Invasive Plants in the Still Creek Watershed

Inventory Results and Restoration Prescriptions

Prepared for:

City of Burnaby
4949 Canada Way
Burnaby, BC
V5G 1M2

and

City of Vancouver
453 West 12th Avenue
Vancouver, BC
V5Y 1V4

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This report presents the results of an inventory of invasive plants in the Still Creek watershed, and recommends prescriptions for restoring riparian plant communities to increase ecological values. This is a component of ongoing work by the City of Burnaby, City of Vancouver, and the Greater Vancouver Regional District to protect and restore biodiversity in the watershed.

The distribution and abundance of invasive plants was surveyed in natural vegetation along Still, Guichon, Chubb, and Beecher creeks using a combination of air photo interpretation and field assessment. Surveys focused on fifteen invasive plant species that are considered of conservation concern in the Still Creek watershed. Field assessment was undertaken between October 15 and November 18, 2005 with some rechecking in December 2005 and January 2006. Analysis focused on identifying the overall distribution and abundance of invasive plants in the study area.

A total of 803 polygons encompassing 122.8 ha of vegetation were inventoried and mapped. The mean polygon size was 0.2 ha and ranged from 10 m² to 6.5 ha. 88.0% of the study area was in the City of Burnaby and 12.0% was in the City of Vancouver. 62.1% of the total area surveyed was classified as floodplain forest and swamp, 27.9% was ravine forest, and 10.1% was fragmented stream corridor.

The most abundant invasive plants, based on total cover in the study area, were Himalayan blackberry, reed canary grass, English ivy, policeman’s helmet, and Japanese knotweed. Himalayan blackberry was substantially more abundant than any other species (found in 52.7% of polygons and covering 19.9% of all vegetation surveyed), and accounted for more plant cover than the rest of the invasive plants combined. Reed canary grass was also prevalent in the lower portion of the Still Creek floodplain, while English ivy, policeman’s helmet, and Japanese knotweed were common in fragmented stream corridors and remnant forests. Only 13 polygons totalling 7.7 ha (6.3%) did not have any invasive plants present.

The recommended approach in the Still Creek watershed is to focus initial management activities on sites where ecological values are compromised by invasive plant dominance, but that have a good potential for improvement. A secondary emphasis is placed on sites and activities that can be used as demonstration projects, both for increasing public awareness and testing restoration techniques.

Six vegetation management prescriptions are recommended for reducing invasive species dominance and restoring natural plant communities in riparian areas of the Still Creek watershed:

- **Prescription 1** – Establish patches of riparian trees in Himalayan blackberry-dominated riparian areas through small-scale clearing.
- **Prescription 2** – Establish riparian trees and shrubs in Himalayan blackberry-dominated riparian areas through soil replacement and vegetation clearing.
- **Prescription 3** – Establish riparian trees in reed canary grass-dominated riparian areas.
- **Prescription 4** – Underplant conifers in deciduous forest.
- **Prescription 5** – Establish native plantings at high profile recreation sites.
- **Prescription 6** – Remove invasive understorey plants in deciduous forest.
ACKNOWLEDGEMENTS

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1 INTRODUCTION

1.1 Project Purpose
This report presents the results of an inventory of invasive plants in the Still Creek watershed, and recommends prescriptions for restoring riparian plant communities to increase ecological values. It is divided into three sections. The first section provides an introduction to invasive plant issues and describes the range and distribution of plant communities in the Still Creek watershed. Section 2 summarizes the methods and results of the invasive plant inventory, and Section 3 recommends priorities for invasive plant management and presents six prescriptions for restoring riparian plant communities and reducing invasive plant dominance along Still Creek and its tributary streams (Beecher, Guichon, and Chubb creeks).

Invasive plants are widespread and abundant in Greater Vancouver but are particularly prevalent in disturbed natural areas such as the Still Creek corridor. Previous disturbance such as land clearing and development, the ecological productivity of riparian zones, the adjacency of residential and industrial lands, and the lack of park development and its associated park maintenance activities have contributed to the rapid increase in invasive plant populations in the Still Creek watershed. However, recent interest in using Still Creek as a recreation and commuter connection between Burnaby and Vancouver (Central Valley Greenway) and the increased emphasis on restoring ecological values throughout the Still Creek watershed has provided an opportunity to begin to address invasive species problems through more active management and restoration.

1.2 Why Worry About Invasive Plants?

The rapid establishment and growth of invasive plants is an important component of urbanization-related environmental change in parks and natural areas throughout Greater Vancouver. The effects of invasive plants include loss of habitat for native plant or wildlife species through competitive displacement, systemic change to soil fertility or disturbance processes, aesthetic changes, reduced human access in natural areas, increased vegetation management costs in parks, and human health risks. Yet, unlike other forms of landscape-scale change associated with urbanization such as forest loss or increased imperviousness, their effects are often subtle and incremental. Populations of many invasive plant species develop slowly and only become highly visible during later stages of invasion.

In the Still Creek corridor, the dominance of invasive species has contributed to a simplification or homogenization of plant communities. In many areas, structurally-diverse riparian forest has been replaced with a species-poor shrub community dominated by Himalayan blackberry, morning glory, Policeman’s helmet, and Japanese knotweed. In remaining forest patches such as the Beecher or Renfrew Park ravines, species-rich forest understorey communities have increasingly been replaced by shade tolerant invasive species particularly English ivy, yellow lamium, and common periwinkle.

It is important to the remember that within the broad group of alien or non-native species that have been introduced to Greater Vancouver, only a few have the potential to become invasive and change natural plant communities. Most will remain inconspicuous and locally distributed. The
few that have or will become widespread and abundant are typically highly competitive (e.g., form dense patches where they monopolize resources and have dispersal mechanisms suitable to urban areas (e.g., garden waste dumping, stormwater systems, soil movement).

1.3 Vegetation Patterns and Restoration Units in the Still Creek Corridor

Natural vegetation surrounding Still Creek and its tributaries can be divided into three types which reflect their vegetation structure and invasive plant composition, as well as recommendations for their restoration: 1) forested ravines of upper Still Creek, Guichon Creek, and Beecher Creek; 2) narrow and fragmented riparian corridors through eastern Vancouver and western Burnaby; and 3) larger patches of floodplain forest and shrub swamp in lower Still Creek. Boundaries between the types are not always distinct and Figure 1 shows their approximate location and their separation by subunit (restoration segment).

**Ravine Forests** - Vegetation surrounding upper Still, Guichon, and Beecher creeks is characterized by 30 to 60 year old deciduous forest dominated by red alder and black cottonwood with lesser amounts of big-leaf maple, bitter cherry, western redcedar and western hemlock. Red maple and horse-chestnut were noted occasionally and vine maple is often a sub-canopy tree. The width of natural vegetation ranges from approximately 95 m in the Renfrew Park ravine to 55 m in the Beecher Park ravine, and 45 m in the upper reaches of Guichon Creek. Most ravines abut private residences which is an important factor contributing to their alien species flora. Vegetation mapping as part of the Still Creek Watershed Biodiversity Case Study (Axys, 2001) described these areas primarily as *deciduous forest*. The understorey is typically composed of a well-developed shrub layer of salmonberry, vine maple, Himalayan blackberry, red elderberry, and Indian-plum; Himalayan blackberry is generally more prevalent and abundant along forest edges but also occurs in interior forest areas at lower abundance. Cherry-laurel, English holly, and to a lesser degree daphne-laurel are alien shrubs that are widespread but seldom abundant within the ravine forests. The ground layer is variable and ranges from salal, Oregon-grape, and trailing blackberry along the upper slopes of the ravine, to sword fern, lady-fern, three-leaved foamflower, and piggy-back plant on moister sites. English ivy and yellow lamium are often present and may be dominant in the understorey, particularly where residences back on the ravine; common periwinkle and goutweed are less common but can be locally abundant.

**Riparian Corridor Width:** average 65 m (40–110 m)
**Stream Width:** average 3.6 m (2.5–6.1 m)
**Total Vegetated Stream Corridor Area:** 21.6 ha
**Structural Complexity:** Moderate; even-aged deciduous vegetation with little conifer forest and few snags or downed logs.
**Shading:** <80% overhead cover from shrub and tree vegetation.
**Bank Stability:** High. Minor erosion observed sporadically. Post-development stabilization has likely occurred.

**Wildlife Habitat Value:** Moderate. Isolation and surrounding urban development reduce overall value of ravine forests for wildlife. Identified as a habitat refuges by Wark and Blyth (2004).

**Fish Habitat Value:** Moderate. No fish present in Renfrew Park ravine; but present in upper Beecher creek. Channel complexity relatively high for urban streams.

**Aesthetic and Recreation Values:** Aesthetic value is high, particularly in the context of landscape diversity. All three ravines are important recreation resources for the surrounding community.
Still Creek Invasive Species Inventory

Fig. 1. Distribution of Natural Areas and Location of Restoration Units

- Floodplain Forest Patch
- Forested Stream Ravine
- Fragmented Stream Corridor
- Stream Segment

Still Creek Invasive Species Inventory

Fig. 1. Distribution of Natural Areas and Location of Restoration Units

- Floodplain Forest Patch
- Forested Stream Ravine
- Fragmented Stream Corridor
- Stream Segment
**Fragmented Stream Corridors** – Sections of Still Creek in the eastern portion of the City of Vancouver (Renfrew Street to Highway 1) and in the eastern portion of the City of Burnaby (Still Creek Avenue to Willingdon Avenue) are contained within a narrow riparian corridor fragmented by roads, utility corridors, and light industrial development. All sections of the stream were relocated and channelized during development of the lowlands. The stream is typically 4 to 6 m wide and the entire corridor is approximately 20 m wide. Riparian vegetation is primarily Himalayan blackberry that occurs as monotypic thickets, or mixed with morning glory, reed canary grass, common tansy, salmonberry, Policeman’s helmet, Japanese knotweed, and American bittersweet. Policeman’s helmet, reed canary grass, and American bittersweet often form a band closest to the stream channel even when Himalayan blackberry is dominant. Black cottonwood is the most common tree, although it occurs sporadically; landscape trees such as red oak and common horse-chestnut may also be present.

**Riparian Corridor Width:** average 19.9 m (13.3–26.4 m)
**Stream Width:** average 6.6 m (2.5–10.5 m)
**Total Vegetated Stream Corridor Area:** 27.3 ha
**Structural Complexity:** Moderate; even aged deciduous vegetation with little conifer forest and few snags or downed logs.
**Shading:** <80% overhead cover from shrub and tree vegetation.
**Bank Stability:** High. Minor erosion observed sporadically. Post-developed stabilization has likely occurred.
**Wildlife Habitat Value:** Low. Low structural complexity; narrow width and intensive urban land use in surrounding area; few large patches of narrow vegetation; some use by urban wildlife including great blue heron.
**Fish Habitat Value:** Low. Poor channel complexity; little riparian cover; fine sediments; channel maintenance; and poor water quality.
**Aesthetic and Recreation Values:** Aesthetic value is high, particularly in the context of the landscape. All three ravines are important recreation resources for the surrounding community.

**Floodplain Forest and Shrub Swamp** – Lower Still Creek flows through two large patches of floodplain forest: one between Willingdon Avenue and Westminster Avenue that is approximately 250 m in width, and a second encompassed by Burnaby Lake Regional Park between Holdom Avenue and the pedestrian bridge at Sperling Avenue that is approximately 500 m in width. In combination, these two patches encompass approximately 62.2% (79.7 ha) of the natural stream corridor vegetation in the Still Creek watershed. Vegetation within Burnaby Lake Regional Park is a combination of deciduous forest (red alder, black cottonwood) inter-mixed with shrub communities ranging from dense thickets of hardhack, salmonberry, red-osier dogwood, and Pacific ninebark. The dominance of hardhack indicates seasonal flooding and suggests the area is a shrub swamp. Himalayan blackberry is uncommon in the interior shrub thicket areas, but forms dense patches, often in combination with Japanese knotweed and morning glory, along the margins of roads, trails, and in the transition between grass and shrub communities. Reed canary grass forms a dense band (10–25 m wide) along the stream channel; its dominance likely reflects winter flooding, previous channel maintenance, and beaver browsing on trees and shrubs along Still Creek.
**Riparian Corridor Width:** average 350 m (250–680 m)

**Stream Width:** average 12.5 m (9.5–23.0 m)

**Total Vegetate Stream Corridor Area:** 79.7 ha

**Structural Complexity:** Variable; low to moderate; shrub swamps

**Shading:** <10% overhead cover from shrub and tree vegetation. Water temperature is elevated during summer afternoons.

**Bank Stability:** High/moderate. Low gradient stream channel with little erosive power contributes to stability. Minor slumping observed.

**Wildlife Habitat Value:** Moderate–High. Some structural diversity (forest edges, shrub patches), limited human access, assemblage of shrub swamp, forest patches, and low gradient stream channel.

**Fish Habitat Value:** Low. Limited overhead cover; little addition of litter and large wood; poor complexity; historic channelization.

**Aesthetic and Recreation Values:** Moderate. Limited recreation use but increasing greenway connections; meandering stream channel amongst forest of moderate value.

### 1.4 Which Invasive Plants are of Conservation Concern in Still Creek?

As noted previously, hundreds of plants have been purposefully or accidentally introduced to Greater Vancouver in the past 130 years. However, only a few are invasive (e.g., widespread and abundant) and have caused ecological harm through competitive displacement of native plants and animals or functional changes to ecosystems. Invasive species can be divided into two groups based on distribution (common to rare) and local abundance (large dense patches to small sparse patches):

1. **primary invasive species** that are widespread and abundant in natural areas in the City of Burnaby or other areas of Greater Vancouver; and
2. **secondary invasive species** which are at initial stages of invasion or lower local abundance in the City of Burnaby but may have demonstrated invasive tendencies in other areas or may become abundant over time.

Based on initial assessment in the Still Creek watershed supplemented with inventory information from the City of North Vancouver, northeast Coquitlam, and the City of Seattle, Table 1 lists plants that are considered invasive in natural plant communities of the study area.

A second way to divide invasive species is based on shade tolerance. This is useful because it clearly demarcates which species are of concern in forest communities with low light levels compared to open or edge habitats.

**Shade tolerant invasive species** are found in the understorey of deciduous and mixed forests and, while often prevalent in edge habitats, establish and grow successfully in moderate shade. Most are evergreen and are able to take advantage of high light levels in deciduous forests in early spring before red alder and black cottonwood have leafed-out. They include English ivy, yellow lamium, common periwinkle, cherry-laurel, English holly, and daphne-laurel. The first three species have similar effects (high abundance in the ground-layer which can displace native species over time) although English ivy grows more rapidly, climbs trees, and disperses by seed, while lamium and common periwinkle are less invasive, disperse primarily from garden waste, and do not climb.

The second group (cherry-laurel, English holly, and spurge-laurel) are evergreen shrubs that are very similar in growth form and invasiveness; holly is more widespread which may reflect better dispersal and
establishment by bird-dispersed seeds. Aucuba 'Goldspot' and Portuguese laurel have similar growth-form but were observed rarely during the inventory adjacent to urban gardens. Himalayan blackberry is tolerant of moderate shade (perhaps because it is only semi-deciduous) but it often achieves less than 10% cover in red alder and black cottonwood forest and flowers sporadically. However, it is abundant along forest edges and in small clearings formed by the death of early successional deciduous trees. Policeman's helmet can also occur in forested areas but it is less abundant than in sunny areas.

(a) English ivy is the most widespread and abundant of shade tolerant invasive species; (b) yellow lamium occurs in forested areas around garden dump sites; (c) daphne-laurel is relatively rare but has the potential to increase in the future; (d) yellow lamium forming a dense patch in the Beecher Creek ravine.

Table 1. Primary and secondary invasive plants in the Still Creek watershed.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
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<tbody>
<tr>
<td><strong>Primary Invasive Species</strong></td>
<td></td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>Rubus armeniacus (syn. Rubus discolor)</td>
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<tr>
<td>reed canary grass*</td>
<td>Phalaris arundinacea*</td>
</tr>
<tr>
<td>English ivy</td>
<td>Hedera helix and Hedera hibernica (and varieties)</td>
</tr>
<tr>
<td>policeman’s helmet</td>
<td>Impatiens glandulifera</td>
</tr>
<tr>
<td>Japanese knotweed (syn. false-bamboo)</td>
<td>Fallopio species and hybrids (syn. Polygonum spp.)</td>
</tr>
<tr>
<td><strong>Secondary Invasive Species</strong></td>
<td></td>
</tr>
<tr>
<td>yellow lamium (syn. yellow archangel)</td>
<td>Lamiastrum galeobdolon (syn. Lamium galeobdolon)</td>
</tr>
<tr>
<td>cherry-laurel</td>
<td>Prunus laurocerasus</td>
</tr>
<tr>
<td>English holly</td>
<td>Ilex aquifolium</td>
</tr>
<tr>
<td>common hop</td>
<td>Humulus lupulus</td>
</tr>
<tr>
<td>common periwinkle (syn. vinca)</td>
<td>Vinca minor</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>Cytisus scoparius</td>
</tr>
<tr>
<td>common tansy</td>
<td>Tanacetum vulgare</td>
</tr>
<tr>
<td>morning glory (syn. field bindweed)</td>
<td>Convolvulus arvensis</td>
</tr>
<tr>
<td>daphne-laurel (syn. spurge-laurel)</td>
<td>Daphne laureola</td>
</tr>
<tr>
<td>clematis (syn. traveller's joy)</td>
<td>Clematis vitalba</td>
</tr>
</tbody>
</table>

* note, reed canary grass is considered a cryptogenic species with both native and introduced varieties present (Merigliano and Lesica, 1998)
Shade intolerant (or sun-loving) invasive species occur in grasslands, shrub communities, riparian areas, forest edges, and clearings where light levels are consistently high. Many edge habitats such as rail and road corridors have high light levels, regular tree removal, and enhanced dispersal from soil or seed movement during construction or maintenance. This group includes Himalayan blackberry, Japanese knotweed, reed canary grass, common tansy, morning glory, and common hops.

(a) the margins of rail corridors are often dominated by invasive species; (b) Himalayan blackberry is exceptionally abundant along forest edges (here it can be seen colonizing the adjacent grassland); (c) Himalayan blackberry is also very abundant along the narrow, fragmented corridor of upper Still Creek; (d) reed canary grass forms a band along the channelized lower reaches of Still Creek.
2 INVASIVE SPECIES INVENTORY

2.1 Methods

The distribution and abundance of invasive plants was surveyed in natural vegetation along Still, Guichon, Chubb, and Beecher creeks using a combination of air photo interpretation and field assessment. Assessment focused on fifteen invasive plant species that are considered of conservation concern in the Still Creek watershed from initial reconnaissance and previous assessment in Greater Vancouver (see sidebar). Identifications were made using field guides and taxonomic treatments (Pojar and MacKinnon, 1994; Douglas et al. 1999-2001). Common tansy, morning glory, and creeping buttercup were often difficult to inventory because of they are widespread but often inconspicuous amongst other dominant invasive plants.

Prior to field assessment, the location and boundaries of natural vegetation surrounding the study streams were delineated on recent (2004) orthophotos. This included contiguous floodplain forest or shrub swamp patches beyond the typical definition of riparian zone. Natural vegetation adjacent to culverted section of the study streams and forest patches that were separated from the stream by road, rail-line, or other infrastructure features were excluded from assessment. Previous vegetation mapping for the Still Creek watershed was also reviewed (Axys, 2001), however, its coarse scale made it too general for invasive species mapping.

Field assessment was undertaken between October 15 and November 18, 2005 with some rechecking in December 2005 and January 2006. Surveys of natural vegetation were conducted primarily on foot and the location and abundance (% cover) of primary invasive plants was mapped using acetate overlays of hard-copy orthophoto maps (see figure below). GPS mapping was not undertaken and is considered inefficient for watershed-scale surveys. Some areas were inaccessible because of private property concerns, industrial use, or dense shrub growth and invasive species are likely under-represented in these areas. As well, some species including Policeman’s helmet and common tansy had begun to senesce by the time the survey was initiated in mid-October. This likely reduced the estimate of their abundance and distribution relative to perennial species.

### Primary invasive plants:
- Himalayan blackberry
- Reed canary grass
- English ivy
- Policeman’s helmet
- Japanese knotweed
- Yellow lamium
- Common hops
- Common tansy
- Common periwinkle
- Scotch broom
- Morning glory
- American bittersweet
- Cherry-laurel
- English holly
- Clematis

Example of field mapping technique for a channelized portion of Still Creek. Invasive plants are mapped both as polygons (e.g., 50% Himalayan blackberry; 35% common tansy) or by specific points of infestation.
Survey information was transferred to a GIS system (Arcview 3.2) for final mapping. Mapping followed the format developed by the Seattle Urban Nature Project (Ramsay et al., 2004). Most invasive plants are broadly distributed within polygons or intermixed with other invasive species (e.g., Himalayan blackberry mixed with Japanese knotweed and reed canary grass) and their distribution band abundance was mapped based on percentage cover (<5%, 5-9%, 10-24%, etc). Species that form small, defined populations (e.g., English holly, cherry-laurel, daphne-laurel) were mapped as point features.

2.2 Data Analysis

Analysis focused on identifying the overall distribution and abundance of invasive plants in the study area. It was undertaken using a combination of Arcview queries and data summarization in MS Excel.

Abundance was measured as:

1) total number of polygons in which the invasive plant was present;
2) total area of polygons in which the invasive plant was present (dense or sparse amalgamated);
3) total cover of the invasive plant (calculated as the sum of % cover x polygon size).

Values were expressed by both number of polygons and number of hectares, as well as by percentage. Analyses were completed for the entire study area, by municipality (City of Burnaby and City of Vancouver) and by habitat type (ravine forests; fragmented stream corridors, floodplain forest and swamp).

2.3 Results

A total of 803 polygons encompassing 122.8 ha of vegetation were inventoried and mapped. The mean polygon size was 0.2 ha and ranged from 10 m² to 6.5 ha. 88.0% of the study area was in the City of Burnaby and 12.0% was in the City of Vancouver. 62.1% of the total area surveyed was classified as floodplain forest and swamp, 27.9% was ravine forest, and 10.1% was fragmented stream corridor. Appendix 1 provides maps of total invasive plant cover in the watershed, and maps of the abundance and distribution of the five primary invasive plants: Himalayan blackberry, reed canary grass, English ivy, policeman's helmet, and Japanese knotweed. Spatial data is also available through the City of Burnaby.

Invasive plants form a substantial component of riparian vegetation throughout the Still Creek watershed. Only 13 polygons totalling 7.7 ha (6.3%) did not have any invasive plants present. Most were found in the Still Creek floodplain where hardhack and Pacific ninebark communities have very minor invasive plant cover. As well, some areas of interior deciduous forest have very low invasive plant cover.

The most abundant invasive plants, based on total cover in the study area, were Himalayan blackberry, reed canary grass, English ivy, policeman's helmet, and Japanese knotweed (Table 2). Himalayan blackberry was substantially more abundant than any other species (found in 52.7% of polygons and covering 19.9% of all vegetation surveyed). Indeed,
Himalayan blackberry accounted for more of the invasive plant cover than the rest of the invasive plants combined. Reed canary grass was also prevalent in the lower portion of the Still Creek floodplain, while English ivy, policeman’s helmet, and Japanese knotweed were common in fragmented stream corridors and remnant forests.

Table 2. Summary of invasive plant abundance in the Still Creek watershed based on number of polygons occupied, total area affected, and total cover.

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Polygons</th>
<th>% Polygons</th>
<th>Total Area</th>
<th>% Total Area</th>
<th>Total Cover</th>
<th>% Total Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Himalayan blackberry</td>
<td>423</td>
<td>52.7</td>
<td>85.0 ha</td>
<td>69.2%</td>
<td>24.4 ha</td>
<td>19.9%</td>
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<tr>
<td>Reed canary grass</td>
<td>198</td>
<td>24.7</td>
<td>35.8 ha</td>
<td>29.2%</td>
<td>8.6 ha</td>
<td>7.0%</td>
</tr>
<tr>
<td>English ivy</td>
<td>76</td>
<td>9.5</td>
<td>5.4 ha</td>
<td>4.4%</td>
<td>3.5 ha</td>
<td>2.8%</td>
</tr>
<tr>
<td>policeman’s helmet</td>
<td>139</td>
<td>17.3</td>
<td>23.5 ha</td>
<td>19.1%</td>
<td>1.4 ha</td>
<td>1.2%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>99</td>
<td>12.3</td>
<td>5.3 ha</td>
<td>4.3%</td>
<td>1.4 ha</td>
<td>1.2%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>18</td>
<td>2.2</td>
<td>0.5 ha</td>
<td>0.4%</td>
<td>0.3 ha</td>
<td>0.3%</td>
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<tr>
<td>common hops</td>
<td>15</td>
<td>1.9</td>
<td>7.4 ha</td>
<td>6.1%</td>
<td>0.3 ha</td>
<td>0.2%</td>
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<td>common tansy</td>
<td>29</td>
<td>3.6</td>
<td>4.4 ha</td>
<td>3.6%</td>
<td>0.2 ha</td>
<td>0.1%</td>
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<tr>
<td>common periwinkle</td>
<td>18</td>
<td>2.2</td>
<td>0.2 ha</td>
<td>0.2%</td>
<td>0.2 ha</td>
<td>0.1%</td>
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<tr>
<td>Scotch broom</td>
<td>14</td>
<td>1.7</td>
<td>3.6 ha</td>
<td>2.9%</td>
<td>0.1 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>morning glory</td>
<td>13</td>
<td>1.6</td>
<td>0.9 ha</td>
<td>0.7%</td>
<td>0.1 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>9</td>
<td>1.1</td>
<td>0.8 ha</td>
<td>0.6%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

1 803 polygons in the study area; 2 122.8 ha of terrestrial vegetation surveyed in the study area.

The main differences between the City of Vancouver and City of Burnaby were the higher abundance of reed canary grass in Burnaby and the higher abundance of Himalayan blackberry and English ivy in Vancouver (Table 3). This reflects the lack of floodplain and wetland habitats that support reed canary grass in Vancouver, and the prevalence of Himalayan blackberry in both Renfrew Park and the fragmented stream corridor in the City of Vancouver. English ivy was also very common in the Renfrew Park ravine.

Himalayan blackberry was common throughout the three habitat types, although it was twice as abundant (31.3% of total cover) in the fragmented stream corridors (Table 4). Reed canary grass was not common or abundant in ravine forests (0.1%), but was very abundant in floodplain habitats (10.3%). English ivy was much more common and abundant in ravine forests (9.2%) than in floodplain or fragmented stream corridors (0.4% and 0.3% respectively), while Japanese knotweed and policeman’s helmet were more common in fragmented stream ravines than other habitats.
Table 3. Summary of invasive plant abundance in the portions of the Still Creek watershed in the City of Burnaby and City of Vancouver based on number of polygons occupied, total area affected, and total cover.

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Polygons</th>
<th>% Polygons</th>
<th>Total Area</th>
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<th>Total Cover</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>City of Burnaby</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Himalayan blackberry</td>
<td>356</td>
<td>53.6</td>
<td>76.2 ha</td>
<td>67.1%</td>
<td>20.5 ha</td>
<td>18.0%</td>
</tr>
<tr>
<td>Reed canary grass</td>
<td>192</td>
<td>28.9</td>
<td>35.2 ha</td>
<td>31.0%</td>
<td>8.6 ha</td>
<td>7.5%</td>
</tr>
<tr>
<td>English ivy</td>
<td>58</td>
<td>8.7</td>
<td>4.3 ha</td>
<td>3.8%</td>
<td>2.6 ha</td>
<td>2.3%</td>
</tr>
<tr>
<td>policeman's helmet</td>
<td>129</td>
<td>19.4</td>
<td>20.7 ha</td>
<td>18.2%</td>
<td>1.4 ha</td>
<td>1.2%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>90</td>
<td>13.6</td>
<td>5.2 ha</td>
<td>4.6%</td>
<td>1.4 ha</td>
<td>1.2%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>16</td>
<td>2.4</td>
<td>0.5 ha</td>
<td>0.4%</td>
<td>0.3 ha</td>
<td>0.3%</td>
</tr>
<tr>
<td>common hops</td>
<td>13</td>
<td>2.0</td>
<td>7.4 ha</td>
<td>6.5%</td>
<td>0.3 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>common tansy</td>
<td>19</td>
<td>2.9</td>
<td>4.1 ha</td>
<td>3.6%</td>
<td>0.1 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>common periwinkle</td>
<td>13</td>
<td>2.0</td>
<td>0.1 ha</td>
<td>0.1%</td>
<td>0.1 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>11</td>
<td>1.7</td>
<td>3.1 ha</td>
<td>2.7%</td>
<td>0.1 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>morning glory</td>
<td>2</td>
<td>0.3</td>
<td>0.1 ha</td>
<td>0.1%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>2</td>
<td>0.3</td>
<td>0.3 ha</td>
<td>0.3%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>City of Vancouver</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>67</td>
<td>48.6</td>
<td>8.8 ha</td>
<td>58.3%</td>
<td>3.9 ha</td>
<td>26.0%</td>
</tr>
<tr>
<td>Reed canary grass</td>
<td>6</td>
<td>4.3</td>
<td>0.6 ha</td>
<td>4.1%</td>
<td>0.0 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>English ivy</td>
<td>18</td>
<td>13.0</td>
<td>1.1 ha</td>
<td>7.0%</td>
<td>0.8 ha</td>
<td>5.5%</td>
</tr>
<tr>
<td>policeman's helmet</td>
<td>10</td>
<td>7.2</td>
<td>2.8 ha</td>
<td>18.5%</td>
<td>0.1 ha</td>
<td>0.4%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>9</td>
<td>6.5</td>
<td>0.1 ha</td>
<td>0.7%</td>
<td>0.1 ha</td>
<td>0.4%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>2</td>
<td>1.4</td>
<td>0.0 ha</td>
<td>0.2%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>common hops</td>
<td>2</td>
<td>1.4</td>
<td>0.1 ha</td>
<td>0.6%</td>
<td>0.0 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>common tansy</td>
<td>10</td>
<td>7.2</td>
<td>0.4 ha</td>
<td>2.5%</td>
<td>0.0 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>common periwinkle</td>
<td>5</td>
<td>3.6</td>
<td>0.1 ha</td>
<td>0.5%</td>
<td>0.1 ha</td>
<td>0.5%</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>3</td>
<td>2.2</td>
<td>0.5 ha</td>
<td>3.1%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>morning glory</td>
<td>11</td>
<td>8.0</td>
<td>0.8 ha</td>
<td>5.5%</td>
<td>0.1 ha</td>
<td>0.6%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>7</td>
<td>5.1</td>
<td>0.5 ha</td>
<td>3.1%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

1, 2 Portion of the study area in City of Burnaby = 664 polygons and 113.5 ha; portion in City of Vancouver = 138 polygons and 15.1 ha.
Table 4. Summary of invasive plant abundance in different habitat types in the Still Creek watershed in the City of Burnaby and City of Vancouver based on number of polygons occupied, total area affected, and total cover.

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of Polygons</th>
<th>% Polygons</th>
<th>Total Area</th>
<th>% Total Area</th>
<th>Total Cover</th>
<th>% Total Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stream Fragments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>150</td>
<td>56.8%</td>
<td>8.5 ha</td>
<td>50.0%</td>
<td>5.4 ha</td>
<td>31.3%</td>
</tr>
<tr>
<td>Reed canary grass</td>
<td>68</td>
<td>25.8%</td>
<td>4.0 ha</td>
<td>23.3%</td>
<td>0.6 ha</td>
<td>3.8%</td>
</tr>
<tr>
<td>English ivy</td>
<td>3</td>
<td>1.1%</td>
<td>0.3 ha</td>
<td>2.0%</td>
<td>0.1 ha</td>
<td>0.3%</td>
</tr>
<tr>
<td>policeman's helmet</td>
<td>65</td>
<td>24.6%</td>
<td>3.9 ha</td>
<td>22.9%</td>
<td>0.5 ha</td>
<td>2.8%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>38</td>
<td>14.4%</td>
<td>2.1 ha</td>
<td>12.4%</td>
<td>0.4 ha</td>
<td>2.1%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>1</td>
<td>0.4%</td>
<td>0.1 ha</td>
<td>0.6%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>common hops</td>
<td>2</td>
<td>0.8%</td>
<td>0.0 ha</td>
<td>0.1%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>common tansy</td>
<td>24</td>
<td>9.1%</td>
<td>1.1 ha</td>
<td>6.6%</td>
<td>0.1 ha</td>
<td>0.5%</td>
</tr>
<tr>
<td>common periwinkle</td>
<td>1</td>
<td>0.4%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>7</td>
<td>2.7%</td>
<td>0.5 ha</td>
<td>3.0%</td>
<td>0.0 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>morning glory</td>
<td>0</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>7</td>
<td>2.7%</td>
<td>0.5 ha</td>
<td>2.9%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td><strong>Ravine Forest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>122</td>
<td>44.0%</td>
<td>21.7 ha</td>
<td>63.1%</td>
<td>4.9 ha</td>
<td>14.5%</td>
</tr>
<tr>
<td>Reed canary grass</td>
<td>2</td>
<td>0.7%</td>
<td>0.1 ha</td>
<td>0.3%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>English ivy</td>
<td>67</td>
<td>24.2%</td>
<td>4.7 ha</td>
<td>13.6%</td>
<td>3.1 ha</td>
<td>9.2%</td>
</tr>
<tr>
<td>policeman's helmet</td>
<td>22</td>
<td>7.9%</td>
<td>5.4 ha</td>
<td>15.8%</td>
<td>0.3 ha</td>
<td>0.8%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>25</td>
<td>9.0%</td>
<td>0.4 ha</td>
<td>1.1%</td>
<td>0.3 ha</td>
<td>0.7%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>16</td>
<td>5.8%</td>
<td>0.4 ha</td>
<td>1.1%</td>
<td>0.3 ha</td>
<td>0.9%</td>
</tr>
<tr>
<td>common hops</td>
<td>1</td>
<td>0.4%</td>
<td>0.1 ha</td>
<td>0.2%</td>
<td>0.0 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>common tansy</td>
<td>0</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>common periwinkle</td>
<td>16</td>
<td>5.8%</td>
<td>0.2 ha</td>
<td>0.5%</td>
<td>0.1 ha</td>
<td>0.4%</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>0</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>morning glory</td>
<td>2</td>
<td>0.7%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.1 ha</td>
<td>0.2%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>1</td>
<td>0.4%</td>
<td>0.0 ha</td>
<td>0.1%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>Floodplain Forest and Swamp</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Himalayan blackberry</td>
<td>151</td>
<td>57.9%</td>
<td>54.8 ha</td>
<td>71.0%</td>
<td>14.1 ha</td>
<td>18.3%</td>
</tr>
<tr>
<td>Reed canary grass</td>
<td>128</td>
<td>49.0%</td>
<td>31.7 ha</td>
<td>41.2%</td>
<td>7.9 ha</td>
<td>10.3%</td>
</tr>
<tr>
<td>English ivy</td>
<td>6</td>
<td>2.3%</td>
<td>0.3 ha</td>
<td>0.5%</td>
<td>0.3 ha</td>
<td>0.4%</td>
</tr>
<tr>
<td>policeman's helmet</td>
<td>52</td>
<td>19.9%</td>
<td>14.2 ha</td>
<td>18.4%</td>
<td>0.7 ha</td>
<td>0.9%</td>
</tr>
<tr>
<td>Japanese knotweed</td>
<td>36</td>
<td>13.8%</td>
<td>2.8 ha</td>
<td>3.7%</td>
<td>0.8 ha</td>
<td>1.1%</td>
</tr>
<tr>
<td>yellow lamium</td>
<td>1</td>
<td>0.4%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>common hops</td>
<td>12</td>
<td>4.6%</td>
<td>7.3 ha</td>
<td>9.5%</td>
<td>0.3 ha</td>
<td>0.3%</td>
</tr>
<tr>
<td>common tansy</td>
<td>5</td>
<td>1.9%</td>
<td>3.3 ha</td>
<td>4.3%</td>
<td>0.1 ha</td>
<td>0.1%</td>
</tr>
<tr>
<td>common periwinkle</td>
<td>1</td>
<td>0.4%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>Scotch broom</td>
<td>7</td>
<td>2.7%</td>
<td>3.1 ha</td>
<td>4.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>morning glory</td>
<td>0</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
<tr>
<td>American bittersweet</td>
<td>1</td>
<td>0.4%</td>
<td>0.3 ha</td>
<td>0.3%</td>
<td>0.0 ha</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

1. Portion of the study area in stream fragments = 264 polygons and 17.1 ha; portion in ravines = 277 polygons and 34.4 ha; portion in floodplain = 261 polygons and 77.1 ha
3 RESTORATION PRIORITIES AND PRESCRIPTIONS

3.1 Priorities

There are three general approaches for identifying site-level priorities for invasive species management. The first approach is to focus management attention on sites with high resource value where few and sparse invasive plants are present. This approach has a goal of preventing further invasion. An example of this approach is to identify forest patches with limited invasive plant cover and prevent the establishment of shade tolerant understorey plants such as English ivy. This approach is supported by broad range of management experience that indicates that prevention of invasion is much less costly and more effective than management activities following establishment of invasive plants. However, there are relatively few areas in the Still Creek corridor that are free of invasive plants, and those that are (e.g., shrub swamps) are likely resistant to invasive species establishment because of environmental factors. The second approach is to focus on restoration of the most degraded sites with existing ecological or aesthetic values are limited and benefits to ecological, aesthetic, or recreational values from management can be substantial. An example of this approach is to restore forest cover in riparian areas that are dominated by Himalayan blackberry and other alien species. The third approach is to select sites based on their potential for public involvement, education, and research. This would include trail corridors, bridge crossings, neighbourhood park areas, or areas adjacent to well-used commercial zones.

The recommended approach in the Still Creek watershed is to focus initial management activities on sites where ecological values are compromised by invasive plant dominance, but that have a good potential for improvement. A secondary emphasis is placed on sites and activities that can be used as demonstration projects, both for increasing public awareness and testing restoration techniques. Figure 2 shows the location of priority sites. Table 5 summarizes the range of potential outcomes based on varying restoration intensity and Table 6 provides a summary of restoration and invasive plant management prescriptions by segment.

Priority 1 – Restore riparian forest in narrow stream corridors in upper Still Creek. Use Prescription 1 (Establishment of riparian forest patches) and Prescription 2 (Establishment of riparian forest patches with soil replacement) in the following segments (see Figure 2):

- Still Creek through eastern portion of City of Vancouver and western portion of City of Burnaby (SC3 to SC14) with initial emphasis on SC4 (Great Canadian Superstore site), SC8 (Vancouver Film Studio), SC9, and SC11.
- Chubb Creek (CC1 (west of SkyTrain) and CC2 (east of SkyTrain).

Priority 2 – Increase riparian forest in areas currently dominated by reed canary grass in lower Still Creek. Use Prescription 3 on a test or demonstration basis in the following areas (see Figure 2):

- Lower Guichon Creek (rail-line to confluence in SC18)
- Lower Still Creek mainstem (SC 19)
- eastern portion of SC 15 (reed canary grass fan on south side of mainstem)

Priority 3 – Increase coniferous forest in deciduous dominated forest patches through underplanting. Use Prescription 4 on the following priority sites (see Figure 2):

- Northern portion of Beecher Creek ravine (BC2) where some underplanting has already occurred.
- Beecher Park area (BC1) north of the ball diamond where limited understorey is currently present a middle aged red alder stand.
Invasive Plants in the Still Creek Watershed – Inventory Results and Restoration Prescriptions

- Guichon Creek forest patches (GC1 to GC7) on south end of BCIT campus (high potential for stewardship involvement through BCIT fish and wildlife).
- Southern portion of the Renfrew Park ravine (SC1).

**Priority 4** – Remove dominant invasive plants in forested park areas. Focus on an assemblage of species: English ivy, yellow lamium, common periwinkle, cherry-laurel, English holly, and daphne-laurel. Priorities sites include (see Figure 2):

- Southern and central portion of Beecher Creek ravine (yellow lamium, English ivy, and English holly primarily) (BC2)
- Southern and central portion of upper Renfrew Park ravine (SC1)
- Upper Guichon Creek ravine (GC1, GC3, GC4, GC5).

### 3.2 Restoration Issues to Consider

**Restoring Riparian Forest** – While shrub swamps and other nonforested plant communities occurred in the Still Creek lowlands prior to urban development, coniferous forest was the dominant plant community in the watershed (North et al. 1979). Large western redcedar stumps observed in the Renfrew Park and Beecher Creek ravines during the survey (see photo to right) suggest it was a dominant tree in riparian areas. Coniferous or mixed coniferous-deciduous riparian forest contributes to the health of small streams, supports a regionally adapted plant and animal community, and is less susceptible to invasive species establishment and growth than deciduous forest because of reduced light levels and an acidic, organic litter layer that prevents establishment (Naiman and Bilby, 1998). Riparian forest is often structurally diverse – edge habitats, multilayered vegetation, large amounts of standing and downed wood, which increases the wildlife diversity. Riparian forest is also critical to healthy streams by shading the stream channel, contributing leaves and other detritus that sustains the food chain, and providing a source of large logs which increase habitat complexity. Water temperature in Still Creek is elevated in summer because of the lack of riparian forest cover (City of Vancouver et al., 2005).

**Removal of Himalayan Blackberry** – Himalayan blackberry is the most widespread and abundant invasive plant species in riparian areas of the Still Creek watershed. It is a problematic species to manage because of both biotic and cultural factors; it is widespread and abundant in a variety of habitats; it has a deep root system that is difficult to remove through conventional vegetation clearing; its berries are used by humans; and, there is a perception that it provides high-quality habitat for birds and small mammals. Two points may help address the concern that Himalayan blackberry is a desirable invasive species. First, blackberry is so widespread in Greater Vancouver that control programs will only target patches in a limited group of sites such as riparian areas, wetlands, and old fields. Opportunities for berry picking will continue to be common. Second, there is contradictory evidence on the importance of blackberry for birds and small mammals. Some naturalists consider it important habitat for overwintering song-birds, while others consider it habitat for rats and other undesirable species. Quantitative research is sparse. A recent study by the Canadian Wildlife Service (Kranznits et al., 2005) in Delta, BC found that landscape structure (e.g., presence of a range of habitat types) was more important than hedgerow composition for bird use and diversity. However, the species richness of birds, and the use by Black-capped Chickadees and Downy Woodpeckers, was negatively associated with hedgerows with...
Table 5. Potential outcome of restoration activities of varying intensity by habitat type.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Effort Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Intensity</td>
</tr>
<tr>
<td></td>
<td>No restoration or management</td>
</tr>
<tr>
<td><strong>Vision</strong></td>
<td>Allow natural succession to occur and maintain existing values</td>
</tr>
<tr>
<td><strong>Ravine Forest</strong></td>
<td>Management Activities</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Potential Outcome</td>
</tr>
<tr>
<td><strong>Fragmented Stream Corridor</strong></td>
<td>Management Activities</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Potential Outcome</td>
</tr>
<tr>
<td><strong>Floodplain Forest + Swamp</strong></td>
<td>Management Activities</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Potential Outcome</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Himalayan blackberry and native shrubs. Wildlife use is often associated with structurally complex habitats – patches of forest or forest edges adjacent to open meadows or shrub thickets. Himalayan blackberry reduces structural diversity by forming monotypic patches.

**Beaver Activity** - Beaver are a natural component of the Still Creek ecosystem. However, the lack of riparian trees and native shrubs in some
areas of the watershed has increased browsing damage by beaver on the limited tree and shrub vegetation that is present. Black cottonwood, one of the few species able to grow rapidly enough to avoid competition from Himalayan blackberry, is very susceptible to beaver damage. Street trees have been affected recently in the City of Vancouver. Beavers can also cause drainage problems on low-gradient stream channels.

**Higher Level Plans** – The *Still Creek Integrated Stormwater Management Plan* (ISMP) (City of Vancouver et al., 2005) provides direction on stormwater planning including strategies for habitat protection, restoration, and invasive species management. As well, the City of Vancouver completed the *Still Creek Rehabilitation and Enhancement Study* (Lees and Associates et al., 2002) to guide restoration activities along Still Creek in the eastern portion of the City. Short-term restoration efforts should be guided by both documents and should be designed to accelerate rather than impede long-term restoration of Still Creek.

**Habitat Protection Requirements** – Stream corridors, by definition, are adjacent to aquatic habitats which must be protected from physical disturbance and sediment, herbicides, or other contaminants. Riparian vegetation including invasive plants such as Himalayan blackberry are considered fish habitat and cannot be removed without consulting Fisheries and Oceans Canada. However, vegetation restoration projects with the goal of establishing trees are not likely to require formal approval. We recommend that restoration plans be discussed informally with Fisheries and Oceans staff prior to implementation. As well, best management practices such as sediment and erosion control, timing windows to avoid bird nesting, and avoiding direct disturbance to the stream channel should be used when working in riparian areas.

### 3.3 Restoration Guidelines

1. Focus restoration activities on maintaining or restoring the composition, function, and diversity of natural plant communities in the Still Creek watershed as a critical component of biodiversity. Incorporate invasive species management as part of restoration planning.
2. In the long-term, increase the width the riparian vegetation in narrow, fragmented stream corridors during the redevelopment process. As well, use opportunities for stream relocation and redevelopment to remove invasive species through excavation and soil replacement.
3. Use demonstration projects in high profile sites such as stream crossing and well-used park areas to showcase vegetation restoration in the watershed.
4. The successful establishment of diverse natural plant communities in areas heavily affected by invasive plants will depend more on pre-planting site preparation and long-term monitoring and maintenance than on plant selection and design. All restoration plans must be accompanied by a monitoring and maintenance schedule. Plantings in parks or natural areas should never be considered maintenance free. New plantings require monthly inspections and maintenance (weeding, tilling, watering, etc) during the first two growing seasons and quarterly inspections and maintenance for up to 5 years. Plantings may require monitoring and maintenance in perpetuity to prevent invasive species establishment.
5. The establishment of competitive, invasion-resistant plant communities should be the focus of planting design and plant selection in park areas and developed areas (e.g., bridge crossings, trailheads, etc) of the Central Valley Greenway. Highly diverse planting plans with flowering plants (wildflowers, ferns, etc) are not recommended without intensive maintenance programs. Plants should be selected based on competitive abilities (e.g., ability to form dense cover which limits soil, light, and moisture resources for invasive plants). Slow growing species such as salal are not appropriate unless long-term maintenance and irrigation are provided.
6. The management of soils contaminated with invasive plant seeds and roots is critical for successful vegetation projects. Native soils should not be used for planting without treatment (e.g., tilling and fallowing over multiple years, chemical treatment, geotextile matting, mulching, etc). Imported growing medium should be used where possible, but will still require weeding and maintenance. Note, soil is often a cause of invasive species dispersal and any soil moved from the site must be trucked to an appropriate location.

7. Preplanting treatments are recommended at least one year in advance of planting in areas with heavy invasive plant cover. This may include repeated mowing during the growing season, soil tilling and herbicide treatment if appropriate. Fallowing (the use of tilling and cover crop planting) may be effective in larger treatment areas. Note, invasive plant material removed from the site must be trucked to an appropriate treatment facility.

8. Seasonal timing is important for some preplanting treatments. Himalayan blackberry can be mowed at any time; Scotch broom and Policeman’s helmet should be mowed prior to seed formation or after seed maturation to prevent more widespread dispersal.

9. Planting plans should address invasive species in adjacent areas because of the rapid migration of invasive species into disturbed, newly planted areas.

10. Plants purchased from nurseries should be free of invasive plants, seeds, or plant parts. Inspection of nursery stock should address this issue.

11. Plant sizing and density should reflect the objective of establishing a competitive plant community. Stock size should generally be over 1 gallon and density should be less than 1 m on centre for shrub plantings.

12. The use of mulches and/or cover crops can be effective for reducing weed and invasive plant establishment. Raw chipped woody plant material from 5 to 15 cm in depth has been effective on some sites and allows planted stock establishment as it begins to break down. Cover crops include restoration seed mixes, turf grass, white clover, or custom mixes.

13. Encourage property owners, businesses, utility companies, and local residents to participate in vegetation restoration, particularly by maintaining newly planted trees.
Still Creek Invasive Species Inventory

Fig. 2. Priority Invasive Plant Management and Restoration Sites

- **Riparian Forest Restoration** (Prescription 1 and 2)
- **Reed canary grass - Riparian Forest Restoration** (Prescription 3)
- **Conifer Underplanting** (Prescription 4)
- **Understorey Invasive Control** (Prescription 6)
Table 6. Restoration prescriptions by habitat type and site in the Still Creek watershed.

<table>
<thead>
<tr>
<th>Restoration Segment</th>
<th>Length</th>
<th>Area</th>
<th>Habitat Type</th>
<th>Prescription Options</th>
</tr>
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<tbody>
<tr>
<td><strong>Still Creek</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC1</td>
<td>620 m</td>
<td>6.6 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>SC2</td>
<td>307 m</td>
<td>5.8 ha</td>
<td>Ravine Forest</td>
<td>P4 + P5 + P6</td>
</tr>
<tr>
<td>SC3</td>
<td>280 m</td>
<td>0.7 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC4</td>
<td>61 m</td>
<td>0.2 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC5</td>
<td>115 m</td>
<td>0.3 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC6</td>
<td>253 m</td>
<td>0.7 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC7</td>
<td>160 m</td>
<td>0.3 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
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<tr>
<td>SC8</td>
<td>222 m</td>
<td>0.5 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC9</td>
<td>172 m</td>
<td>0.4 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
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<td>SC10</td>
<td>207 m</td>
<td>0.3 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
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<td>SC11</td>
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<td>P1 + P2</td>
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<td>170 m</td>
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<td>Fragmented Corridor</td>
<td>P1 + P2</td>
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<tr>
<td>SC13</td>
<td>233 m</td>
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<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC14</td>
<td>192 m</td>
<td>1.5 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>SC15</td>
<td>791 m</td>
<td>16.4 ha</td>
<td>Floodplain Forest</td>
<td>P3 + P4 + P6</td>
</tr>
<tr>
<td>SC16</td>
<td>694 m</td>
<td>2.1 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
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<tr>
<td>SC17</td>
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<td>0.5 ha</td>
<td>Fragmented Corridor</td>
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</tr>
<tr>
<td>SC18</td>
<td>1,008 m</td>
<td>48.0 ha</td>
<td>Floodplain Forest</td>
<td>P3 + P4 + P6</td>
</tr>
<tr>
<td>SC19</td>
<td>475 m</td>
<td>15.3 ha</td>
<td>Floodplain Forest</td>
<td>P3 + P4 + P6</td>
</tr>
<tr>
<td><strong>Chubb Creek</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC1</td>
<td>360 m</td>
<td>1.3 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>CC2</td>
<td>202 m</td>
<td>0.8 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td><strong>Beecher Creek</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC1</td>
<td>208 m</td>
<td>3.2 ha</td>
<td>Ravine Forest</td>
<td>P4 + P5</td>
</tr>
<tr>
<td>BC2</td>
<td>840 m</td>
<td>6.1 ha</td>
<td>Ravine Forest</td>
<td>P4 + P5 + P6</td>
</tr>
<tr>
<td>BC3</td>
<td>139 m</td>
<td>0.5 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>BC4</td>
<td>165 m</td>
<td>0.4 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>BC5</td>
<td>204 m</td>
<td>0.7 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2 + P3</td>
</tr>
<tr>
<td><strong>Guichon Creek</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GC1</td>
<td>490 m</td>
<td>3.0 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC2</td>
<td>122 m</td>
<td>0.4 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
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<tr>
<td>GC3</td>
<td>192 m</td>
<td>0.6 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC4</td>
<td>444 m</td>
<td>1.6 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC5</td>
<td>134 m</td>
<td>1.9 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC6</td>
<td>291 m</td>
<td>3.0 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC7</td>
<td>166 m</td>
<td>1.0 ha</td>
<td>Ravine Forest</td>
<td>P4 + P6</td>
</tr>
<tr>
<td>GC8</td>
<td>215 m</td>
<td>0.9 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>GC9</td>
<td>183 m</td>
<td>0.5 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
<tr>
<td>GC10</td>
<td>128 m</td>
<td>1.0 ha</td>
<td>Fragmented Corridor</td>
<td>P1 + P2</td>
</tr>
</tbody>
</table>
3.4 Restoration Prescriptions

Six prescriptions were developed for reducing invasive species dominance and restoring natural plant communities in riparian areas of the Still Creek watershed:

**Prescription 1** – Establish patches of riparian trees in Himalayan blackberry-dominated riparian areas through small-scale clearing.
**Prescription 2** – Establish riparian trees and shrubs in Himalayan blackberry-dominated riparian areas through soil replacement.
**Prescription 3** – Establish riparian trees in reed canary grass-dominated riparian areas.
**Prescription 4** – Underplant conifers in deciduous forest.
**Prescription 5** – Establish native plantings at high profile recreation sites.
**Prescription 6** – Remove invasive understorey plants in deciduous forest.

**Prescription 1 - Establish Riparian Forest Patches**

**Objectives**

1. Establish riparian forest in narrow riparian areas currently vegetated with dense Himalayan blackberry and other invasive plants without intensive clearing programs.
2. Increase riparian vegetation diversity both for wildlife and aesthetic values.
3. Increase shading of the stream channel to reduce water temperature concerns.

**Method**

1. Delineate tree planting sites that are 50 to 200 square meters in size and distributed at a spacing of approximately four per 50 m of riparian corridor (two per side). Uniform distribution should be avoided to increase naturalness. The location of proposed trees should be marked with flags (if access permits) and the clearing boundary should be extended to 3 to 5 m around the planting sites. This is designed to prevent encroachment from the invasive plants in the surrounding area.

Before Restoration

After Restoration
2. Remove all Himalayan blackberry, morning glory, and common tansy using mechanical brushcutters or using a flail mower operated from adjacent roads or parking areas. Cut existing vegetation to ground level. Leave any significant native plants such as salmonberry or black cottonwood trees. If possible, leave cut material on site for mulch. Mowing or brushing should be repeated twice during the growing season to reduce Himalayan blackberry re-establishment.

3. If exposed soil is visible after initial mowing or brushing in mid May, immediately seed with a general purpose turfgrass mix. Alternately, uncomposted leaves and chipped branches from vegetation maintenance activities can be placed on the cleared area to a maximum depth of 10 cm.

4. Tree planting should occur during the second spring between March 15 and April 30. Mowing or brushing should be undertaken at time of planting if required. Trees should be approximately 1.0 to 1.5 m tall (2 to 5 gallon) planted at a spacing of 2.5 to 3.5 m on centre. No staking is recommended. Recommended species are shown in the box to the left. Native species are recommended because of their suitability for riparian areas, as well as to focus restoration efforts on native plant community values.

5. A 1 m high wire beaver control fence should enclose the entire planting area. Fencing should consist of 2”x2” posts on 1.5 m centres with wire mesh fencing 1 m high with a mesh size no greater than 1” square. The fencing also provides a clear boundary for maintenance activities.

6. Signs (8.5” x 11”) should be affixed to the fence every 5 m of length on the side away from the stream channel. The sign should clearly state: “Still Creek Tree Planting Site – No Disturbance” (or similar).

Maintenance and Monitoring
1. Trees should be inspected every 45 days during the first two growing seasons (May 1, June 15, August 1, and September 15) to remove new growth of blackberry (hand tilling, pulling, or pruning) and inspect trees for signs of moisture stress or beaver damage. Hand-watering should be implemented if required.
2. In years 3, 4, and 5, planting sites should be inspected around May 15 and September 15 and invasive plants should be removed or cut. More frequent maintenance clearing should be undertaken if invasive plant growth is increasing.

Recommended Sites
See Figure 2 for priority sites.
- Still Creek through eastern portion of City of Vancouver (SC3 to SC14).
- Chubb Creek (CC1 and CC2).
- Guichon Creek (GC8).

Timing
May (first year) = delineation of planting area; mowing; seeding; fencing
July (first year) = second mowing or brushing treatment
September (first year) = third mowing or brushing treatment
March – April (second year) = planting

Cost
- Site preparation (per treatment) = 2 – 4 hrs at $55 per hour per 100 square meters ($1.10 to $2.50 per square meter)
- Seeding = $0.50 per square meter
- Fencing = $20.00 per linear meter ($50 per linear for permanent chainlink).
- Plant materials = $4.00 – $10.00 per square meter depending on stock size ($11 each planted for budgeting).
- Planting = 50% of plant material costs.
- Monitoring and maintenance = 2 – 4 hrs x 4 times annually for first three years (approximately $1200 per 100 m² per year) including photodocumentation and very brief letter report.
Prescription 2 - Riparian Forest Establishment with Soil Replacement

Objectives
1. Establish riparian forest community in riparian areas currently vegetated with dense Himalayan blackberry and other invasive plants using intensive excavation.
2. Increase riparian vegetation diversity both for wildlife and aesthetic values.
3. Increase shading of the stream channel to reduce water temperature concerns.

Potential for Success
2. Moderate to high potential for invasive species control in long-term with regular maintenance.
3. High potential for increasing diversity and structure of riparian corridor.

Method

1. Obtain appropriate environmental approvals (FOC, MOE Instream Works notification, etc).
2. Delineate work areas no less than 20 linear meters on one side of the stream. Smaller patches may be appropriate but increase the proportion of edge habitat.
3. Between June 1 and September 30 (low flows), fully excavate vegetated riparian margin and associated soils to a depth of 50 cm using an excavator or rubber tired backhoe. Deeper excavation may be required if roots remain visible.
4. Remove excavated soil and vegetation from the site and dispose of it without risk to contamination of other sites.
5. Replace soil with a weed-free constructed growing medium. The coarse fraction can be increased by the minor addition (<10% by volume) of a granular or road base material. No native soils are to be used.
6. Planting Option 1 (bioengineering) Install willow (*Salix lucida, Salix scouleriana, Salix sitchensis*) brush layers (1.5 m long live willow cuttings) in layers between biodegradable erosion control matting. Dormant season installation is preferred but growing season installation can occur with good stock handling and regular irrigation.

Recommended trees

- black cottonwood 15%
- red alder 5%
- Douglas-fir 30%
- western redcedar 25%
- big-leaf maple 5%
- Pacific willow 5%

Recommended shrubs

- Indian-plum (15%)
- Nootka rose (10%)
- thimbleberry (30%)
- salmonberry (20%)
- red flowering currant (5%)
- Sitka willow (10%)
- beaked hazel (10%)

7. Planting Option 2: Install standard container grown trees and shrubs (see list to left). If required, install a standard erosion control matt (SC150 or equivalent) on the lower 1 m (in elevation) of the stream channel to prevent soil loss. Alternately, install silt fencing at the toe of the soil placement area.
8. Tree planting should occur during the second spring between March 15 and April 30. Trees should be approximately 1.0 to 1.5 m tall (2 to 5 gallon) planted at a spacing of 2.5 to 3.5 m on centre. No staking is recommended. Recommended species are shown in the box to the left.
Native species are preferred but non-native landscape trees such as tulip-tree, sweetgum, or other species can be substituted if adjacent businesses prefer.

9. Seed exposed soil immediately following planting with a general purpose turfgrass mix. Alternately, uncomposted leaves and chipped branches from vegetation maintenance activities can be placed on the cleared area to a maximum depth of 10 cm.

10. Install semi-permanent automated irrigation system for use in first growing season.

**Maintenance and Monitoring**

1. Trees and shrubs should be inspected every 45 days during the first two growing seasons (May 1, June 15, August 1, and September 15) to remove weed growth (hand tilling, pulling, or pruning) and inspect trees for signs of moisture stress or beaver damage.

2. In years 3, 4, and 5, planting sites should be inspected around May 15 and September 15 and invasive plants should be removed or cut. More frequent maintenance clearing should be undertaken if invasive plant growth is increasing.

**Recommended Sites**

- Still Creek through eastern portion of City of Vancouver (SC3 to SC14).
- Chubb Creek (CC1 and CC2).
- Guichon Creek (GC8).

**Timing**

- June 1 to September 30 = soil excavation and bioengineering
- October = conventional planting

**Cost**

- Site preparation = excavation and regrading at $35 per m³.
- Disposal of waste soil = $150 per truck.
- Soil and soil placement = $35 per m³.
- Seeding = $0.50 per square meter.
- Bioengineering (3 layers or wraps of willow, soil, + geotextile) = $150-$300 per linear meter.
- Fencing = $20.00 per linear meter ($50 per linear for permanent chain-link).
- Plant materials = $4.00 - $10.00 per square meter depending on stock size ($11 each planted for budgetting).
- Monitoring and maintenance = 2 to 4 hrs x 4 times annually for first three years (approximately $1200 per 100 m²) per year including photodocumentation and very brief letter report.)
Prescription 3 - Establish Riparian Trees in Reed Canary Grass Areas

Objectives
1. Establish riparian forest community in riparian areas of lower Still Creek currently vegetated with monotypic reed canary grass.
2. Increase riparian vegetation diversity both for wildlife and aesthetic values.
3. Increase shading of the stream channel to reduce water temperature concerns.

Potential for Success
1. Moderate to high potential to increase riparian forest diversity and stream channel shading.
2. Moderate to high potential to address reed canary grass dominance through shading.
3. Low potential to reduce invasive plant cover in long-term because of the increased opportunity for Himalayan blackberry to invade deciduous forest.

Method
1. Install fast growing, flood tolerant riparian trees including red alder, Pacific willow, black cottonwood, and western redcedar in patches.
2. Target sites approximately 10 m by 20 m (200 square meters). Plant at a density 1.5 to 2.0 m on centre. Willow livestakes or black cottonwood whips may also be interplanted with the container stock to increase density.
3. Select sites with dense reed canary grass growth but are generally free of Himalayan blackberry (to reduce initial competition). Avoid sites with high native plant diversity.
4. Use stock that is a minimum of 1.5 m tall and well branched (2 or 5 gallon).
5. Excavate planting hole and remove reed canary grass matt (typically upper 15 cm) at least 50 cm across.
6. Install trees; do not plant in standing water. Ensure air pockets are removed in dense soils. Flag trees to improve monitoring during grass growth.
7. Install beaver exclusion fencing (1 m, anchored to ground; 2”x2” posts) around each tree or each patch.
8. Alternative approaches include planting on raised micro-sites such as installed stumps or wood debris.

Maintenance and Monitoring
Regular cutting of reed canary grass and other competing vegetation will increase establishment success. If possible, inspect tree monthly during first two growing seasons.

Recommended Sites
See Figure 2 for priority sites.
Lower Still Creek = Segments SC19 and SC20.

Timing
March to June (extended planting season because of
Avoid fall and winter planting when soil saturation may cause water-logging.
Cost
- Site preparation = excavation and regrading at $35 per m$^3$.
- Disposal of waste soil = $150 per truck.
- Soil and soil placement = $35 per m$^3$.
- Seeding = $0.50 per square meter.
- Bioengineering (willow, soil, + geotextile (3 layers) = $150-$300 per linear meter.
- Fencing = $20.00 per linear meter

Prescription 4 - Underplant Conifers

Objectives
1. Increase the structural complexity of remnant forest patches dominated by red alder and black cottonwood.
2. Reduce invasibility of riparian forest by reducing understorey light levels in the long-term.
3. Prevent rapid establishment of Himalayan blackberry in forest gaps caused by red alder mortality.
4. Increase stream channel complexity in the long-term by increasing the potential for stable large wood additions.

Potential for Success
1. Low short-term potential for invasive species control (<5 years).
2. Moderate potential for invasive species control in long-term (10-25 years).
3. Moderate-high potential for increasing forest diversity and structure in long-term (>10 years).

Method
1. Underplant 1 or 2 gallon western redcedar (50% of total trees planted), western hemlock (15%), and grand-fir (35%) container grown trees or 415 plugs (4 cm x 15 cm) by hand. Larger stock (maximum 1.5 m tall) can be used for high profile sites or where competition from existing vegetation is intense.
2. Plant at a spacing of 3 to 5 m on centre. Where limited stock is available, plant in clusters of 10 to 15 rather than spreading isolated plants through a broader area. Mark plants.
3. Select planting sites away from trail margins where damage from recreation activities may occur. Select sites that do not experience winter flooding or have saturated soils. Where possible, select sites with the highest light levels such as natural canopy gaps or forest margins.
4. Do not plant western hemlock within 30 m of buildings or major trails to avoid windthrow risk to infrastructure at maturity.
5. Prune surrounding shrub vegetation within 1 m of the planting site to reduce competition from surrounding vegetation.

Maintenance and Monitoring
1. Inspect sites within 2 months of planting to identify any initial problems (moisture stress, vandalism, etc.).
2. Undertake watering between July 1 and October 15 if required (e.g., dry year and obvious moisture stress).
3. Enumerate planted stock annually to assess establishment success and growth.
4. Prune competing vegetation once annually (May-June) to reduce competition.

**Priority Sites**
See Figure 2 for priority sites.
- Northern portion of Beecher Creek ravine (BC2) where some underplanting has already occurred.
- Beecher Park area (BC1) north of the ball diamond where limited understorey is currently present a middle aged red alder stand.
- Guichon Creek forest patches (GC1 to GC7) on south end of BCIT campus (high potential for stewardship involvement through BCIT fish and wildlife).
- Renfrew Park ravine (SC1 + SC2).

**Timing**
October 15 to November 30 or April 1 to May 15. Avoid summer planting.

**Cost**
1. Material cost $1,600 to $8,500 per hectare depending on stock size ($1.50 for plugs to $7.50 for 2 gallon container stock) and density.
2. Planting cost are approximately 50% of stock costs = $800 to $4,250 per hectare
3. Maintenance and monitoring costs are variable; annual monitoring and reporting ranges from $100 to $500 per hectare. Maintenance costs are approximately 50% of initial planting costs per hectare ($800 to $4,000) depending on intensity of clearing, requirements for replanting, etc).

**Prescription 5 - High Profile Native Plantings**
**Objectives**
1. Create high profile native plant communities at important points along the Central Valley Greenway, trail, or bridge crossings.
2. Develop a palate of “signature” plantings that identify the Central Valley Greenway.
3. Incorporate environmental signage with plantings.

**Potential for Success**
High potential for success with good design, irrigation, and regular maintenance.

**Method**
There are a broad range of possible methods and designs for these planting and specific details are best left to design professionals on the CVG.
High diversity should be avoided and massed plantings (20 square meters minimum) of one or two species are recommended.
Soil management is critical. Native soils cannot be used; weed-free growing medium is essential.
Plantings should be structured to have lower growing species near the foreground and taller species in the background. Small, fragile, or slow growing plants should be avoided because of the potential for trampling and other disturbance. Temporary fencing may be required during initial establishment.

Possible plants for use in signature plantings:
Sun: Large-leaved lupine, hedge-nettle, native cow-parsnip, goat's beard, lady fern, tall camas
Shade: sword fern, lady fern, colt's foot, twisted stalk
Shrubs: red flowering currant, Indian-plum, mock-orange, red-osier dogwood, Hooker's willow

**Maintenance and Monitoring**
Regular maintenance required on a monthly or bimonthly basis during the growing season.

**Recommended Sites**
Trailheads, bridge crossings, viewing platforms and other high profile, easily accessible sites along the Central Valley Greenway and connected recreational links.

**Timing**
Spring planting recommended to allow plants to rapidly establish before moisture stress. Fall planting is not recommended because

**Cost**
Highly variable depending plants and other landscape features. Site preparation, soil, plants, planting, other landscape features, irrigation, maintenance, monitoring are typically required.

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**Prescription 6 - Removal Invasive Understorey Species**

**Objectives**
1. Remove dense growth of shade tolerant understorey species (particularly English ivy and yellow lamium but including common periwinkle, English holly, cherry-laurel, and daphne-laurel) to increase native plant diversity.
2. Prevent damage (e.g., increased windthrow) to trees from English ivy infestation.

**Potential for Success**
1. Moderate short-term potential for invasive species control with repeated treatments (<5 years).
2. Low potential for invasive species control in long-term (10-25 years) because of likely regrowth from remnant root systems.

**Method**
1. There are a variety of methods for removing understorey invasive species including pulling, shallow digging, pruning or girdling (for arboreal ivy), and raking.
2. Experienced stewardship staff with previous involvement in ivy pulls or other invasive species projects should provide on-site direction.
3. Most debris must be removed from sites, although tarping of some materials may be sufficient to prevent regrowth. Shrubs such as English holly, cherry-laurel, and daphne-laurel that do not grow from cut stems or leaves may be left on-site.
4. Success depends on focused efforts on well-defined patches and careful removal of roots. Some methods break plants into smaller pieces that can re-establish or disperse the patch.
5. Care must be taken to avoid disturbance or damage to native shrubs, ferns, forbs, and tree seedlings.
6. Replanting may be used after removal to increase understorey diversity, however, planting is unlikely to prevent re-establishment or regrowth of invasives without intensive maintenance. Conifers (see Prescription 1) may be partially successful in shading some species.

**Maintenance and Monitoring**
Treated sites require ongoing inspection and maintenance. Treated sites should be revisited within 2 months of initial removal to identify regrowth. Maintenance clearing is required at the beginning (May) and end (September) of each growing season for 3 to 5 years.

**Recommended Sites**
See Figure 2 for priority sites.
- Beecher Creek ravine (BC2) particularly south end on west side.
- Guichon Creek forest patches (GC1 to GC5).
- Renfrew Park ravine (SC1 + SC2).

**Timing**
All year. Winter activities may minimize damage to inter-mixed native plants.

**Cost**
- Labour costs = $0.50 to $2.50 per square meter per treatment.
- Equipment costs (gloves, shovels, pruners, etc) = $100 per person.
- Disposal costs = $250 per bin / $150 per truck.
4 References


Vitousek et al., 1996