City of White Rock
Integrated Stormwater Management Plan

FINAL

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URBANSYSTEMS®

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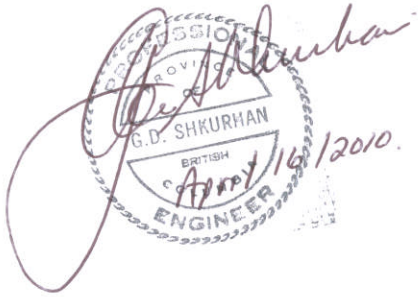

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- Friends of Semiahmoo Bay
- Ministry of Environment
- Department of Fisheries and Oceans
- City of White Rock Environment Committee
- EPCOR Utilities Inc.
- The City of Surrey

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List of Acronyms

BBAMP	Boundary Bay Ambient Monitoring Program
BMP	Best management practice
BNSF	Burlington Northern Rail of Santa Fe
BOD	Biological oxygen demand
Cu	Copper
DCC	Development cost charge
DPA	Development permit area
EIA	Effective impervious area
EPCOR	EPCOR Utilities Inc.
GVRD	Greater Vancouver Regional District
ISMP	Integrated stormwater management plan
NPS	Non-point source
O&M	Operation and maintenance
OCP	Official community plan
PAH	Poly-aromatic hydrocarbon
TDS	Total dissolved solids
TIA	Total impervious area
TSS	Total suspended solids
Zn	Zinc

EXECUTIVE SUMMARY

Integrated Stormwater Management Plans

In 2001, White Rock agreed to complete an Integrated Stormwater Management Plan (ISMP) by 2014 as part of its commitment under Metro Vancouver's Liquid Waste Management Plan. This ISMP has been completed to fulfill Metro Vancouver's requirements and follows the Greater Vancouver Regional District (GVRD, now Metro Vancouver) ISMP Terms of Reference Template as appropriate.

An ISMP is a plan that brings together **engineering**, **planning** and **environmental** perspectives to create a long-term strategy for effectively managing stormwater. Over the past forty years, approaches to managing stormwater in urban and urbanizing communities have undergone a significant evolution. To better address impacts of urban development on streams, soils and local environments, communities are now adopting approaches that go beyond basic engineering perspectives on flood control. Concerns for fish habitat and water quality are now at the fore, and stormwater runoff is becoming thought of as a resource to manage and protect rather than a nuisance to avoid or correct. ISMPs reflect this new way of thinking.

Since the major storm in 1999, the City has focused most of its attention towards understanding its infrastructure and implementing a strategy to minimize future flood risks. While these efforts have successfully dealt with flooding and erosion, they do not address water quality and related environmental issues that are gaining greater awareness today. Finding effective and efficient ways of protecting the environment as well as the City's drinking water source requires a comprehensive approach, which is addressed by this ISMP.

Vision and Objectives

The vision communicates what the City and its residents feel is most important, and has guided all aspects of plan development. The draft vision was developed in consultation with City Staff and with reference to White Rock's Official Community Plan, which provides policy direction on the environment, infrastructure, financing, and development, all of which are relevant to stormwater management. Successful implementation of this ISMP will help White Rock achieve its community vision articulated in the Official Community Plan (OCP). To help the City realize its vision, objectives for this ISMP have also been identified.

VISION

The City of White Rock's approach to redevelopment and infrastructure management has created a secure, healthy, and livable community for generations to come. Environmental habitats are preserved through effective land use planning and development policies, infrastructure management, and environmental stewardship initiatives. Water is of high quality through the application of effective source protection and treatment. The City successfully manages flood risk through a proactive asset management and infrastructure renewal program. The City's approach establishes White Rock as a provincial leader in sustainable development and infrastructure management. The City's pristine beach and beautiful urban setting continue to create high demand for both residents and visitors.

OBJECTIVES

- *To ensure adequate and stable funding for stormwater management initiatives.*
- *To establish a proactive implementation strategy and associated tools.*
- *To proactively manage drainage infrastructure over time, in order to maintain desired levels of service.*
- *To improve the quality of runoff discharging into local watercourses and Semiahmoo Bay such that it does not compromise the long term health of the local ecosystem or pose a risk to public health.*
- *To preserve and/or enhance remaining biological functions.*
- *To reduce flood risks.*

Key Stormwater Issues in White Rock

Through a comprehensive review of background information (including previous studies) and consultation with City Staff, it became apparent that certain stormwater issues are more significant than others in White Rock. This ISMP focuses on addressing those issues that are most significant.

Given that runoff discharges directly into Semiahmoo Bay and the City is nearly built-out, water quality is the most significant stormwater-related issue in White Rock. The number of potential substances, organic and inorganic, that can be, and are often found in urban runoff may be surprising to many. In essence, just about anything that finds its way onto urban surfaces, particularly impervious surfaces such as roads, parking lots and buildings, can be washed off those surfaces by rain and snowmelt and can be carried into receiving water bodies as non-point source (NPS) pollution.

Many of these pollutants can be acutely toxic at higher concentrations, although in general such toxicity is not normally associated with "typical" urban runoff. Rather, the accumulated effect of pollutant wash off over time can yield unacceptable chronic toxicity or bioaccumulation in aquatic life. In the absence of contrary evidence, it should be assumed that pollutants such as fecal coliforms, metals, and oil and grease, are present in White Rock's runoff.

Using a NPS (non point source) pollutant loading model, the generation and wash off of five key pollutants from the City into Semiahmoo Bay was estimated. The pollutants simulated in the model are:

- total suspended and dissolved solids (TSS and TDS)
- bacteria (fecal coliforms)
- total and dissolved copper
- total and dissolved zinc

These pollutants, which are highly correlated with the type of urban development in White Rock, are considered to be the most relevant to the health of the aquifer and Semiahmoo Bay.

The recommendations have been developed primarily to address stormwater quality, and intend to build on basic infrastructure needs identified through earlier study. Flooding and conveyance issues were not a key focus of this ISMP, as these issues are already addressed through the City's current drainage capital plan. Since there are no fish bearing streams in White Rock, environmental enhancement of the City's three remnant streams was not a focus of this ISMP either.

Key Considerations

To assist with developing an ISMP's strategy that is feasible and practical, the following key considerations were taken into account:

- The City is nearly at build-out

- Redevelopment of the City will be a slow and low term process
- There is a limited availability of public land
- The City is reliant on groundwater for drinking water
- The City is currently updating a number of bylaws

Recommendations

The following table offers a set of recommendations for the City's consideration. This list represents a long term strategy to achieve the staged vision, not only short term commitments.

The recommendations in this ISMP reintroduce basic infrastructure needs identified through past study, then expand on improving the quality of stormwater that discharges into Semiahmoo Bay and on protecting the City's drinking water aquifer. These recommendations are first about keeping "clean water clean," by reducing the amount of rainwater flowing over impervious surfaces and collecting pollutants. Second, these recommendations are about treating stormwater before it enters Semiahmoo Bay. Beyond physical works, the recommendations address implementation issues such as cost, regulations, and education.

Recommendations have been grouped into the following five categories:

- Environmental Protection and Enhancement
- Municipal Infrastructure
- Planning and Analysis
- Policy and Regulation
- Public Education and Outreach

Retrofitting an established and extensive community to combat water quality is a costly endeavour. These costs must be considered and balanced with many other priorities of the City. The actions and costs described herein represent a long term, ultimate state. Realistically, it is expected to take decades to fully achieve it. However, the start point is to identify the long term actions that can be supported to reach the vision. The next step is to develop a practical implementation schedule to achieve it. Consideration for the City's storm sewer capital program and road reconstruction program are both very influential in preparing a comprehensive implementation and financial strategy. It is therefore recommended that consideration for a holistic asset management program be given.

Table E.1: Recommendations

Recommendations	Estimated Costs
Municipal Infrastructure	
Implement drainage capital program	$20 Million over 20 years
Complete condition assessment	Current City initiative
Install low impact biofiltration systems (on select streets and public parking lots). Generally long term initiatives linked with paving and road reconstruction programs.	$6.2 million for initial capital costs and $478,000 annually for O&M
Install enhanced stormwater treatment systems (for 7 catchments). Generally intended to be a shorter term program to address highest risk areas of the City.	$6.8 million for initial capital costs and $372,000 annually for O&M
Require low impact BMPs (on-lot). Long term initiative as redevelopment occurs.	Developer funded (Typically in order of $5,000 - $10,000 per lot depending on size and complexity of the lot)
Develop agreements with land owners south of Marine Drive for access to drainage infrastructure	In house costs
Environmental Protection and Enhancement	
Develop urban tree planting program	$25,000-$35,000
Complete shoreline restoration (at West Beach boat ramp to pier; and near the rock)	Review with local stewardship groups
Improve fish access to Coldicutt Creek	Review with local stewardship groups
Planning and Analysis	
City to liaise with EPCOR re: mapping aquifer vulnerability	In house costs
Track watershed health indicators	In house costs to participate in the BBAMP, plus $10,000 every 5 years for reassessing tree canopy and impervious area indicators
Policy and Regulations	
Establish a Development Permit Area to include: landscaping guidelines; a requirement to meet the stormwater management standards in the Subdivision Bylaw; and a requirement for minimum building elevations.	$15,000
Update Zoning Bylaw to limit impervious area	In house costs
Update Drainage Utility User Fee Bylaw to incorporate relevant costs identified in this ISMP and to provide incentives for improved	$50,000

Recommendations	Estimated Costs
Stormwater Management Practices	
Update the Development Cost Charges Bylaw to incorporate relevant costs identified in this ISMP	$60,000
Additions to the Subdivision Bylaw to establish standards and requirements for stormwater management, particularly for the use of various roadway and on-lot BMPs, as well as landscape standards,	$20,000
Revise the Tree Management Bylaw to expand the definition of "protected tree" to include a wider range of species	In house costs
Develop future neighbourhood plans to be consistent with this ISMP	In house costs
Adopt an erosion and sediment control bylaw to establish specific requirements for controlling sediment during construction	$50,000
Public Education and Outreach	
Establish a recognition award for local innovation in stormwater management and environmental protection (potentially for residents, business owners or developers)	At the City's discretion
Develop and implement a public education program regarding environmental protection, the City's vision and action plan, and how its residents and development community can contribute.	$30,000 - $50,000 for initial development

*All costs are high level estimates and will need to be reconsidered through the development of detailed work programs prior to setting annual budgets.

1 INTRODUCTION

1.1 Plan Organization

This Integrated Stormwater Management Plan (ISMP) is organized into six sections. Section 1 includes an overview of stormwater management and the ISMP process. Section 2 includes the community's vision for the watershed. Section 3 identifies key focus areas for this ISMP and Section 4 discusses opportunities and constraints. Section 5 provides recommendations that will help the City achieve its vision, and Section 6 contains a more detailed implementation plan with priorities.

This ISMP also includes several appendices that contain technical information that supports the recommendations. References to relevant appendices are made throughout.

1.2 Stormwater Management – An Evolution

Over the past forty years, approaches to managing stormwater in urban and urbanizing communities have undergone a significant evolution. To better address impacts of urban development on streams, soils and local environments, communities are now adopting approaches that go beyond basic engineering perspectives on flood control. Concerns for fish habitat and water quality are now at the fore, and stormwater runoff is becoming thought of as a resource to manage and protect rather than a nuisance to avoid or correct.

Communities are beginning to see the value of eliminating causes of stormwater problems, rather than dealing only with the consequences of land use decisions. ISMPs reflect this proactive approach by bringing land use, environmental, and engineering perspectives together in a comprehensive plan.

The Province has issued guidelines, described in the document "Stormwater Planning: A Guidebook for British Columbia," that promote the development of ISMPs. The Guidebook encourages municipalities to view stormwater as a resource and to apply scientifically defensible analysis in the formulation of stormwater management strategies. These Provincial guidelines recommend stormwater management approaches that mimic the natural water cycle and take better account of receiving watercourses, and discourage the use of older approaches that rely primarily on moving runoff away from properties as quickly as possible.

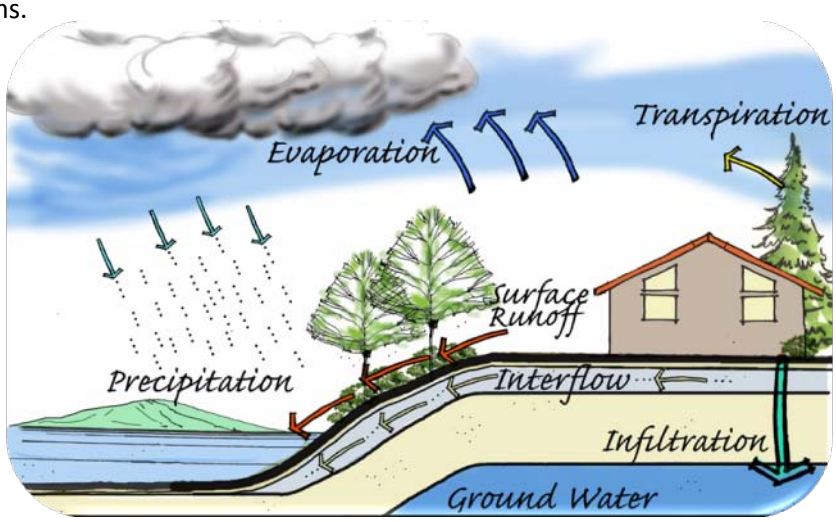
Integrated Stormwater Management Plans

An Integrated Stormwater Management Plan (ISMP) is a plan that brings together **engineering**, **planning** and **environmental** perspectives to create a long-term strategy for effectively managing stormwater.

What Happens to Rainwater?

Water moves through a continuous, closed cycle, above and below the surface of the Earth. We must responsibly manage the water we use today, as it will be the same resource we draw from in the future. Under natural conditions (i.e., no development), soil and plants absorb rainwater, filter out impurities and replenish groundwater or feed streams.

During development, buildings, roads and other "impervious surfaces" replace soils and vegetation. This causes the volume and rate of runoff, as well as the level of contaminants in the runoff, to increase. When it rains, runoff quickly flows over impervious surfaces and enters the City's storm drains, most of which empty into Semiahmoo Bay.



1.3 An ISMP for White Rock

One might first ask why the City should proceed with stormwater management planning at this time. First, there are compelling reasons to do so from external authorities. Under the Federal Fisheries Act, the City is responsible for ensuring that no "deleterious substances" are discharged into fish habitat. Trace metals, petroleum hydrocarbons, sediment, pesticides and herbicides and other polluting substances that are routinely found in urban runoff should be considered deleterious substances. White Rock has also made a commitment as a member of Metro Vancouver to complete an ISMP. In 2001, Metro Vancouver member municipalities agreed to complete ISMPs by 2014 as part of their commitment under the Liquid Waste Management Plan.

However, the most important reasons for completing an ISMP are internal. Since the major storm in 1999, the City has directed most of its attention towards understanding its infrastructure and implementing a strategy to minimize future flood risks. While these efforts are successfully dealing with flooding and ravine erosion, they do not address water quality and related environmental issues that are gaining greater awareness today. Finding effective and efficient ways of protecting the environment as well as the City's drinking water source requires a comprehensive approach, which this ISMP provides.

This ISMP has been developed to meet the Greater Vancouver Regional District (GVRD, Metro Vancouver) ISMP Terms of Reference Template, but in a way that is tailored to the City's unique characteristics and needs. The scope and magnitude of the GVRD Template is extensive if applied in its entirety. Throughout the development of this ISMP, each component of the GVRD template has been considered to identify how best to apply the template and determine the depth of study required.

The ISMP identifies specific strategies to protect and restore the natural watershed; to reduce the threat of flooding and erosion; and to guide sustainable community development. This ISMP is one of several important initiatives the City is undertaking to improve the community's sustainability

1.4 The ISMP Process

This ISMP has been developed in four stages as outlined in the graphic below. To date, the public has been involved in this ISMP through one open house, which was held in October 2009. In addition to the first open house, a survey was posted on the City's website to obtain feedback from residents. Consultation also took place with the City's Environment Committee and with City of Surrey staff. The Draft Report was reviewed by the City's Mayor and Council, Infrastructure and Transportation Committee, Environmental Committee, City staff, the City of Surrey, MOE and DFO; comments received have been incorporated herein.

Appendix A includes further details on the public open house and the online survey.

Stage 1 What Do We Have?

Stage 1 involved collecting data on rainfall, water quality, infrastructure, etc., to complete the analysis.

Stage 2 What Do We Want?

Stage 2 involved identifying a vision for the watershed and assessing strategies to realize that vision. As part of the consultation process, the City called on residents to help identify stormwater related objectives for their community.

Stage 3 How Do We Put It Into Action?

Once clear direction had been set in Stage 2, the next stage was to develop recommendations and an implementation plan. The implementation plan will include action items related to: drainage infrastructure, environmental enhancement, policy and regulations, education, land use, and monitoring as well as finance.

Stage 4 How Do We Stay On Target?

Implementing an ISMP is an ongoing process. To make sure the City stays on track, key performance targets, a monitoring program, an assessment plan and an adaptive management process were developed in Stage 4.

2 VISION AND OBJECTIVES

The vision communicates what the City and its residents feel is most important, and has guided all aspects of plan development. The vision was developed in consultation with City Staff and with reference to White Rock's Official Community Plan, which provides policy direction on the environment, infrastructure, financing, and development, all of which are relevant to stormwater management. Successful implementation of this ISMP will help White Rock achieve its community vision articulated in the OCP. To help the City realize its vision, objectives for this ISMP have also been identified.

VISION

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3 KEY ISSUES

The GVRD Template provides an exhaustive list of items that could be addressed in an ISMP. As is the case for many communities, giving the same weight to all sections of the GVRD Template would not be practical or useful. Through a comprehensive review of background information (including previous studies) and consultation with Staff and the public, it became apparent that certain issues are more significant in White Rock than others. This ISMP focuses on addressing those most significant issues.

3.1 Environmental Issues

As a precursor to this ISMP, a preliminary screening of biophysical and water quality issues was completed [1]. This study identified vegetated areas for preservation, provided preliminary recommendations regarding opportunities for environmental rehabilitation, and identified fecal coliform contamination of Semiahmoo Bay as a key issue to be addressed through the ISMP.

Previous studies provide sufficient information to characterize environmental conditions in White Rock for this ISMP (see Appendix B for a list of studies reviewed). The review of habitat information for White Rock confirms that the main concerns about effects of stormwater are in regards to Semiahmoo Bay, which receives the bulk of the stormwater directly (most of the 23 stormwater outfalls in White Rock drain directly into the Bay). Water quality, rather than habitat, is therefore of greatest interest.

As indicated in Figure 1, there are few remaining streams (Anderson Creek, Duprez Creek and Coldicutt Creek) in White Rock, none of which contain fish. As a result, the ISMP approach used by other Metro Vancouver jurisdictions, which focuses on managing the impact of stormwater on streams and fish habitat, is not as applicable at this time in White Rock. Rather, the primary receiving environment of concern is Semiahmoo Bay, which provides important habitat for birds, salmon, crabs, shellfish and many other species, and also provides recreational and economic benefits to the community. Notably, shellfish harvesting in Semiahmoo Bay has been closed since 1972 due to fecal coliform contamination, to which there are many contributors, including sanitary sewer cross connections, septic fields and pet and wildlife wastes, which may originate beyond the boundaries of White Rock. To address the water quality issues in Semiahmoo Bay, the City is participating in the Boundary Bay Ambient Monitoring Program (BBAMP) to develop a baseline measure of ambient water quality, sediment quality, and biota (flora and fauna) in the Bay.

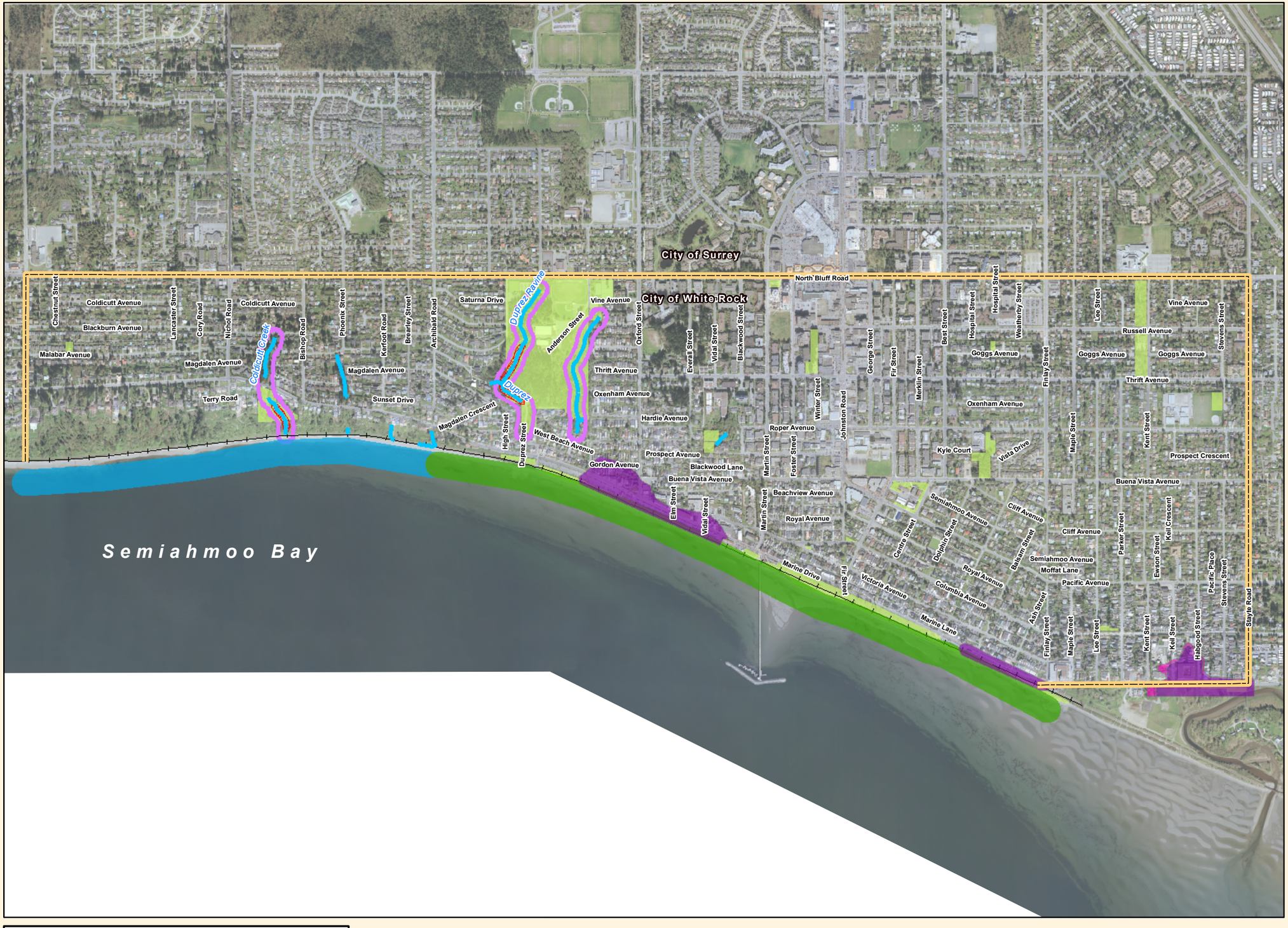
In terms of terrestrial habitat values, White Rock has a mixture of residential, urban, commercial and municipal park land. The larger Coldicutt and Centennial parks provide fragmented, but natural forest habitat for wildlife; however, no specific

[1] *Integrated Stormwater Management Plan – A Biophysical/Water Quality Overview,* Jacques Whitford and Urban Systems Ltd., 2008.

areas of habitat for species of conservation concern have been identified in White Rock.

While the City does not have significant terrestrial habitat values, its trees are still an important environmental asset. Tree canopy is considered to be an important environmental asset for many reasons, including the fact that it helps manage rainwater naturally, through interception of rain by the tree canopy and rainwater uptake through the root system.

Appendix B provides further information on the environmental review.



CITY OF WHITE ROCK

Legend

- Stream
- Railway
- White Rock Boundary
- Parks
- Potential Fish Habitat
- Areas of Protection / Potential Restoration
- Approximate Ocean Floodplain - 3.90m Contour Level
- Approximate Campbell River Floodplain - 4.60m Contour Level
- Conservation
  Areas of habitat where primary use is the maintenance and enhancement of continued biological productivity. Conservation areas may be used for activities which do not impair the continued biological productivity of the area.
- Recreation / Park
  Areas designated for public open space and recreation.

Integrated Stormwater Management Plan

Biophysical Assessment Freshwater Fish Habitat

Figure 1

0 250 500 1,000
Meters

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3.2 Hydrogeology and Aquifer Protection Issues

Because White Rock receives its drinking water from an aquifer underlying the City, protection of groundwater quality is a high priority. To better understand the possible linkages between surface water and groundwater, a desktop hydrogeological assessment of White Rock was completed as part of this ISMP. Appendix C includes the full hydrogeological report, which describes soil types, hydraulic conductivity, groundwater occurrence, groundwater recharge and characteristics of the Sunnyside Uplands Aquifer underlying the City, and discusses considerations for infiltration of stormwater as a management strategy.

In general, near surface soils within the City limits have a reasonable capacity for infiltration of rain, and can justify and support the application of infiltration based management techniques, however available information suggests variations in the near surface infiltration potential.

Well logs provided by EPCOR provide clear evidence of a thick clay layer that separates the deep aquifer from upper groundwater, which protects the deep groundwater from surface influences. This thick clay layer, however, does not appear to overlie the entire aquifer. Available information suggests potential vulnerability in the lower elevations below the confining layer. In the upper elevations, the confining clay layer did not appear in the log for the production well located in the vicinity of the hospital, however the risk may be somewhat mitigated by the deep position of the aquifer.

Available information is limited to the central zone of the City and does not provide ample understanding for the east and west limits of the City. Because the clay layer could not be readily identified in all the well records, the lateral extent of the protective clay layer is not understood fully, nor can it be within the scope of this ISMP.

Although the Ministry of Environment considers the underlying aquifer to have low vulnerability to adverse influences, additional study (i.e., borings and monitoring well installations) would be needed to confirm the lateral and vertical distribution of confining units (e.g., blue clay) in areas away from the vicinity of the existing production wells.

Responsibility for the health of the aquifer is shared between EPCOR and the City. As the water purveyor, EPCOR is directly responsible for assessing and monitoring the drinking water source and systems. While not directly responsible for drinking water, the City is responsible for considering aquifer health as part of land use, development and infrastructure decisions.

3.3 Infrastructure Issues

Stemming from the flood of 1999, the City has invested considerable effort into developing a capital program to address capacity and hydraulic performance issues with the City's drainage system. The "Comprehensive Drainage Assessment Study" (Urban Systems Ltd., 2000, 2004) identified performance criteria and a related infrastructure program to ensure the system meets those established criteria. This plan is expected to be updated from time to time as works are completed and new information becomes available. However,

based on feedback received from the City during the consultation process for this ISMP, there is no need to depart from these previously defined strategies at this time. Therefore, this ISMP makes no further recommendations regarding the City's stormwater conveyance system. Future updates to the program will occur following the completion of the storm sewer condition assessment study (currently underway) and the adoption of this ISMP.

While this ISMP does not specifically re-evaluate the performance of the City's existing drainage system from a capacity and hydraulic performance perspective, it is worth noting the following infrastructure issues:

- **Flooding along Marine Drive and required pump station upgrades**

The Official Community Plan (OCP) identifies three floodplain zones along Marine Drive that are more vulnerable to flood risks than other areas of the City. Flood risk at these specific locations is governed somewhat by infrastructure capacity, but largely by ocean levels and storm surges. Studies on climate change suggest that ocean levels within Semiahmoo Bay will rise over time[2], and although changes in ocean level have not yet been quantified in any great detail, it is expected that flood risks will increase in these three floodplain zones. While it is premature to quantify the change in risk or recommend specific actions within the scope of this ISMP, it is recognized that the identified flood zones will continue to have unique flood risks compared to other parts of the City. All reconstruction / redevelopment in these zones should be completed with appropriate recognition of these potential risks.

Two of the floodplain zones are reliant on drainage pump stations, both of which are aging stations with limited capacity. There are no records to indicate what standard these stations were designed to, but recent capacity assessments indicate that capacity lies below the City's current 1:10 year minor criteria[3]. The City has undertaken further investigation into the capacity and upgrade strategy of the Habgood storm pump station separate from this ISMP[4].

- **Flooding risk to subsurface floor space**

The City's drainage system was not intended to provide flood protection to buildings with habitable space below grade (i.e., basements), yet the demand for subsurface dwelling space has increased over the years. Regardless of whether foundation sump pumps are used or not, there are inherent challenges and risk associated with floor space being located below the 100 year hydraulic grade line. The storm sewer capital program will result in progressively lower hydraulic grade lines over time; however, in most areas of the City today, the 100 year hydraulic grade may well surcharge and even reach ground surface. As such, floor elevations of new construction should be set above the 100 year hydraulic grade line (as predicted to

[2] *Technical Memorandum – Crescent Beach Functional Plan Evaluation of Tidal Levels*, Golder Associates Ltd., 2008.

[3] *Comprehensive Drainage Assessment Study*, Urban Systems Ltd, 2000 and 2004.

[4] *Habgood Street Storm Pump Station Replacement - Final*, Urban Systems Ltd, 2006.

occur at the time the development application is made).

- **Rights-of-way for drainage infrastructure**

There are a few locations within the City where communal drainages enter private property over which the City does not have a right-of-way. The current storm sewer capital program addresses some of these through the planned installation of sewer diversions; however, of more significance are lands south of Marine Drive.

The City will continue to need drainage routes for the discharge of stormwater into Semiahmoo Bay. Under the current land ownership structure, renewal and sustainable management of the City's systems depends on agreements with land owners south of Marine Drive, most significantly with Burlington Northern Rail of Santa Fe (BNSF). At this time, the City does not have a blanket works agreement for the renewal and installation of works on BNSF lands. As such, a challenging approval process is required each and every time works are required. Pursuit of a blanket works agreement between the City and BNSF to streamline the approvals process for operation, maintenance and renewal initiatives would be advantageous for both parties.

- **Infrastructure renewal**

The City recognizes that it must plan for the eventual replacement of its aging drainage infrastructure. As mentioned earlier, as a first step towards addressing this issue, the City is currently completing a condition assessment of its storm sewers. This assessment will provide detailed information about the system's current condition and will also identify recommended rehabilitation methods, where needed. The combination of the past capacity assessment with the current condition assessment will allow the City to develop a comprehensive asset management program by redefining system priorities, resource needs, and an overall implementation strategy. This comprehensive review will update the current storm sewer capital program.

3.4 Stormwater Quality Issues

The number of potential substances, organic and inorganic, that can be, and often are, found in urban runoff may be surprising to many. In essence, just about anything that finds its way onto urban surfaces, particularly impervious surfaces such as roads, parking lots and buildings, can be washed off those surfaces by rain and snowmelt and carried into receiving water bodies as non-point source (NPS) pollution. As shown in Figure 2, stormwater from White Rock discharges into Semiahmoo Bay via numerous outfalls.

Table 1 provides a list of some major NPS pollutant sources and the pollutants that they commonly generate. Many of these pollutants can be acutely toxic at higher concentrations, although in general such toxicity is not normally associated with "typical" urban runoff. Rather, the accumulated effect of pollutant wash off over time can yield unacceptable chronic toxicity or bioaccumulation in aquatic life. In the absence of contrary evidence, it should be assumed that many, if not all of the pollutants listed in Table 1 are present in White Rock's runoff.

CITY OF WHITE ROCK

Legend

- Outfall
- Catchment Boundary
- General Catchment Outflow Direction

Catchment #	Hectares
1	16.45
2	31.65
3	20.60
4	11.08
5	7.90
6	26.50
7	30.89
8	6.72
9	55.78
10	8.40
11	18.08
12	63.30
13	4.66
14	13.63
15	24.95
16	23.70
17	44.72
18	63.65

Integrated Stormwater Management Plan

Catchment Boundaries

Figure 2

URBANSYSTEMS.

0 250 500 1,000

Meters

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Table 1: Typical Non-Point Source Urban Pollutants and Their Sources

Source	Major Pollutants
Atmospheric deposition	From urban and rural areas: fine particles, phosphorus, ammonia, nitrate, metals, pesticides, petroleum products, and toxic organics
Litter and leaf fall	Personal and commercial debris discarded to roadway and parking lots such as plastics, paper, cans, and food; leaves and organic debris from roadside and parking lot trees: biological oxygen demand (BOD_5), nitrogen, phosphorus, humic organics, and metals
Residential and roadside landscape maintenance	Bacteria, phosphorus and nitrogen, pesticides and herbicides, dissolved organics from soil amendments
Transportation vehicles	Fuels, brake drum and tire wear, body rust: fine particles, metals in particular zinc, copper, cadmium, lead, and chromium; and petroleum products such as oil & grease and poly-aromatic hydrocarbons (PAH)
Pavement and pavement maintenance	Temperature modification; petroleum derivatives from asphalt; materials from abraded or degraded pavement
Pavement deicing	Chlorides, sulfates, organics from acetate deicers, coarse sediments, and cyanide
Building exteriors	Galvanized metals, chipped and eroded paints, corrosion of surfaces accelerated by acid rain, metals
Commercial businesses	Parked vehicles; improperly disposed refuse such as discarded food, used cooking oil and grease, and packaging materials; internal drains improperly connected to the storm system: metals, BOD_5, bacteria, phosphorus, nitrogen, oil, and grease
Residential activities	Landscaping, pest control, moss control, vehicle maintenance, painting, wood preservation, pesticides and herbicides, phosphorus, nitrogen, petroleum products, zinc, and bacteria
Site development	High pH from fresh concrete surfaces; petroleum products from fresh asphalt and spills; organics and particles from landscaping materials; eroded sediment and associated constituents like phosphorus; pollutants associated with improperly disposed construction materials like fresh concrete and paints; cement from preparation of exposed aggregate concrete
Public infrastructure	Metals from galvanized stormwater drain systems; metals and petroleum products from maintenance shops; bacteria, nitrogen, phosphorus, and organics from exfiltrating or overflowing sanitary sewers

Source: Table 2.3, in G. Minton, *Stormwater Treatment: Biological, Chemical and Engineering Principles, Second Edition,* 2005

Using a NPS pollutant loading model called *WinSLAMM*, the generation and wash off of four key pollutants from the City into Semiahmoo Bay were estimated. The pollutants simulated in the model are:

- total suspended and dissolved solids (TSS and TDS)
- bacteria (fecal coliform)
- total and dissolved copper
- total and dissolved zinc

These pollutants are considered to be the most relevant to the health of the aquifer and Semiahmoo Bay. These pollutants are also highly correlated with the type of urban development found in White Rock. Appendix D includes a detailed discussion of why these pollutants were chosen.

Table 2 identifies suitable, long-term performance targets for these non-point source pollutants in White Rock. The purpose of these performance targets is two-fold. In terms of this ISMP, having targets allows comparison of alternate management strategies or, put differently, allows for "apples to apples" comparisons. In terms of implementing the ISMP, having targets puts everyone (public and private alike) on an even footing with respect to what is expected for runoff quality controls. ISMP recommendations related to runoff quality have been developed to meet these performance targets over the long term.

Table 2: Performance Targets for Non-Point Source Pollutants

Total Suspended Solids	Fecal Coliform	Hydrocarbons (Oil and Grease)	Dissolved Metals (Cu and Zn)
Remove or reduce 90% of the annual average load, with an average maximum concentration of 30 mg/L for any system discharging to a storm drain, ditch or the Bay	≤200/100 mL (geometric mean)	≤10 mg/L (mean)	Remove or reduce 50% of the annual average loads for both total copper and total zinc

Based on the forgoing, Table 3 on the following page provides a list and evaluation of issues pertaining to the five primary categories, which are: Environment; Drinking Water Quality; Stormwater Runoff Water Quality; and Recreational Amenities and Infrastructure. These issues have been foundational in the development of recommendations introduced in Section 5 of this Plan.

Concurrent with this study, Stantec Consulting Ltd. has been conducting a separate investigation titled "White Rock Water Quality Assessment" (Draft, April 2010). This study involves field sampling to better identify potential sources of elevated coliform pollutants. It also completed a literature review of pollutant loading from similar urban areas. While coliform levels are higher than desired, the Draft findings did not identify any specific point source in the areas sampled, nor did it find the conditions in the City of White Rock to be unique. Results appear to be generally consistent with other Metro Vancouver jurisdictions.

Table 3: Key Stormwater Issues in White Rock

ISMP Focus Areas	Is this a key focus area in White Rock?	Rationale	Is this focus area addressed in this ISMP?
Environment			
Freshwater habitat	No	No fish bearing streams in White Rock; only three remnant streams.	No
Marine habitat	Yes	Stormwater is directly discharged into Semiahmoo Bay, a highly valued habitat for marine vegetation, intertidal productivity, salmonids, other marine species, and birds.	Yes
Terrestrial habitat	No	The larger Coldicutt and Centennial parks provide fragmented natural forest habitat for wildlife, but no specific areas of habitat for species of conservation concern have been identified in White Rock.	No
Tree canopy	Yes	Maintenance of urban trees was identified as a high priority in the Environmental Strategic Plan, and trees play an important role in taking up stormwater through their roots and through interception in the canopy itself.	Yes
Drinking Water Quality			
Aquifer protection	Yes	White Rock obtains its drinking water from six deep wells, which obtain water from a sand and gravel aquifer underlying the City. While this aquifer is classified as having a low vulnerability to surface contaminants, infiltration of polluted stormwater may increase the risk of contamination.	Yes – through runoff water quality improvements
Stormwater Runoff Water Quality			
Point source pollution	No	The City does not include extensive commercial or industrial uses that may generate unique point sources of pollution.	No
Non-point source pollution	Yes	Urban surfaces, in particular impervious surfaces such as roads parking lots and buildings, accumulate various physical, chemical and biological materials that can be washed off into local storm drains and water bodies. Since the City is nearly built-out, non-point pollution is expected to be significant. Given the City's proximity to Semiahmoo Bay and its current drainage approach (curb and gutter, storm drains), non-point sources of pollution are washed off impervious surfaces quickly and directly into Semiahmoo Bay.	Yes – quality of stormwater runoff is the primary focus of this ISMP
Recreational Amenities			
White Rock beach	Yes	White Rock's beach is a significant community asset that is vulnerable to pollution from stormwater runoff.	Yes – through runoff water quality improvements
Infrastructure			
Flooding	Yes	The 2004 Comprehensive Drainage Assessment Study and subsequent upgrades addressed flooding issues in most areas of the City. Flooding remains a concern for homes with basements and within floodplain zones along Marine Drive; however, these are considered unique flood risks within the City.	No – addressed through past initiatives
Erosion	No	The 2004 Comprehensive Drainage Assessment Study and subsequent upgrades addressed erosion issues. The last significant erosion risk to be resolved is in the "Everall Ravine" east of Oxford Street and north of Buena Vista Avenue. The first phase of a storm sewer diversion project is currently in the design process. Once complete, this initiative will dramatically reduce the risk of erosion and address operational challenges that currently exist.	No – addressed through past initiatives

ISMP Focus Areas	Is this a key focus area in White Rock?	Rationale	Is this focus area addressed in this ISMP?
Infrastructure renewal	Yes	Aging infrastructure is a concern for all communities, including White Rock. A separate storm sewer condition assessment project is currently underway and will provide additional information to supplement the 2004 Comprehensive Drainage Assessment Study, and which will allow the City to develop a strategic infrastructure renewal program based on both condition and capacity.	No – separate initiative currently underway
Cross connection control	No	Cross connection are cases where a component of the sanitary sewer system connects to the storm system, or vice versa. Current standards and inspection routines have dramatically reduced such occurrence; however such instances do occur, particularly in older systems. This is not a widespread concern in White Rock. The City has dedicated significant efforts over the years to identify and eliminate such occurrence, but it is unknown whether all have been eliminated. Through its ongoing infrastructure management programs and initiatives, the City continues to address cross connection issues as they become known.	No
Pump station capacity	Yes	The Marine Drive corridor is reliant on two stormwater pump stations in two of the floodplain zones. Both are under the desired capacity and are considered aging infrastructure.	No – addressed through past initiatives
Conveyance system capacity	Yes	The 2004 Comprehensive Drainage Assessment Study addresses conveyance capacity issues.	No – addressed through past initiatives

4 OPPPORTUNITIES AND CONSTRAINTS

Identifying opportunities and constraints allows the development of practical recommendations that suit White Rock's particular circumstances. Each recommendation included in Section 5 reflects these opportunities and constraints.

4.1 Opportunities

Table 5 identifies a number of opportunities to improve stormwater management in White Rock. The most significant opportunities are related to:

- **Future neighbourhood planning**

The City is expected to develop plans for several neighbourhoods to increase density (primarily for small-lot single family development). These new plans will provide opportunities to incorporate stormwater management considerations as an integral part of the land use planning process.

- **Other bylaw updates**

The fact that the City is now in the process of establishing or updating several bylaws directly related to stormwater management creates significant opportunities to strengthen regulations. The current review of the Subdivision Bylaw, which establishes standards and requirements for all works and services, including drainage, gives the City a specific opportunity to require stormwater best management practices (BMPs). As well, the City's Tree Management Bylaw, which is currently under development, is an opportunity to strengthen regulations to protect trees and, thereby, help manage stormwater more effectively.

- **Drainage utility**

Another significant opportunity is related to financing. Unlike most municipalities, which rely on general revenues to fund stormwater initiatives, the City has already established a dedicated drainage utility. This utility provides the City with reliable and stable funding for stormwater management.

4.2 Constraints

In addition to identifying opportunities, Table 4 also identifies circumstances that may constrain efforts to improve stormwater management in White Rock. The most significant constraints relate to:

- **Limited future development potential**

The most significant constraint is the fact that White Rock is nearly at build-out, and that future re-development is expected to occur gradually and over a long time horizon. These circumstances make implementing stormwater management initiatives challenging for the following reasons:

- Without significant redevelopment, there are expected to be few opportunities each year to replace traditional ways of managing stormwater with new approaches on private property.

- The City cannot heavily rely on new development to implement or fund stormwater management initiatives.

- Since a significant portion of infill development is expected to be small-lot single family

residential development, there will be limited opportunity to install on-lot stormwater management features.

- **Limited availability of public land**

Because comparably little public land is available to make large scale communal changes to stormwater management approaches, any significant change would require private landowners to implement practices on their own lots (e.g., by installing rain gardens or disconnecting roof leaders). It will be challenging to provide landowners with the education and incentive to make these types of changes, particularly if costs are associated.

- **Reliance on groundwater for drinking water**

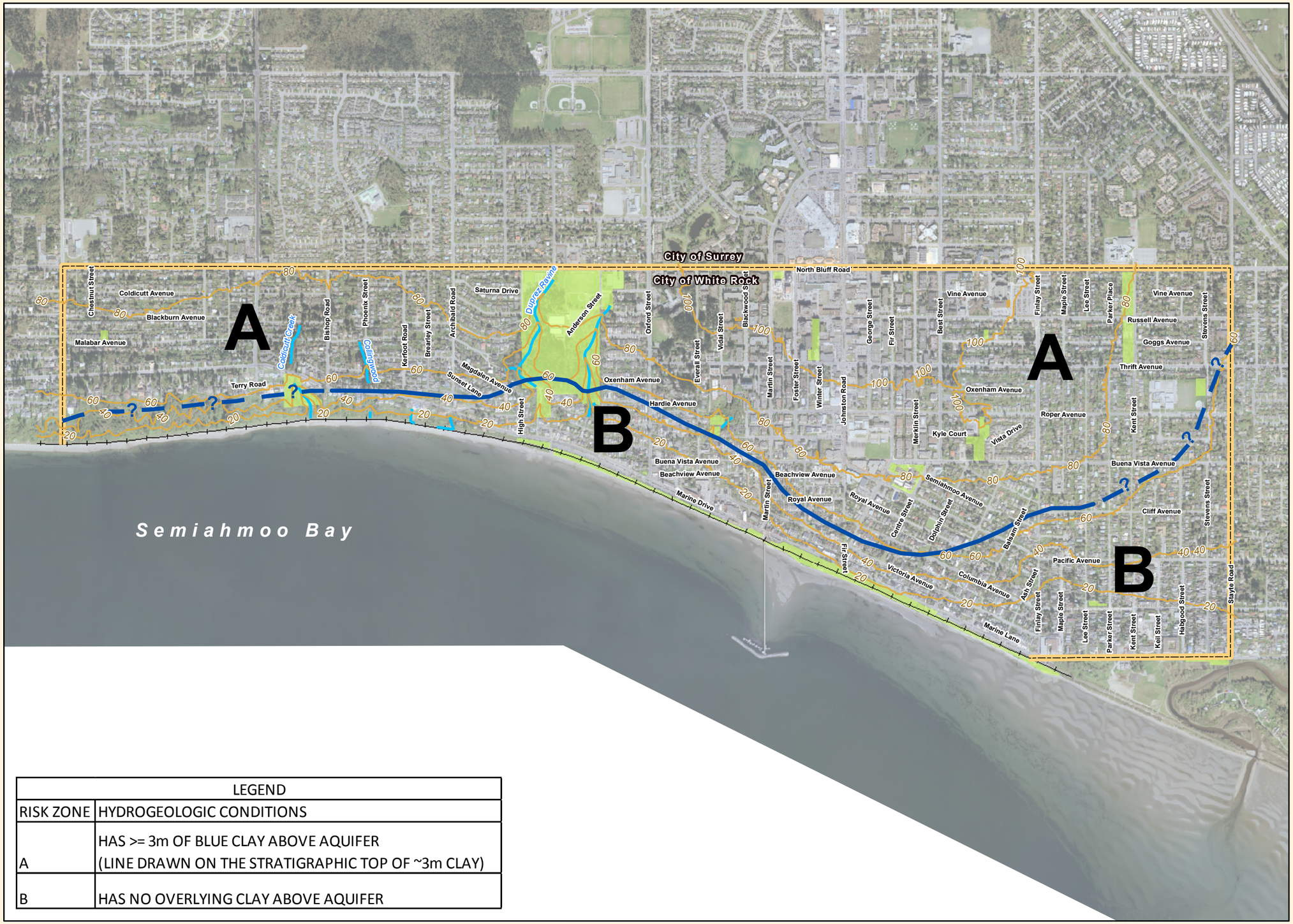
Another constraint is the fact that White Rock obtains its drinking water from an aquifer underlying the City. Infiltration (or recharge) galleries in combination with bioswales have become a commonly promoted mitigation strategy in the region (Lower Mainland and western Washington) to offset the effects of urbanization, which typically results in increased stormwater runoff, reduced recharge to underlying aquifers and degraded water quality. However, infiltration is not the best solution in all cases. For example, contaminated surface water runoff from development (primarily from roads and parking lots) could infiltrate directly into an aquifer that has no overlying low permeability clay layer and result in negative effects to a water supply. Thus, long-term management strategies for municipalities, such as White Rock, should be developed that consider hydrogeologic conditions such as varying soil properties, stratigraphy (i.e., the distribution, deposition, and age of rock/sediment layers), percolation rate, depth to aquifer, and potential percolation pathways in addition to effective stormwater design.

With these constraints in mind, preliminary risk zones were identified within the City limits. Figure 3 depicts Zone A, which is inferred to have at least three metres of a clay layer lying above the Sunnyside Uplands Aquifer, while Zone B has no overlying clay layer above the aquifer. The line between Zone A and Zone B was drawn at the projected top of the three metre thick clay layer. The stratigraphy is unknown in areas in the eastern and western parts of the City limits (noted by dashed lines with question marks). In these areas, more work should be required to demonstrate the presence of a low permeability layer above the aquifer.

Table 4 provides a summary of the opportunities and constraints.

- **Limited Resources and Competing Priorities**

Addressing water quality issues is not the only issue and priority of the City.



LEGEND	
RISK ZONE	HYDROGEOLOGIC CONDITIONS
A	HAS >= 3m OF BLUE CLAY ABOVE AQUIFER (LINE DRAWN ON THE STRATIGRAPHIC TOP OF ~3m CLAY)
B	HAS NO OVERLYING CLAY ABOVE AQUIFER

CITY OF WHITE ROCK

Legend

- Preliminary Risk Zones
- Stream
- Contours (20m)
- Railway
- White Rock Boundary
- Parks

Prepared for use with the ISMP. Risk zones are provided for general reference only. Site specific information must be obtained and provided to the City to confirm actual site conditions at any location.

Integrated Stormwater Management Plan

Preliminary Risk Zones

Figure 3

0 250 500 1,000
Meters

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Table 4: Opportunities and Constraints

Opportunities	Constraints
• Future neighbourhood planning under consideration • Parks Master Plan is supportive of actions that allow for greater rainwater infiltration (e.g., east-west trail linkage) • OCP is supportive of stormwater BMPs and other "green" initiatives • The City's 'Unopened Street Allowances' (as outlined in OCP-Policy 3.4.9) are supportive of future stormwater best practices initiatives (opportunity to implement stormwater BMPs) • Relevant bylaws in process of being updated/adopted: – Tree Management Bylaw – Subdivision Bylaw • Improvements to the existing road network have been proposed in the City's Strategic Transportation Plan. As these road improvements are undertaken, stormwater BMPs can be integrated into the road design • Financing tools are already in place – Drainage utility already in place – Development cost charge bylaw already in place • Condition assessment of drainage system is currently underway • Favourable public view of Stayte Road • EPCOR has commissioned a comprehensive report on the City's drinking water wells. Results are expected in summer 2010.	• Limited potential for large-scale development – White Rock is a built-out community – any new development will be infill development – Limited potential for significant development within the near - to mid-term – The nature of re-development is generally quite piece-meal (e.g., 2-lot splits) • Limited public land available for stormwater management • Limited financial resources for initial capital, O&M, and enforcement costs • Because drinking water is obtained from an aquifer underlying the City, more caution has to be applied to infiltrating rainwater • Few natural areas to preserve • Tree planting potentially controversial (due to potentially obstructing views and increased capital and maintenance costs) • A greater number of infrastructure components requires additional resources to implement and maintain • Potentially difficult to persuade landowners to install on-lot stormwater BMPs on private property • White Rock's hilly topography makes it challenging to implement certain BMPs that promote infiltration

5 RECOMMENDATIONS

Based on the information contained in the previous sections, the following offers a set of recommendations for consideration by the City.

The recommendations in this ISMP reintroduce basic infrastructure needs identified through past study, then expand on improving the quality of stormwater that discharges into Semiahmoo Bay and on protecting the City's drinking water aquifer. These recommendations are first about keeping "clean water clean," by reducing the amount of rainwater flowing over impervious surfaces and collecting pollutants. Second, these recommendations are about treating stormwater before it enters Semiahmoo Bay. Beyond physical works, the recommendations address implementation issues such as cost, regulations, and education.

Recommendations have been grouped into the following five categories:

- **Environmental Protection and Enhancement**

Projects generally intended to enhance the overall environment and in-stream conditions for fish.

- **Municipal Infrastructure**

This ISMP primarily focuses on recommendations for stormwater treatment. Projects to improve the functioning of the City's stormwater collection and conveyance system have, by and large, already been identified in past studies and are not repeated herein.

- **Planning and Analysis**

Activities and tasks to enhance the City's understanding of local conditions, to evaluate the success of past actions, and to determine the feasibility of undertaking additional actions or adapting to changing conditions.

- **Policy and Regulation**

Development and adoption of bylaws, guidelines and other regulatory tools.

- **Public Education and Outreach**

Programs and activities intended to educate the public, developers, contractors and others about stormwater management and its benefits to White Rock.

5.1 Municipal Infrastructure

As mentioned in Section 2, the City has already invested considerable effort into investigating and addressing runoff conveyance and flooding issues. At this time, there is no new information to warrant a different strategy. As such, the City will continue with its current storm sewer capital plan (see Figure 4), which calls for an approximate expenditure of $20 Million over twenty years. However, this overall program should be revisited once the current storm sewer condition assessment is complete and this ISMP has been adopted.

Because of the long term need to operate and upgrade infrastructure on BNSF lands, it is recommended that attempts be made by senior City officials to establish a blanket agreement with BNSF. This agreement should strive to reach a more

in-depth common understanding of the long term needs of the drainage system, and to develop a streamlined approvals process for operation and renewal initiatives.

Beyond addressing capacity and flood protection needs identified through past strategic initiatives, this ISMP process has now identified additional actions that address environmental and water quality issues. The following recommendations are suggested to help the City meet the long term water quality goals and performance targets outlined in Section 3 (see Appendix D for further details).

CITY OF WHITE ROCK

Legend

- Upgrade Pending
- Upgrade Complete
- Currently Under Design

Integrated Stormwater Management Plan

Drainage Infrastructure Capital Program (Revised 2006)

Figure 4

URBANSYSTEMS.

0 250 500 1,000

Meters

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Based on the analysis of runoff quality and potential strategies for treating it in White Rock, it is recommended that the City consider the following:

- **Install low impact biofiltration systems (on streets, lanes, and public parking facilities) –** Low impact biofiltration systems (bioswales or equivalent) and, where feasible, narrower streets and/or porous asphalt parking lanes, should be constructed on as many streets, lanes, and public parking facilities within the City. Figure 5 identifies rights-of-way that may be suitable for the installation of low impact biofiltration systems, specifically those with profile grades of less than 6% (total of approximately 19 km). In some areas of steeper overall topography (>10% slope), it may be difficult to add biofiltration systems even though the street is sloped less than 6%. In these locations, we recommend further study to clarify what kinds of systems may be installed. To address potential sensitivities of underlying aquifer, as discussed in Section 4.2 and Appendix C, specific direction with respect to the application on infiltration based BMP's is provided in Table 5. It is expected that it will take decades to fully implement all opportune roadway biofilters. It is envisioned that their installation would coincide with the City's long range road reconstruction program, or as other opportunities arise.

- **Require low impact BMPs (on-lot) –** Although significant change across the City is also expected to take decades, new commercial, institutional and multi-family residential developments and redevelopments should be required to use low impact BMP's to provide treatment. Similar to that described above, to address potential sensitivities of underlying aquifer, specific direction with respect to the application of infiltration based BMP's is provided in Table 5.

Table 5: Recommended BMPs Associated with the Preliminary Risk Map (Figure 3)

Risk Zone	Zone A	Zone B
Slopes > 2:1	No infiltration systems within 75 m of slopes > 2:1	
Slopes < 2:1, but > 4:1	If a significant low permeability unit* (e.g., compact till or clay layer ~0.5 m thick or more) is encountered within 5 m of the surface, use perforated underdrains with a low permeability liner in biofiltration-type systems within 75 m of slopes > 4:1, to convey underflow to storm sewers. Assumes no infiltration to occur.	Use perforated underdrains with a low permeability liner in biofiltration-type systems to convey underflow to storm sewers. Assumes no infiltration to occur.
	If no significant low permeability unit* (e.g., compact till or clay layer ~0.5 m thick or more) is encountered within 5 m of the surface, infiltration systems in biofiltration-type system is recommended.	
Slopes < 4:1	if a significant low permeability unit* (e.g., compact till or clay layer ~0.5 m thick or more) is encountered within 5 m of the surface – use perforated underdrains in biofiltration-type systems to convey underflow to storm sewers	
	if no significant low permeability unit* (e.g., compact till or clay layer ~0.5 m thick or more) is encountered within 5 m of the surface - infiltration systems in biofiltration-type system is recommended.	
Slopes < 10:1	if no significant low permeability unit* (e.g., compact till or clay layer ~0.5 m thick or more) is encountered within 2 m of the surface - infiltration systems in biofiltration-type system is recommended.	
Site-specific Investigations	Depending on the areal extent of the development and total volume of runoff to control, perform site-specific investigations to confirm the presence of confining layers. For larger developments, this may include performing a minimum of two 5 m deep geotech borings; add one boring for every additional 15 m in swale length > 15 m. Further, conduct a minimum of three infiltration tests; add one test for every additional 15 m in swale length > 15 m.	Assumes no infiltration to occur, so design will not require identification of low permeability unit or infiltration tests.
In areas of White Rock where the zone delineation is uncertain, demonstration of low risk conditions (i.e., the existence of a laterally continuous > 3m thick low permeability unit) is required.	Depending on the areal extent of the development and total volume of runoff to control, perform site investigations to confirm the presence of confining layers. For larger developments this may include one 20 m deep geotech boring near the center of the proposed infiltration system and an additional minimum of four 20 m deep geotech borings oriented radially and spaced 50-100 m distance from center of proposed infiltration system. The borings must be separated by a horizontal distance of at least 70 m. The area is considered low risk if the low permeability unit can be interpreted to be laterally continuous and indentified in all five borings. The soil data obtained from each geotechnical boring should be sufficient to estimate vertical percolation (unsaturated media) and vertical/horizontal conductivities (saturated zones); this includes grain size analyses of specific hydrostratigraphic units, permeater tests on core samples, recovery tests, etc.	

*infiltration rate < 2.5 mm/hr

CITY OF WHITE ROCK

Legend

- Streams
- Road Slope: 0 to 3 %
- Road Slope: 3 to 6 %
- Topography With Slope Less Than 10%
- Catchment Boundaries

Integrated Stormwater Management Plan

Streets Potentially Suitable for Biofiltration Systems

Figure 5

URBANSYSTEMS.

0 250 500 1,000
Meters

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- **Install advanced stormwater treatment systems –** For the catchments identified in Figure 6, provide "end-of-pipe" advanced treatment to remove suspended sediments, oil and grease, and fecal coliforms, along with metals and other pollutants associated with the sediments. The treatment must include settling, skimming or flotation (for hydrocarbons) and filtration, as well as a process for disinfection, in order to provide a level of treatment similar to that available through low impact biofiltration systems. These enhanced treatment systems are superior to the typical oil/grit separator or sediment removal structures installed in many parking lots around the Lower Mainland. The typical structures are insufficient to meet the standards sought as they only provide settling and skimming or flotation. In fact, these oil/grit separators are often used for "pretreatment" to an enhanced treatment system, in order to extend the life of the filtration process. These catchments have been targeted for end-of-pipe stormwater treatment because, as high-density development (commercial and multi-family) areas, they represent the highest pollutant generators, and given the City's current state of development and projected growth, it is unlikely that distributed source controls could be successfully implemented in these areas within a reasonable time frame. End-of-pipe systems should be designed to meet the performance standards discussed in Section 3.

- **Cost estimates for public runoff treatment infrastructure improvements —** The estimated capital and O&M costs for public runoff treatment infrastructure improvements (enhanced treatment systems; roadway-based biofiltration systems) are shown in Table 6. As shown, the total capital cost is estimated to be $13 Million, with annual O&M of about $0.85 Million. Capital costs include allowances for engineering and administration (20%) and contingency (35%). The construction costs represent mid-range values over a variety of system types, which will have to be confirmed with more detailed engineering prior to a decision to install a system. O&M costs are based on a percentage of construction. Based on available literature, biofiltration system O&M is reported to range between 4% and 10%, while enhanced treatment system O&M is reported over a much greater range of 2% to 13%. The O&M costs used in this ISMP are 7% and 6% of construction for enhanced treatment and biofiltration, respectively.

These public infrastructure improvements would remove upwards of 90% of the annual TSS load from catchments receiving treatment and about 56% of the annual TSS load from the entire City. The overall annual unit cost for constructing these improvements is $6.85/Kg of TSS removed.

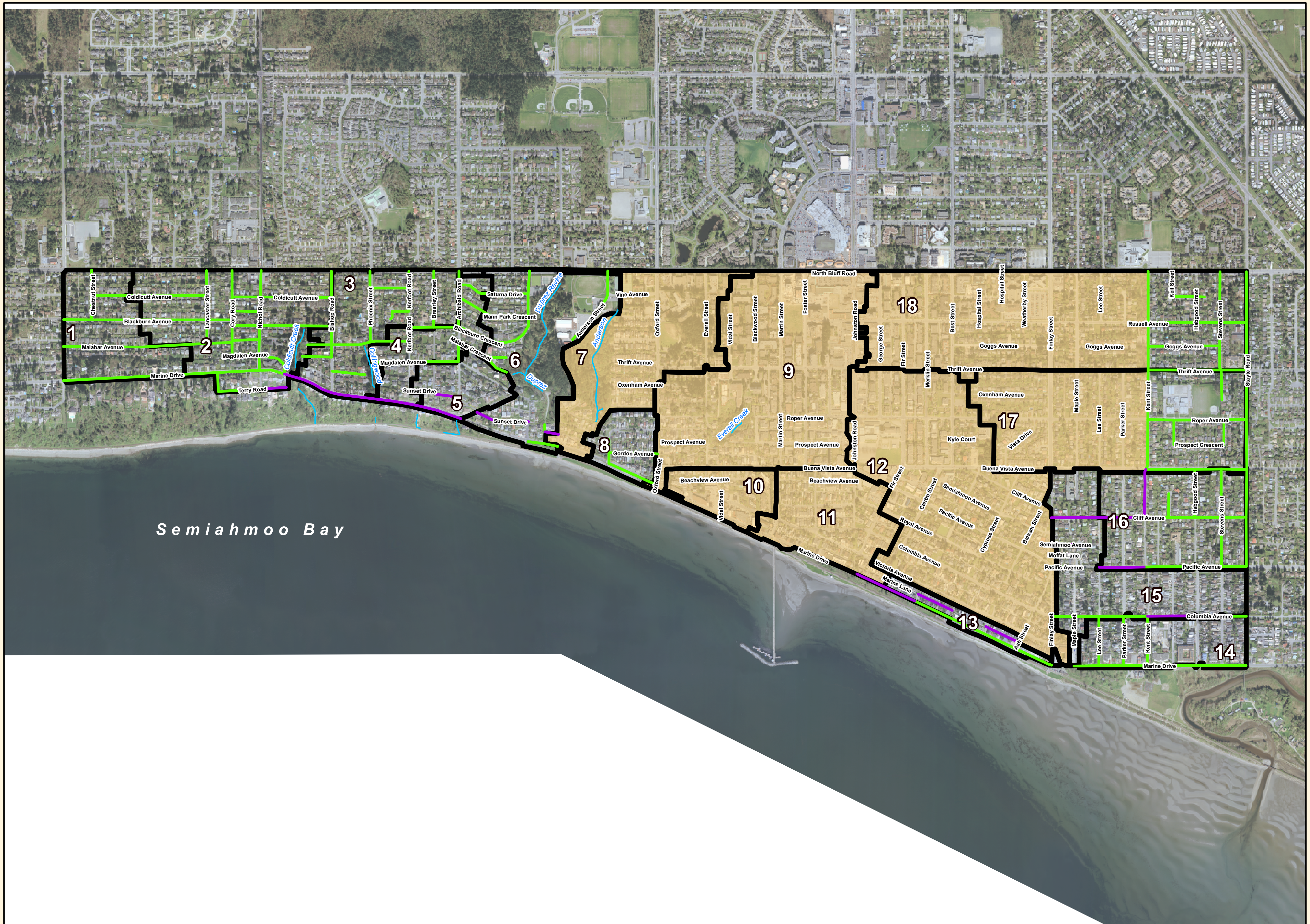
Clearly, retrofitting the City's drainage system to address water quality is an expensive undertaking. The program outlined in Table 5 is comprehensive, consisting of a large number of initiatives that have been designed to help the City fulfill its long-term vision and goals for the watershed; however, it is recognized that this program is not attainable in the short term. An

attainable and financially feasible implementation plan is required to help the City move forward on water quality issues. In general, greatest priority and emphasis should be put to the identified end-of-pipe treatment systems, requiring approximately $6.8 Million of capital investment. While a suggested implementation strategy is offered in Section 6, the City will need to better define priorities and an implementation schedule that can be completed within a realistic budget and timeframe. The overall implementation strategy is expected to be significantly influenced by both the ongoing storm sewer condition assessment investigation and the overall road reconstruction program. The full integration of the three programs will require future work once all information becomes available.

Table 6: Estimated Costs for Stormwater Treatment Infrastructure Improvements

Catchment #	Treatment Type	Estimated Capital Cost* ($)	Estimated Annual Operation & Maintenance ($/yr)
1	Biofiltration in ROW	$789,500	$55,270
2	Biofiltration in ROW	$1,547,700	$108,340
3	Biofiltration in ROW	$748,400	$52,390
4	Biofiltration in ROW	$293,800	$20,570
5	Biofiltration in ROW	$42,800	$3,000
6	Biofiltration in ROW	$418,200	$29,270
7	Enhanced	$640,100	$38,410
8	Biofiltration in ROW	$273,000	$19,110
9	Enhanced	$1,812,900	$108,770
10	Enhanced	$560,400	$33,620
11	Enhanced	$1,312,000	$78,720
12	Enhanced	$1,109,400	$66,560
13	Biofiltration in ROW	$231,400	$16,200
14	Biofiltration in ROW	$314,600	$22,020
15	Biofiltration in ROW	$314,600	$22,020
16	Biofiltration in ROW	$501,000	$35,070
17	Biofiltration in ROW Eastern 1/3 of catchment	$488,700	$34,210
17	Enhanced Western 2/3 of catchment	$333,100	$19,990
18	Biolfiltration in ROW Eastern 1/4 of catchment	$689,900	$68,890
18	Enhanced for 3/4 of catchment	$434,600	$26,080
	Total:	**$13,036,100**	**$850,510**

* Capital costs include allowances for engineering and administration (20%) and contingency (35%). The construction costs represent mid-range values over a variety of system types, which will have to be confirmed with more detailed engineering prior to a decision to install a system. O&M costs are based on a percentage of construction. By literature, biofiltration system O&M is reported to range between 4% and 10%, while enhanced treatment system O&M is reported over a much greater range of 2% to 13%. The O&M costs used in this ISMP are 7% and 6% of construction for enhanced treatment and biofiltration, respectively.



CITY OF WHITE ROCK

Legend

- Streams
- Roads for ROW Biofiltration Systems - Recommended
- Roads for ROW Biofiltration Systems - More Study Required
- End-of-Pipe Enhanced Treatment - Recommended
- Catchment Boundaries

Integrated Stormwater Management Plan

Potential Water Quality Infrastructure

0 250 500 1,000
Meters

Figure 6

URBANSYSTEMS.

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

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- **Disconnect roof leaders (single family and duplex development in specific areas of the City)** – The City should also encourage roof leaders within single-family and duplex developments to be disconnected from the City's drainage system. A previous study[5] concluded that disconnecting roof leaders is suitable only in certain areas of the City (see Figure 7). Requiring disconnection of roof leaders would entail an amendment to the City's Subdivision Bylaw and is discussed under the Policy and Regulations section.

It is absolutely critical that whatever systems are finally implemented be maintained and replaced over time in order to obtain the desired runoff quality treatment.

See Appendix D for further details on water quality.

[5] *Comprehensive Drainage Assessment Study*, Urban Systems, 2004.

CITY OF WHITE ROCK

Legend

- Catchment Boundaries
- Zone of Roof Leader Connections to Storm Drain
- Zone of Roof Leader Disconnects

Note: Zone designation based on "Comprehensive Drainage Study - 2004 Update"

Integrated Stormwater Management Plan

Roof Leader Connection Specified Areas

Figure 7

Semiahmoo Bay

URBANSYSTEMS.

0 250 500 1,000
Meters

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Table 7: Recommendations for Municipal Infrastructure

Recommendation	Benefits	Cost Estimate
Capital program Continue with the implementation of the current drainage infrastructure capital program until new information is available (see items below).	Satisfies infrastructure renewal issues and addresses flooding and erosion risks. Recommended for review following completion of the storm sewer condition assessment (see below), and adoption of the ISMP.	Provided in the 2004 Comprehensive Drainage Assessment Study – approximately $20M over 20 years.
Condition assessment Complete the current condition assessment program and update the capital program as new information becomes available.	Ensures levels of service are maintained over time and mitigates risk of flooding and erosion. Provides new information for the preparation of a comprehensive asset management program.	Current City initiative
Low impact biofiltration systems (on select streets and public parking lots) Low impact biofiltration systems (bioswales or equivalent) and, where feasible, narrower streets and/or porous asphalt parking lanes, should be constructed on as many streets and lanes as possible within the City (see Figure 5).	Reduces runoff volume, which, in turn, reduces the amount of pollution being washed off hard surfaces and into the City's piped drainage system and then into Semiahmoo Bay. Low impact biofiltration systems also provide treatment to improve runoff quality, which protects the health of the City's drinking water aquifer and improves quality in Semiahmoo Bay. These are considered relative long term, lower priority initiatives that can be implemented to coincide with the City's road reconstruction program.	$6.2 M for initial capital costs and $478,000 annually for O&M
Enhanced treatment systems For the catchments identified in Figure 6, provide end-of-pipe treatment that should include settling, and filtration. End of pipe systems should meet the performance standards discussed in Section 3.	Treats runoff quality to meet established standards for non-point source pollutants. Improves the health of Semiahmoo Bay. These are considered relative shorter term, higher priority initiatives in order to treat the highest risk area of the City.	$6.8 M for initial capital costs and $372,000 annually for O&M

Recommendation	Benefits	Cost Estimate
Low impact BMPs (on-lot) Require commercial, institutional, and multi-family developers to install on-lot low impact BMPs to manage runoff volumes and quality (where infiltration conditions are favourable – see Figure 3). Some areas of the City have been identified as unsuitable for infiltration of runoff. In these areas, low impact BMPs may be used, but only when provided with a perforated underdrain system.	Where infiltration conditions are favourable, low impact on-lot BMPs will help reduce runoff volume and improve runoff quality (and therefore, protect the health of the aquifer and Semiahmoo Bay). Where infiltration is not recommended, the underdrains intercept runoff before it is infiltrated and redirect it to the City's storm drains. While this means that runoff volume will not be significantly reduced in these cases, it does mean that runoff will have been provided treatment through contact with soil prior to eventual discharge to Semiahmoo Bay.	Developer funded. Typically in the order of $5,000-$15,000 per lot, depending on the size and complexity of the lot.
Disconnect roof leaders for single-family and duplex development in certain areas of the City Roof leaders should discharge to the ground for single-family and duplex developments in certain areas of the City (see Figure 7).	Roof leader disconnection will reduce runoff volumes and improve the quality of runoff entering the City's drinking water aquifer and Semiahmoo Bay.	In house
Agreements with land owners south of Marine Drive Pursue necessary long range infrastructure renewal and operation agreements with land owners south of Marine Drive.	Eliminates current challenges with respect to accessing and upgrading infrastructure vital to the City's overall system.	In house