TOPSOIL REQUIREMENTS IN VANCOUVER:

THE NEED, THE BENEFITS, AND THE NEXT STEPS

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August 10, 2016

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Acknowledgements

I would like to thank all of the people who took interest in the project and generously offered their contributions and support. Special thanks to: the City of Vancouver Topsoil Working Group for their incredible input to the project; staff at the case study municipalities for their willingness to share their experiences; and to Jennifer Bailey for reviewing the report. Extra thanks to Shelley Heinricks for her close involvement in the project along the way – you went the extra mile.

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Vancouver Board of Parks and Recreation

Parks and Recreation

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- Nick Page
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Acknowledgements

Case Study Municipalities:

- Jeannie Lee (City of Surrey)
- David Hislop (City of Surrey)
- Rod Stott (City of Maple Ridge)
- Melony Burton (City of Coquitlam)
- Carie Liefke (City of Vernon)
- Corey Davis (City of Kelowna)
- Nancy Gothard (City of Courtenay)
- Derek Richmond (formerly City of Courtenay)
- Nick Carello (District of Metchosin)
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- Jake Lund (City of Olympia)

External Supportors:

- Robert Hicks (Metro Vancouver)
- Eileen Butler (Metro Vancouver)
- Farshad Mortazavi (Metro Vancouver)
- Kim Stephens (The Partnership for Water Sustainability in B.C.)

This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City 2020 Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

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Acronyms

Acronym	Definition
AWC	Available Water Capacity
BCLNA	British Columbia Landscape and Nursery Association
BMP	Best Management Practice
COV	City of Vancouver
DP	Development Permit
DPA	Development Permit Area
ESC	Erosion and Sediment Control
GCAP	Greenest City 2020 Action Plan
ILWRMP	Integrated Liquid Waste and Resource Management Plan
IRMP	Integrated Rainwater Management Plan
ISMP	Integrated Stormwater Management Plan
LID	Low Impact Development
LPCD	Litres Per Capita Per Day
MMCD	Master Municipal Construction Documents
NCP	Neighbourhood Concept Plan
OCP	Official Community Plan
OM	Organic Matter
USDA	United States Department of Agriculture

Executive Summary

This report was produced to support implementation of the City of Vancouver's Greenest City 2020 Action Plan (GCAP) and its goal of being the greenest city in the world. The city is facing many challenges and resultant opportunities surrounding water, particularly the conservation of potable water and management of rainwater. High levels of water consumption, population growth, climate change, and urbanization are all challenges that the City is working to address. The GCAP Clean Water Goal includes a target to reduce water consumption by 33% from 2006 levels. As of 2015, there is a 17% reduction still to be achieved by 2020. A topsoil requirement is one of key tools that the City can use to meet its water conservation and rainwater management goals. This report summarizes the need for both improved water conservation and rainwater management in Vancouver; presents the benefits of topsoil for both of these aspects, among others; and puts forth recommended next steps for the City to get started on a topsoil requirement.

Key findings of the research include:

- Topsoil can help the City to meet its water conservation and rainwater management goals because of its capacity to hold and retain water, which is important for reducing the need for irrigation during the summer and managing rainwater when it rains.
- The main factors that determine how well topsoil holds and retains water are soil composition and depth.
- Topsoil also offers benefits that support several of the city's strategies and goals, such as supporting the urban forest and biodiversity.
- It is important to follow Best Management Practices (BMPs) for topsoil during development and there are several key resources available in the region.
- The current topsoil practices in the public realm are sufficient in parks, but there is opportunity to improve on city streets.
- There is presently no topsoil requirement for private properties and the current practices do not meet those advised in the BMP guides.
- There are leading cities in B.C. and Washington, such as the City of Surrey and the City of Olympia, that have topsoil requirements for private properties and there are lessons to learn from their experiences.
- Metro Vancouver is currently developing a Region-Wide Baseline for On-Site Rainwater Management, which includes a topsoil requirement. It will apply to single family lots, duplexes, and triplexes, in areas where there is currently no rainwater management requirement.

In response to these findings, it is recommended that the City of Vancouver develop, implement, administrate, and evaluate a topsoil requirement for the private realm and lead the way with its practices in the public realm. A topsoil requirement will help the City to reach its water conservation and rainwater management goals and to move closer to becoming the greenest city in the world.

Introduction

Introduction

The City of Vancouver has set important objectives for water conservation and rainwater management, which are critical to the City reaching its goal to be the greenest city in the world. A topsoil requirement is a tool available to the City to help meet both water conservation and rainwater management goals. Topsoil can hold up to 20% of its volume; and the deeper it is, the greater the water holding capacity[1]. Therefore, it reduces the need for irrigation during the summer and helps to manage rainwater when it rains. Moreover, the benefits of a topsoil requirement go beyond water conservation and rainwater management, supporting several of the City's strategies to make Vancouver sustainable, healthy, biodiverse, and resilient. This research was catalyzed by the City's Water Design Branch, leading to the creation of the Topsoil Working Group. This group is a multi-departmental collaboration and has representation from the Sewer and Drainage Design Branch, the planning department's Landscape Branch, and the Vancouver Board of Parks and Recreation. This approach has led to a diversity of contributions to the research from different stakeholders within the City.

Research Objectives, Methods, and Limitations

Objectives

The objectives of this research report are:

- to present the benefits that a topsoil requirement has to offer the City of Vancouver, particularly for meeting its water conservation and rainwater management goals;
- to outline the Best Management Practices (BMPs) for topsoil;
- to introduce topsoil requirement tools and examine how other cities are using them;
- to describe considerations for development, implementation and administration of a topsoil requirement in Vancouver;
- to make recommendations for Vancouver's next steps.

Methodology

The methods included a literature review, interviews, and focus groups. The literature review included research into the Vancouver context and the need for water conservation and rainwater management; soil science and the benefits of a topsoil requirement; topsoil BMPs; and topsoil requirement tools and how they are used by other cities. Interviews were held with City of Vancouver staff to identify the current topsoil practices in Vancouver's public and private realms. To learn from experiences had by other municipalities who currently have topsoil requirements, interviews were conducted with staff from a number of cities in B.C. and Washington State. Meetings and focus groups were held with the Topsoil Working Group comprised of individuals with key interests in a topsoil requirement. A presentation to the working group and other city staff was held at the interim of the research to collect feedback and recommendations for the research.

Limitations

Due to breadth of the project scope and the time period available, the level of depth into the different research components needed to be kept to a manageable level. To quantify the benefits of water conservation and rainwater management on a site or city scale would require further time and resources as it would require detailed research design to produce defensible results. Similarly, in order to generate a comprehensive plan for implementation and administration of a topsoil requirement will require further engagement with City of Vancouver staff and other stakeholders. Therefore, considerations for topsoil requirement development, implementation, and administration are presented as a starting point, from which further expansion must take place.

Image 1. Garden bed landscaping[2].

Report Overview

The components of this report are grouped into four major sections:

Section 1 reviews the context for this research. It includes a description of the current Vancouver landscape and why both water consumption and rainwater needs to be managed in the city.

Section 2 is about topsoil and its benefits. The basics of soil science are explained, particularly in relation to water holding capacity; and the benefits of topsoil for water conservation, rainwater management, and beyond are presented.

Section 3 covers topsoil BMPs. The key BMP resources and their soil specifications are summarized and the recommended practices during the different stages of development are consolidated into a sequential list. Thereafter, the current topsoil practices in both the public and private realms are discussed and compared to the BMPs. The potential risks of optimum topsoil application are also discussed.

Section 4 is on the recommended next steps for a topsoil requirement. It outlines the topsoil requirement tools available to the City of Vancouver and looks at how other cities are using these tools for their topsoil requirements. Furthermore, it describes regional requirements and considerations for the development, implementation and administration of a topsoil requirement, and puts forth recommendations for the City of Vancouver.

Supplementary maps and examples of topsoil requirement official language are located in the appendices.

Section 1: Context

1. Context

The City of Vancouver has both an imminent need and incredible opportunity to be resilient to climate change and to be an environmental leader. In 2009, the City set an ambitious goal to be the greenest city in the world by 2020 and created the Greenest City 2020 Action Plan (GCAP) to realize the goal[3]. In addition to the GCAP, there are several drivers – policies, plans, and laws – providing additional motivation and support to the City in reaching its goals. These key drivers range in scale from the city level to provincial and federal levels. In this section, the current Vancouver landscape is described and the cases for both outdoor water conservation and rainwater management are presented; followed by summaries of the drivers in place to support these goals.

1.1 The Vancouver Landscape

Vancouver is a vibrant city with a 2015 population of approximately 648,600 residents[4]. The city experiences high amounts of precipitation in the fall through spring and warm and dry summers. November experiences the greatest amount of precipitation, approximately 190mm; whereas, July, the month with the lowest amount of precipitation, only experiences approximately 30mm[5]. The city's native subsoils have been influenced by glaciers and are highly variable[1] (see Map 1, Appendix A). Native topsoil loss has been significant, due to development and urbanization.

Image 2. Vancouver landscape[6].

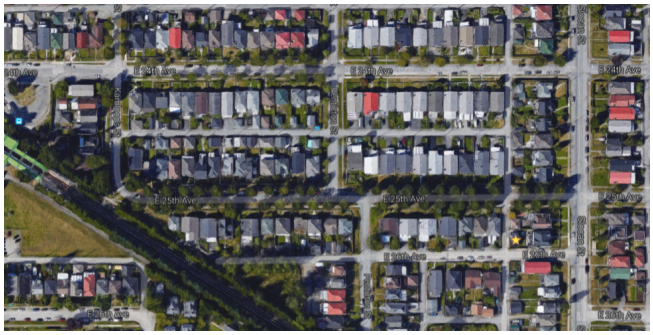


Image 3. Google aerial image of the East Vancouver landscape near the Nanaimo skytrain station[7].

Land use is varied, yet analysis for the City's Integrated Rainwater Management Plan (IRMP) shows that single family homes and duplexes occupy the majority of the city's land base (33%). It is followed by streets, which occupy 30% of the city. Industrial-Commercial-Institutional land uses occupy 16% of the land base and multi-family residential uses 6%. Parks and greenspace account for 14% and agriculture 1% (see Figure 1 and Map 2, Appendix A). The majority of the city's natural and pervious surfaces (approximately 2000 hectares (ha)) are located on single family and duplex lots. Parks and greenspace are the land use with the next highest amount of pervious surface coverage (approximately 1600 ha), followed by local streets with approximately 900 ha (see Figure 2 below and Map 3 in Appendix A)1. Finally, the city is rapidly developing, with approximately 900-1000 new single family homes re-developed in each of the last few years.

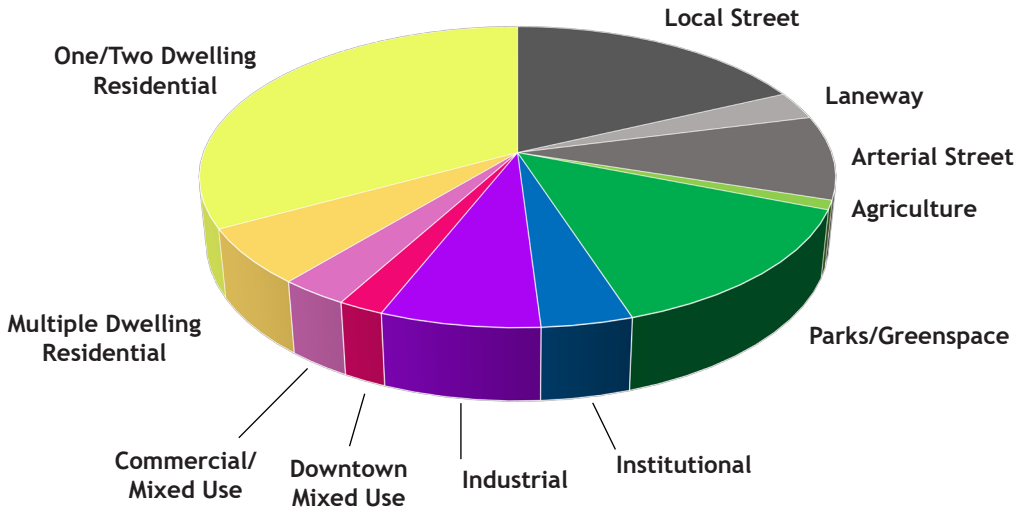


Figure 1. Land use in Vancouver. Reflects land use in the IRMP area (see Map 1, Appendix A, for area of application)[1].

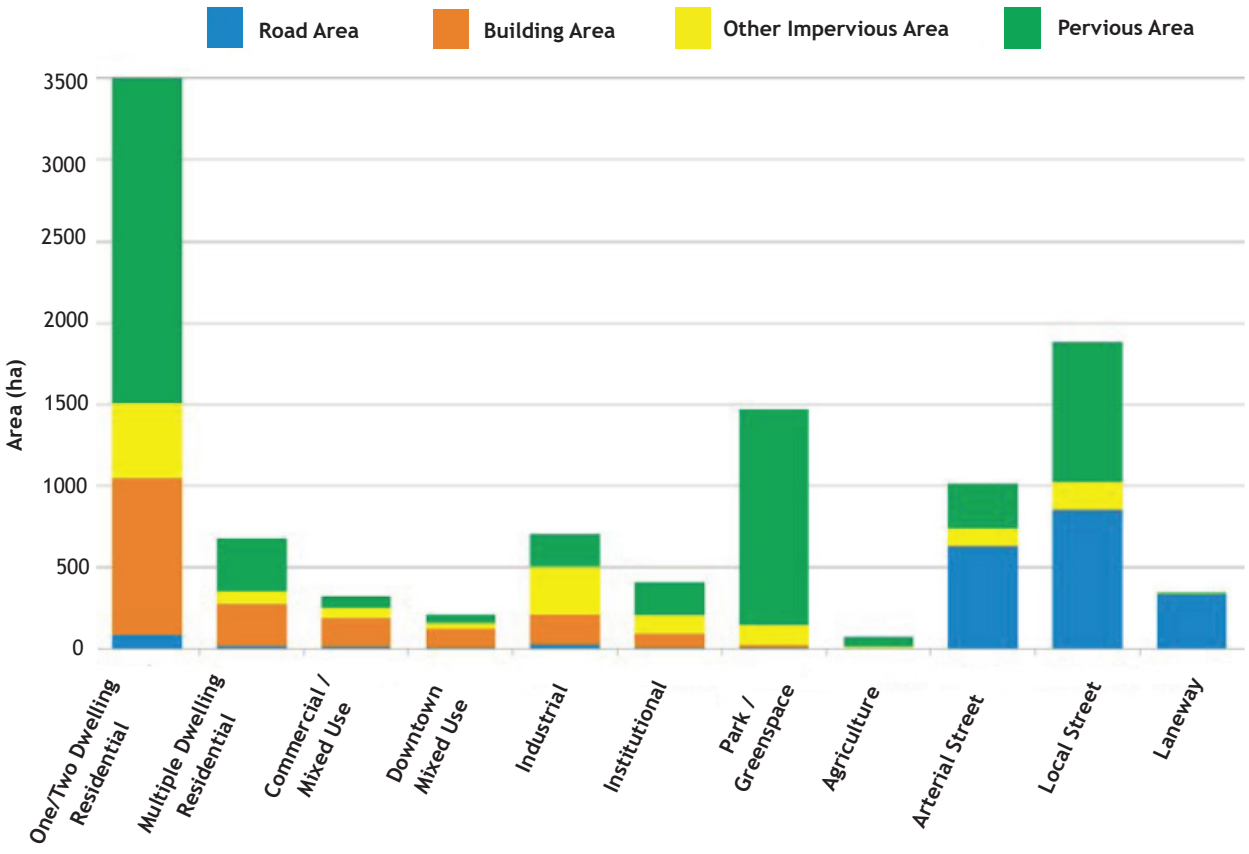


Figure 2. Areas of land use types in Vancouver (see Map 2, Appendix A, for area of application)[1].

1.2 Why Do We Need to Reduce Water Consumption in Vancouver?

1.2.1 Key Reasons

There are four key reasons why water consumption in Vancouver needs to decline: (1) the current rate of high consumption, (2) regional population growth, (3) climate change, and (4) cost factors.

Current High Consumption

Per capita water consumption in Vancouver is significantly higher than necessary. The GCAP Clean Water Goal is to reduce per capita consumption by 33% by 2020 from 2006 baseline levels – from 583 to 390 liters per capita per day (LPCD)[3]. As of 2015, consumption had been reduced to 493 LPCD, which means there is approximately a 17% reduction that still needs to be achieved by 2020[8]. In the last couple of years, there has actually been a slight increase in consumption, up from 480 LPCD in 2013[9]. There are cities similar to Vancouver that consume significantly less water, such as Melbourne, London, and Copenhagen which have consumption rates between 150 and 200 LPCD[3]. Figure 3 demonstrates the break-down of water use in Vancouver by sector, showing that residential consumption is the highest of any sector[10]. Residential consumption in 2015 in Vancouver was estimated to be 290 LPCD[11]. The amount of water determined to be sufficient for personal and domestic uses by the United Nations is between 50-100 LPCD[12]. These comparisons highlight that Vancouver's current water consumption is much higher than necessary. Therefore, a considerable reduction in consumption needs to occur in the residential sector in order to meet the GCAP 2020 goal (see Figure 4).

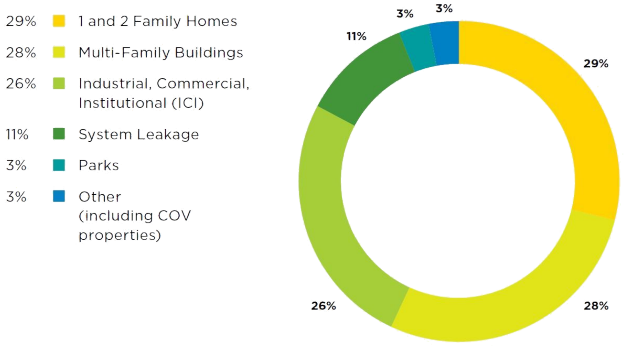


Figure 3. Vancouver water use by sector (2014)[10].

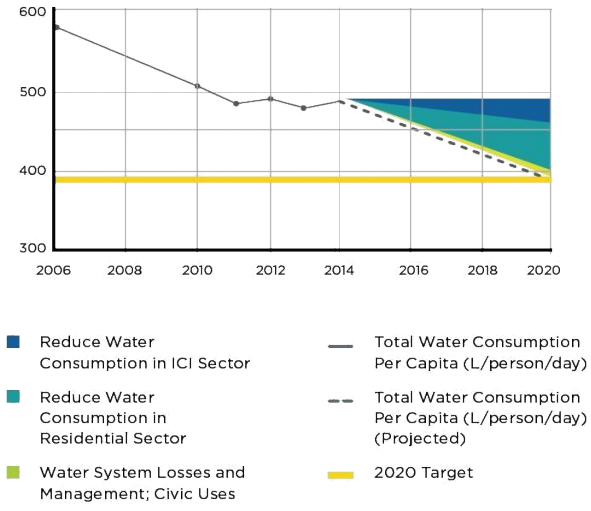


Figure 4. Past, present, and projected water consumption per capita[10].

Population Growth

Vancouver draws its potable water from regional source waters: the Capilano, Seymour, and Coquitlam reservoirs. With a growing city and regional population, there will be increasing demand on this supply. The City of Vancouver's population is projected to grow by approximately 150,000 between 2011 and 2041 – from 617,200 residents to 765,000. This is significant in itself; however, the entire Metro Vancouver region is projected to increase by over 1,000,000 people by 2041[13]. These numbers are projections, yet the region already grew by 9.3% in just five recent years (2006 to 2011), which provides evidence that these projections are likely to occur[14].

Climate Change

The effects of climate change in this region will affect the region's water supplies in multiple ways. Snow pack is projected to decrease by approximately 65% in winter and spring by the 2050s, and warmer spring temperatures will result in earlier snowmelt. This means there will be less water in the reservoirs at the start of summer. Further, summers are expected to be hotter and drier, with 20% less rain. This means that there will be less rain replenishing the reservoirs when it is most needed[15]. The summer of 2015 was a wake-up call to the risk of drought and the potential impacts it could have if not effectively planned for.

Cost Factors

All of the water that is supplied by the City through the distribution system is treated and there is a cost to its delivery and wastewater treatment and disposal. This is expensive both in economic and environmental terms. Expanding the region's reservoirs to maintain current levels of consumption is by far from the sustainable choice. It is not aligned with Vancouver's goal to be the greenest city in the world, especially given Vancouver's already high consumption rates. Therefore, efforts are best focused on reducing consumption[16].

1.2.2 Why is Outdoor Water Consumption Important to Target?

In order to reduce Vancouver's total water consumption, it is critical to target reductions in outdoor water use. There are two key reasons for this. First, demand for water increases by nearly 50% in the residential sector during the summer months – the time of year when replenishment of the reservoirs is significantly reduced[17]. Demand goes up, while supply goes down. To demonstrate, the average daily total use consumption in the week of greatest water use (in summer) in 2014 was 622 LPCD[18]; compared to the average in the week of lowest consumption (in winter), which was approximately 409 LPCD[19,4]. Second, the majority of water used outdoors is for non-essential uses, such as watering lawns. Essential uses are those such as drinking, cooking, cleaning, and bathing, for which it is necessary to have clean drinking water. Outdoor water use accounts for approximately 40% of the average Vancouver household's annual water use, which is nearly as much as the amount used for baths, showers (20%) and laundry (23%)[17]. Again, all of the water that is in the system is treated and there are cost implications of this use.

Image 4. Lawn sprinkling[20].

Image 5. Garden bed irrigation[21].

1.2.3 Drivers for Water Conservation

Scale	Driver	Purpose
Province	Living Water Smart Plan	The province has developed this plan with a vision to ensure that B.C.'s water stays healthy and secure. • Target: By 2020, water use in B.C. will be 33% more efficient[22]
	Drought Response Plan	The province outlines key actions for local governments before, during, and after droughts to reduce its impacts. The focus is on protecting the basic water needs of people and aquatic ecosystems in times of scarcity[23].
Metro Vancouver	Drinking Water Management Plan	Metro Vancouver aims to ensure the sustainable use of water resources, to allow for growth while sustaining the quality of life and the environment[16].
	Water Shortage Response Plan	Metro Vancouver's plan to manage demand for drinking water during the summer months and during emergencies[24].
City of Vancouver	Greenest City 2020 Action Plan	The City of Vancouver aims to be the greenest city in the world by 2020. • Clean Water Goal Target: Reduce per capita water consumption by 33% by 2020 from 2006 levels[3]
	Climate Change Adaptation Strategy	The City has a strategy to remain a liveable and resilient city in the face of climate change. • Objective 4.1: Minimize per capita water consumption (GCAP target) • Objective 5.1: Increase resilience of the built environment to future climate conditions • Objective 5.2: Increase the long-term health and vigor of urban forests, green spaces and trees[25]
	Environmental Framework for Municipal Operations	The City aims to lead the way towards all of the GCAP goals with the Green Operations Plan. • Target: Reduce corporate water consumption by 33% from 2006 levels[26]
	2016 Corporate Plan	The City's corporate plan sets the priorities for the current year. • 3A. Implement highest-priority actions of the City's Green Operations Plan, with a current year focus on … civic-use water consumption … • 3B. Develop and implement a set of initiatives to reduce the amount of potable water consumed by City operations by 33% by 2020, in alignment with the Greenest City Action Plan's Clean Water goal[27]
	Water Works Bylaw	This bylaw allows the City to implement outdoor water use restrictions during the summer as advised by Metro Vancouver. There are four stages of restrictions, and each stage further restricts outdoor uses. The primary target of the restrictions is on lawn watering[28].

Table 1. Drivers for water conservation.

1.3 Why Do We Need to Manage Rainwater in Vancouver?

1.3.1 Key Reasons

Before Vancouver was developed, the fate of rainfall was much different than it is today. When rain fell, it was either intercepted by plants, evaporated, or slowly infiltrated into the earth. Of the infiltrated water, some became groundwater and some was slowly released to streams over time, until eventually reaching the ocean. When the city was urbanized, the ground surface changed from natural surfaces such as soil and plant cover, to impervious surfaces such as pavement and buildings. Underground sewer systems were also developed to quickly remove rainfall from the built environment and deliver it streams and the ocean (see Images 6, 7, and 8). With these alterations to the landscape also come impacts to ecosystems and recreation.

Water Quantity Impacts

The quantity of runoff from impervious surfaces is increased 8-10 times during high rainfall events[1], which is harmful when delivered to streams too quickly by the sewer system (see Image 5). It leads to erosion and destruction of aquatic habitat for fish and other aquatic species. It also results in lower stream baseflows during the summer months, because the rainfall was never able to infiltrate into the ground. This is particularly important for the existing surface streams in Vancouver, but also for those that will be daylighted in the future.

Water Quality Impacts

Water quality is also impacted from these changes to Vancouver's hydrological system. When it rains, the sewer system quickly carries contaminants from streets and residences to creeks and the ocean. Due to the increase in impervious surfaces, the natural cleansing services that soils and plants provide has declined. Water quality is also affected by extreme rainfall events that result in combined sewer overflows (CSOs). Stormwater is currently conveyed directly to False Creek, Coal Harbour, and beaches in English Bay, Kitsilano, Jericho and Spanish Banks, and also to the Fraser River. Contaminated water not only affects ecosystems, but can also pose health risks to humans and limitations on water-based recreation[1].

Climate Change

These water quantity and quality impacts will be further exacerbated by climate change. The city's sewer system was designed based on storm predictions from historical data, prior to climate change anticipation. Therefore, it was not built to manage extreme storm events that will become more frequent with climate change in the future[1]. It will also result in lower summer stream baseflows, harmful to aquatic ecosystems. Where water quality is impaired, lower baseflows will also result in higher concentrations of contaminants because the water is less diluted.

Image 6. Storm sewer on a street[29].

To address these problems and return the city's hydrological system to one that is more similar to a forest, the City of Vancouver is starting to take action. In April 2016, the City adopted the Citywide Integrated Rainwater Management Plan (IRMP)[1]. The plan addresses the areas of Vancouver where there are no surface streams, in which rainwater is delivered to the combined sewer or ocean outfalls. The long-term target of this plan is to capture and treat 90% of Vancouver's average rainfall through implementation of green infrastructure. There are also integrated stormwater (rainwater) plans for the watersheds with surface streams, Still Creek (2006)[30] and Musqueam Creek (in progress)[31].

Image 7. Sewer outfall into a stream with fast flows[1].

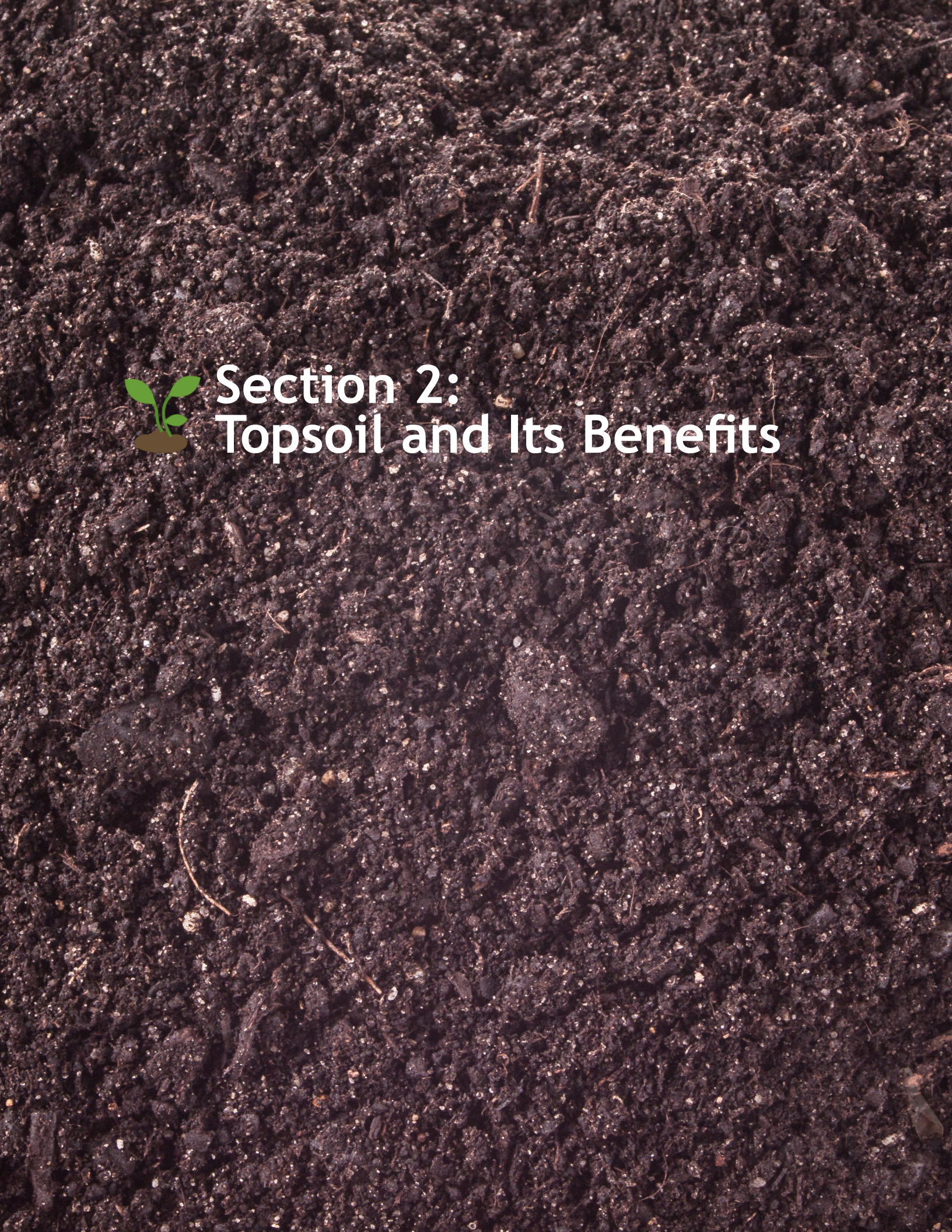
Image 8. Sewer outfall into the ocean[1].

Image 9. Contaminated ocean water[1].

1.3.2 Drivers for Rainwater Management

Scale	Driver	Purpose
Federal	Environment Canada's Water Quality Guidelines	Guidelines for water quality and urban runoff that the City must meet[32].
	Fisheries and Ocean's Canada	Regulations to protect aquatic habitat that the City must meet[33].
Province	Living Water Smart Plan	The province has developed this plan with a vision to ensure that B.C.'s water stays healthy and secure[22].
	Environmental Management Act	The Metro Vancouver Integrated Liquid Waste and Resource Management Plan is authorized under the *Environmental Management Act* and must meet the provincial regulations.
Metro Vancouver	Integrated Liquid Waste and Resource Management Plan	It is through this plan that the region has outlined how it will meet the requirements of the senior levels of government[34]. This plan was the catalyst for the Integrated Stormwater Management Plan (ISMP) requirement.
	Region-Wide Baseline for Onsite Rainwater Management	Metro Vancouver is facilitating the development of a region wide baseline for single family, duplex, and triplex lots. The specification will include rainwater management targets that will apply to the entire region and will need to be implemented by member municipalities[35]. It will be expected that member municipalities update their plans and bylaws accordingly by January 2018.
City of Vancouver	Greenest City 2020 Action Plan	Improvements in rainwater management with green infrastructure will contribute to the GCAP Green Economy, Green Buildings, Access to Nature, and Clean Water goals[1].
	Citywide Integrated Rainwater Management Plan	A strategy to return Vancouver's hydrological system to that more similar to a forest with a target of capturing and treating 90% of average rainfall with green infrastructure[1].
	Sewer Utility Long Range Plan	A plan to update Vancouver's sewer system and reduce (eventually eliminate) combined sewer overflows (CSOs)[36].
City of Vancouver/ City of Burnaby/ Metro Vancouver	Still Creek Integrated Stormwater Management Plan	A plan to protect and restore the Still Creek watershed and to integrate development with stormwater management[30].
City of Vancouver/ Musqueam First Nation	Musqueam Integrated Stormwater Management Plan	A plan to protect and restore the Still Creek watershed and to integrate development with stormwater management[31].

Table 2. Drivers for rainwater management.



Section 2: Topsoil and Its Benefits

2. Topsoil and Its Benefits

Topsoil plays critical roles in retaining rainfall and irrigated water and also in supporting biodiversity. In this section, soil science basics are explained, with a focus on topsoil water holding capacity; and then the benefits of topsoil for water conservation, rainwater management, and beyond are presented and discussed.

2.1 Soil Science Basics

2.1.1 Soil Layers and Properties

Topsoil is the layer closest to the surface, in which plants grow. Below the topsoil layer is subsoil and then bedrock. The Canadian Soil Classification System[37] classifies these layers more specifically as horizons. Each layer is unique in its properties and can vary in depth depending on various physical and biological factors. The soil profile in Figure 5 illustrates the different horizons and how they correspond with common references to the layers, such as topsoil and subsoil.

Mineral content in soil is commonly summarized with the United States Department of Agriculture (USDA) soil triangle[38] (refer to Figure 6). The mineral content determines the texture and appearance of soils. Sandy soils feel gritty; whereas, when wet, silty soils feel silky and clayey soils feel sticky. Image 10 shows soils that are dominant in sand, loam, and clay. A loam soil is one that is well balanced in sand, silt, and clay components. Soils also contain organic matter (OM), such as from leaf litter and compost (see Image 11). It is broken down to become humus, which is the most stable form of OM. Compost is on average 40-50% OM content[39]. Among the soil particles are pores, which hold air and water. For plant growth purposes, the ideal balance between solid material (minerals and OM) and pore space is half and half[40,41].

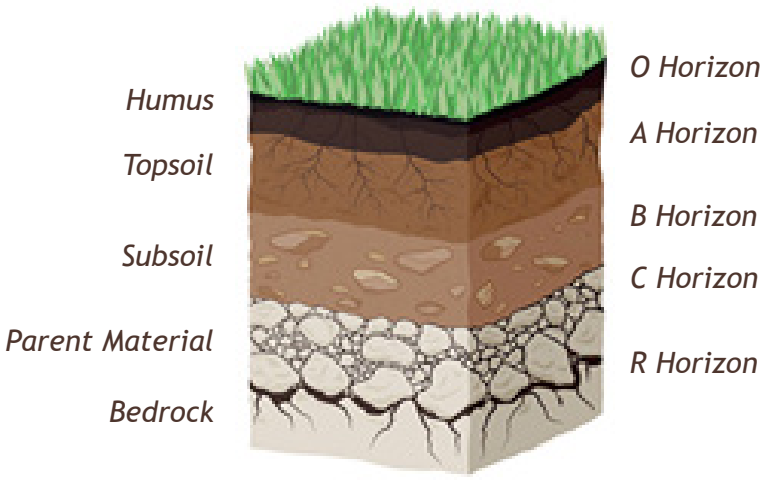


Figure 5. Soil profile with lay terminology on the left and scientific classification on the right[42].

Topsoil is composed of minerals and OM, and is alive with microorganisms. These microorganisms provide the vital service of breaking down OM into humus in the "O" (organic) horizon. Water and soil animals help to distribute the humus into the "A" horizon, which is where plant roots are located, because of the soil nutrients and pore space that allows for root growth and water retention. The "B" horizon below, commonly referred to as "subsoil", changes more slowly than the "A" horizon and contains less OM and more mineral content. The "C" horizon, commonly referred to as parent material, is the lowest soil layer above bedrock (the "R" horizon), and contains even less OM and even more mineral content[43].

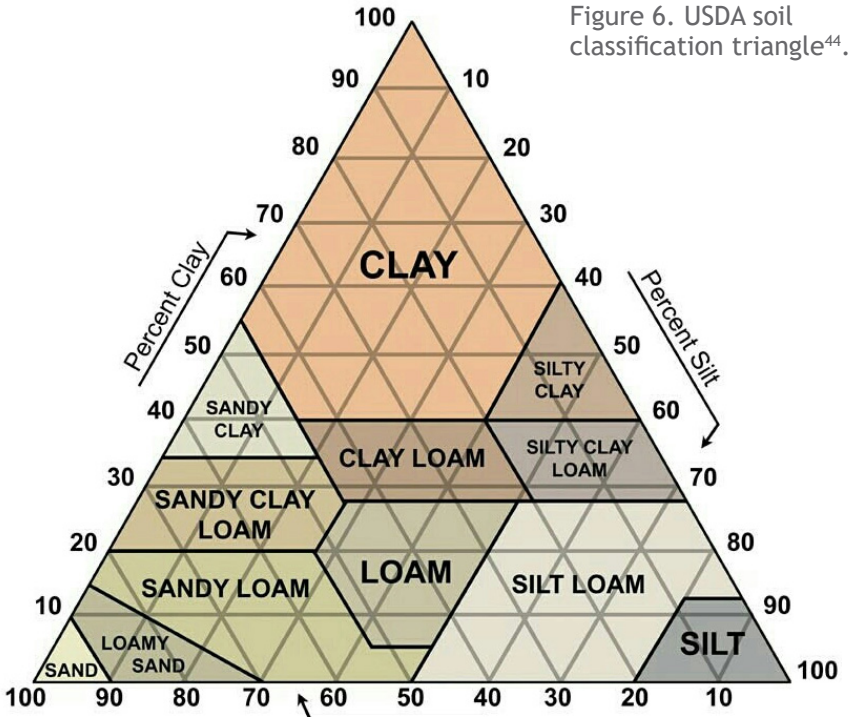


Figure 6. USDA soil classification triangle[44].

Image 10. Soils with different mineral contents. On the left is sandy soil, in the center is loam, and on the right is a clay dominant soil[45].

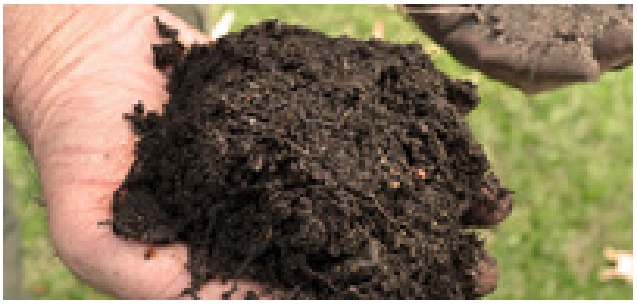


Image 11. Compost rich in organic matter[46].

2.1.2 Topsoil and Water Holding Capacity

The composition of topsoil is key to how well it can hold and retain water. Soils with sufficient pore space have more room to hold water than soils that are compacted (see Figure 7). Clayey particles are smaller and therefore retain more water than larger sand particles, which drain more quickly (see Figure 8). Micro-organisms also play an important role in maintaining soil porosity, but they do not thrive in disturbed and compacted soils like they do in native soils or well-maintained engineered soils (see Figure 9). Soils can hold approximately 8-20% of the soil volume, depending on the texture (see Table 3)[43,47]. If a soil's pores are only filled with air, and there is no water in the pores, the plant will wilt - referred to as the wilting point. On the other hand, if a soil's pores are completely saturated with water and there is no air, plants can drown. After rain or irrigation, the point at which a soil has drained and air starts to return is called field capacity (see Figure 10). From this stage until the wilting point is when water is available to plants and is the best for plant growth. The best pore space air/water balance for plant success is approximately half air and half water[40].

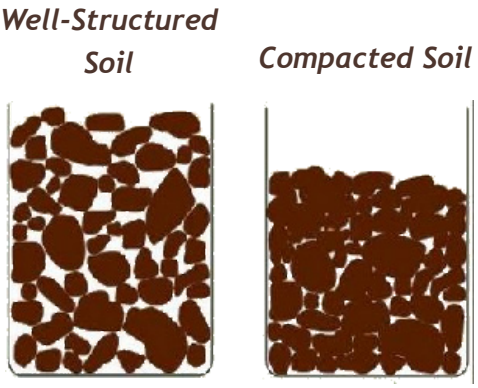


Figure 7. Soil structure[48].

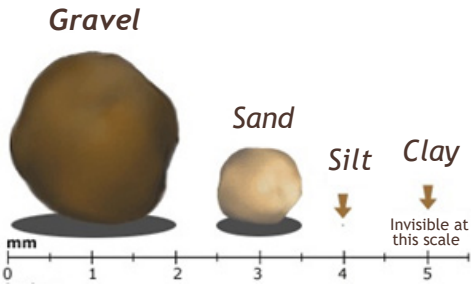


Figure 8. Sizes of different particle types[49].

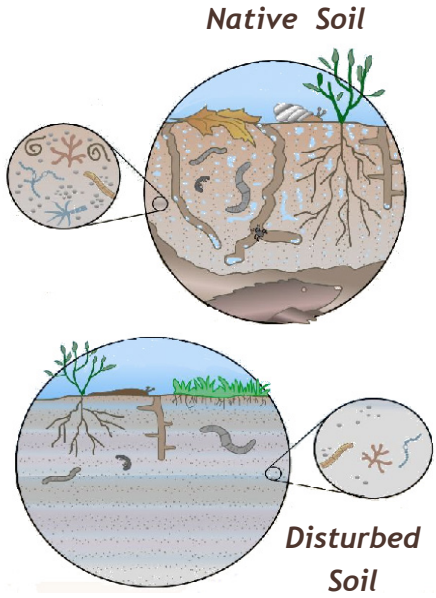


Figure 9. Soil micro-organisms in native soil compared to disturbed and compacted soil[50].

The amount of OM in the soil also affects water retention. OM increases the amount of pore space, which helps with the infiltration of water in silty and clayey soils and retention in sandy soils. Among several benefits, OM also supplies nutrients to plants and maintains the presence of microorganisms[51]. The heavily referenced study by Berman Hudson found that plant available water capacity (AWC) increases in all soil types when OM is added. When OM was increased by 1% (dry weight), the plant available water increased by 2.2% in sandy soil, by 2.8% in silt clay loam soil, and by 3.7% in silt loam soil. Therefore, the average increase in AWC for these soils was 2.9% when amended with OM[52].

A Guide to Available Water Storage Capacities of Soils		
Textural Class	Available Water Storage Capacity	
	mm water / m of soil	% of soil volume
Clay	200	20
Clay loam	200	20
Silt loam	208	21
Loam	175	18
Fine sandy loam	142	14
Sandy loam	125	13
Loamy sand	100	10
Sand	83	8

Table 3. Available water storage capacity of different soil types[47].

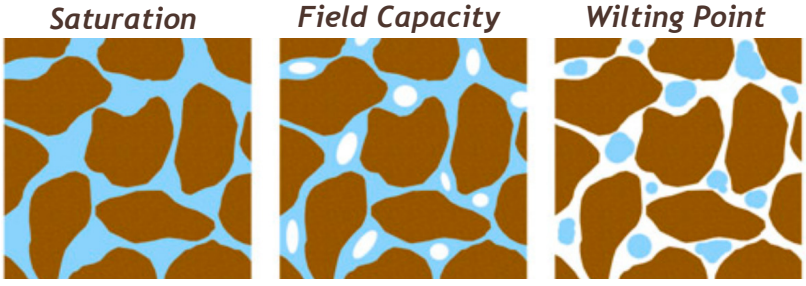


Figure 10. Soil particles, water, and air at saturation, field capacity, and wilting point[53].

Another critical factor in topsoil water retention is depth. The deeper the soil, the greater are the benefits of optimum composition and structure described above. To demonstrate, a good quality soil with a 20% water holding capacity that is 450mm deep can hold approximately 90mm of water; whereas, a soil that is 120mm deep can only hold only 24mm (see Figure 11). Deeper topsoil is also important for plant success. The deeper the topsoil, the deeper the plant can grow roots, making it healthier and more resilient (see Figure 12).

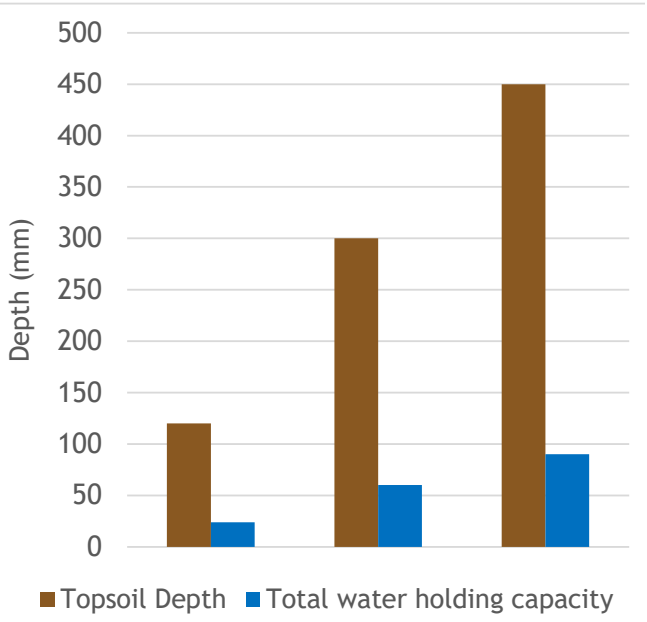


Figure 11. Influence of depth on soil water holding capacity, based on a 20% holding capacity.

Figure 12. Soil depth, plant rooting, and plant success[54].

2.2 The Benefits of Topsoil

2.2.1 How Can Topsoil Help the City Meet Its Outdoor Water Conservation Goals?

Good quality topsoil of adequate depth is an incredible tool for conserving water outdoors. It reduces the need for irrigation by retaining water for longer periods of time when it is hot and dry, therefore, reducing the frequency that irrigation is required. As discussed in section 1 on context, demand for water in Vancouver increases by nearly 50% in the residential sector during the summer – the time of the year when the reservoirs are not being replenished. The typical Vancouver home uses 40% of its total potable water outdoors[17] and single family and duplex dwellings account for the majority of pervious surfaces in Vancouver. Lawns and gardens, which there is a water demand for, account for a significant amount of these natural surfaces. Water savings from topsoil amendments will vary depending on a variety of factors at a particular site, including soil texture type and OM content as discussed above; but also on other factors such as the water requirements of the plant species, slope, aspect, temperature, and wind exposure. In Redmond Washington, which is similar in climate to Vancouver, it was estimated that the potential water savings for a lawn with compost amended soil on a typical site with minimal slope and wind, summer irrigation needs could be reduced by 60% compared to a site with unamended topsoil[55]. Thus, if the topsoil on Vancouver's landscaped areas is deep and of good quality as described above, irrigation needs will decline and considerable amounts of potable water can be conserved.

2.2.2 How Can Topsoil Help the City Meet Its Rainwater Management Goals?

Topsoil is a critical component of the City's new IRMP. The target of the plan is to capture and treat 90% of Vancouver's average rainfall and the Absorbent Landscapes tool is the first listed in the plan. Absorbent Landscapes are composed of soil and plants that grow in the soil, such as trees, shrubs, groundcover, and grass. Both the amount of OM and soil depth influence how well the soil and plants perform at capturing and treating rainwater and runoff from impervious surfaces. The soil and plants act like a sponge to hold water when it rains, and then slowly release it into the subsoil, after which it will eventually make its way to streams or groundwater. In areas with till subsoils, like much of Vancouver, approximately 300mm of topsoil will store 60mm of rainfall (20% of its volume)[56]. The outcome is that contaminated runoff is transported to streams and the ocean by the sewer system much slower or not at all, which otherwise may cause damage to those ecosystems; and that streams are provided with the baseflow they need during the summer. Topsoil and plants also provide the vital service of filtering out harmful contaminants before rainfall makes its way to streams and/or the ocean. Thus, topsoil plays a critical role in returning the city's hydrological system to one that is more natural like a forest. Since such a significant amount of the city's pervious areas are located on single family and duplex lots, parks, and streets, there is an incredible opportunity to enhance the absorptive capacity of sites with these land uses.

2.2.3 What Other Benefits Does Topsoil Have for Vancouver?

Topsoil has a multitude of benefits that could help the City in reaching its goals beyond those that are water related. Notable benefits are, but not limited to:

- Topsoils high in OM are high in nutrients and do not require application of artificial fertilizers.
- Native soils and well maintained engineered soils contain more microorganisms, important for Vancouver's ecosystems and biodiversity.
- Good quality and sufficient depth of topsoil leads to healthier plants. There are an incredible amount of benefits from increasing the abundance and success of plants in the city; such as, biodiversity enhancement, access to nature, carbon sequestration, mitigation of the urban heat island effect, and clean air.
- Strong and successful plants are more resilient to pests[50], such as the European Chafer beetle, which is a growing concern in Vancouver. Animals and birds, such as raccoons and crows feed on the beetle larvae in the grass, resulting in damage to lawns. As of July 2016, neonicotinoid pesticides are banned in Vancouver due to their environmental impacts[57] and can no longer be used to treat Chafer beetles. Growing healthy plants by use of good topsoil and recommended maintenance practices is the best way to increase resilience to pests such as the Chafer beetle[58]. The City of Coquitlam has developed a month-by-month natural program for Chafer beetle resistance, in which compost application and soil aeration are important tasks[59].

Image 12. European Chafer beetle larvae[59].

Image 13. Lawn with European Chafer beetle damage[60].

There are several strategies in place and in development to lead the City towards its goal of being the greenest city in the world. The strategies that topsoil could benefit either directly or indirectly include: GCAP Climate and Renewables, Green Buildings, Zero Waste, Access to Nature, Local Food, Clean Air, Green Economy, and Lighter Footprint goals; the Biodiversity Strategy; Urban Forest Strategy; Healthy City Strategy; Bird Strategy; Climate Adaptation Strategy; Food Strategy; and the Renewable City Strategy.

Section 3: Topsoil Best Management Practices

3. Topsoil BMPs

In order for the City of Vancouver to develop a topsoil requirement, it is critical that BMPs are referred to. In this section, the key BMP resources in the region are described. The topsoil specifications are summarized and the recommended practices during the different stages of development are consolidated into a sequential list. Thereafter, the current topsoil practices in both the public and private realms are discussed and compared to the BMPs. The potential risks of optimum topsoil application are also discussed.

3.1 Key BMP Resources and Soil Specifications

There are a few key resources commonly referred to in the region for topsoil BMPs. These include the British Columbia Landscape and Nursery Association (BCLNA) Standards[61], the Master Municipal Construction Documents (MMCD)[62], the Metro Vancouver Stormwater and Source Control Guidelines[56], the Topsoil Bylaws Toolkit[43], and the City of Vancouver Water Wise Landscape Guidelines[17]. These resources contain specifications on topsoil depth and composition, as well as best practices for before and after development. The objectives of the guides and specifications are not all the same; however, there is overlap in several of the recommendations.

The following are the primary objectives of the BMP guidelines:

- The BCLNA Standard provides BMPs that are best for landscaping purposes
- The MMCD provides BMPs that are best for construction scenarios
- The Metro Vancouver guidelines are focused on rainwater management objectives
- The Topsoil Bylaws Toolkit is focused on both outdoor water conservation and rainwater management
- The Water Wise Guidelines provide BMPs for outdoor water conservation

The key topsoil BMPs in these resources are summarized below and further details are consolidated in Table 4. The soil specifications included in this table are depth, texture, OM content, pH, drainage, subsoil scarification, and mulch. These BMPs apply to low traffic turf and planted beds. Playing fields have special stability requirements and maintenance needs and due to scope were left out of the analysis.

3.1.1 BCLNA Standard

The BCLNA Standard is the primary resource utilized by the landscaping industry in B.C.. It was recently consolidated into the new Canadian Landscape Standard, however, the topsoil specifications are the same in this new resource as in the 2012 BCLNA Standard. The standard outlines specifications for different landscaping purposes as well as maintenance and irrigation regimens. The minimum topsoil depth is 150mm for lawns, 300mm for beds, and 450-900mm for shrubs/trees for all maintenance and irrigation regimens. The topsoil texture increases in silt and clay content for areas

that will receive less irrigation – moving from the recommended sand and sandy loam for high maintenance areas to sandy loam and loam for low maintenance areas. The OM recommendations are relatively consistent: 2-10% for low traffic lawns/ shrubs/trees to 5-20% for beds. 150mm of subsoil scarification and 50mm of mulch are recommended[61].

3.1.2 MMCD Specifications

The MMCD Specifications are similar to those of the BCLNA, which is listed as a reference in the MMCD guide. The minimum depths are the same. The key differences are that the MMCD does not have specifications for low maintenance/irrigation areas and that the OM requirements in the MMCD are higher for beds (25-30%) than in the BCLNA standard. Recommended drainage should be 20mm/ hour. 150mm of subsoil scarification and 50mm of mulch are recommended[62].

3.1.3 Metro Vancouver Stormwater Source Control Guidelines

This guideline has become a key resource in the region for stormwater management infrastructure. Absorbent Landscapes are the first source control outlined in the guide. The topsoil specifications are 150-450mm of loamy sand or sandy loam and 8% minimum OM content for lawns and 15% for planting areas. The recommended drainage rate is higher than the MMCD, at 50mm/ hour. Vancouver's new IRMP has used the majority of these specifications, however, requirements for depth and infiltration have not been set at this point. 150mm of subsoil scarification and 50mm of mulch are recommended[56].

3.1.4 Topsoil Bylaws Toolkit

This B.C. specific resource was a consolidation of well-regarded primers on the technical[63] and legal[64] aspects of topsoil requirements developed by the Green Infrastructure Partnership. The Topsoil Bylaws Toolkit was developed by the Okanagan Basin Water Board, the Green Infrastructure Partnership, and the Partnership for Water Sustainability in B.C.. It takes a dual perspective towards topsoil requirements by examining the benefits and BMPs for both rainwater management and water conservation. The topsoil specifications in this resource are the same as in the Metro Vancouver guidelines (depth and OM content), except that recommended texture and drainage rates are not explicitly outlined. 100mm of subsoil scarification and 50mm of mulch are recommended[43].

3.1.5 City of Vancouver Water Wise Landscape Guidelines

The City of Vancouver Water Wise Landscape Guidelines provide BMPs for water efficient landscapes in the Vancouver context. Although less prescriptive than the above resources, its primary focus on water conservation provides important representation in this BMP summary. Healthy soils for water wise landscapes are discussed in the guide, along with plant selection and design practices to reduce water use. Topsoil depth should be 150mm-300mm for lawns and throughout the entirety of planted beds. The use of 50mm of mulch to conserve water is particularly emphasized and best practice maintenance is described[17].

3.2 Topsoil BMPs

Several of the topsoil BMPs recommended by these guides are consistent among each other. The BMPs are summarized as steps from the beginning to the end of the development process, and ongoing maintenance. At the end of each step, the guides that the particular BMPs were recommended in are included in brackets. The BCLNA standard is noted as BCLNA; similarly is MMCD; the Metro Vancouver Stormwater Source Control Guidelines are abbreviated as MV; the Topsoil Bylaws Toolkit is abbreviated as TBT, and the City of Vancouver Water Wise Landscape Guidelines as COV.

3.2.1 Prior to Development

1. Maximize the coverage of pervious surfaces on the site (MV, TBT, COV).
2. Analyze the existing soil on the site for texture, OM content, porosity, and pH (MV, TBT, BCLNA, MMCD, COV).
3. Conserve as much native soil and vegetation as possible and take measures to protect it from disturbance and compaction, such as temporary fencing (MV, TBT, COV).
4. Determine areas of the site where the existing topsoil can be stockpiled (TBT, BCLNA, COV).
5. When stripping soil, use appropriate measures to not damage soil structure (TBT, MMCD).
6. Provide effective erosion control during development (MV, TBT).

3.2.2 After Building

1. Scarify the subsoil to 150mm. This increases the ability of rainwater to infiltrate into the subsoil layer (BCLNA, MMCD, MV, TBT).
2. If the existing soil that has been stockpiled does not match the OM content specification, it should be amended to meet the specification (MMCD, MV).
3. If soil is being imported to the site, it should:
   - match the native soil in texture.
   - be an acceptable pH (e.g. 6.0 to 8.0) (BCLNA, MMCD, TBT).
   - be free of contaminants and noxious weeds (BCLNA, MMCD).
   - contain the recommended OM content (e.g. minimums of 8% for lawns and 15% for beds) (BCLNA, MMCD, TBT, MV, COV).
   - have an acceptable infiltration rate (e.g. 50mm/hour) (BCLNA, MMCD, MV, COV).
4. Use design techniques to meet the rainwater management objectives for the site, such as use of flat areas and areas with gentle sloping (MV, TBT, COV).
5. Blend the scarified subsoil with the topsoil to create a transition in soil texture to enhance infiltration (MV).

6. Apply topsoil to the site and it should settle at the desired depth (apply approximately 15% more than the desired depth[50]). Recommended depths range from 150mm to 450mm, depending on landscaping type and water retention objectives. Ensure it is the appropriate level of compaction (approximately 80% Proctor Density)[56] (BCLNA, MMCD, MV, TBT, COV).

7. Plant vegetation and apply 50mm of mulch to exposed soil. Mulch increases water use efficiency by reducing evaporation and preventing weeds; and it also prevents erosion. Mulch should not have a high wood chip content however, because they float (MV, TBT, COV).
   - To further enhance irrigation efficiency, group plants into hydrozones according to their water needs (COV).

8. Provide effective erosion control until vegetation is established (MV, TBT, COV).

3.2.3 Ongoing Maintenance

1. Protect soils from disturbance and compaction (COV).
2. Amend soils with OM regularly (COV).
3. For lawns,
   - dethatch in the spring (COV).
   - aerate in the fall (COV).
   - top-dress with compost (COV).
4. Maintain mulch to a depth of 50mm over exposed soil (COV).
5. Utilize natural landscape care practices and do not use toxic pesticides or herbicides (COV).

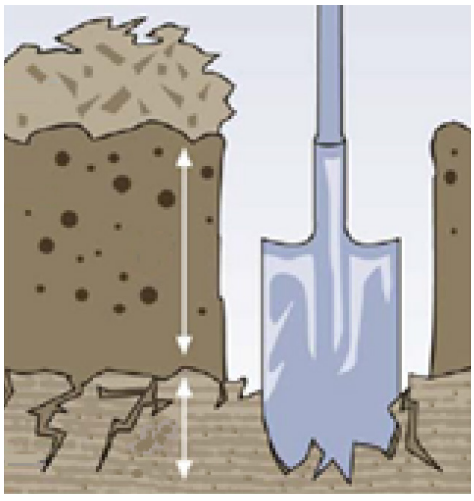


Figure 13. Organic matter amended topsoil with subsoil scarified, sufficient depth, and mulch at the surface[50].

Image 14. Garden bed with organic mulch[65].

BMP Resources Topsoil Specifications Summary

BMP Document	Minimum Topsoil Depth			Topsoil Texture (% dry weight)		Minimum Topsoil OM Content (% dry weight)		pH	Drainage	Subsoil Scarification	Mulch for Beds
	Lawn (Low Traffic)	Beds	Shrubs/ trees	Lawn (Low Traffic)	Beds	Lawn (Low Traffic)/ shrubs/trees	Beds/ shrubs				
BCLNA (2012) - “Well-groomed Areas” in which irrigation is recommended	150mm	300mm	450-900mm	Sand: 50-70% Silt: 10-25% Clay: 0-20% (Silt/clay max: 25%)	Sand: 50-70% Silt: 10-25% Clay: 0-20% (Silt/clay max: 25%)	3-10%	10-20%	Lawn/shrubs/ trees: 6.0-7.0 Beds: 4.5-6.5	“Percolation shall be such that no standing water is visible 60 minutes after at least 10 minutes of moderate to heavy rain or irrigation”	150mm	50mm
BCLNA (2012) - “Groomed” and “Moderate” Areas in which automatic irrigation is recommended	150mm	300mm	450-900mm	Sand: 50-70% Silt: 10-25% Clay: 0-20% (Silt/clay max: 35%)	Sand: 40-80% Silt: 10-25% Clay: 0-25% (Silt/clay max: 35%)	3-10%	10-20%	Lawn/shrubs/ trees: 6.0-7.0 Beds: 4.5-7.0	“Percolation shall be such that no standing water is visible 60 minutes after at least 10 minutes of moderate to heavy rain or irrigation”	150mm	50mm
BCLNA (2012) - “Open Space/ Play” and “Background” Areas in which irrigation is required less frequently	150mm	300mm	450-900mm	Sand: 30-70% Silt: 15-50% Clay: 15-30% (Silt/clay max: 60%)	Sand: 30-70% Silt: 15-50% Clay: 15-30% (Silt/clay max: 60%)	2-10%	5-20%	Lawn/shrubs/ trees: 6.0-7.0 Beds: 4.5-7.0	-	150mm	50mm
Master Municipal Construction Documents (2009)	150mm	300mm	450-900mm	Sand: 50-70% Silt: 10-30% Clay:7-20%	Sand: 50-70% Silt: 10-30% Clay:7-20%	5-10%	25-30%	Lawn/shrubs/ trees: 6.0-6.5 Beds: 4.5-6.0	Minimum saturated hydaulic conductivity (cm/ hr): 2.0	150mm	-
Metro Vancouver Stormwater Source Control Guidelines (2012)	150mm	450mm	450mm	Sand: 50-70% Silt: 10-25% Clay: 0-25%	Sand: 40-80% Silt: 10-25% Clay: 0-25%	8%	15%	-	Minimum infiltration rate should be 50mm/hr	150mm	Mulch is recommended
Topsoil Bylaws Toolkit (2012)	150mm-450mm	150mm-450mm	150mm-450mm	-	-	8%	15%	6.0-8.0	-	100mm	50mm
City of Vancouver Water Wise Landscape Guidelines (2009)	150mm-300mm	150mm-300mm	150mm-300mm	-	-	OM amendments are recommened		6.0-7.0	-	-	50mm

Table 4. BMP resources topsoil specifications summary.

3.3 How Do We Fair? Current Topsoil Practices in Vancouver

After discussing the BMPs above, how is the City of Vancouver doing in comparison to those BMPs? This section will summarize the current practices in the public realm, such as parks and streets; and also what is occurring on private lands in the city. The City of Vancouver's current topsoil practices in Vancouver's public realm were determined through review of specifications in guidelines and through discussions with City staff. These methods were used to determine the current practices in the private realm as well, with the addition of literature review.

3.3.1 Public Realm

Parks

The Vancouver Board of Parks and Recreation developed new Park Development Standards[66] in 2015. This comprehensive standard includes soil specifications as well as BMPs for the development process. The required topsoil depths are 250mm for lawn, 450mm for beds, and 250mm-900mm for shrubs/trees. Texture specifications are for sandy loam or loamy sand. OM specifications for growing medium require 12-15% of OM for beds and 8-10% for lawn. Subsoil should be scarified to 200mm prior to placement of the topsoil. There is also a mulch requirement of 50mm for shrubs and 25mm for ground cover. Compared to the BMP resources discussed above, these specifications are similar – and even better in terms of soil depth and OM requirements - to those recommended in the different guides.

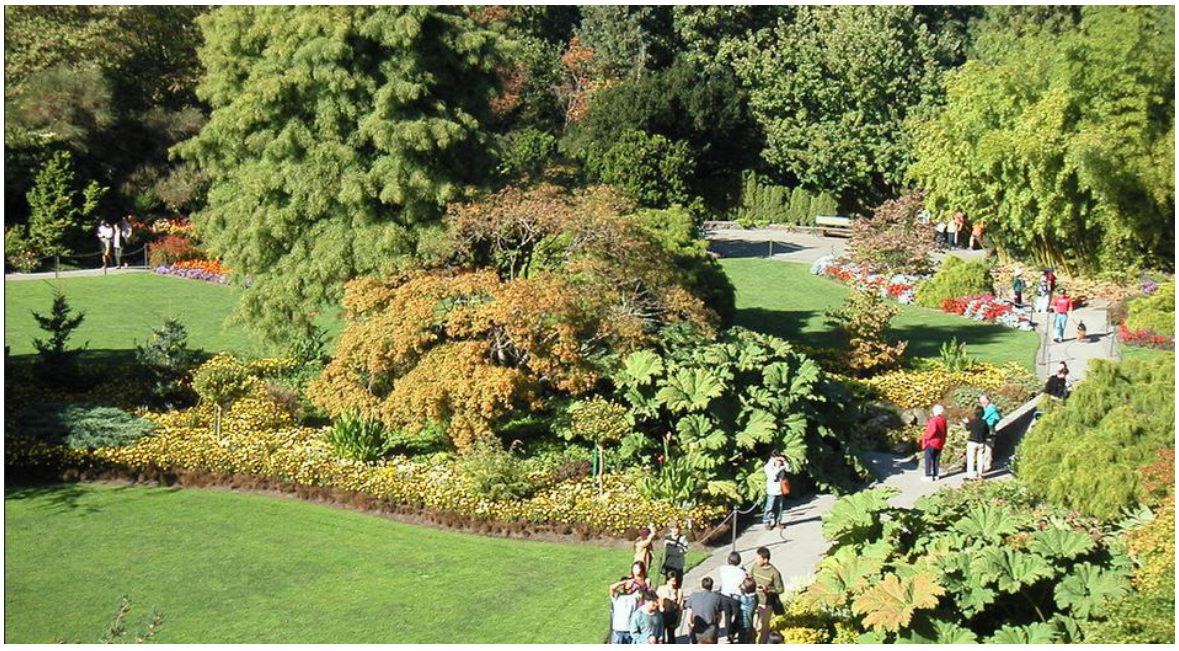


Image 15. Queen Elizabeth Park[67].

Streets

The guidelines that determine practices on city streets are the Streets Restoration Manual (2008) and the Street Tree Guidelines (2011). The former outlines specifications for lawns; whereas the former is for street trees. For lawns, the required topsoil depth is 150mm; texture is sandy loam or loamy sand; and OM is 5-10%. For street trees, the required depth is 400-600mm of sandy loam or loamy sand topsoil and 8-10% OM. The topsoil texture for streets contains more silt and clay than for parks, and the reason for this is because the streets are not irrigated. Soils with higher silt and clay content retain more water than do soils higher in sand content. In most cases, it is the City that conducts street restoration works, but in some cases it is a developer, such as for larger scale developments. The educated assumption of City staff is that approximately only 50-100mm of topsoil is placed during a typical restoration project for grassed areas, whether it is City crews or developers conducting the work.

The City is taking steps, however, to start to address these gaps and improve topsoil practices in streets. For example, the City is in progress with an update to the Street Tree Guidelines and has already approved some specifications. For instance, the specification for OM in beds was increased from 5-10% to 8-10%. There are also draft proposed specifications for soil volume on sites where existing topsoil is not present. The minimum soil volume for trees with large canopies is $30m^3$ for a single tree and $20m^3$ for a row of trees; for trees with medium sized canopies, $20m^3$ is required for a single tree and $15m^3$ is required for a row; and for trees with small canopies, $10m^3$ for a single tree and $5m^3$ for a row is required. These volumes of soil must be met in order to meet tree performance objectives. This update to the Street Tree Guidelines supports the City's Urban Forest Strategy[68]. Furthermore, the City is planning on updating the Streets Restoration Manual in 2016/2017. The City is also conducting a pilot project to install a soil depth of 300mm in a grassed boulevard on Seymour Street in fall 2016[69]. Finally, the City also updated its specifications for the supply of soil for parks and streets maintenance purposes in the end of 2015[70].

Image 16. Turf and trees in city boulevard[71].

City of Vancouver Public Realm Topsoil Specifications

Specifications Document	Minimum Topsoil Depth				Topsoil Texture (% dry weight)			Minimum Topsoil OM Content (% dry weight)			Subsoil Scarification	Mulch for beds
	Lawn (Low Traffic)	Beds	Shrubs/ trees	Soil Cells or Soil Structural Mixes (Beneath Hardscapes)	Lawn (Low Traffic)	Beds/shrubs/trees	Soil Cells or Soil Structural Mixes (Beneath Hardscapes)	Lawn (Low Traffic)	Beds/ shrubs/ trees	Soil Cells or Soil Structural Mixes (Beneath Hardscapes)		
Streets Restoration Manual (2008)	150mm	-	-	-	Sand: 50-80% Silt: 5-15% Clay: 1-5% (Silt/clay max: 5-15%)	-	-	5-10%	-	-	-	-
Street Tree Guidelines (2011) *Update is in progress and newly approved specifications are listed	-	-	400-600mm	-	-	Sand: 83-88% Silt: 12-17% Clay: 0-5% (Silt/clay max: 12-16%)	Sand: 45-55% Silt: >25% and <35% Clay: > 10% and < 15% (Silt/clay combined: 35-45% (approved in 2016)	-	8-10% (approved in 2016)	10-15% (approved in 2016)	-	70-90mm
Vancouver Board of Parks and Recreation Park Development Standards (2015)	250mm	450mm	250mm-900mm	-	Sand: 85-92% Silt: 3% Clay: 2% (Silt/clay max: 5%)	Sand: 80-88% Silt: 3% Clay: 2% (Silt/clay max: 5%)	-	8-10%	12-15%	-	200mm	Trees and shrubs: 50mm Ground cover: 25mm

Table 5. **City of Vancouver public realm topsoil specifications.**

3.3.2 Private Realm

The current common topsoil practices in the private realm in Vancouver are likely not meeting the BMP requirements or practices. The City of Vancouver does not currently inspect topsoil during the development process, therefore evidence as to the current practices is lacking. However, in the absence of topsoil requirements, the educated assumption based on general site investigations by City staff is that BMPs are not followed. What is believed to occur is that first, native soil is neither protected nor securely stockpiled for post-development use. Instead, it is often permanently removed from the development site. Second, subsoil is left compacted from construction activities. It is not scarified as recommended to assist with infiltration of rainwater into the subsoil layer. Third, the new soil that is applied after building is often low in OM, does not match the native soils in texture, and is only approximately 120mm deep. Lower quality soil tends to be opted for because of its low cost, especially for lawns. Higher quality topsoil is often used for beds. Although the industry guidelines, such as the BCLNA Standard and the MMCD Specifications discussed above, exist; they are recommended guidelines as opposed to legal requirements and are therefore completely optional. Staff in the Landscape Development department recommend that developers and homeowners follow the Water Wise Landscape Guidelines, but it also has no legal standing. Resources from the BC government[72], Toronto[73], and Washington State[50] cite a similar lack of topsoil BMPs in the absence of official requirements.

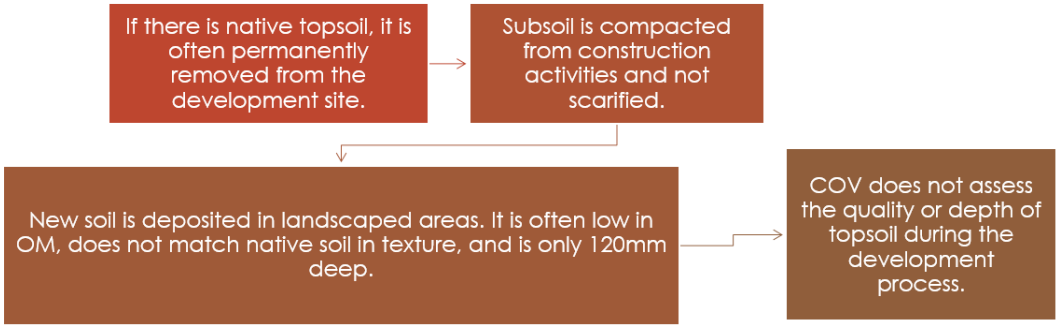


Figure 14. Current topsoil practices during the development process.

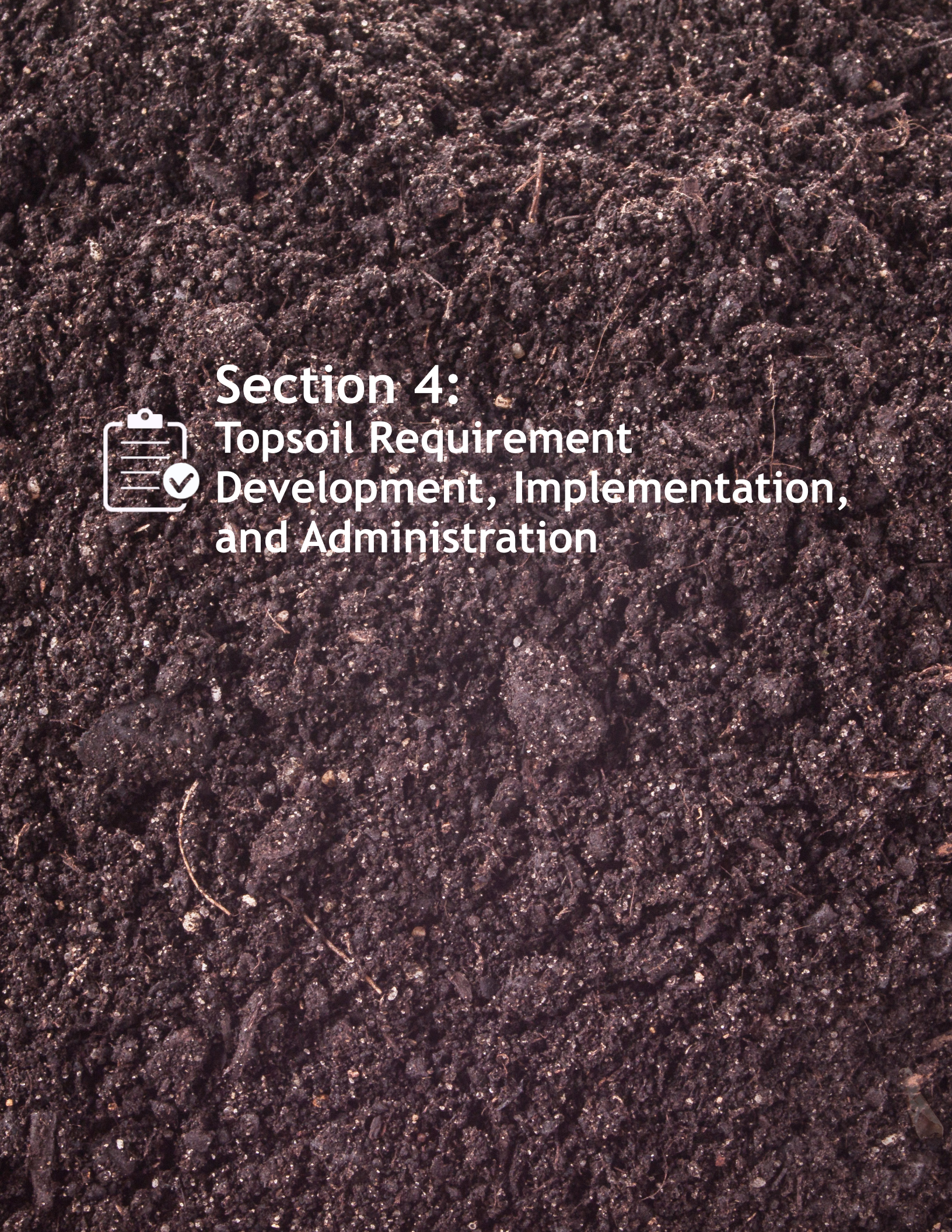
Image 17. Compacted subsoil on a development site[73].

3.4 Potential Risks of Optimum Topsoil Application

There are some potential risks identified through the literature review, interviews, and focus groups. The risks are not considered to be severe, and are primarily those related to aesthetic and nuisance concerns. It is recommended that further research be conducted into mitigation of these potential risks and concerns as part of implementation of a topsoil requirement. The consensus is that the benefits of a topsoil requirement far outweigh the potential risks.

The potential risks and concerns can be grouped into three categories: (1) concerns inherent to soil import that already exist, but may be increased by greater volumes of soil and OM movement; (2) concerns specific to greater soil depths and higher OM content; and (3) rainwater management performance concerns. The additional soil that would be imported into Vancouver due to the topsoil requirement is subject to the existing City of Vancouver specifications that soil be free of harmful contaminants and invasive species[70]. There are also some concerns due to the greater soil depth. The first of these is the risk of erosion on steep slopes. The maximum slope that a topsoil requirement could apply to is 10%. It is recommended that slopes are terraced to a maximum of 10% in order to accommodate soil depths. The second is the concern about topsoil settling, which can result in dips in soil, "sinking" lawns and garden beds, and soggy lawns and puddles in rainy conditions. To avoid "sinking" it is recommended that 15% more soil is applied that the recommended depth so that it settles at the desired level[50]. Higher amounts of OM will help to reduce sogginess, however, some public education will likely be required to change public perception about these aesthetic aspects. Furthermore, there are potential risks in regards to rainwater management performance and site applicability that will be resolved during the development review process. Some lots will not be appropriate for roof leader disconnection due to hazardous conditions, such as those near steep banks and with infiltration restrictions, which would be uncovered during on-site professional analysis. There is a concern that the volume of runoff will exceed what a site is capable of capturing and treating. The actual volume of water that a site could potentially hold and infiltrate depends on a variety of factors and requires site-specific analysis prior to disconnection from roof leaders. It is also recommended that Absorbent Landscapes have a lawn basin inlet connected to the storm sewer for high rainfall storm events[74] (see Image 18).

Image 18. Lawn basin inlet[75].



Section 4:
Topsoil Requirement Development, Implementation, and Administration

4. Topsoil Requirement Development, Implementation, and Administration

As the City looks to implement a topsoil requirement, it is beneficial to review existing tools and how these tools are successfully used in other cities. There are also several aspects that the City needs to consider in the development, implementation, and administration of a topsoil requirement. In this section, the topsoil requirement tools are outlined and several case studies of cities with topsoil requirements are discussed, which includes a summary of lessons learned and advice for Vancouver from these cities. Finally, regional requirements and considerations for a topsoil requirement are discussed and recommendations for the City of Vancouver are put forth.

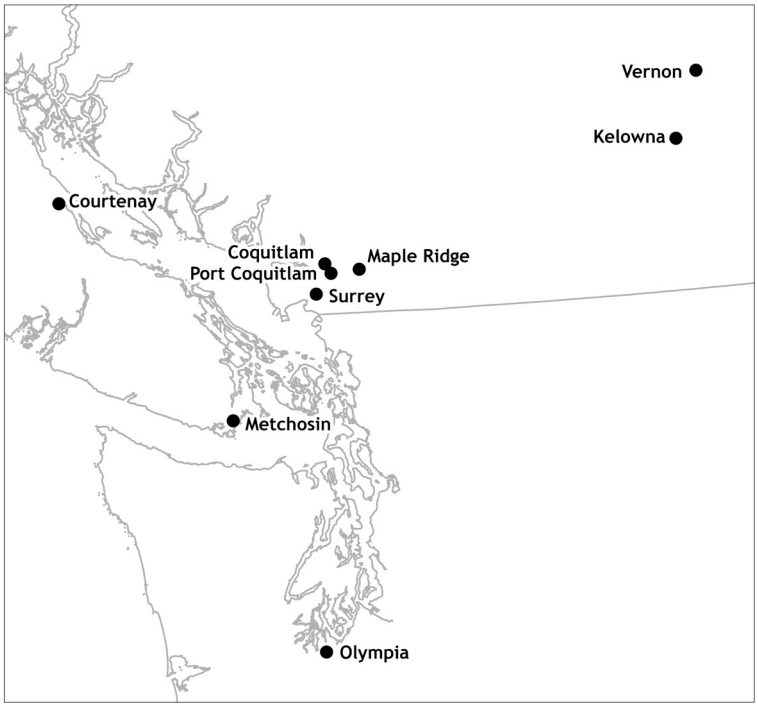
4.1 What are the Topsoil Requirement Tools?

Local governments in B.C. have the power to regulate topsoil with delegated power from the Province through the *Community Charter* and the *Local Government Act*. The City of Vancouver has its own charter, the *Vancouver Charter*, and through this has greater authority over some aspects than other municipalities. In particular, Vancouver has the ability to have its own building code. When a city has the authority to regulate a particular aspect of land use, they have several options by which to do it and are not limited to any particular choice. These tools can be summarized into five categories: (1) planning, (2) BMPs, (3) regulation, (4) information, and (5) enforcement. These tools can be used individually or in combination.

Planning tools include community plans, which contain policies that could outline the City's approach to rainwater management, water conservation, and topsoil. They can also include Development Permit Areas (DPAs), which control what happens at the time of development, in different areas of the city or the entire city. ISMPs and IRMPs are also types of plans that can be used. Regulatory tools, such as bylaws, allow the City to regulate different aspects of land use at all times, not only during the time of development. The Vancouver Building Bylaw, however, is focused on regulating what occurs at the time of development. BMP guides provide the details on topsoil practices. These include the types of industry guidelines discussed in the previous section and also those that are developed by a city itself. Furthermore, cities can also require that information about a site is provided before development, so that the City can make an informed choice about how development should unfold. For example, information could be provided on the native soils on the site. Finally, enforcement tools are important to make sure that the requirement is met. Commonly used enforcement tools are the collecting of a security deposit and placement of a covenant. The security deposit is returned to the property owner or developer upon post-development inspection; or if the works are not carried out as planned, then the municipality can use the funds to do so. The placement of a covenant on the topsoil ensures that the topsoil is maintained on the property over time and with different property owners, and allows for legal action if the covenant is broken[76].

4.2 How are Other Cities Using These Tools for Topsoil Requirements?

In order for the City of Vancouver to make an informed choice about which topsoil requirement tools to utilize, it is important to learn from other cities who have already taken the step in implementing a topsoil requirement. Topsoil requirements from nine municipalities in B.C. and Washington were studied through a combination of interviews and literature review. The types of literature reviewed primarily included bylaws, official community plans (OCPs), development guidelines, and stormwater management plans. All of the Metro Vancouver member municipalities were researched and contact was made to confirm the presence or non-presence of topsoil requirements. All but a few municipalities were confirmed, yet it is believed that those discussed below are the only municipalities in Metro Vancouver with topsoil requirements. The focus of the case research is on topsoil requirements on private land, particularly re-development of single family lots; however, requirements for land uses and development scenarios beyond this are also discussed in some cases. All of the cities have exemptions for works considered to be of minimal or no impact, however, the details of exemption are not included in the analysis due to scope. Discussion of the topsoil requirements in the various municipalities are discussed below and summarized in Table 5. Examples of topsoil requirement official language from the case studies are located in Appendix B.



Map 4. Locations of case study cities in B.C. and Washington.

4.2.1 Leading Cities

City of Surrey

The City of Surrey is one of the leading Metro Vancouver municipalities for rainwater management and topsoil requirements. The East Clayton Neighbourhood Concept Plan (NCP)[77] was the first development plan in Metro Vancouver to require Low Impact Development (LID) rainwater controls[78]. The plan for the 809 ha area was first adopted by Surrey council in 2003. The minimum depth of topsoil required for all on-lot landscaped areas was 600mm. Surrey also has topsoil requirements through its ISMPs. Surrey's first ISMPs, Hyland Creek and Cougar Creek, were completed in 2009; and to date, twenty one have been completed[79]. The topsoil requirements in the ISMPs vary depending on the watershed, ranging from 150mm to 600mm. Some ISMPs require that a rainfall retention performance target is met, rather than requiring prescriptive topsoil requirements; however, topsoil could be used to meet these targets. Texture and OM requirements are based on the MMCD. The requirements under the ISMPs are given legal standing through a reference statement in the Stormwater Drainage Regulation and Charges Bylaw[80]. For the few areas that currently do not have an ISMP, the topsoil requirement is generally 450mm as part of Service Agreements. There is also 450mm of topsoil required on city boulevards[81].

City of Coquitlam

The City of Coquitlam has a topsoil requirement in its Rainwater Management - Source Controls: Design Requirements and Guidelines[82]. The primary objective of the rainwater management requirements are to restore stream health in Coquitlam. The requirement applies to all land uses – single family, multi-family, industrial, commercial, institutional, and boulevards. The minimum requirement is 300mm of absorbent topsoil for all landscaping purposes. Coquitlam has produced a helpful resource that summarizes the requirements in the Rainwater Management Design Requirements and Guidelines for the development and building communities[83]. At present, the review process is different for large scale developments that involve contractors than developments on typical single family lots. Coquitlam is currently working with Metro Vancouver on the Region-Wide Baseline for On-Site Rainwater Management for single family lots to enhance the administration of its rainwater management and topsoil requirements.

City of Port Coquitlam

The City of Port Coquitlam has included a topsoil requirement in its Environmental Conservation DPA. This DPA applies to the areas where other DPAs are already mapped out, in areas where there are commercial, industrial, multi-residential, and intensive residential land uses. The objective of the requirement is both rainwater management and water conservation and this is explicitly stated in the OCP. If development on a property located within a DPA is proposed, then unless exempt, it must follow the DPA guidelines. This includes a stormwater management plan, which needs to include measures for stormwater treatment and reduction of irrigation needs. The topsoil requirement is not prescriptive, however, often 300mm is said to be required. There are also requirements for drought tolerant plants and high-efficiency irrigation systems[84].

City of Maple Ridge

The City of Maple Ridge has a topsoil requirement through its Watercourse Protection Bylaw[85]. The primary objectives of the bylaw are to improve rainwater management, control erosion, and protect stream health through on site pro-active measures. The requirement applies to all land uses – single family, multi-family, industrial, commercial, and institutional (with some exceptions for ALR lands). The requirements primarily apply to development permits, building permits, and tree and soils permits where significant vegetation removal, re-grading, or construction activity occurs. The topsoil requirement is also triggered by other activities that may have an impact on the environment and require an Environmental Development Permit, such as in lands designated as conservation in the OCP, lands in and around a stream or on slopes greater than 15%. The topsoil requirement is the same as the Metro Vancouver Stormwater and Source Control Guidelines and is referenced in the Watercourse Protection Bylaw. The minimum depth required is generally 300mm. Topsoil composition requirements include a texture of sand (50-70%), silt (10-30%) and clay (7-20%) and OM content of 8% for lawn and 15% for other landscape areas. Inspection is done by the Erosion and Sediment Control (ESC) monitor or Engineer of record, who provide final letters of inspection to the City in addition to final site inspection by municipal staff before the security deposit is returned. The requirement is enforced by use of securities as well as spatially explicit covenants to support ongoing maintenance of topsoil amendments. The covenants ensure that current and future homeowners are aware of the topsoil requirements and the ongoing need for maintenance.

City of Courtenay

The City of Courtenay has included Water Balance Model and topsoil requirements for the City's DPAs and subdivisions since 2005. The requirements and guidelines are easily accessible in the City's OCP[86]. The objective of this requirement, along with rainwater management retention and release targets, is to protect the natural environment and move towards a watershed-based approach to development. The broad goal is water sustainability, which includes water conservation as well as rainwater management. The DPA topsoil requirement applies to commercial, industrial, multi-residential, and intensive residential land uses. If development on a property located within a DPA is proposed, then unless exempt, it must meet the DPA guidelines. In addition to a required drainage plan with implementation steps to meet Courtenay's rainwater management targets, all landscaped areas require a minimum depth of topsoil. The minimum depth is 300mm for lawns and groundcover; 450mm for shrubs; and 300mm for tree root balls. The soil can either be native topsoil or amended organic soil, however, there is no prescriptive requirement for OM content. Courtenay has developed DPA compliance checklists for each of the DPAs for developers and homeowners; and those that include topsoil requirements explicitly state the necessary depths for the different uses[87,88]. The City's Engineering Division in the Department of Development Services administrates the Water Balance Model and topsoil requirements. The administration for the DPAs and subdivisions are different. For

DPAs, a Landscape Architect is involved in the development of landscape plans and the final sign off that the works have been carried out as planned. A security deposit is used to ensure that the landscaping, including topsoil, is completed as planned. Once sign-off takes place, the deposit is returned.

District of Metchosin

The District of Metchosin has a topsoil requirement in its Bylaw for the Protection and Management of Rainwater (Bylaw 467)[89]. This bylaw is both progressive and comprehensive. There are seven key principles of the bylaw: ecosystem integrity, sustainability (including water quantity), stewardship, accountability, water quality, public awareness, and property values. The rainwater management performance target is to address 90% of rainfall on site. The bylaw was spearheaded by planning staff in 2004 and remains a leading example for rainwater management bylaws in B.C.. At the time of implementation in 2004, the district reduced the footprint of its DPA for the Bilston Creek Floodplain and introduced the new bylaw[90]. The benefit of the DPA is limited to a specific area and is primarily only enforced when a development takes place; whereas, the bylaw is in effect across the District and can be implemented indefinitely.

The bylaw applies to all land use in the district, including single family residential, which accounts for the majority of the land base. When Effective Impervious Area exceeds a certain threshold (465 square meters on lots less than 0.8 ha and 5% on lots greater than 0.8 ha), a report from a qualified professional is required. Impervious surfaces in existence prior to adoption of the bylaw were considered to be 'grandfathered'; however the District encourages land owners to address all impervious surfaces as per the bylaw.

The topsoil requirement applies to all areas that previously contained trees and undergrowth and that are to remain as pervious surfaces. The minimum depth of topsoil is 300mm for lawn and other landscaped areas (the BCLNA Standard for medium or better landscape). Ranges of acceptable soil textures are: sand (55-90%), silt/clay (5-25%), and OM (5-20%). The rainwater management and topsoil requirements under the bylaw are reviewed by the District staff, including the reporting from professionals. Helpful resources, such as information on source controls and checklists are included in the bylaw document. Staff at the District also wrote a Statement of Intent, which explains the purpose of and summarizes the bylaw in easy to understand language[90].

City of Kelowna

The City of Kelowna has a topsoil requirement in place and is taking steps to reduce outdoor water consumption. The Landscaping Standards section of the consolidated zoning bylaw states that all landscaped areas shall meet or exceed the BCLNA Standards[91], which includes specifications for topsoil depth for different landscaping types and as well as texture and OM content[61]. The bylaw applies to intensive residential, multi-family residential, industrial, and commercial land use. The bylaw is enforced by Planning and

Parks Department staff in conjunction with sign-off by qualified professionals, such as landscape architects.

Kelowna also has a Water Regulation Bylaw which includes a requirement for a Landscape Water Conservation Report before installation of any irrigation systems[92]. The report must include a completed Landscape Water Conservation Checklist of irrigation and design standards, a summary of Estimated Landscape Water Use and a Landscape Water Budget. Irrigation efficiency is a component of the formula to determine the landscape water use. As explained above, in the topsoil benefits section, the depth and quality of topsoil plays a critical role in reducing the need for irrigation by storing higher quantities of water in the soil for longer periods of time. Kelowna has resources on landscape water efficiency on its website and has also developed a Landscape and Irrigation Guide to Water Efficiency - which is a comprehensive, yet easy-to-understand resource for development professionals and home owners. The importance of topsoil and mulch is described in the guide[93].

City of Vernon

The City of Vernon has a topsoil requirement in its Landscape Standards Bylaw[94] that was adopted in 2006. Outdoor water conservation is a key objective of the bylaw, and it even includes provisions for xeriscape landscaping. It applies to all land uses, except for single family homes, duplexes and triplexes. The bylaw states that 150mm of topsoil is required for lawns and all other landscaped areas require "adequate amounts of suitable soil". There are no prescriptive requirements for soil texture or OM content, but the bylaw requires "soils with a composition and nutritional value that act as an appropriate growth media for plant material, and maintain soil moisture". There is also a mulch requirement of 150mm for beds. The topsoil requirement is administrated by Planning Department staff.

City of Olympia

The City of Olympia in Washington State is known as a leading municipality for stormwater management and a key component of this is their topsoil requirement. Since 2007, cities in Western Washington have been mandated by the state to manage their stormwater[95]. Stemming from the federal Clean Water Act, the purpose of the Western Washington Phase II Stormwater Permit is to protect the integrity of the country's waters. The requirement applies to eighty one cities in Western Washington[96]. The Washington State Department of Ecology, along with academic, non-governmental organizations, and local governments, have produced a wealth of stormwater management resources on BMPs, implementation, and administrative processes.

Olympia's Drainage Design and Erosion Control Manual and Engineering Design and Development Standards[97] contain the topsoil specifications, and these documents are both adopted by Olympia's municipal code[98], giving the requirements regulatory standing. The requirement applies to pervious surfaces of any land use. The required topsoil depth is 9.5 inches (240mm) at the time of application and a settled depth of 8 inches (200mm). Subsoils need to be scarified at least 4 inches (100mm) and should be mixed with the topsoil to avoid layer stratification. The minimum OM

is 5% for turf and 10% for planting beds, by dry weight. If native soil on a site is disturbed during development, then it must also meet the amendment specifications. The Community Planning and Development department administrates the requirement, along with the assistance from inspectors in the Public Works department and private contractors for larger scale developments. Topsoil requirements are inspected by using soil core tools. Documentation for the volume, quality, and source of compost are also required during inspection. Property owners are required to maintain their stormwater infrastructure, including topsoil, through Stormwater Facility Maintenance Agreements. These are legally binding agreements between property owners (or the entity responsible for maintenance) and the City of Olympia, which are included on private property land titles. Since they are legally binding, the requirements can therefore be enforced over time if necessary. Olympia also offers financial incentives to help meet the above goals, such as a raingarden rebate[99] and a free lawn aerator rental program[100]. They are currently working on Low Impact Development (LID) guidelines specific to the building community in Olympia.

Soil Removal and Deposit Bylaws

A number of these municipalities also have bylaws that regulate soil removal and/or deposit. Although a topsoil requirement for the purposes of rainwater management and water conservation could be included in a soil removal bylaw; the purpose of the bylaws reviewed tended to be for environmental protection. Such as, to require proper practices to contain soil during transport and to control movement of contaminated soils. The removal or deposit of a certain volume of soil (sometimes within a certain amount of time) will trigger the requirement for a permit. The permit will outline standards that need to be followed to meet the municipalities' objectives of the bylaw. Sometimes this includes a requirement to restore the landscape, but rarely are prescriptive topsoil application requirements included.

4.2.2 Lessons Learned and Advice for Vancouver

In addition to descriptions of topsoil requirements in the case study cities discussed above, staff from these cities also shared lessons learned and advice for Vancouver on developing, implementing, and administrating a topsoil requirement. Several of the case study cities have experienced challenges in administrating their topsoil requirements. There are two main reasons for this: shortfalls in the development of the requirement and gaps in the administrative process. Therefore, the lessons learned and advice for Vancouver is organized into two categories – (1) developing a topsoil requirement and (2) implementing and administrating a topsoil requirement. A number of comments are relevant for both categories, especially as it is important to consider what will make administration successful during the development of the requirement and early implementation.

Developing a Topsoil Requirement

Ensure that the topsoil requirement does not contradict other City requirements

- If the topsoil requirement contradicts what is required under other bylaws or development controls, it may lead to inconsistent implementation of the requirement.
- To avoid contradiction with other bylaws and development controls, include staff from the department that will be administrating the requirement in the development and writing of the requirement.
- Consolidating the topsoil requirement with other requirements that apply during the development stage into a single guide with a checklist will make administrating the requirement easier and more efficient for staff and it will also result in more consistent implementation.

Make the topsoil requirement easy to understand

- It is important that the topsoil requirement is easy to understand for everyone involved. It should be accessible to home owners, developers, construction workers, and landscapers. Producing educational resources specific to these different communities can help with this.
- Prescriptive requirements, such as a specific topsoil depth and OM percentage, are easier to understand than qualitative measures.

Implementing and Administrating a Topsoil Requirement

Be clear on roles and responsibilities

- Be clear about the roles and responsibilities of the City departments that are inspecting components of the topsoil requirement during the different stages of development.
- Be clear on the responsibilities of developers and home owners.

Enhance staff capacity

- In order to properly enforce the requirement, City staff need to understand the requirements and how to either conduct inspections or receive sign-off from professionals.

Provide support on soil sourcing

- Reliable topsoil sourcing in or near the community that developers and contractors can use to carry out their works can be challenging. The City should help to address this challenge, such as by developing an approved soil vendors list.

Use enforcement tools

- Enforcement tools, such as security deposits and covenants, increase the success of the topsoil requirement being met and maintained over time.

4.2.3 Case Study Summary

The case study cities have both differences and commonalities among one another in overall objectives and in implementing and administrating their topsoil requirements. The cities all have the power to regulate topsoil, but have used different tools to do this. Some have used a bylaw and some DPAs. The purpose of the topsoil requirements tended to be for either rainwater management or water conservation. Only one municipality explicitly stated that the topsoil requirement was for both objectives. The majority of the municipalities specified a certain depth of required topsoil and slightly less specified topsoil texture and OM content, for different landscaping purposes. Most of the topsoil requirements were prescriptive, yet some municipalities used a descriptive rather than a quantitative metric. Four municipalities have requirements for subsoil scarification and only three have requirements for mulch. Some cities included all of the topsoil specifications directly in the primary topsoil requirement document (bylaw or community plan), yet many made reference to other documents for specifications and BMPs; such as the BCLNA, MMCD, or guidelines that the city had developed themselves. For five of the municipalities, the requirements applied to single family lots as well as intensive-residential, multi-family, industrial, commercial, and institutional land use (to which all requirements applied to in all municipalities). The reason that some of the cities did not apply the requirement to single family lots is likely because the cities did not want to put the responsibility on home owners. For the municipalities using DPAs, the requirements sometimes only applied in the DPAs; or the requirements were different inside and outside of the DPA. The development scenario triggers for the topsoil requirements were both new development and re-development in the areas that the topsoil requirements applied, in all of the municipalities. All of the municipalities have exemptions however, for works considered to be of minimal or no impact.

All of the cities have experienced challenges in enforcement and inspection of some sort. In some cases, this was because of gaps during the topsoil requirement development process and for some others it is due to gaps in the administrative process. The use of securities and covenants have proven to be helpful enforcement tools for the cities that use them. Finally, there is a shortfall when it comes to evaluating the topsoil requirement – determining in what ways the requirement is or is not meeting the objective it is intended for, whether that be water conservation, rainwater management, or both. Evaluation is an incredible challenge in the local government setting, yet it is a very important step to strive for.

Case Study Cities Topsoil Requirements in the Private Realm Summary

Region	City	Land Use Applicability	Development Scenario Trigger	Minimum Topsoil Depth Minimum			Topsoil Texture (% dry weight)		Minimum Topsoil OM Content (% dry weight)		Subsoil Scarification	Mulch for beds	Regulatory Tool and References
		SF = Single family; ISFR = Intensive single family residential; MF = Multi-family; ICI = Industrial, Commercial & Institutional		Lawn (Low Traffic)	Beds	Shrubs/trees	Lawn (Low Traffic)	Beds/shrubs/ trees	Lawn (Low Traffic)	Beds/ shrubs/ trees			
Metro Vancouver	City of Surrey	SF, MF, ICI	Any development scenario, unless exempt due to small impact	150mm-600mm	150mm-600mm	150mm-600mm	Sand: 50-70% Silt: 10-30% Clay: 7-20%	Sand: 50-70% Silt: 10-30% Clay: 7-20%	5-10%	25-30%	150mm	-	ISMPs, Surrey Stormwater and Drainage Regulation and Charges Bylaw (#16610), and MMCD (for soil texture, OM content, and scarification)
	City of Coquitlam	SF, MF, ICI	Any development scenario, unless exempt due to small impact	300mm	300mm	300mm	"Absorbent topsoil"				-	-	Rainwater Management Design Requirements and Guidelines
	City of Port Coquitlam	ISFR, MF, ICI (with DPAs)	Any development scenario, unless exempt due to small impact	"Sufficient depth of topsoil or composted materials for well-rooted plantings" (generally 300mm)			-	-	-	-	-	-	Development Permit Areas (OCP)
	City of Maple Ridge	SF, MF, ICI	Any development scenario, unless exempt due to small impact	300mm	300mm	300mm	Sand: 50-70% Silt: 10-30% Clay: 7-20%	Sand: 50-70% Silt: 10-30% Clay: 7-20%	8%	15%	150mm	-	Watercourse Protection Bylaw (#6410) (refers to Metro Vancouver Stormwater Source Control Design Guidelines, and MMCD) and Development Permit Areas (OCP)
Vancouver Island	City of Courtenay	ISFR, MF, ICI (within DPAs with topsoil requirements)	Any development scenario unless exempt due to small area of impact	300mm	300mm	shrubs: 450mm; trees: 300mm below root ball	-	-	-	-	-	-	Development Permit Areas (OCP)
	District of Metchosin	All land use	Any development scenario, unless exempt due to small area of impact	300mm	300mm	300mm	sand: 55 - 90% silt/clay: 5 - 25%		5 - 20%		-	-	A Bylaw for the Protection and Management of Rainwater (#467)
Okanagan	City of Kelowna	ISFR, MF, IC	All development scenarios, except for small area of impact and uncommon exemptions	150mm	300mm	450-900mm	Sand: 50-70% Silt: 10-25% Clay: 0-25%	Sand: 40-80% Silt: 10-25% Clay: 0-25%	3-5%	15-20%	150mm	Mulch is recommended	Consolodated Zoning Bylaw (#8000) and BCLNA Standards
	City of Vernon	MF, ICI	All development scenarios, except for small area of impact and uncommon exemptions	150mm	"all landscape areas are to have an adequate amounts of suitable soil utilized during the installation of plant materials"		"soils with a composition and nutritional value that act as an appropriate growth media for plant material, and maintain soil moisture"				-	150mm	Landscape Standards Bylaw (#515)
Washington State	City of Olympia	All land use	Any development scenario, unless exempt due to small area of impact	240mm	240mm	240mm	-	-	5%	10%	100mm	50mm	Drainage Design and Erosion Control Manual and Municipal Code

Table 6. Case study cities topsoil requirements in the private realm summary.

4.3 Regional Requirements, Considerations and Recommendations for Vancouver

4.3.1 Metro Vancouver Region-Wide Baseline for On-Site Rainwater Management

Metro Vancouver is currently developing minimum requirements for stormwater management on single-lot residential developments as part of the Metro Vancouver Integrated Liquid Waste and Resource Management Plan (ILWRMP). As discussed above, the driver behind this plan and the requirements for ISMPs is the B.C. *Environmental Management Act*[34]. In September 2015, the Options for a Region-Wide Baseline for On-Site Rainwater Management report[74] was presented to Metro Vancouver municipalities for their feedback. It includes baseline requirements that would apply to areas that have not developed ISMPs and to the land uses that ISMPs have often left out of rainwater management requirements (single family, duplex, and triplex residential land uses). The City of Vancouver has ISMPs for its two watersheds with surface streams and the new IRMP (which is simply a different name for an ISMP) for the remainder of the city. The City of Vancouver is currently working on the third volume of the IRMP, which will include more details on implementation.

The options that Metro Vancouver presented include a minimum 450mm of topsoil depth, among other rainwater management source controls for properties that require further infrastructure. The September 2015 report included draft brochures and a draft model bylaw. At present, representatives from Metro Vancouver municipalities are working together to address concerns and refine the proposed bylaw. Until the end of July 2016, Metro Vancouver was conducting stakeholder engagement with the development, building, and landscape architecture industries through a survey[35]. A report with the results should become available in October 2016. It is expected that Metro Vancouver municipalities will update their bylaws to reflect the region-wide baseline or refer to their ISMPs/IRMPs by January 2018.

4.3.2 Considerations

The following eleven aspects were considered in the development of the recommendations. They were compiled through literature review, interviews with the City of Vancouver Topsoil Working Group and through the case research. Each consideration includes a question and an answer for the City of Vancouver.

Land Use Applicability

What land use and zoning will the requirement apply to?

The requirement will apply to all land use in the City, including single family lots. This is necessary to meet the Metro Vancouver Region-Wide Baseline requirements, but single family lots are also where the greatest benefits will be seen for both water conservation and rainwater management because it accounts for the majority of the pervious land base.

Development Scenario Trigger

What type of development would trigger the topsoil requirement? New development? Re-development? Both?

In order for the topsoil requirement to meet its objective of outdoor water conservation and rainwater management, it will apply to both new development and re-development. Exemptions should be determined during the topsoil requirement development stage.

Topsoil Requirement Tool

What planning and/or regulatory tool should the City use for its topsoil requirement?

If the topsoil requirement is going to have an impact, it needs to have legal power and longevity. A policy or guideline would not meet these goals, but a bylaw would.

Topsoil Specifications and BMPs

How should the City determine what topsoil specifications and BMPs to use? How will the requirements be documented?

The City should use the information in this report as a starting place to learn about the topsoil specifications recommended by the BMPs and the specifications used by the nine case study municipalities studied. They can also read the BMP summary from guides commonly used in the region.

Ease of Understanding

How can the topsoil specifications and BMPs be made easy to understand so that they are accessible to everyone, resulting in greater success of implementation?

The specifications and BMPs should be summarized to a level of simplicity to assist with implementation. For example, the specifications could be limited to those most critical for the objectives of the requirement: depth, texture ranges, OM content, subsoil scarification, and mulch.

Equity

How can equity be incorporated into the implementation and enforcement of the topsoil requirement?

It is important that the new topsoil requirement is implemented in a way that is equitable and fair. For example, setting requirements in one neighbourhood of the city and not others may be considered unfair and result in more challenging implementation.

Administrative Processes

Which City of Vancouver department will administrate the requirement? How can it best fit into the City's current development review process?

The City's Planning Department Landscape Development Team should administrate the requirement. Merging the new requirement, as best as possible, into the City's existing development review process will support ease of implementation for both the City and the community.

Enforcement

How can the City make sure that the topsoil requirement is met? At the time of development? After development? Will it rely on professionals or train staff to do the inspection? What tools should the City use to enforce the topsoil requirement?

A security deposit will ensure that the requirement is met at the time of development and a covenant could support best maintenance practices over time. For inspection, the City will need to decide if it wants to rely on professionals or City staff. The benefit of relying on professionals is that it is reliable, but the cost is greater to the applicant. Relying on City staff may be less costly to the applicant, but requires greater capacity within the City.

Logistics

What does the City need to determine in terms of logistics? Will there be a sufficient supply of topsoil that meets the specifications to meet the demand?

As part of implementing the topsoil requirement, the City should verify that there is sufficient soil supply sources to meet the volume of soil required at the proper specifications.

Topsoil Cost

What will the cost of topsoil that meets the specifications be for developers, home-owners, and landscapers?

Metro Vancouver estimated that the cost for approximately 250m^3 of absorbent topsoil at 450mm deep, was $6,500 (2012 value). This is for engineered topsoil, as opposed to native topsoil, which would be more affordable[61].

It is important to note that the cost of absorbent topsoil is significantly less costly than other rainwater source controls, such as rain gardens and cisterns[61,101]. *Further, considering the bigger picture, green infrastructure such as topsoil, is more affordable than traditional grey infrastructure, such as the sewer system, and offers significantly more benefits to the community and the environment. Cities in B.C. are starting to assess their natural capital and make plans to conserve and create more of it, knowing that not only is more green infrastructure better for people and ecosystems, but it is also better for the City's bottom line*[102,103,104].

Adaptability

How can adaptability be built into the topsoil requirement specifications and administrative processes so that it can be refined and improved over time?

It is important that the topsoil requirement tool allows for adaptability over time. Specifications and administrative processes may need to be improved and refined over time and it is important to plan for this during the development of the requirement.

4.3.3 Recommendations

It is recommended that the City of Vancouver implement a topsoil requirement to support its water conservation and rainwater management goals. A topsoil requirement is the low hanging fruit option that will help the City with both of these goals. The benefits are two for one – and even greater when the multitude of other benefits are considered. Further, it is recommended that the City take steps to develop and implement a topsoil requirement to take advantage of the current rate of re-development and timing of the Metro Vancouver Region-Wide Baseline. In each of the last few years, there have been approximately 900-1000 new single family homes re-developed in Vancouver. Therefore, at present, not only is the city rapidly losing its native topsoil, but it is thought to not be replenishing with adequate volumes and quality of topsoil. Until the City implements a requirement, this trend is likely to continue. Taking action on implementing a topsoil requirement is also an opportunity for the City of Vancouver to join the municipalities in Metro Vancouver that are leading the way for the rest. Topsoil is the medium from which life grows and is a critical component to help Vancouver become the greenest city in the world.

The following are recommendations for the City to get started in developing a topsoil requirement:

1. **That the City be a leader and commit to developing a topsoil requirement**

   a) Lead the way in adopting the recommended topsoil specifications and BMPs for City practices on streets, parks, and City properties.

   b) Join the leading Metro Vancouver municipalities in taking action on topsoil requirements.

2. **That the City develop a topsoil requirement**

   a) The requirement should apply to all land use, including single family lots; and all development scenarios, including re-development. For the requirement to be equitable, it should apply city-wide.

   b) The City should use a tool, or combination of tools, that have legal power and longevity.

   - For example, the City could develop a standalone bylaw; combine it into an existing bylaw if it is appropriate; or create a new bylaw with room for future related additions.
   - The bylaw should be a necessary condition for a building permit and/or development permit.

- Development of a topsoil requirement should be an internal collaboration and involve all departments that have a stake and to ensure that the requirement is not incompatible with other City regulations. Departments that should be involved include: Planning, particularly the Landscape Branch; Engineering, particularly Waterworks Design, Sewer and Drainage Design, and Streets and Electrical Design; Parks and Recreation; Legal Services; and other departments if helpful.
- Compatibility with the topsoil requirements of other Metro Vancouver municipalities should be considered. This will help with uptake from the development, building, and landscaping communities.
- The use of security deposits to support enforcement at the time of development is recommended. The City should also consider using covenants to increase the likelihood of best practice topsoil maintenance and to create the option of legal action if necessary.
- The topsoil requirements should also apply to scenarios where developers are undertaking works in the public realm, such as on City streets, such as through Development Servicing Agreements.

c) The City of Vancouver should develop its own topsoil standard and BMP guidelines

- This document can be given legal power through reference in the bylaw discussed above. A separate standard and BMP document will be easier to approach and understand than a bylaw. It can also allow for easier adaptations, as making amendments to a guideline is simpler than a bylaw.
- The City should take a dual approach to water conservation and rainwater management, as opposed to solely water conservation or solely rainwater management.
- To determine the topsoil specifications and BMPs for Vancouver, all departments that have a stake in topsoil should be involved in the creation of Vancouver's topsoil standard and BMP guidelines.
- BMPs from commonly used resources in the region, as summarized in the BMP section of this report, should be discussed and considered.
- The soil specifications should be consistent with what is required by Metro Vancouver. Metro Vancouver requirements beyond topsoil could also be met in the bylaw. If a performance based approach is desired, it is still recommended that there be a minimum topsoil requirement in all areas where there is landscaping in order to meet the water conservation objectives.

- Requirements for texture, OM, subsoil scarification, and mulch are recommended in addition to meeting Metro Vancouver's soon-to-be requirement for topsoil depth.

d) The City should highlight the benefits of a topsoil requirement that go beyond water conservation and rainwater management, particularly biodiversity.

- Demonstrate how the topsoil requirement supports the city's various strategies to be sustainable, healthy, biodiverse, and resilient.
- Incorporate the above into the marketing of the topsoil requirement.

e) The City should engage with the development, building, and landscaping communities as well with property owners[35,28].

- Implementation will be more successful if the affected groups are given the opportunity to provide input. Engagement should be focused on issues that can be resolved to make implementation as simple as possible; for example, on how the topsoil requirement can be made easy to understand and on the administrative process. Professionals also have expertise that could assist with some aspects of implementation, such as on soil sourcing. Refer to Metro Vancouver's engagement for the region-wide baseline, expected to become available in October 2016.

3. That the City implement the topsoil requirement

a) Incorporating the topsoil requirement into existing development processes will help with ease of implementation[35].

b) Produce a checklist to assist with implementation.

- The topsoil requirement checklist should include all components of the topsoil requirement.
- The topsoil requirement checklist should be incorporated into a master checklist for the planning department. This will make it clear where topsoil fits into the administrative process and bring to light any conflicting requirements.

c) Educate City staff about the new topsoil requirements, the benefits of topsoil, and the objectives of the requirement.

- This will help with uptake by staff and will also be passed on to people that staff communicate with, such as developers and homeowners.

d) Educate the public about the topsoil requirement, the benefits of topsoil, and the objectives of the requirement[35,105].

- Create easy to understand educational guidelines specific to affected communities: developers, builders, landscape architects, and home owners. Educating home owners is important for the long term maintenance of topsoil and sufficient irrigation practices. The topsoil requirement will likely result in home owners having topsoil that is deeper and better quality than they have in the past, and it is critical that they understand that less water is required for irrigation with their new situation.

e) Facilitate the sourcing of soil by producing an approved topsoil vendors list.

f) Consider incentives for topsoil maintenance.

- Proper maintenance of topsoil is important for long term performance. It is suggested that the City consider incentives to assist home owners in maintaining healthy topsoil, such as the Lawn Aerator program in Olympia[100] and discounts on compost.

4. That the City evaluate the performance of the topsoil requirement and make adaptations if necessary

a) The City of Vancouver could partner with a university interested in conducting this research, such as the University of British Columbia[106]. It is important to evaluate the requirement to ensure that it is performing as planned, and that it is supporting the City in meeting its water conservation and rainwater management goals. If it is not performing as planned, then evaluation will help identify what needs to be changed and the requirement can be adapted.

It is suggested that the City's next tasks include conducting further work on:

- The cost to developers.
- The sourcing of soil.
- Enforcement methodologies for soil testing.
- On-site topsoil storage techniques.
- Inspection processes.

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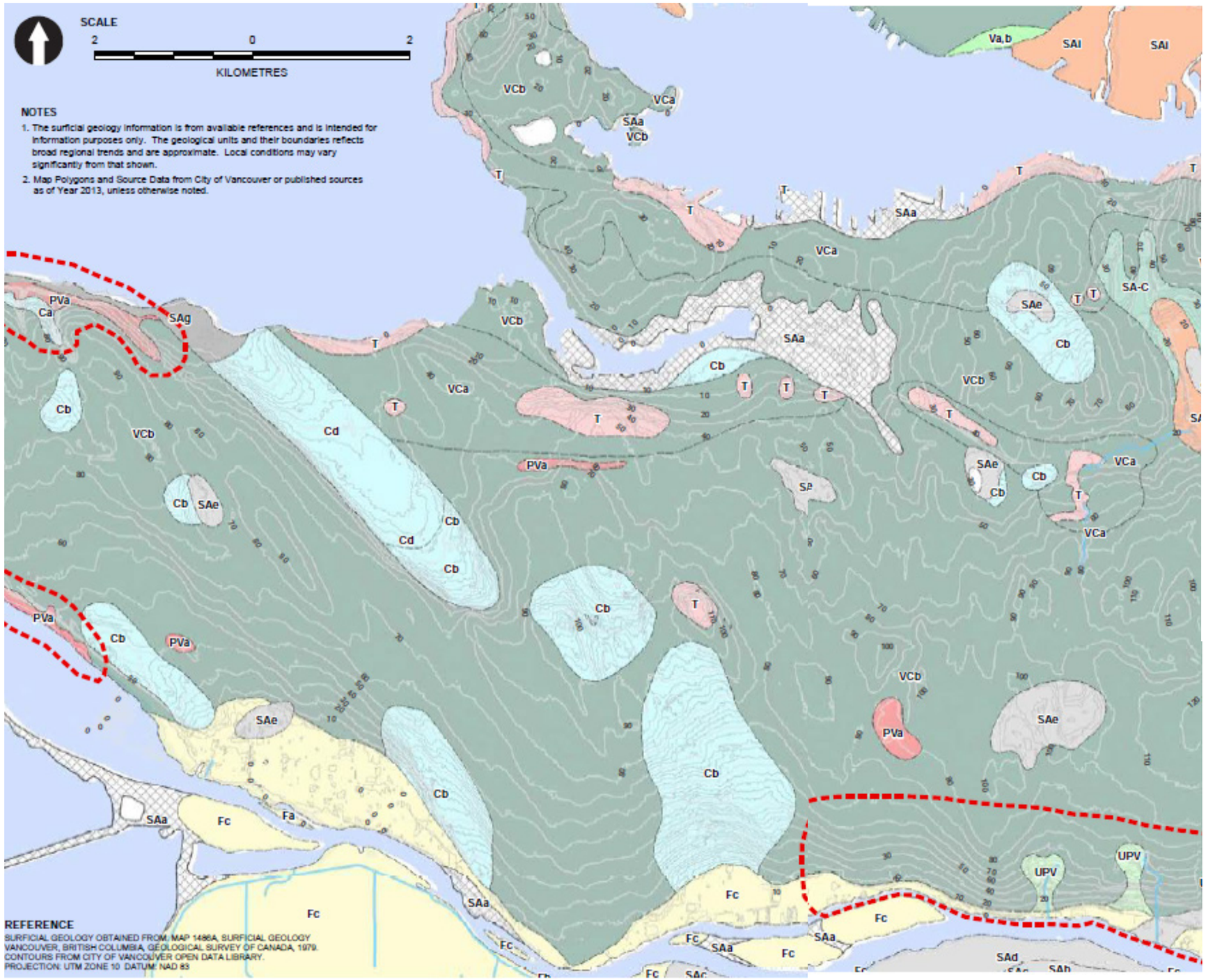
Appendix A:
Supplementary Maps



Map 1. Vancouver Geology and Soils.

LEGEND

SPECIAL INVESTIGATION AREAS - SLOPE STABILITY RISK

WATERCOURSE

ELEVATION CONTOUR (10m)

ELEVATION CONTOUR (2m)

QUATERNARY

POSTGLACIAL

SALISH SEDIMENTS

SAa — Landfill including sand, gravel, till, crushed stone, and refuse

SAb-e — Bog, swamp, and shallow lake deposits: SAb, lowland peat up to 8 m thick overlying Fb,c; SAc, lowland peat up to 1 m thick, underlying Fb (up to 2 m thick); SAd, organic-rich sandy loam to clay loam 15 to 45 cm thick overlying Fd; SAe, upland peat up to 8 m or more thick overlying VC units

SAf,g — Marine shore sediments (beach deposits): SAf, sand to sandy loam up to 2 m thick overlying Fe; SAg, sand to gravel up to 8 m thick

SAh-j — Lowland and mountain stream deltaic, channel fill, and overbank sediments: SAh, lowland stream channel fill and overbank sandy loam to clay loam, also organic sediments: up to 8 m thick; SAi, mountain stream marine deltaic medium to coarse gravel and minor sand up to 15 m or more thick. SAj, mountain stream channel fill sand to gravel up to 8 m thick

FRASER RIVER SEDIMENTS

Fa-e — Deltaic and distributary channel fill sediments overlying and cutting estuarine sediments and overlain in much of the area by overbank sediments: Fa, channel deposits, fine to medium sand and minor silt occurring along present day river channels; Fb, overbank sandy to silt loam normally less than 2 m thick overlying 15 m or more of Fd; Fc, overbank silty to silt clay loam normally less than 2 m thick overlying 15 m or more of Fd; Fd*, deltaic and distributary channel fill (includes tidal flat deposits), 10 to 25 m interbedded fine to medium sand and minor silt beds; may contain organic and fossiliferous material; Fe*, estuarine, fossiliferous, interbedded fine sand to clayey silt (sand content increases from bottom to top of sequence), 10 to 185 m thick

POSTGLACIAL AND PLEISTOCENE

SA-C — Marine shore and fluvial sand up to 8 m thick, Cb in part has been reworked and redeposited by lowland streams (SAh)

PLEISTOCENE

CAPILANO SEDIMENTS

Ca-d — Raised marine, deltaic, and fluvial deposits: Ca, raised marine beach, spit, bar, and lag veneer, poorly sorted sand to gravel (except in bar deposits) up to 10 m thick mantling older sediments and containing fossil marine shell casts up to 175 m above sea level; Cb, raised beach medium to coarse sand 1 to 5 m thick; Cc, raised deltaic and channel fill medium sand to cobble gravel up to 15 m thick deposited by proglacial streams and commonly underlain by silty to silty clay loam; Cd, marine and glaciomarine stony (including till-like deposits) to stoneless silt loam to clay loam with minor sand and silt, normally less than 3 m thick but up to 10 m thick in upland areas

VASHON DRIFT AND CAPILANO SEDIMENTS

VCa,b — Glacial drift including; lodgment and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glaciolacustrine laminated stony silt; up to 25 m thick; in most places correlated with Va,b; overlain by glaciomarine and marine deposits similar to Cd, normally less than 3 m but in places up to 10 m thick. Marine derived (Ca) lag gravel normally less than 1 m thick containing marine shell casts has been found mantling till and glaciomarine deposits up to 175 m above sea level; above 175 m till is mantled by bouldery gravel that may be in part ablation till, in part colluvium, and in part marine. VCa, bedrock within 10 m or less of the surface; VCb, bedrock more than 10 m below surface

VASHON DRIFT

Va,b — Till, glaciofluvial, glaciolacustrine, and ice-contact deposits: Va, lodgment till (with sandy loam matrix) and minor flow till containing lenses and interbeds of glaciolacustrine laminated stony silts; Vb, glaciofluvial sandy gravel and gravelly sand outwash and ice-contact deposits

PRE-VASHON DEPOSITS

PVa,b,e-h — Pre-Vashon glacial, nonglacial, and glaciomarine sediments: PVa, Quadra fluvial channel fill and floodplain deposits, crossbedded sand containing minor silt and gravel lenses and interbeds; PVb, Quadra deltaic deposits and crossbedded sand and gravel; PVe, Cowichan Head organic sediments; PVf, Semiahmoo glaciomarine, glaciofluvial sediments and till; PVg, Highbury fluvial, marine, and bog and swamp deposits; PVh, Westlynn till and glaciomarine stony silty clay loam

UNDIVIDED PRE-VASHON DEPOSITS

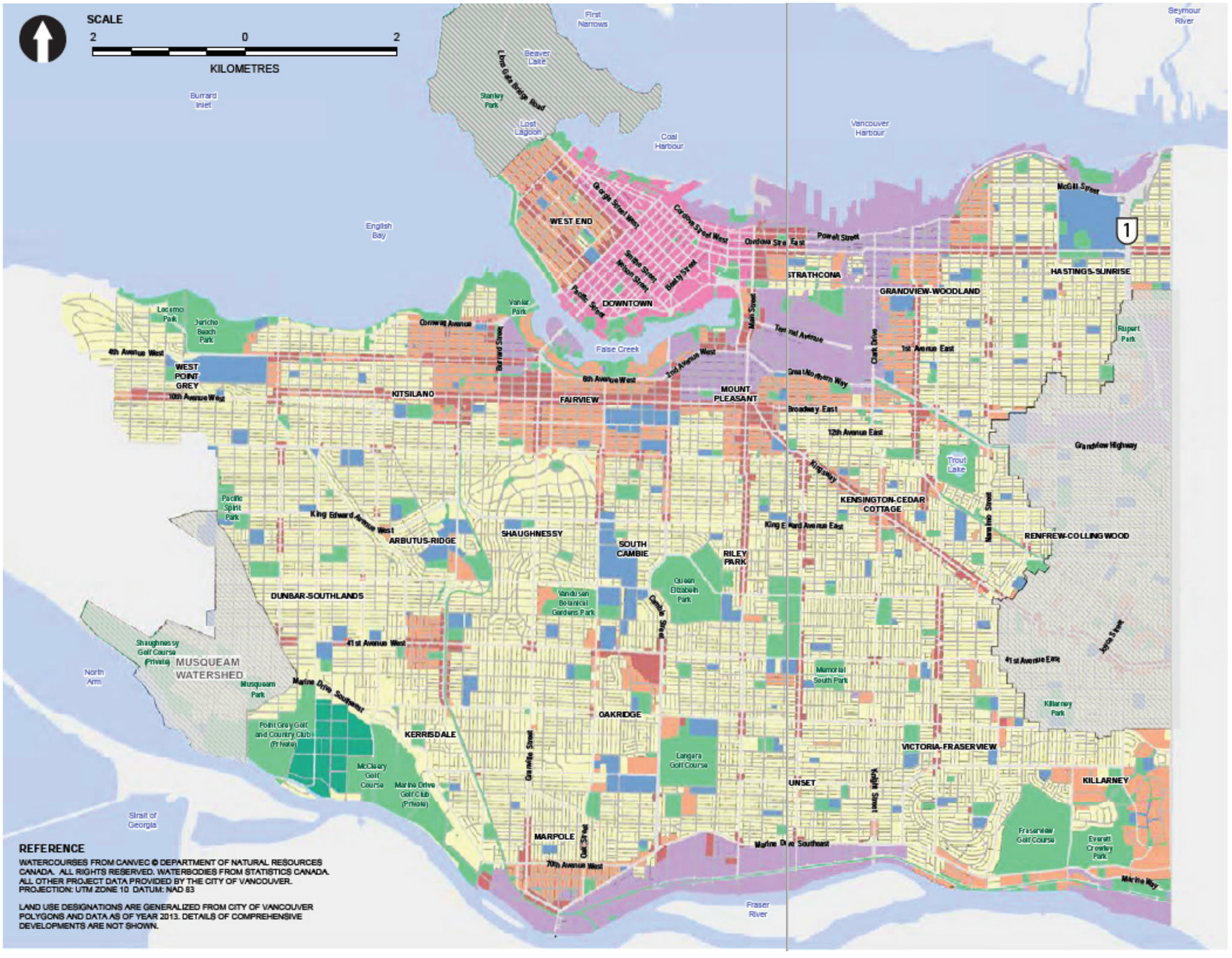
UPV — Till, glaciofluvial, glaciolacustrine, fluvial marine, and organic sediments

TERTIARY

T — Tertiary bedrock including sandstone, siltstone, shale, conglomerate, and minor volcanic rocks; where bedrock is not exposed it is covered by glacial deposits and colluvium

PRE-TERTIARY

PT — Mesozoic bedrock including granitic and associated rock types; where bedrock is not exposed it is covered by glacial deposits and colluvium



Map 2. Vancouver Land Use.

LEGEND

- AREA EXCLUDED FROM STUDY

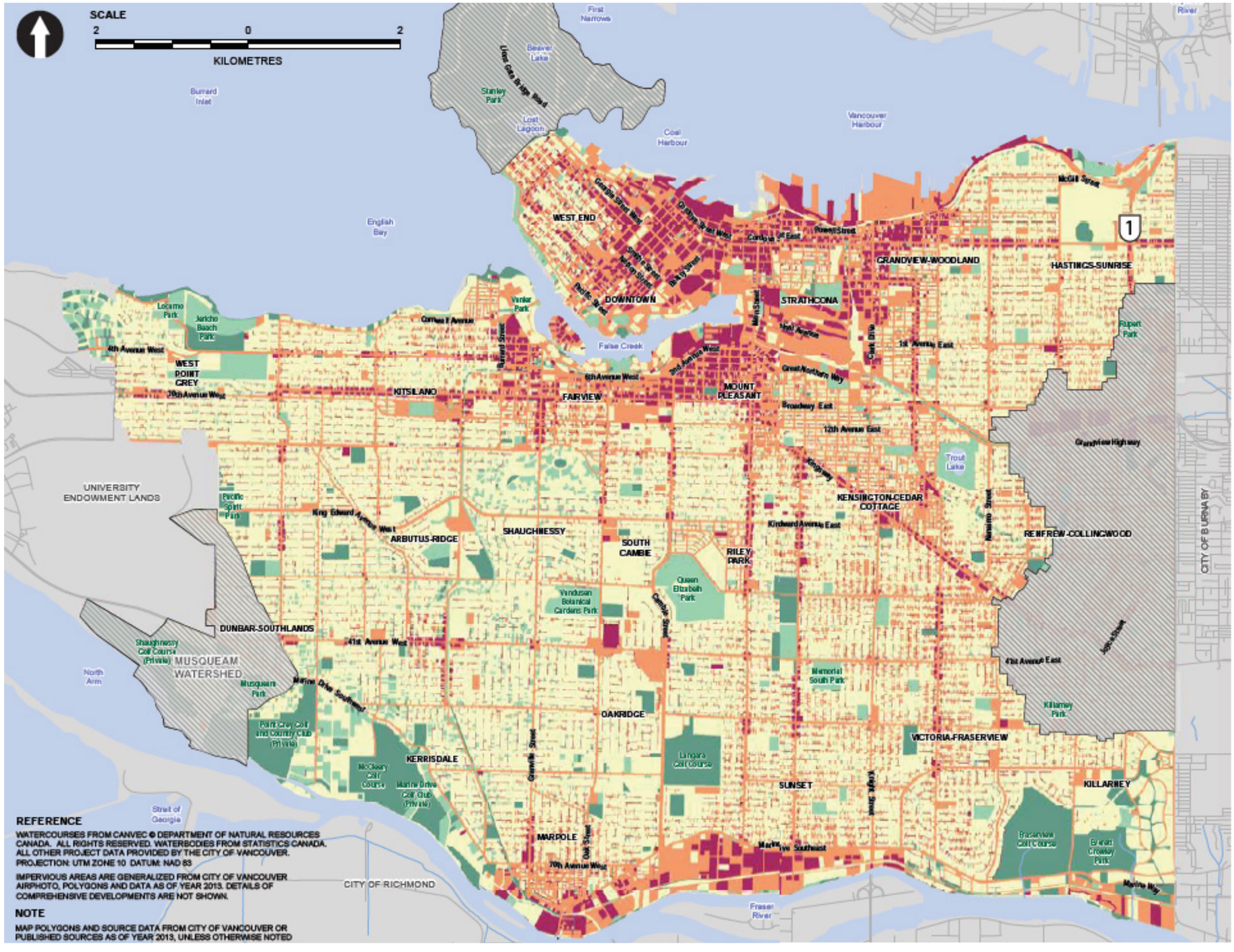
LAND USE TYPOLOGY

- ONE/TWO DWELLING RESIDENTIAL
- MULTIPLE DWELLING RESIDENTIAL
- COMMERCIAL / MIXED USE
- DOWNTOWN MIXED USE
- INDUSTRIAL
- INSTITUTIONAL / AGRICULTURE
- PARK / GREENSPACE
- AGRICULTURE
- ARTERIAL STREET
- LOCAL STREET
- LANEWAY

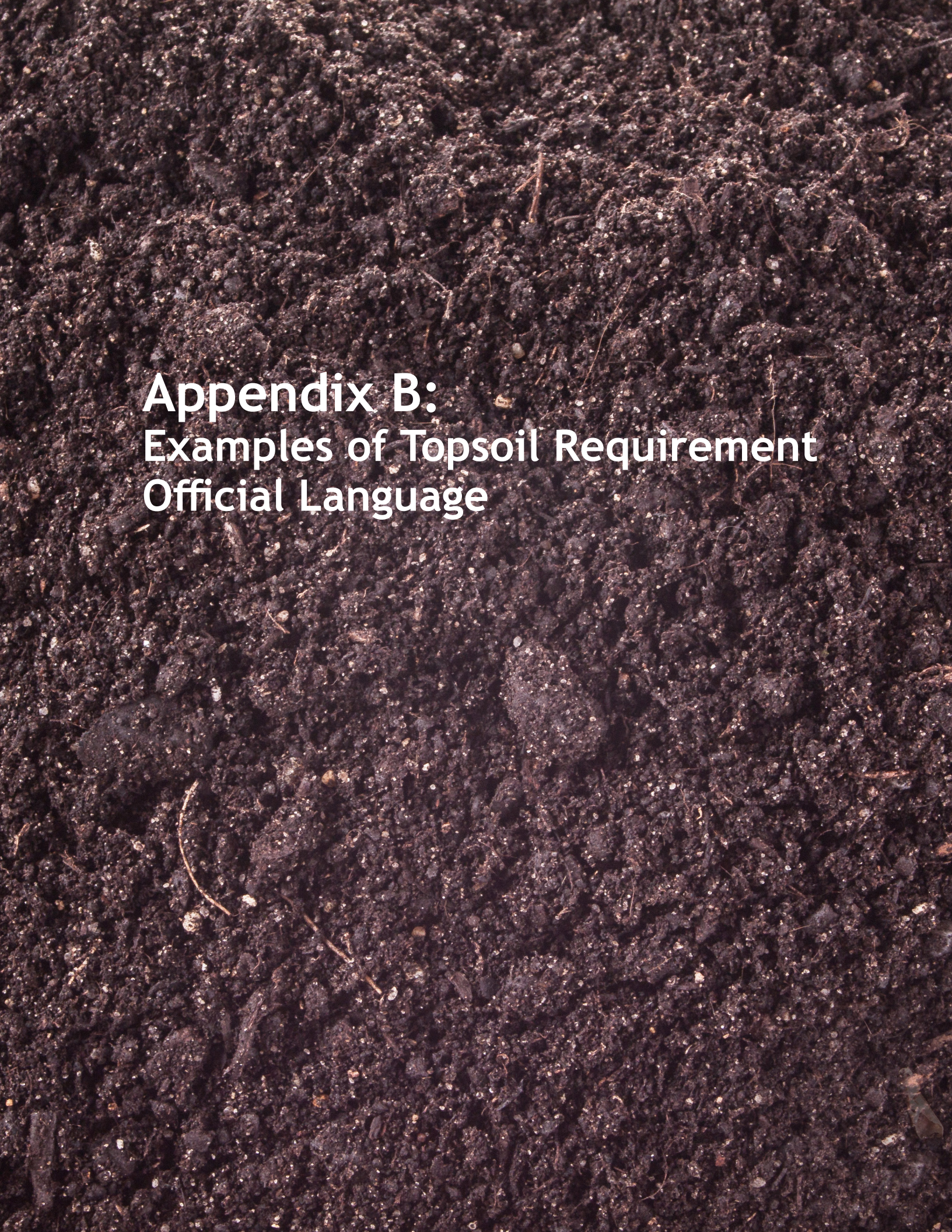
REFERENCE

WATERCOURSES FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. WATERBODIES FROM STATISTICS CANADA. ALL OTHER PROJECT DATA PROVIDED BY THE CITY OF VANCOUVER. PROJECTION: UTM ZONE 10 DATUM: NAD 83

LAND USE DESIGNATIONS ARE GENERALIZED FROM CITY OF VANCOUVER POLYGONS AND DATA AS OF YEAR 2013. DETAILS OF COMPREHENSIVE DEVELOPMENTS ARE NOT SHOWN.



Map 3. Vancouver Impervious Areas.



Appendix B:
Examples of Topsoil Requirement Official Language

City of Surrey

Document: Surrey Stormwater Drainage Regulation and Charges Bylaw No. 16610 (2008).

Topic: Language in the bylaw that gives power to the neighbourhood plans, master drainage plans, and ISMPs to regulate stormwater and topsoil.

Page #: 8-9

Text: PART 5 - ON-SITE STORMWATER MANAGEMENT REQUIREMENTS

9. Newly created parcels shall be constructed with on-site stormwater management facilities when these are prescribed through Council approved neighbourhood plans, master drainage plans, integrated stormwater management plans or as required in a Servicing Agreement or specific service connection.

10. The owner of real property where an on-site stormwater management facility has been installed must ensure that the facility is accessible and is maintained in good condition and functioning as designed at all times.

11. For properties with commercial and industrial uses as detailed in Section 51, proof of maintenance or operation reports for on-site stormwater management facilities shall be submitted to the City for approval prior to the renewal or issuance of a business license.

City of Coquitlam

Document: Rainwater Management - Source Controls: Design Requirements and Guidelines (2009).

Topic: Topsoil requirement language.

Page #: 5

Text: 1.4 Neighbourhood Applicability
For All Developments, absorbent top soil layers shall be a minimum of 300mm deep for all grassed and vegetated areas.

For Single Family Lots, the following measures shall be implemented:

- 300mm absorbent top soils for all pervious areas.
  Grade hard surfaces (sidewalks, driveways, parking pads, patios) towards lawns, planted areas, and rain gardens.
- Connections for rain barrels connected to roof downspouts with soaker hoses to rain gardens and/or lawns are encouraged. The use of permeable materials for paved areas is also encouraged.

City of Port Coquitlam

Document: Official Community Plan (2013).

Topic: Environmental Conservation Deveopment Permit Area (DPA) overview language, water conservation section language, and implementation section language.

Page #: 128-129

Text:

9.11 Environmental Conservation
These areas are designated as DPAs under Sections 919.1(h), (i) and (j) of the *Local Government Act* for the establishment of objectives to promote energy conservation, water conservation, and reduction of greenhouse gas emissions (GHGs).

1. Location and Boundaries

The Environmental Conservation Development Permit Area includes the Downtown, Northside Centre, Intensive Residential, Commercial and Industrial Development Permit Areas and lands within the Institutional Zones P1 and P2.

1. Objectives

The objectives of this DPA designation are:
1) to encourage sustainable development and building design;
2) to make efficient use of energy, water and other resources; and
3) to reduce waste, pollution and environmental degradation.

b. Water Conservation

i. An integrated stormwater management plan shall be provided that will treat and retain storm water and reduce irrigation needs. The following elements shall be considered in the design:

- pervious surface areas and permeable or porous paving materials in on-grade parking areas;
- bio-swales and rain gardens;
- stormwater capture, treatment and storage for landscape irrigation or other purposes;
- retention or restoration of forest, wetland, and other high-value vegetation;
- automated, high-efficiency mechanical irrigation systems;
- sufficient depth of topsoil or composted materials for well-rooted plantings; and
- drought-tolerant and indigenous tree, shrub, and plant species and other xeriscaping techniques.

d. Implementation

i. To facilitate implementation of these guidelines, any development permit issued for properties within this Development Permit Area may, subject to the restrictions of the *Local Government Act*, and unless otherwise specified in the guidelines, vary or supplement any provision of the bylaws regulating zoning, parking, works and services, drainage, signage, screening, landscaping and subdivision.

ii. Minor alterations to an approved development permit which do not change the intent of the guidelines may be permitted without an amendment of the development permit, subject to the approval of the Director of Development Services.

City of Maple Ridge

Document: Watercourse Protection Bylaw No. 6410 (2006).

Topic: Language in the bylaw that gives power to the stormwater management guides, such as the Metro Vancouver Stormwater Source Control Guidelines; and outlines how rainwater management requirements fit into the development process.

Page #: 5-6

Text: 10. The City of Maple Ridge currently requires that subdivision and servicing applicants, building permits, applicants that require environmental DPs, and larger scale Tree or Soils Permit Applicants follow stormwater management practices set out in the following guides:

(a) Current Department of Fisheries (Federal) Urban Stormwater Guidelines and Best Management Practices for Protection of Fish and Fish Habitat;

(b) Current Master Municipal Construction Design Guidelines MMCD. Stormwater management plans may be required to be accompanied with a letter of assurance or calculations from the Engineer of Record that demonstrate compliance with the three tier rainwater management approach where possible, as outlines in the following guidelines:

c) Current Ministry of Water, Land, and Air Protection's Stormwater Planning Guidebook for British Columbia, and

d) Current Greater Vancouver Regional District Stormwater Source Control Design Guidelines.

A brief technical memo that outlines how and where 3 tier stormwater/ rainwater management requirements are being applied on site to deal with volumes, pre-development runoff rates, and water quality improvements must be provided to the City by the Professional Engineer of record. In some cases the City requires a letter of assurance along with calculations that supports the fact that stormwater management plans comply with the Watercourse Bylaw requirements with respect of but not limited to the velocity, volume, and water quality requirements outlined in the Bylaw and DFO Stormwater guidelines.

City of Courtenay

Document: Official Community Plan (2016).

Topic: Development Permit Area (DPA) Water Balance Model Requirement.

Page #: 79

Text: The City of Courtenay shall require an applicant to supply a drainage plan, complete with recommendations for implementation that address water quality, water quantity and erosion control that are satisfactory to the City, where applicable, so as to minimize impacts on fish habitat and to comply with the City's stormwater management policies and plans and the City's Water Balance Model.

It is City policy to limit the peak run off from areas of new development to that which the same catchment areas would have generated under the pre-development land use. A storm water management plan will be required as part of any development and shall be prepared by a Professional Engineer to comply with the City's stormwater management policies and plans and the City's Water Balance Model.

Document: Official Community Plan (2016)

Topic: DPA Topsoil Requirement language in the following DPAs:

- Downtown Development
- Commercial Development
- Shopping Centre
- Industrial
- Multi-residential
- Intensive Residential (this DPA includes the integration of new housing into existing neighbourhoods, but has not been used to date)
- Old Orchard and Area (this DPA regulates the development of the Old Orchard and Area local area and has been utilized)

Page #: 78-128

Text: The City will require the following minimum depth of topsoil or amended organic soils on all landscaped areas of a property. (a) shrubs – 450 mm (b) groundcover & grass – 300 mm (c) trees – 300 mm around and below the root ball.

Document: Intensive Residential Development Permit Checklist and Downtown Development Permit Checklist.

Topic: DPA Compliance Checklist Language.

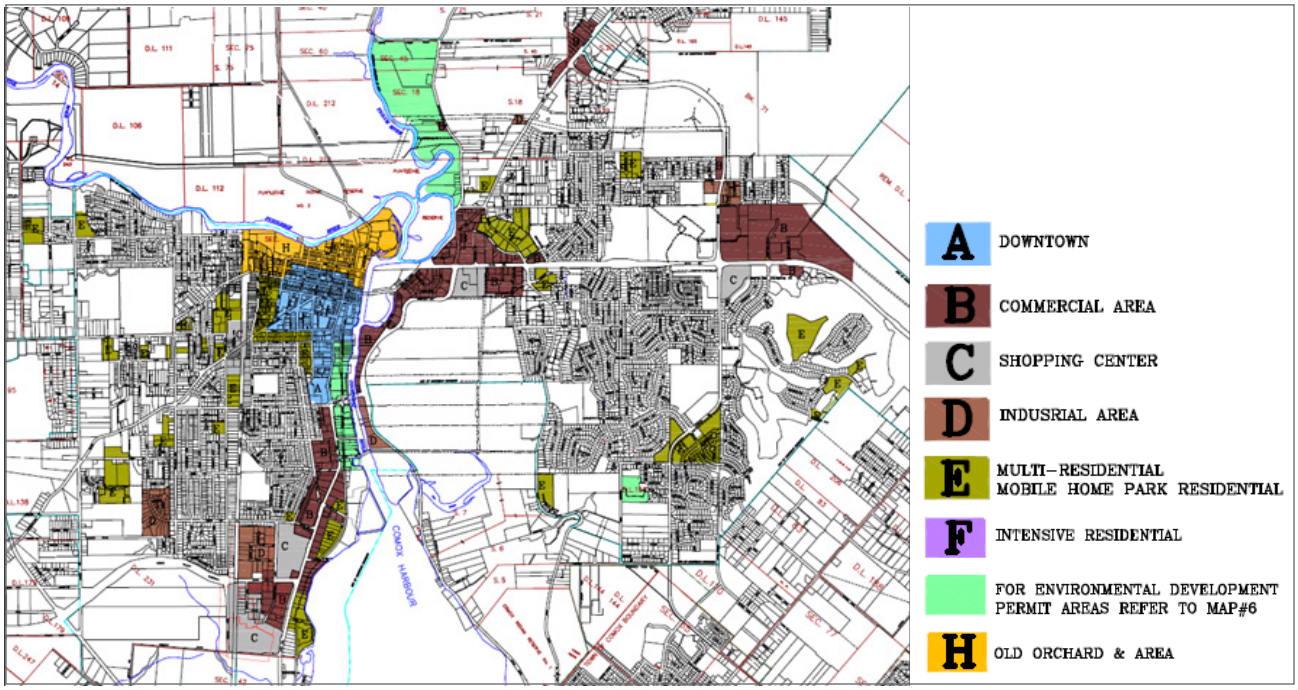
Page #: 2

Text: The City will require the following minimum depth of topsoil or amended organic soils on all landscaped areas of a property:
- shrubs – 450 mm
- groundcover & grass – 300 mm
- trees – 300 mm around and below the root ball

Document: DPA Map.

Topic: The map below portrays the location of the DPAs in Courtenay. Note that the language in the OCP for DPAs states that in addition to these lands any application for multi-family residence, commercial, industrial, and environmentally sensitive areas require the issuance of a DP whether they are included in the map or not.

Page #: 2



District of Metchosin

Document: Rain Water Protection and Management Bylaw No. 467.

Topic: Application and purpose of the bylaw.

Page #: 3

Text: 1.1 APPLICATION

1.1.1 This Bylaw applies to all lands within the District of Metchosin. The Bylaw provides regulations for the use and development of land that minimizes the impact on a watershed by emphasizing the conservation and balance of water in and over the land.

1.1.2 A visual flow chart of the steps required pursuant to this Bylaw is attached as Chart A.1 in Appendix A. Where this Bylaw and Chart A.1 appear to conflict, this Bylaw shall take precedence.

1.2 PURPOSE

1.2.1 The purpose of this Bylaw is to provide for the protection and effective management of rain water and drainage, to maintain and improve water quality in watercourses, water bodies, and Riparian-wetland Areas, and to protect the Proper Functioning Condition of watercourses, water bodies, and Riparian-wetland Areas throughout the District of Metchosin.

1.2.2 The Bylaw intends to achieve and employ the following principles:

(1) Ecosystem Integrity - aims to take a long-term, holistic approach to water management, to conserve and protect it for all its many uses, users and values, so as to ensure the protection of property and habitat.

(2) Sustainability - water resources should not be used beyond their capacity to be naturally replenished, both in quality and quantity.

(3) Stewardship - strives for a commitment between all users of rain water to share responsibility for the resource.

(4) Accountability - promotes the conservation of water as a limited resource, and the accountability of its users to accept that the use of rain water is a privilege and should be treated with care and respect, and with consideration for other users.

(5) Water Quality - water quality should be maintained through planning and proactive source controls to eliminate or reduce pollutants, rather than as a reactive response to environmental damage.

(6) Public Awareness - promotes action through awareness and involvement at all levels of the community.

(7) Property Values - protects and supports the rights of property owners to use and manage their land to the maximum extent coincident with the protection and management of rain water over that land.

Document: Rain Water Protection and Management Bylaw No. 467.

Topic: Absorbent landscaping (and topsoil requirement) language.

Page #: 27

Text: 4.5 ABSORBENT LANDSCAPING

4.5.1 Unless the Qualified Professional indicates to the Clerk that this requirement cannot be met to the District's satisfaction, absorbent landscaping techniques, as set out in Section 6 of Appendix A, will be used on all development sites to mimic natural vegetated areas, so that the landscaping results in no net change in the hydrologic response for all on-site pervious areas.

4.5.2 Where clearing is proposed of areas that supported forest and undergrowth, and these areas are to remain as pervious surfaces (e.g. grassed or landscaped), a minimum depth of absorbent soil shall be provided which meets the BC Landscape Standard for medium or better landscape. The range of acceptable soil textures is provided as follows:

- sand: 55 - 90%
- silt/clay: 5 - 25%
- organic matter: 5 - 20%

4.5.3 The minimum depth of absorbent soil shall be 300 mm under grassed, turfed and other landscaped areas.

City of Kelowna

Document: Consolidated Zoning Bylaw No. 8000 - Section 7 Landscaping and Screening.

Topic: Language for requirement that all landscaping must meet BCLNA standards.

Page #: 7-1

Text: 7.2.1 All landscape areas and installations shall meet or exceed the British Columbia Nursery Trades Association Standards and be regularly maintained.

Document: Water Regulation Bylaw No. 10480.

Topic: Language for requirement for a Landscape Water Conservation Report.

Page #: 15-16

Text: 4.4 Landscape Water Conservation Report and Irrigation Controller Requirements

4.4.1 No Property owner shall install or operate an outdoor landscape irrigation system, in such a manner that the Estimated Landscape Water Use for the outdoor landscape area exceeds the Landscape Water Budget as calculated in accordance with Schedule “C” of this bylaw.

4.4.2 A Property owner must make application to the City to install any new or Renovated Landscape Irrigation System.

4.4.3 Any Property owner who applies to the City to install an outdoor landscape irrigation system shall provide for approval to the Manager a landscape Water Conservation Report, which shall be generally in the form set out in Schedule “C” of this bylaw. The Landscape Water Conservation Report shall include a completed Landscape Water Conservation Checklist of basic landscape and irrigation design and installation standards, and shall set out the calculations for the Estimated Landscape Water Use and the Landscape Water Budget of the proposed outdoor landscape irrigation system in accordance with Schedule “C” of this bylaw.

4.4.4 The Manager may refuse to approve the installation of an outdoor landscape irrigation system if the calculations in the Landscape Water Conservation Report show that the Estimated Landscape Water Use exceeds the Landscape Water Budget, or if the Landscape Water Conservation Checklist is not satisfactory. The Manager may accept a Landscape Water Conservation Report in a form alternate to Schedule C in cases of applications for large scale renovated landscape irrigation systems (such as golf courses and schools), provided that the Report calculates to the satisfaction of the manager a minimum 15% reduction in estimated landscape water use compared to pre-renovation conditions.

City of Vernon

Document: Landscape Standards Bylaw No. 5015.

Topic: Language for the topsoil requirement, xeriscape landscaping, and steps that must be taken during the development process.

Page #: 5-8 (selections)

Text:

5. The owners and occupiers of any and all real property shall utilize a landscape professional for the planning, installation and maintenance of all landscape areas.

6. The owners and occupiers of any and all real property shall install xeriscape landscaping utilizing the following:

a. use of appropriately drought resistant plant materials.

b. use of soils with a composition and nutritional value that act as an appropriate growth media for plant material, and maintain soil moisture.

c. irrigation will be conducted at times of day when evaporation will be limited.

d. landscape areas shall be comprised of a maximum of 30% lawn areas.

e. landscape areas shall be planned to use tree plant materials to create microclimate for the protection of other plant materials.

f. daily water provisions for plant materials are to be provided in a one or two applications in order to ensure water penetrates into the soil to a depth sufficient to create deeper plant materials rooting.

9. The owners and occupiers of any and all real property shall install all landscape areas, with the exception of lawn areas on the property and within the adjacent road boulevard according to the following requirements:

a. minimum width for landscape areas containing plant materials shall be 1.2 meters.

b. minimum width for landscape areas containing plant materials including trees shall be 1.8 meters.

c. all landscape areas are to have suitable excavation of parent soils to ensure proper drainage of landscape areas and to ensure sufficient suitable soil can be provided for all plant materials.

d. all landscape areas are to have an adequate amounts of suitable soil

utilized during the installation of plant materials.

e. all landscape areas are to include drip irrigation, all irrigation is to take place between the hours of 7:00 p.m. and 7:00 a.m. in order to reduce water loss through evaporation into the air.

f. weed barrier and ground cover materials are to be installed for all landscape areas

g. fabric weed barrier is to be of a quality that it will retain its weed inhibiting characteristics for a minimum of 15 years, and is to be over-lapped a minimum of 30 centimeters at all seams.

h. mulch weed barrier is to be of a minimum depth of 15 centimeters.

i. landscape areas with a width greater than 2 meters and/or a length of greater than 10 meters shall utilize a minimum of two different types of ground cover materials.

j. ground cover materials 5 centimeters or smaller shall be separated by edging from areas of other ground cover materials.

k. ground cover materials are to be of a coloration and character complimentary to the coloration and character of the development on the property.

l. landscape areas are to be separated from lawn areas and permeable surface materials with edging.

m. edging is to be of a type and quality that its separating characteristics will be retained for a minimum of 15 years.

n. all landscape areas are to contain plant materials selected according to the Vernon Landscape Standards Materials Selection Guide.

o. all landscape areas are to be maintained according to the Landscape Maintenance Bylaw #5014.

p. all landscape areas are to meet the requirements of the Zoning Bylaw #5000, as amended

10. The owners and occupiers of any and all real property shall install all lawn areas on the property and within the adjacent road boulevard according to the following requirements:

a. shall be a minimum of 1.2 meters in width and a minimum of 3.0 meters in length.

b. shall be sod, lawn areas exceeding 100 square meters in size and having a minimum width of 2.0 meters can be seeded.

c. all lawn areas are to have a minimum of 15 cm of suitable soil graded and rolled prior to installation of plant materials.

d. all lawn areas to have suitable irrigation consisting of sprinkler irrigation, where the adjacent roadway does not have a curb and or sidewalk the sprinkler heads are to be installed a minimum of 0.5 meters from the edge of the road surface. All irrigation is to take place between the hours of 7:00 p.m. and 6:00 a.m. in order to reduce water loss through evaporation into the air.

e. all lawn areas are to be soded with, or seeded with grass species suitable to the local area, and suitable to the micro site of the lawn areas.

f. grass species are to be selected according to the Vernon Landscape Standards Materials Selection Guide.

g. all lawn areas are to be maintained according to the Landscape Maintenance Bylaw #5014.

h. lawn areas shall only be permitted where they serve an active and/or passive recreation use for the public, residents, customers and/or employees.

City of Olympia

Document: Municipal code.

Topic: Topsoil requirement language and drawing from the Engineering Design and Development Standards, adopted by the municipal code.

Page #: n/a

Text:

THE CITY OF OLYMPIA ACCEPTS THE EXECUTION OF THE FOLLOWING PROCEDURES TO MEET THE REQUIREMENTS OF STORMWATER MANUAL BMP T5.13.

PREPARATION METHOD

1. TILL THE SUB GRADE SOIL TO AN 8–INCH DEPTH; THOSE AREAS SUBJECTED TO VEHICLE TRAFFIC SHALL BE TILLED TO A DEPTH OF 12 INCHES. DO NOT SCARIFY OR TILL WITHIN THE DRIP LINE OF EXISTING TREES THAT WILL BE RETAINED.
2. PLACE 3 INCHES OF COMPOST MATERIAL AND TILL INTO 5 INCHES OF SOIL (A TOTAL AMENDED DEPTH OF ABOUT 9.5 INCHES, FOR A SETTLED DEPTH OF 8 INCHES).
3. RAKE THE AREA SMOOTH AND REMOVE SURFACE ROCKS LARGER THAN 1 INCH IN DIAMETER.
4. PLACE 2 INCHES OF AA COMPOST AND RAKE.
5. IN WELLHEAD PROTECTION AREAS, COMPOST USED WITHIN THE SITE SHALL BE COMPRISED ENTIRELY OF VEGETABLE MATTER (NO MANURE OR BIOSOLIDS).

COMPOST AMENDMENT QUALITY STANDARDS

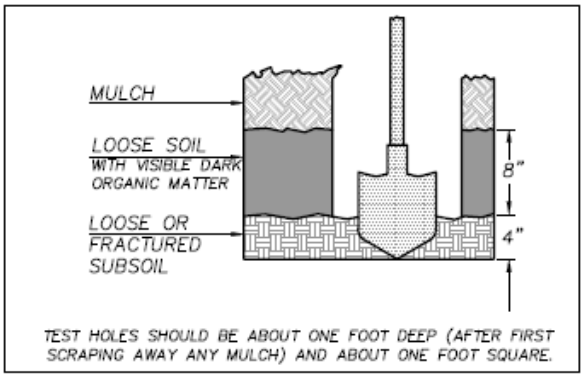
1. THE ORGANIC CONTENT FOR "PRE–APPROVED" AMENDMENT RATES CAN BE MET ONLY BY USING COMPOST THAT MEETS THE DEFINITION FOR "COMPOSTED MATERIALS" IN WAC 173–350–220, AVAILABLE ONLINE AT http://www.ecy.wa.gov/programs/swfa/organics/soil.html
2. THE COMPOST MUST ALSO HAVE AN ORGANIC MATTER CONTENT OF 35 TO 65 PERCENT, CARBON TO NITROGEN RATIO BELOW 25:1.
3. THE CARBON TO NITROGEN RATIO MAY BE AS HIGH AS 35:1 FOR PLANTINGS COMPOSED ENTIRELY OF PLANTS NATIVE TO THE PUGET SOUND LOWLANDS REGION.

FOR SINGLE FAMILY RESIDENTIAL LOTS: PREPARATION FOR INSPECTION

- PROVIDE SIX HOLES PER SITE; TWO FOR THE FRONT YARD, ONE EACH FOR SIDE YARDS, AND TWO FOR THE BACKYARD. ALL HOLES SHALL BE EVENLY PLACED THROUGHOUT THE PROPERTY TO DEMONSTRATE AUGMENTATION HAS BEEN COMPLETED.
- TEST HOLES SHALL BE A MINIMUM OF 1 FOOT DEEP AND 1 FOOT SQUARE.
- PERMITTEE SHALL PROVIDE DOCUMENTS FOR THE AA COMPOST VOLUME DELIVERED TO THE SITE TO CONFIRM COMPOST ORIGIN AND QUALITY.

INSPECTION VERIFICATION

- 2 INCHES OF ORGANIC MULCH MATERIAL ON ALL DISTURBED SURFACES.
- LOOSE SOIL FOR 8 INCHES WITH VISIBLE DARK ORGANIC MATTER.
- LOOSE FRACTURED SUB SOILS SHOULD NOT BE EASY TO PENETRATE WITH A SHOVEL 4 INCHES BELOW THE 8 INCHES. TOTAL DEPTH OF AUGMENTED AND LOOSENED SOIL SHALL BE 12 INCHES.



TEST HOLES SHOULD BE ABOUT ONE FOOT DEEP (AFTER FIRST SCRAPING AWAY ANY MULCH) AND ABOUT ONE FOOT SQUARE.

APPROVED BY	REVISED DATE	CITY OF OLYMPIA	STD. DWG. NO.
FRAN R. EIDE, PE CITY ENGINEER	9/1/2015	POST–CONSTRUCTION SOIL QUALITY AND DEPTH	5–11