3.1 Maintenance Agreements

One way that local governments can address this issue is by establishing a stormwater maintenance agreement, or a contract between the local government and the property owner. This contract will help ensure that specific maintenance functions in regards to the green infrastructure will be adequately performed. The property owner could enter into such an agreement as a condition of receiving development rights, through an incentive program, or on a voluntary basis. Such an agreement would be of benefit to the local government as it would place the responsibility for the maintenance of the infrastructure on the property owner (or other legally recognized party), while the local government can restrict their responsibilities to inspection and plan processing.

Maintenance agreements should clearly define the responsibilities of all parties entering into the agreement. The contract should be accessible to all parties, as the language must be comprehensive but easy to understand.

The Centre for Watershed Protection outlines six factors that should be included in a stormwater maintenance agreement. The following is a summary of these suggested inclusions:[64]

1. **Performance of Routine Maintenance**
   The agreement should state who should perform which maintenance tasks. Some local governments may require that property owners do the aesthetic maintenance (i.e., mowing, vegetation removal) but elect to perform structural maintenance and sediment removal themselves. Local governments may want to consider using language that will allow them to increase the maintenance requirements if it becomes necessary to do so to preserve the functionality of the infrastructure.
2. **Maintenance Schedules**
   The agreement should state when inspections, maintenance and repairs should be performed. The local government should provide the landowner with these standards and a performance checklist. An

[64] Center for Watershed Protection. (2008, July). *Managing Stormwater in Your Community – A Guide for Building an Effective Post-Construction Program*.

annual report should also be submitted by the land owner to the local government which may then choose to perform an inspection of the facility.

3. **Inspection Requirements**

   Local governments may obligate themselves to an inspection schedule, or they may choose to perform inspections when they are deemed necessary.

4. **Access to the Facilities**

   The agreement should grant permission to the local government's stormwater officials to enter onto the property and inspect the stormwater facilities.

5. **Failure to Maintain**

   The agreement should outline the steps for dealing with a 'failure to maintain' situation. The agreement should state if the local government will perform the maintenance in such a situation and the method in which the costs will be recovered from the property owner or the consequences that may be imposed (repayments and interest, liens).

6. **Registering the Maintenance Agreement**

   Local governments may want to register the agreement on title. Doing so will ensure that the maintenance agreement is bound to the property in perpetuity. Depending on the type of maintenance strategy the local government employs, this may or may not be necessary.

7.3.2 Statutory Rights-of-Way

Local governments may opt to include statutory rights-of-ways (SROWs) into their maintenance agreements. An SROW is an agreement that confers on an individual, company or municipality the right to use a landowner's property in some way. While these agreements grant rights, they also have the effect of partially restricting an owner's use of the affected portions of land.[65] SROWs are often used by utility companies when primary gas lines pass under a landowner's property in order to guarantee the utility company access to the line and restrict usage of the land that may prevent such access. In British Columbia, SROWs are commonly established for B.C. Hydro rights of way for transmission lines. However, it is also possible for conservation organizations that are designated under section 214 of the *Land Title Act* to hold SROWs.[66]

Local governments currently require SROWs for traditional drainage infrastructure and this practice may be extended to green stormwater infrastructure if required. SROWs are generally registered on the certificate of title to the property. They are permanently attached to the land and are automatically transferred to the new landowner when the property is sold. While the landowner continues to own the land covered under an SROW, the beneficiary holds certain rights regarding usage. Section 214 of the *Land Title Act* reads as follows:

[65] Alberta land Surveyors' Association. *Easements & Rights-of Way.* Accessed December 5, 2008, http://www.alsa.ab.ca/GeneralInfo/easements.htm#WhatIs

[66] Findlay, Barbara and Hillyer, Ann. (1994, January). *Here Today, Here Tomorrow – Legal Tools for the Voluntary Protection of Private Land in British Columbia.* West Coast Environmental Law Research Foundation.

1. *A person may and is deemed always to have been able to create, by grant or otherwise in favour of*
   a) *the Crown or a Crown corporation or agency,*
   b) *a municipality, a regional district, the Greater Vancouver Transportation Authority, a local trust committee under the* Islands Trust Act *or a local improvement district,*
   c) *a water users' community, a public utility, a pulp or timber, mining, railway or smelting corporation, or a corporation authorized to transport oil or gas, or both oil and gas, or solids, as defined in the Pipeline Act, or*
   d) *any other person designated by the minister on terms and conditions that minister thinks proper, an easement, without a dominant tenement, to be known as a "statutory right of way" for any purpose necessary for the operation and maintenance of the grantee's undertaking, including a right to flood.*
2. *To the extent necessary to give effect to subsection (1), the rule requiring an easement to have a dominant and servient tenement is abrogated.*

2.1 *The minister may delegate to the Surveyor General the minister's powers under subsection (1) (d).*

3. *Registration of an instrument granting or otherwise creating a statutory right of way*
   a) *constitutes a charge on the land in favour of the grantee, and*
   b) *confers on the grantee the right to use the land charged in accordance with the terms of the instrument, and the terms, conditions and covenants expressed in the instrument are binding on and take effect to the benefit of the grantor and grantee and their successors in title, unless a contrary intention appears.*
4. *A person who executes an instrument in which a statutory right of way is created is not liable for a breach of a covenant in the instrument occurring after the person has ceased to be the owner of the land.*
5. *This section is retroactive in its application and applies to all statutory rights of way, whenever created.*
6. *A recital in a grant or reservation of a statutory right of way that it "is necessary for the operation and maintenance of the grantee's undertaking", or a statement to that effect in the application to register the statutory right of way, is sufficient proof to the registrar of that fact.*

7.3.3 Conservation Covenants

A covenant concerning land is an agreement in which a landowner agrees to do or not to do something in connection with his or her land (positive or restrictive covenants). A covenant differs from a SROW in that an SROW is the right granted by a landowner to another landowner to use the grantor's land in a particular way or to prevent the grantor from using his or her land in a particular way.[67]

While there are different types of covenants used throughout North America, in BC covenants are voluntary, written agreements between a landowner and the holder of the covenant. The agreement will generally state that the landowner promises to

[67] Findlay, Barbara and Hillyer, Ann. (1994, January). *Here Today, Here Tomorrow – Legal Tools for the Voluntary Protection of Private Land in British Columbia.* West Coast Environmental Law Research Foundation.

protect a portion of a parcel of property. The agreement gives the covenant holder the right to enforce the covenant if the property owner does not abide by the agreed upon terms. A conservation covenant is a tool that can be used to impose restrictions on the development of the land by registering a covenant that "runs with the land" and binds the subsequent owners under the scheme.[68] The restrictions can be imposed at the time that the land is being sold by a developer to individual landowners. Covenants can also be attached to land that is owned by governments which is then sold for the purposes of development. The attachment of covenants to parcels of land is sometimes called statutory building schemes and can be very restrictive in nature. The builder and buyer voluntarily agrees to be bound by a covenant on title restricting specific development rights.

A conservation covenant is registered against the title to the property, under section 219 of the Land Title Act:

> *4. A covenant registrable under subsection (3) may be of a negative or positive nature and may include one or more of the following provisions:*
> *a) any of the provisions under subsection (2);*
> *b) that land or a specified amenity in relation to it be protected, preserved, conserved, maintained, enhanced, restored or kept in its natural or existing state in accordance with the covenant and to the extent provided in the covenant.*

7.3.4 Securities

A security (or bond) is a financial tool that may be used to ensure that green stormwater infrastructure is constructed to the standards set by the local government, and to ensure that the infrastructure is properly maintained over a set period of time. While securities are not currently used for on-lot BMPs in British Columbia, performance and maintenance bonds or securities may be a viable component of a future maintenance strategy.

A performance bond can be used to guarantee that if a developer defaults, funds are available to finish the construction of the infrastructure and to ensure it functions

[68] Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law.

properly.[69] Local governments may require that developers provide a bond from a bank or insurance company so that the local government can complete the construction and recover any damages that may be sustained as a result of the developer's default. The maximum limit of the bond will usually be equal to the estimated construction costs.

A maintenance bond may prove to be an extremely successful, shorter term maintenance tool for local governments. A maintenance bond will protect against design and installation defects of the infrastructure and will guarantee that facilities constructed under a permit will be regularly and adequately maintained throughout the maintenance period.[70]

Local governments may chose to implement performance bonds or maintenance bonds however the trouble lies in the inherent "temporary" nature of the bond. Maintenance bonds are usually only in place for a limited amount of time which will not span the life of the property (generally 1-3 years). Local governments will need to address how they will ensure the maintenance of the infrastructure after the bond has been lifted. Short term securities or bonds however can be very useful in guaranteeing the functionality and determining the long-term maintenance needs of green stormwater infrastructure.

The Stormwater Manager's Resource Center[71] outlines four points of information that should be clearly stated in the bond language:

---

[69] Stormwater Manager's Resource Center. *Stormwater Management Fact Sheet: Performance Bonds*. Retrieved December 5th 2008 from http://www.stormwatercenter.net/

[70] Ibid.

[71] Ibid.

1. **Establish the total dollar amount required for the bond**
   Many stormwater ordinances set the amount of a bond as a percentage of the estimated cost. This number can vary, but most communities tend to set the sum of the performance bond at 100% of the estimated cost of construction for the STP. Maintenance bonds often use a figure of 10% of construction cost as the required amount.

2. **Specify the length of the bond**
   Bond lengths are typically required for fixed rate of time following a project milestone, after which the local government releases the bond. For construction performance bonds, this is usually after completion and final approval of the STP and then posting of a maintenance bond. The maintenance bond typically guarantees that the project owner will maintain the STP for a fixed period of time, most often up to two years. At the end of this time, a local government may inspect the system and extend the maintenance bond requirement if all contract stipulations are not met.

3. **Set the requirements for notice of defect or lack of maintenance**
   Local governments should outline the time period for completion of corrections to an STP after a notice of defect. In addition, the bond should establish a time period for response from the bonding company if the permittee fails to meet their obligation.

4. **Bond enforcement.**
   If the permittee does not successfully complete all required work or violates any requirement of the bond, the local government should spell out any enforcement measures it deems necessary to ensure project completion and proper maintenance. Bonds often provide for a local government to take corrective measures and to charge the cost to the permittee. These costs can include the actual cost of any work deemed necessary as well as administrative and inspection costs. Local governments may also reserve the right to solicit a new bid and contract for the correction of problems after expiration of the time limits, with liability for costs assigned to the current contractor and the insurance company or bank.

7.3.5 Stormwater Management Bylaw

A stormwater management bylaw is another effective tool to ensure the maintenance of on-lot infrastructure. Such a bylaw may regulate the construction and post-construction for new and redevelopment projects. An effective bylaw will help establish clear stomwater management goals, standards, maintenance requirements and the penalties for violation of the bylaw.

The City of Redmond, Washington has implemented a comprehensive Stormwater Maintenance Code which accompanies their successful education and community outreach program. The Redmond Stormwater Division also prepares a concise information handout outlining the minimum requirements for on-lot maintenance. This handout is delivered to all utility billing accounts within the city. Some of the key components of the Code relating to private on-lot maintenance requirements are as follows:[72]

Minimum requirements

a) All stormwater facilities shall be inspected at regular intervals and maintained and repaired as needed to comply with the Minimum Operating Standards, the approved designs for stormwater facilities, stormwater permits which may be issued by the City of Redmond, the State Department of Ecology, or the Environmental Protection Agency (EPA), applicable construction standards, and the minimum requirements as stated in the Stormwater Management Manual.

b) All stormwater facilities shall be inspected by the City on a periodic basis. For example, facilities such as grassy swales shall be inspected more frequently than piped stormwater conveyance systems as specified in the Minimum Operating Standards. If, during an inspection, a facility is found not to be in compliance with the Minimum Operating Standards, all subsequent inspection and maintenance intervals shall be scheduled more frequently if determined by the Director to be necessary in order to assure future compliance.

c) Where maintenance and repair is found necessary to correct health or safety problems, to control harmful materials entering the stormwater system, or to remove harmful materials that have entered the stormwater system, such work shall be completed by the owner or operator of the stormwater system or stormwater facility within 24 hours. When maintenance and repair is found necessary to prevent water quality degradation, such work shall be completed within 14 calendar days. For other related problems, maintenance or repairs shall be completed within 30 calendar days.

Compliance required

Property owners are responsible for the maintenance, operation and repair of stormwater systems and BMPs within their property. Property owners shall maintain, operate and repair these facilities in compliance with the requirements of this chapter and the Stormwater Management Manual.

Inspection requirements

The Director is authorized to develop inspection procedures and requirements for all stormwater facilities in the City of Redmond.

Inspection and maintenance schedule

The Director shall establish inspection and maintenance scheduling and standards for all publicly and privately owned stormwater facilities. At a minimum, for all privately owned stormwater facilities, the base frequency for inspection and maintenance shall be annually. Adjustment to the maintenance frequency may be authorized when found appropriate by the Director.

[72] City of Redmond. (2008, July). *Stormwater Maintenance Code. Redmond Municipal Code*. Ordinance No. 2408.

Inspection and maintenance records

Owners of storm drainage systems will be required to provide the Director with all existing inspection, maintenance and repair records, as well as any record drawings or diagrams that they may have for their storm drainage systems.

Enforcement policy

Enforcement action shall be taken whenever a person has violated any provision of this chapter. The choice of enforcement action taken and the severity of any penalty shall be based on the nature of the violation, the damage or risk to the public or to public resources, and/or the degree of bad faith of the persons subject to the enforcement action.

Orders

The Director shall have the authority to issue to an owner or person(s) representing an owner an order to maintain or repair a component of a stormwater facility or BMP to bring it in compliance with this chapter, the Stormwater Management Manual and/or other City regulations. The order shall include:

a) A description of the specific nature, extent and time of the violation and the damage or potential damage that reasonably might occur.
b) A notice that the violation or the potential violation cease and desist and, in appropriate cases, the specific corrective action to be taken.
c) A reasonable time to comply, depending on the circumstances.
d) Penalties that may be incurred by any owner of a stormwater system not in compliance with this chapter.
e) An order to the owner to provide to the Director a detailed plan showing drawings and steps that will be taken to achieve compliance within a specified time. This plan is subject to approval by the Director.

Penalty for violations

a) Persons Subject to Penalty. Any person who violates or fails to comply with the requirements of this chapter or who fails to conform with the terms of an approval or order issued by the Director shall be subject to a civil penalty to be administered by the Code Compliance Hearing Examiner as provided in Chapter 1.14 of the Redmond Municipal Code. Each day of continued violation shall constitute a separate violation for purposes of this penalty.
b) Aiding or Abetting. Any person who, through an act of commission or omission, aids or abets in the violation shall be considered to have committed a violation for the purposes of the civil penalty.
c) Procedure for Imposing Penalty. The procedure for notice of violation and imposition of penalties under this chapter shall be the same as for other code violations as described in Chapter 1.14 of the Redmond Municipal Code; provided, that such procedures may be initiated by either the Director or the Code Compliance Officer upon request of the Director.
d) Community Service Alternative. The Director may, at his/her discretion, provide the option for payment of all or part of any penalties incurred by any person(s) to be made in the form of community service that will be of benefit to the environment and the City. If a person decides to avail themselves of this option when offered by the Director, the Director and the person shall enter into a formal, written agreement providing for the community service. This agreement shall include in detail the description of the service(s) to be rendered by the person(s) in penalty for noncompliance of this chapter. The description shall include the hours of service needed to offset the above mentioned penalties based on a mutually agreed upon hourly rate for service.
e) Re-Inspection Fees. In addition to the penalties to be imposed by the Code Compliance Hearing Examiner, the Director may impose a re-inspection fee for any account or storm drainage facility found not to be within compliance of this chapter.

Penalties due

Penalties imposed by the Code Compliance Hearing Examiner under this chapter shall become due and payable 30 days after receiving notice of penalty unless application for remission or mitigation is made or an appeal is filed. If the amount of a penalty owed is not paid within the time specified in this section, the City of Redmond may take actions necessary to recover such penalties.

7.3.6 Voluntary Programs

As the impacts of poorly managed stormwater systems become widely understood, some residents are volunteering their time, knowledge and skills to educate and improve stormwater management practices on their own property and on lots throughout their communities. A primary component of a voluntary stormwater management program is education. Such a program should encourage homeowners to be better stewards of water resources by teaching them how to implement and manage green stormwater infrastructure on their own property. Many of the voluntary organizations that have established such programs have achieved success through the construction of demonstration projects located in highly visible areas. Demonstration sites provide residents with an opportunity to visualize the positive impacts green infrastructure will have on their property and to learn about the maintenance tasks that they can expect to undertake, post-installation of the green infrastructure on their own property. Below is a description of a program that used the demonstration of BMPs, voluntary educational programs and small grant incentive programs to reach out to the public and encourage on-lot green stormwater BMPs and the proper maintenance practices of these BMPs.[73]

[73] DiNardo, F. Madeline. et al. (2008). *Stormwater Management in Your Backyard: An Extension Initiative for New Jersey, New York and Virginia.* National Water Program.

Stormwater Management in Your Backyard: An Extension Education Initiative for New Jersey, New York and Virginia

This project was intended to empower local stakeholders, specifically the volunteer Master Gardeners and landscape professionals to design, install and maintain community and private on-lot rain gardens as a stormwater management initiative. These stakeholders were trained, mostly by university faculty and staff from Rutgers, Virginia Tech and Cornell Cooperative Extension.

This program was based on the success of other community outreach programs for adults and children which have indicated an increase awareness of stormwater management practices that protect stormwater. The "Stormwater Management in Your Backyard" project built upon the lessons learned in the previous demonstration projects and aimed to address certain issues that were identified such as installation problems, drainage challenges, labour and financial issues.

Three major activities were undertaken throughout this project as a means to promote education, proper installation and maintenance techniques and on-lot green stormwater management practices:

1. Rain garden installation and maintenance program for professional landscapers - This training program focused on stormwater regulations; rain garden site selection, soil amendments, drainage improvement, native plant selection, installation, maintenance and marketing.
2. Rain garden education program for volunteer master gardeners and farmers – Ninety volunteer Master Gardeners and farmers completed a rain garden education program through which nine community rain gardens were established and maintained. The Master Gardeners conduct public outreach programs include maintenance actions, at the demonstration sites.
3. Rain garden "mini-grant" incentive program – This aspect of the program was established to encourage the adoption stormwater management practices, specifically rain gardens, on private residential properties. These grants were available to the volunteer and public outreach program participants.

The "Stormwater Management in Your Backyard" program runs until 2010 and the program will serve to train landscape professionals on the installation of raingardens, educate community members and volunteers on implementation and maintenance practices for their own on-lot stormwater practices and help to fund new on-lot rain gardens for "mini-grant" recipients.

PART 8: CONCLUSION

Local governments in British Columbia are facing a new level of responsibility for sustainable building practices in terms of encouraging, managing and leading by example. Since most development is occurring in the private sector, local governments in BC must take advantage of the opportunity to be proactive in facilitating, and ensuring the long-term maintenance of green development practices.

Despite the complexity of the problem and the need for a solution that is tailored to each region, there are four steps that will facilitate the implementation of on-lot green infrastructure and the development of a maintenance plan. These steps are to:

1. Determine the recommended on-lot BMPs specifically for the region. This will likely be a collaborative effort between planners, engineers and perhaps community organizations. While a handful of the most popular on-lot BMPs are discussed in this report, there are many other practices that may prove suitable depending on local conditions. By recommending specific BMPs, local governments can develop and provide infrastructure user guides to residents, and develop expertise in matters relating to the identified BMPs.
2. Establish design standards which address site planning and facility design. This will require collaboration with engineers, water management professionals, consultation with local governments and with agencies that have been through the process of establishing design standards.
3. Establish performance standards which will help local governments evaluate the success of the BMPs once implemented.
4. Develop an enforcement strategy to ensure the maintenance of the on-lot infrastructure. As discussed throughout this report, local governments will need to evaluate the applicability of the regulatory and policy tools available and determine the most suitable maintenance strategy. The development of a maintenance program will be a consideration throughout the entire process, for example, certain BMPs will be recommended on the basis of their maintenance requirements.

This list is by no means inclusive but provides the foundational steps in an on-lot green stormwater program.

The objective of this report has been two-fold. First, the report addresses the need for local governments to understand the benefits and solutions that are inherent to green stormwater management practices. In order for local governments and individual property owners to implement these low impact development practices, they must first understand nature's processes and they must know how to engineer their land to be able to maintain those natural processes rather than destroy them. Extensive research has been conducted on the benefits and on the rationalization for green on-lot stormwater infrastructure, the main points of which have been integrated into the first section of this report. The second portion of the report shows how these practices can be effectively managed; an issue that has received little attention, considering the significant barrier management issues have created in the implementation of green on-lot stormwater infrastructure.

This report does not attempt to propose a single management solution for local governments in British Columbia, but rather, each jurisdiction will have a different development and political climate, physical and climatic conditions, and various levels of public support for the regulation and maintenance of green infrastructure practices. Instead of offering one “blanket” solution, this report has identified the issues that must be considered when choosing a management strategy. This report has also identified and described programs that have been successfully implemented by other jurisdictions. The intent is that local governments in BC will be able to use their regulatory and policy tools, (Part 6) to implement the best suited management tool (Part 7).

The future of on-lot green stormwater infrastructure will depend on the successes of collaborative efforts among architects, engineers, stormwater managers, planners, developers and of course, individual property owners. Through a collaborative approach, local governments in BC can use the tools, case studies and rationale for on-lot green stormwater infrastructure provided in this report, to take the next steps towards a management plan for on-lot green stormwater infrastructure.

REFERENCES

Alberta land Surveyors' Association. *Easements & Rights-of Way*. Accessed December 5, 2008, http://www.alsa.ab.ca/GeneralInfo/easements.htm#WhatIs

BC Ministry of Community Services. (2005). Development Cost Charge Guide for Elected Officials.

BC Statistics, Ministry of Management Services. (2004). *British Columbia Population Projections*.

Banting et al. (2005, October). *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto*.

Booth, B, D., Visitacion, B. and Steinemann, C. Anne. (2006, August). *Damages and Costs of Stormwater Runoff in the Puget Sound Region.* The Water Center, Department of Civil and Environmental Engineering, University of Washington.

Bradford, J. Michael., Irvine, R. James. (2000). *Land Use, Fishing, Climate Change, and the Decline of Thompson River, British Columbia, Coho Salmon*. Canadian journal of Fisheries and Aquatic Sciences. 57(1).

Boston Metropolitan Area Planning Council. *Massachusetts Low Impact Development Toolkit.* Retrieved December 5th 2008 from http://www.mapc.org/LID.html

British Columbia Ministry of Community Development. (2007). *B.C. Climate Action Charter.*

British Columbia Office of Housing and Construction Standards. (2008, September). *Greening the BC Building Code: First Steps.*

Capital Regional District, Water Services. (2007, February). Rainwater Harvesting in Greater Victoria.

Center for Watershed Protection. (2008, July). Managing Stormwater in Your Community – A Guide for Building an Effective Post-Construction Program.

City of Maryland, Department of the Environment. (2000, October). Maryland Stormwater Design Manual.

City of Redmond. (2008, July). *Stormwater Maintenance Code*. Redmond Municipal Code. Ordinance No. 2408.

City of Vancouver. (2006). *Crown Street – Sustainable Streetscapes and Fish Habitat Enhancement Project.*

City of Vancouver. (2008). *RS-1 District Schedule. Zoning and Development Bylaw.* Bylaw No. 3575.

Coffman, S. Larry., Clar, L. Michael and Weinstein, Neil. (1998*). New Low Impact Design: Site Planning and Design Techniques for Stormwater Management.* Proceedings of the 1998 National Planning Conference. AICP Press.

DiNardo, F. Madeline. et al. (2008). Stormwater Management in Your Backyard: An Extension Initiative for New Jersey, New York and Virginia. National Water Program.

Dovetail Consulting Inc. (1996, November). *Urban Stream Stewardship: From Bylaws to Partnerships – An Assessment of Mechanisms for the Protection of Aquatic and Riparian Resources in the Lower Mainland. Canadian journal of Fisheries and Aquatic Sciences.* Prepared for Fisheries and Oceans Canada and Environment Canada.

Environmental Services – City of Portland. (2006, July). *Soakage Trenches (Infiltration Trenches).*

Findlay, Barbara and Hillyer, Ann. (1994, January). *Here Today, Here Tomorrow – Legal Tools for the Voluntary Protection of Private Land in British Columbia.* West Coast Environmental Law Research Foundation.

Fischenich, J. Craig. (2001, May). *Technologies for Urban Stream Restoration and Watershed Management.* Technology News from the Ecosystem Management and Restoration Research Program.

Fisheries & Oceans Canada. (1997). *Wild, Threatened, Endangered and Lost Streams of the Lower Fraser Valley – Summary Report*. Lower Fraser Valley Stream Review, Vol. 3.

Government of British Columbia. (2008). *Living Water Smart – British Columbia's Water Plan.*

Greater Vancouver Regional District (GVRD). *Template for Integrated Stormwater Management Planning.* 2005.

Haugland, John. (2005, February). *Changing Cost Perceptions: An Analysis of Conservation Development.* Conservation Research Institute.

Kloss, Christopher. Low Impact Development Center (2006, June). *Rooftops to Rivers – Green Strategies for Controlling Stormwater and Combined Sewer Overflows.* Natural Resources Defense Council.

Legislative Assembly of British Columbia. (2008). *Bill 27- 2008, Local Government.* Green Communities Statutes Amendment Act.

Nowlan, Linda., Rolfe, Chris and Grant, Kathy. (2001). *The Smart Growth Guide to Local Government Law and Advocacy*. West Coast Environmental Law.

Portland Bureau of Environmental Services. (2008, October). Stormwater Management Manual.

Province of British Columbia. Local Government Act, R.S.B.C. (1996).

Robertson, Tatiana. (2008). *Overview of Bill 27* (Powerpoint Presentation). Ministry of Community Services.

Rutherford, Susan. (2006). *The Green Buildings Guide – Tools for Local Governments to Promote Site Sustainability.* West Coast Environmental Law. 2.1.1.

Smart Growth BC. (2005). *Affordable Housing Policy*.

Stormwater Manager's Resource Center. *Stormwater Management Fact Sheet: On-Lot Treatment.* Retrieved December 5th 2008 from http://www.stormwatercenter.net/

Town of Comox. (2006). *Comox Water Rates and Regulations Bylaw*. Zoning and Development Bylaw. Bylaw No. 2867.