APPENDIX

OBJECTIVES BY ALTERNATIVES MATRIX

Preliminary analysis of path surface options.

Q: What is the best path surface for the CVG when it runs near urban watercourses?

Alternatives → Fundamental Objectives	**Asphalt**	**Concrete**	**Gravel**	**Pervious Concrete and Permeable Pavers**	**Filter Strips (Country Lane)**	**Recycled Plastic Lumber Boardwalk**
Ecology	-highly impervious -runoff: high -tar-based (?) (contains petroleum products) -contains volatile organic compounds such as polycyclic aromatic hydrocarbons and in some cases heavy metals - can leach into water and soil - dark in colour and therefore absorbs heat and can affect runoff temperature -significantly alters hydrology -erosive capability of water increased	-highly impermeable -runoff: high -light in colour, less urban heat island effect -significantly alters hydrology -erosive capability of water increased	-no chemical leaching -medium permeability -relatively high level of sediment mobilization from gravel itself	-highly permeable, increased infiltration -helps reduce runoff -helps reduce transport of pollution to streams -natural drainage patterns and boundaries preserved	-permeability of path area enhanced by filter strips -may reduce storm runoff by 40% -some of natural infiltration system preserved	-contains no toxic or corrosive chemicals, does not leach -made of recycled HDPE: reduces deforestation and keeps plastic out of landfills -highly compatible with natural drainage patterns -soil underneath pathway not compacted -minimal impact on hydrology
Safety	-skid resistant -very smooth	-highly skid resistant -very smooth	-if not well packed cyclists,	-highly skid resistant -very smooth	-highly skid resistant -very	-skid resistant -smooth surface except

	-may buckle or crack if not properly maintained -highly firm and stable	-very durable and excellent weight bearing capacity -highly firm and stable	others may skid -most bumpy of all alternatives -less firm and less stable – depends on packing	-eliminates dangerous surface water pockets -highly firm and stable	smooth -possible crowding -highly firm and stable	for very small depressions between boards -highly firm and stable -highly shock absorbent
Accessibility	5/5	3/5	5/5	5/5	5/5	4?/5 –ie. those on rollerblades, scooters, skateboards may have trouble
Cost (/feasibility)	~$1 per square ft. -requires much maintenance	~$5-7 per square ft. -requires less maintenance	~$2-6 per sq. ft. -requires frequent maintencance	-medium -requires moderate maintenance (ie. occasional sweeping and pressure washing to keep pores unclogged -reduces or eliminates need for other stormwater management or drainage facilities	~ 50% more expensive than concrete -high maintenance -reduces need for other stormwater management or drainage facilities	~$1.20-$3.30 per foot, or 20-50% more expensive than conventional treated lumber that typically used to construct boardwalks -approx. same cost as high grade cedar -little or no maintenance required; lifespan of 50+ years (most expensive for initial installation but least expensive to maintain)
Function	-not appropriate in close proximity to watercourses, particularly those that bear fish	-not appropriate in close proximity to watercourses, particularly those that bear fish	-coupled with appropriate vegetation, is more suitable for areas close to watercourses	-can be used anywhere pavement can be used (and more) -due to high permeability, might be used closer to streams	-further tests required to determine appropriate distance from watercourses -possible community involvement in maintenance of filter	-appropriate in ecologically sensitive areas such as bogs, wetlands, in riparian areas

					strips	
Active transportation	Fast surface	Fast surface	Slower surface, often avoided by cyclists	Fast surface	Fast surface, although travel speed may be slowed by crowding	Fast surface, although some users, such as cyclists, might be uncomfortable riding on a raised surface

Still Creek Rehabilitation and Enhancement Report

Prepared by: General manager of Parks and Recreation
Planning & Operations
To: Board of Parks and Recreation
Vancouver, BC

July 11, 2002

http://www.city.vancouver.bc.ca/parks/bdpackg/2002/020722/stillcreek.htm

Park Board has a longstanding interest in Still Creek. In 1988, both the Board and Council approved a comprehensive set of policies and actions that aimed at protecting and enhancing Still Creek. As a result, the open watercourse on the Superstore site (3185 Grandview Highway) was protected, and a new zoning by-law which stated "Still Creek shall be retained and enhanced as an open watercourse" was adopted. These positive steps were tempered by the fact that about 120 meters of Still Creek were culverted in 1989 - this occurred because the Rupert Square development (2750 Rupert Street) preceded the new zoning by-law.

That Still Creek is an area of concern is clear from the adoption of a zoning bylaw, in 1988, stating that "Still Creek shall be retained and enhanced as an open watercourse" (from, to Board Members, July 11, 2002.

A section of which states:

"There are three important reasons for preserving, restoring and enhancing Still Creek in the Grandview-Boundary Industrial Area:

- it will provide an important recreational amenity: Still Creek is part of a larger recreation corridor that includes Renfrew Ravine Park, Burnaby Lake and Brunette River (a distance of 18

kilometers). This corridor is considered to have significant recreational and natural value and, as a result, was included in Greater Vancouver's Green Zone in 1993;

- it will improve the quality of the water in Still Creek, Burnaby Lake and Brunette River, thus contributing to enhanced fish habitat and reducing the quantity of contaminants that reach the Fraser River; and

- it will provide better management of rain water during and after storms, reducing the risk of flooding in Vancouver and Burnaby."

From the Still Creek Report, Appendix3, available at http://www.city.vancouver.bc.ca/commsvcs/cityplans/StillCreekReport/Appendix3.pdf, we have the following sections, which illustrate policy concerns regarding Still Creek and the Brunette River:

Brunette Basin Watershed Plan

This plan provides the overarching framework for stormwater management withinthe Still Creek – Brunette River Watershed. It was adopted by Vancouver CityCouncil in 2000 with the recommendation that:

"… the goals, objectives and guiding principles in the draft Brunette Basin

Watershed Plan be taken into consideration when carrying out City activities in theStill Creek drainage basin."

The policies and principles of the Brunette Basin Watershed Plan that are relevant toStill Creek include:

• Develop floodplain management strategy and associated bylaws;

• Develop watercourse protection and sediment and erosion control bylaws ;

• Consider property acquisition of riparian, wetland and flood storage areaswhere local planning process provides opportunity;

• Integrate stormwater management and Best Management Practices guidewith land use planning tools - policy statements in Official Community

Plans and zoning and subdivision or bylaw;

• Develop sub-watershed stormwater management plan;

• Improve fish passage and enhance/re-vegetate as part of facility repair or

upgrades, and,

• Consider daylighting the creek where local planning process provides

opportunity.

The Brunette Basin Watershed Plan also includes recommendations for educationand stewardship programs, as well as specific improvement programs for a varietyof issues.

Still Creek CD-1 Guidelines

The Still Creek CD-1 Guidelines were adopted by City Council in April 1990. Theguidelines call for "development to occur in a manner consistent With retaining andenhancing the open watercourse." The guidelines include the following section:

"6.0 Amenity Areas: Still Creek shall be retained and enhanced as an openwatercourse, except for pedestrian and vehicular crossings, the location and designof which shall be subject to the approval of the Director of Planning".

Highway Oriented Retail, I-2 and I-3 Policies

This document was adopted in July 1999, and includes policies and guidelines forland use in the Grandview/Boundary Industrial area (GBIA). It includes a number ofinnovative approaches to re-development and enhancement of Still Creek. Theseinclude daylighting the creek, limiting impervious cover and using on-site retentionof stormwater among other Best Management Practices.

Section 10.2 Water: Surface and Groundwater Protection includes the following

recommendations:

(a) Permeable surfaces should be maximized to reduce stormwater runoff andrecharge groundwater in the following priority order: First, grass then gravel on sandand, third, paving stone on sand.

(b) Consider providing on-site stormwater storage by incorporating ponds or similar recreational/ amenity features that have dual functions.

(c) Streams should be daylighted where feasible and supported by Engineering Services to expand recreational opportunities and feed into Still Creek.

(d) Ditches or swales should be created, where appropriate, to carry, filter and reduce surface runoff as well as minimize underground infrastructure.

(e) Grey water should be recycled on site, if possible, for irrigation purposes to reduce water use, waste water and runoff."

It is the City's intention to fully daylight the creek and provide pedestrian/bicycle access and landscaped public open space amenities along the creek edge. Still Creek should beretained and enhanced as an open watercourse. The ability to secure this amenitywill be a key criteria in assessing proposed developments."

From the Brentwood Design Project we have the following table describing impacts on streams of impervious surfaces:

http://www.sustainable-communities.agsci.ubc.ca/projects/Brentwood/Eco_Table1.html#Eco_Table1

SUSTAINABLE URBAN LANDSCAPES
The Brentwood Design Charrette

ECOLOGICAL INFRASTRUCTURE Back

TABLE 1 - Summary of impacts of urban streams associated with increased imperviousness.
Changes
Impact

Changes in stream hydrology
- increase in magnitude/frequency of severe floods
- decrease in base flows
- decrease in groundwater recharge
- increase in flow velocities during storms

Changes in stream morphology
- channels widen
- downcutting of streambeds, erosion of streambanks
- reduction in hydraulic capacity die to shifting bars of coarse sediments
- loss of pool/riffle structure

Changes in stream water quality
- increase in nutrient loads (organic and inorganic nitrogen, phosphorous) causing algal growth
- bacterial contamination
- increase in sedimentation affecting the food chain
- increase or decrease in pH levels
- deposits of heavy metals and other toxic chemicals onto stream sediments
- increase in hydrocarbon concentrations
- increase in water temperatures due to heat reflected from impervious surfaces

Changes in stream ecology
- reduction in diversity of aquatic organisms
- sedimentation creates barriers to fish migration
- loss of in-stream habitat structures (pool and riffle sequences, overhead cover)
- decline in amphibian populations

US Environmental Protection Agency discussion of Porous Pavement

http://www.epa.gov/owm/mtb/porouspa.pdf

POROUS PAVEMENT:
Porous pavement is a special type of pavement that allows rain and snowmelt to pass through it, thereby reducing the runoff from a site and surrounding areas.
In addition, porous pavement filters some pollutants from the runoff if maintained.
There are two types of porous pavement: porous asphalt and pervious concrete. Porous asphalt pavement consists of an open-graded coarse aggregate, bonded together by asphalt cement, with sufficient interconnected voids to make it highly permeable to water. Pervious concrete consists of specially formulated mixtures of Portland cement, uniform, open-graded coarse aggregate, and water.
Pervious concrete has enough void space to allow rapid percolation of liquids through the pavement. The porous pavement surface is typically placed over a highly permeable layer of open-graded gravel and crushed stone. The void spaces in the aggregate layers act as a storage reservoir for runoff. A filter fabric is placed beneath the gravel and stone layers to screen out fine soil particles. Figure 1 illustrates a common porous asphalt pavement installation. Two common modifications made in designing porous pavement systems are (1) varying the amount of storage in the stone reservoir beneath the pavement and (2) adding perforated pipes near the top of the reservoir to discharge excess storm water after the reservoir has been filled. Some municipalities have also added storm water reservoirs (in addition to stone reservoirs) beneath the provide for infiltration through the underlying subsoil.

APPLICABILITY
Porous pavement may substitute for conventional pavement on parking areas, areas with **light traffic***, and the shoulders of airport taxiways a runways, provided that the grades, subsoils, drainage characteristics, and groundwater conditions are suitable. Slopes should be flat or very gentle. Soils should have field-verified permeability rates of greater than 1.3 centimeters (0.5 inches) per hour, and there should be a 1.2 meter (4-foot) minimum clearance from the bottom of the

system to bedrock or the water table.

ADVANTAGES AND DISADVANTAGES
The advantages of using porous pavement include:
• Water treatment by pollutant removal.
• Less need for curbing and storm sewers.
• Improved road safety because of better skid resistance.
• Recharge to local aquifers.
The use of porous pavement may be restricted in cold regions, arid regions or regions with high wind erosion rates, and areas of sole-source aquifers. The use of porous pavement is highly constrained, requiring deep permeable soils, restricted traffic, and adjacent land

***emphasis added.**