
City of Vancouver
CROWN
STREET
Sustainable Streetscapes and
Fish Habitat Enhancement Project

EXECUTIVE SUMMARY

Building on the success of the award-winning Country Lanes project, the City of Vancouver has undertaken an exciting new approach to residential street design and stormwater management. Vancouver's Crown Street has thus become the city's first Sustainable Streetscape. The design of this street uses innovative ideas to integrate transportation into an environmentally sensitive setting.

Located in the Southlands Community of Vancouver, the 5900-6200 blocks of Crown Street had a badly deteriorated road surface compounded by soft shoulder conditions. The local watershed contributes stormwater runoff to Musqueam and Cutthroat Creeks, two of the last salmon bearing streams in Vancouver. To date, the creek's viability as salmon habitat has been precarious, prompting the Musqueam First Nation, David Suzuki Foundation and Musqueam Ecosystem Conservation Society to undertake projects to preserve and restore these salmon bearing streams. Given the sensitive setting of the street, the City understood that the old gutterless asphalt road could not be replaced with the standard residential street design. City of Vancouver's Engineering Services responded to this challenge with an innovative design that would fit the overall character of the community, beautify the street, and nuture the salmon habitat of the adjacent streams.

The Crown Street design features a narrow, meandering roadway flanked by vegetated swales and retention ponds. The road width was reduced from the standard 8.5m to 6.7m and is composed of 3.5m of asphalt flanked by 1m concrete bands and 0.6m of structurally reinforced grass on each side. The structural grass serves to separate the road surface from the swales and sidewalks, and also provides permeable parallel parking. A meandering street alignment provides traffic calming by breaking long sightlines.

Stormwater runoff is facilitated by a network of swales and retention ponds. The swales are layered with 30cm of absorbent soil and vegetated with grasses and native plants. Pollutants are filtered by the vegetation and rainwater runoff infiltrates naturally into the ground. The system is designed for a 10-year storm, with overflow directed into a detention pond constructed in the adjacent park. As a result, the salmon-bearing streams are protected from rain-induced volume surges and the rainwater is filtered naturally versus the roadway runoff being directly discharged into the streams.

Water quality and infiltration volume is being monitored in partnership with the University of British Columbia. Over the next five years, data will be collected and compared to a neighbourhood street which utilizes standard curb-and-gutter drainage. In 2006, Engineering Services will prepare a formal summary report for Vancouver City Council to review the potential for future residential street improvement options to be influenced by the Crown Street design.

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I.0 INTRODUCTION

The City of Vancouver, in partnership with the Musqueam First Nation, Federation of Canadian Municipalities, University of British Columbia, Greater Vancouver Regional District and the local residents, has undertaken an exciting new approach to residential street design and stormwater management. The project is the transformation of Vancouver's Crown Street into the City's first Environmentally Sustainable Streetscape. This project provides a model that may be used in future street reconstruction throughout Vancouver.

1.1 Project Background

Located in the Southlands Community of Vancouver, the 5900-6200 blocks of Crown Street had a badly deteriorated road surface compounded by soft shoulder conditions. The project site is 485 metres long and is bordered by 23 houses on the east side, and Musqueam Park on the west side. The street also serves as a tributary into the Musqueam Watershed, where there have been significant efforts by the Musqueam First Nation and the David Suzuki Foundation to preserve and restore two of the last remaining salmon bearing streams within Vancouver, Musqueam and Cutthroat Creeks.

2.0 DESIGN

The Crown Street design addresses four main issues: stormwater management, aesthetics, traffic calming and maintenance. The entire design process stretched over three years, including conceptual development, public consultation and review, funding applications and detailed design.

2.1 Project Team

The Crown Street Sustainable Street project was the first of its kind in Vancouver and involved collaboration between the City of Vancouver, Federation of Canadian Municipalities, University of British Columbia, Musqueam Indian Band, Greater Vancouver Regional District and the local residents.

Funding for this innovative project was provided by the following contributors:

- City of Vancouver
- Federation of Canadian Municipalities, Green Municipal Funds
- Crown Street Residents
- Musqueam Indian Band
- Greater Vancouver Regional District, Stormwater Interagency Liaison Group

The preliminary design was developed through cooperation of the Greenways, Streets Design, and Sewers & Drainage Design branches at the City of Vancouver.

Through a competitive bid process, Dillon Consulting Ltd. was selected to perform the detailed design work for the project. Columbia Bitulithic Ltd. was the project contractor, and Lees and Associates provided the detailed landscape design. Project environmental monitoring is being provided by Dr. Ken J. Hall from the University of British Columbia. The monitoring program will help evaluate the positive impact of the Crown Street project on the nearby salmon bearing streams.

2.2 Conceptual Development

The street rehabilitation project was initiated through a resident request to repair the existing cracked and worn asphalt street surface. A neighbourhood plan known as the 'Southlands Plan' prohibits curb and gutter for this area, so the City's Streets Division saw this as an excellent opportunity to try something different. The Sustainable Streetscapes and Fish Habitat Enhancement Project: Crown Street, is the fruition of this opportunity. The conceptual design was done by the City of Vancouver's Streets Design, Greenways, and Sewer & Drainage Design Branches.

Figure 2.1 Crown Street Conceptual Drawing

2.3 Public Consultation

Public consultation was very extensive and consisted of three public meetings, four surveys, and a great deal of independent feedback from Crown Street residents. It was important to effectively communicate the design goals and concepts, as the local residents were required to vote in majority support of the project. Resident concerns focused on parking, landscaping, impacts of improvements on property values, and a possible influx of wildlife due to the increased vegetation. Staff worked with each resident and, where requested, provided parallel and pod parking, designed unique landscaping, and conducted background research on the effect of swales on animal life. Communication has continued throughout the entire project, with residents requesting minor planting, sidewalk and parking adjustments during construction, and informal meetings on-site post-construction to discuss maintenance plans and ongoing cooperation between the Vancouver Parks Board and the residents.

2.4 Funding Applications

The completion of a new and innovative demonstration project outside of the conventional bounds of street construction required additional investment to help cover increased design costs. City Council approved funding of $705,162, while local residents provided $49,363. The City also received a grant of $563,500 from the Federation of Canadian Muncipalities' Green Municipal Funds, with an additional $30,000 designated for long-term monitoring. The Greater Vancouver Regional District Stormwater Interagency Liaison Group (GVRD SILG) provided $9200 to purchase stomwater monitoring equipment, and Dr. Ken Hall of the Institute for Resources, Environment and Sustainability at the University of British Columbia offered his expertise to supervise environmental monitoring and performance of the project post-construction. The Musqueam Indian Band provided $33,197 to continue the unique treatment onto the Musqueam Reserve.

2.5 Detailed Design

Detailed design work was completed by Dillon Consulting Ltd. Unique design issues included the profiling and drainage characteristics of the roadside swales and detention ponds, as well as the open-bottom culvert, headwall and entrance/exit upgrades. The integrated system is designed with flow and retention capacity for a 10-year storm.

Figure 2.4a Swales and Detention Ponds

Recycled materials were encouraged with old concrete sidewalks used as pathways and granite curbs as weir drop structures in the swales. Once grassed in, the broken concrete pathways increase permeable surface area, as well as provide an aesthetic improvement. With a total site slope of 5%, the granite weirs reduce the effective slope of the swales, thereby increasing infiltration volume and detention time.

Figure 2.4b Recycled Concrete Sidewalk and Granite Weir

Innovative technologies include structural grass and structural soil (see Figure 2.4c). Structural grass is a rigid plastic grid that can support vehicles and prevent grass roots from being compacted and rutting the soil. Structural soil is a mixture of aggregate, which provides structural stability, and a sand/soil mixture that allows for drainage and provides the soil components required for grass growth. These elements have been used by the City of Vancouver in several other projects, including Country Lanes and portions of the Stanley Park S-Curve Project.

Figure 2.4c Structural Grass and Structural Soil

However, the outstanding environmental feature of this project is the integration of many different elements into a single sustainable design. Benefits of the project design include:

- improved water quality and increased infiltration
- improved wildlife habitat
- reduction in the urban heat-island effect
- reduction in peak flows in streams and rivers
- increase of base flows in streams and rivers
- improved traffic calming measures
- aesthetic 'liveable' improvements

3.0 CONSTRUCTION

To expedite construction, the project was separated into two phases. Phase I was completed in February 2004 and Phase II was completed in November 2005.

3.1 Phase I Implementation

Phase I included a traffic-calmed street with minimal impermeable surfaces and a naturalized stormwater management system between SW Marine Drive and W 46th Avenue.

Phase I construction began on October 12 2004. Heavy civil work was completed before Christmas, and periods of extended rain delayed additional construction until February 2005. Swale, pond and meandering road construction required additional survey and layout relative to conventional curb and gutter system. A series of construction pictures are shown below.

Figure 3.1a Construction Photos

3.2 Phase I Changes and Challenges

The Crown Street project involved the integration of many unique and innovative features into a single design. Therefore, there were many changes and challenges throughout the three years of project development. Several major challenges included swales, construction excavation and landscaping.

3.2.1 Swales

The swale conceptual design proposed a broad shallow channel, with landscaping throughout. The detailed engineering design resulted in a swale with a larger and deeper cross-section, including drop structures to reduce the swale slope. These engineering-related changes were required to collect and convey the precipitation volume and intensity of a 10-year storm.

However, in addition to increased cost, there are several other implications for larger, deeper swales. Deeper swales require substantial pedestrian crossing and vehicle parking structures, allow less landscaping, reduce parking space and ability, and are more difficult to maintain.

Additionally, in order for water to effectively be infiltrated into a swale, it is best to design a non-point source entrance mechanism, or a smooth transition from impermeable road surface to permeable parking to swale. A natural transition induces an undefined road edge, allowing the potential for a deeper swale to be a parking hazard. The Crown Street project defined the at-grade road edge using occasional trees and upright granite blocks.


Figure 3.2.1 Swales and Road Edge

3.2.2 Construction Excavation

Due to the presence of two salmon bearing streams, the existing soil provided a structurally poor road base. Compounded by the presence of an underground spring, additional excavation was required to ensure long-term durability of the road structure. Additional excavation would also have been required for a conventional curb and gutter street design. However, excavation of the swales required careful attention to sloping and grading.

3.2.3 Landscaping

Post construction challenges include maintenance for the landscaping by the Crown Street residents. While some residents maintain and care for the planting in front of their properties, others make less of an effort. The result was that some areas of landscaping look spectacular, while other areas appear neglected. It is hoped that sporadic landscaping maintenance will be improved through continued communication with the residents.

Figure 3.2.3 Finished Product

3.3 Phase II Implementation

Phase II involved the replacement of two stream crossings (Musqueam and Cutthroat creeks), street rehabilitation, and pedestrian safety improvements between W 46th Avenue and W 48th Avenue. Due to a construction window imposed by the Department of Fisheries and Oceans designed to safeguard the salmon's lifecycle, the in-stream portion of construction was restricted between August 1st and September 30th, 2005. The undersized concrete channel culverts were replaced with considerably larger, natural-bottomed, aluminium arches. Weirs were placed up and downstream of the culvert to create ideal fish habitat at the culvert entrances and exits. Future plans include informational displays to educate the community on fish and wildlife habitat and to describe the environmental benefits provided by the Crown Street project.

Figure 3.3a Culvert Replacement

Figure 3.3b Salmon Habitat Enhancement

3.4 Financial Information

Construction costs of the demonstration project were significantly higher than the estimated costs of a standard curb and gutter treatment. While partial cost premiums can be attributed to new construction materials and methods, it is expected that this innovative treatment will still retain a cost premium over the traditional curb and gutter treatment. However, many of the indirect benefits are difficult to cost quantify, and with replication, the construction process and materials selection would be refined to make the process more affordable for implementation across a greater area. Widespread implementation could produce additional cost savings through the reduction in stormwater pipe sizes, water treatment costs, and reparation of stormwater-related environmental damage.

3.5 Replicability

The Sustainable Street demonstration project has provided a design that can be used as an inspiration or template for future street improvement projects. The University of British Columbia has referenced "green street designs such as the City of Vancouver's Crown Street" as an inspiration to "push the limits of innovation and provide a showcase of sustainability." In 2006, Engineering Services will prepare a formal summary report for Vancouver City Council to review the potential for future residential street improvement options to be influenced by the Crown Street concepts.

4.0 MONITORING

Project monitoring will help quantify performance improvement and provide data that can be used to predict the benefit of future implementation.

4.1 Environmental Impacts and Protection

Land development in a drainage area or watershed involves replacing or modifying some of the natural surface cover with roads, roofs, driveways and other impervious materials. Impervious surfaces greatly diminish the capacity of the soil to infiltrate water, thereby transforming a high percentage of rainfall into urban stormwater runoff that needs to be collected to reduce flooding. Presently, urban stormwater is collected and conveyed through a massive network of pipes and catch basins to a central facility where it is treated before release into the environment. While the impact of pollutants to the receiving waters is reduced, by far the more serious impact is related to water quantity. Fast moving and high volume surface drainage reaches streams quickly through the network of pipes, causing damage to the stream ecosystem. Peak runoff rates for a smaller and more frequent storm event, such as a 2 year storm, increase fourfold, from 5 percent to 21 percent, which creates an acute problem for the local channels and streams. The increase in peak flow rates and volumes in the rainy season, and the decrease in base flows in the summer season, threatens the integrity of the stream ecosystem.

While in-stream enhancement can address some aspects of degradation, the real effort needs to be directed to the upper watershed where most of the adverse processes originate. Projects designed to decrease runoff peak flows and volumes, and encourage increased soil infiltration should be pursued. Crown Street: Sustainable Streetscapes manage stormwater runoff onsite, naturally filtering and infiltrating the water.

In addition to water pollution prevention, Sustainable Streets reduce air and heat pollution through increased vegetation and biomass.

4.2 Monitoring Plan

Crown Street is currently being monitored in partnership with the University of British Columbia, Institute for Resources Environment and Sustainability. The Federation of Canadian Municipalities has provided $30,000 to cover the costs of monitoring reporting. The monitoring plan will produce reports at 2 and 5 years after construction. Specific attention will be given to:

- Sediment and water quality
- Trace metals in stormwater runoff
- Total hydrocarbon fraction
- Temperature, conductivity, turbidity
- Rainfall volume and water table levels
- Infiltration performance

All this data will be compared to a street just east of Crown, Holland Street, which uses a traditional curb and gutter system. The comparison will be used to help quantify performance improvement.

5.0 CONCLUSION

Crown Street is an exciting new development for residential street design in Vancouver. Utilizing innovative ideas, it pushes forward the City of Vancouver's initiatives to provide residents with functional streets while minimizing impact to the environment. The narrow, meandering roadway flanked by vegetated swales and retention ponds integrates stormwater management, aesthetics and traffic calming into a single sustainable design.

The University of British Columbia referenced "green street designs such as the City of Vancouver's Crown Street" as an inspiration to "push the limits of innovation and provide a showcase of sustainability." The innovative project reduces the hydrological footprint of street construction and serves to further the efforts of the Musqueam First Nation, David Suzuki Foundation and Musqueam Ecosystem Conservation Society to restore two of Vancouver's remaining salmon bearing streams, Musqueam and Cutthroat Creeks. Project environmental monitoring provided by the University of British Columbia will help evaluate the positive impact of the Crown Street project on these important salmon bearing streams. Ultimately, the Sustainable Street Demonstration Project has provided a design that can be used as an inspiration or template for future street improvement projects.