City of North Vancouver

Invasive Plant Inventory and Restoration Plan

Submitted to:

Angela Negenman
City of North Vancouver
141 West 14th Street
North Vancouver, BC
V7M 1H9

November 3, 2011

Diamond Head Consulting Ltd.
342 West 8th Avenue, Vancouver, BC V5Y 3X2
P: 604.733.4886 F: 604.733.4879
www.diamondheadconsulting.com

Table of Contents

List of Figures

List of Tables

1.0 INTRODUCTION

Protected natural areas within our urban centers are under increasing pressure as our population base continues to grow. Urban development, increasing recreational use, habitat fragmentation, wind storms, pests and diseases, and the introduction of non-native species are some of the factors affecting natural processes. Invasive plant species in particular have established throughout the Lower Mainland and are a major component of urbanization-related changes in parks and green spaces. These plants are rapidly spreading, non-native species that have become regionally common and locally abundant. They have the potential to cause changes to the composition, structure, and function of native ecosystems. They cause habitat loss for native species, modify ecological processes, and alter hydrology and aesthetics. In addition, they can pose human health risks, reduce access to natural areas, and increase cost for park operations and maintenance.

Diamond Head Consulting Ltd. (DHC) was retained by the City of North Vancouver ("City") to conduct a baseline invasive plant survey, spatial analysis and restoration plan for all City owned parkland and green spaces. The survey and mapping components of the study identify and document the presence of invasive species. The analysis of this data directed the development of management recommendations and restoration guidelines. This report provides the City with a framework for the development of a locally relevant and cost-effective invasive plant management program.

2.0 METHODOLOGY

A detailed ground survey was conducted to determine the distribution and abundance of invasive plant species in City owned parkland and green spaces. The goal of this assessment was to quantify the distribution and abundance of invasive plant species and provide baseline data for effective long term management and monitoring. The methodology focused on 16 non-native plant species (Table 1). All but one of these species (hops) are listed as invasive plants in the Lower Mainland by the Invasive Plant Council of Metro Vancouver (IPCMV). Ten species inventoried are profiled as 'Target Species' by the IPCMV. Potential new emergent invasive plants (in addition to the 16 species in Table 1) were also noted during the field inventory.

Table 1. Invasive species targeted during field inventory.

Common Name	Species Name
Butterfly bush	*Buddleia davidii*
Cherry-laurel	*Prunus laurocerasus* and related species
Clematis	*Clematis vitalba*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix* and *Hedera hibernica*
Giant hogweed	*Heracleum mantegazzianum*
Goutweed (Bishop's weed)	*Aegopodium podgaria*
Hops (common)	*Humulus lupulus*
Himalayan blackberry	*Rubus armeniacus*
Knotweed species	*Fallopia spp., Persicaria spp.* and hybrids (syn. *Polygonum spp.*)
Lamium (yellow lamium/yellow archangel)	*Lamium galeobdolon*
Periwinkle	*Vinca minor*
Policeman's helmet (Himalayan balsam)	*Impatiens glandulifera*
Scotch broom	*Cytisus scoparius*
Small flowered touch-me-not	*Impatiens parviflora*
Spurge laurel (daphne-laurel)	*Daphne laureola*

The standards and methodology for the field inventory were developed in consultation with the City. The study area was defined and baseline data was compiled including existing invasive species inventories and GIS data (orthophotos, park parcel boundaries, roads, trails, streams and the 2008 giant hogweed coverage). Test GIS products were submitted to the City for approval. The field inventory was carried out using ArcPad software loaded onto a GPS (Trimble Juno). All relevant base layers were loaded onto the GPS as well as field forms designed in ArcStudio.

The field survey was carried out on foot between April and July 2011. The location and abundance of invasive species were mapped on 2010 orthophotos (see example in Figure 1 and Figure 2). Areas of infestation were denoted either as points or polygons. Point features represent small infestations (20 m^2 and smaller). Each point feature represented a single species and includes an approximated infestation size. Polygon features were used for larger infestations (greater than 20 m^2) and recorded the percent cover of each species within the polygon. Percent cover was defined as the percent of ground affected by the species. This mapping strategy reflects the amount of ground that would require disturbance if the plant was removed and prevents under or over estimations of cover due to seasonality (e.g. in the spring, vegetation was often not yet fully developed). The total percent cover affected by all species within a polygon was recorded in a separate data field to account for overlapping infestations (e.g. periwinkle growing under Himalayan blackberry).

Where possible, mapping included infestations which spread immediately outside of park parcel boundaries or were located in close proximity to park edges (typically private property or transportation corridors). These areas are not included in the infestation area analysis.

In addition to species and infestation area, other information important for management was collected. For both point and polygons it was noted whether vine species (English ivy, common hops and clematis) were currently climbing trees. In some cases Himalayan blackberry was also noted to be climbing native vegetation. Green waste dump sites and other points of note (such as fire pits, camps/shelters, debris, etc.) were recorded as point features in a separate spatial coverage.

Upon completion of the field inventory, all point and polygon features were downloaded and edited in ArcEditor. Editing involved cleaning the polygon linework and ensuring data consistency. The spatial distribution and extent of infestation within the City was then summarized.

This inventory was completed on foot and provides a comprehensive coverage of invasive plant species in the City of North Vancouver. Certain areas, however, were challenging to access due to unsafe terrain, waterways or the presence of aggressive dogs (Appendix 11.0 contains a map of these locations). Although every effort was made to provide as comprehensive an inventory as possible, some invasive plant locations have undoubtedly been missed. This primarily is the case with species which may grow as scattered individuals rather than as contiguous patches (i.e. cherry laurel, English holly, spurge laurel and giant hogweed). Giant hogweed removals were ongoing by City crews and volunteers during the inventory. Every effort was made to include the location of recently removed plants. Although a paper map showing removal locations by volunteers in Mahon Park was provided, the accuracy of translating this information into GIS is questionable and therefore it was not included in the inventory. **Due to these limitations, this inventory should be considered an under-representation of the degree of infestation, particularly in the case of giant hogweed.**

Figure 1. Example of raw field inventory data as it appears in ArcPad on a Trimble Juno GPS unit.

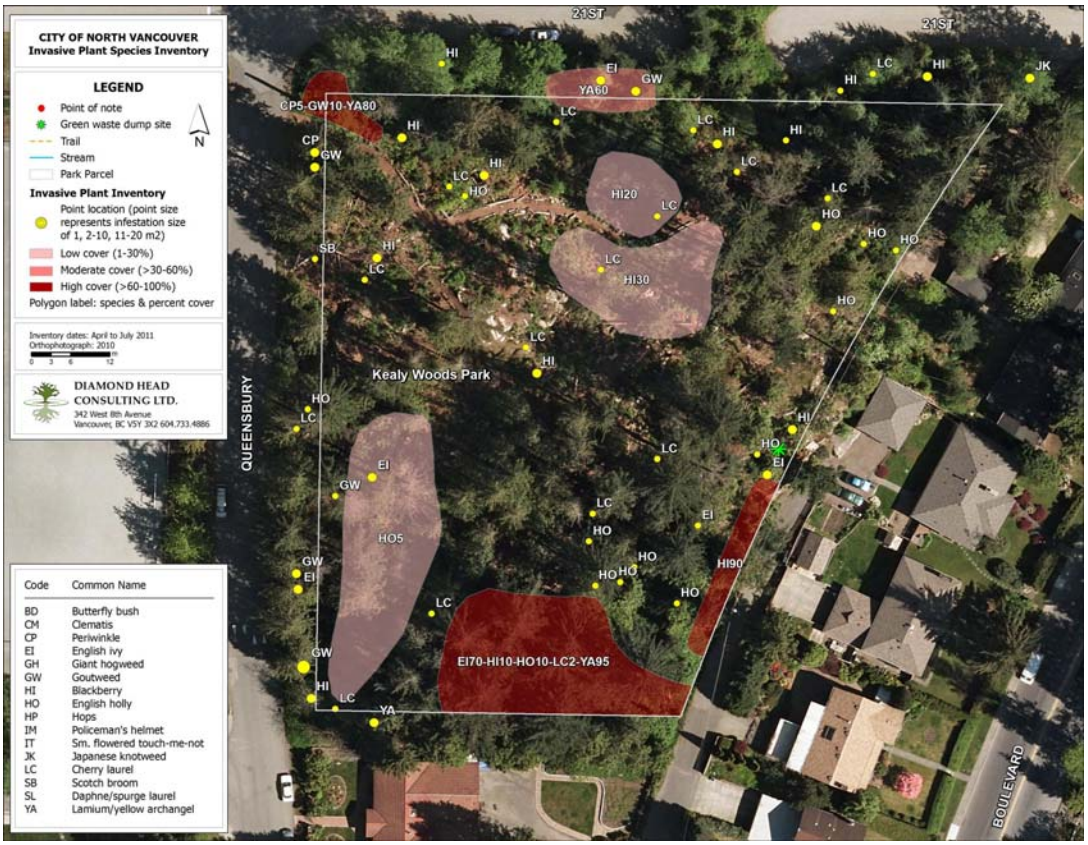


Figure 2. Example of final mapping product.

3.0 INVASIVE SPECIES INVENTORY ANALYSIS

The total area of park parcels inventoried is 147 ha. Approximately 98 ha are considered natural area. The total area impacted by invasive species in City parks was approximately 29.5 ha or 20% of the total surveyed area (an additional 3 ha was inventoried outside of parcel boundaries). A total of 5,174 points features and 913 polygon features were recorded (includes occurrences adjacent parks). The polygons range in size from 25 m^2 to 0.8 ha and averaged 454 m^2 in size. Point features accounted for 1.8 ha of the affected area.

The total area infested by each individual species is summarized in Table 2 and illustrated in Figure 3. Table 2 also summarizes the number of individual occurrences (points and polygons) of each species. The total of each column in the table will not equal the overall impacted area because of overlapping infestations within polygons. Appendix I summarizes infestation area by species for each park parcel.

Table 2. Total area of infestation by invasive species in City of North Vancouver parks.

Common Name	Total Area	Points	Polygon	Total Occurrences
English ivy	15.1 ha	597	508	1105
Himalayan blackberry	10.0 ha	543	439	982
Goutweed	1.4 ha	320	151	471
Lamium	0.9 ha	90	67	157
Knotweed species	0.8 ha*	257	81	338
Periwinkle	0.7 ha	108	62	170
Cherry-laurel	0.5 ha	597	48	645
Small flowered touch-me-not	0.4 ha	47	30	77
English holly	0.4 ha	1359	67	1426
Hops	0.2 ha	9	27	36
Clematis species	0.2 ha	104	29	133
Policeman's helmet	0.1 ha	56	21	77
Giant hogweed	0.1 ha**	250	8	258
Spurge laurel	0.1 ha	303	15	318
Scotch broom	342 m^2	61	7	68
Other species	241 m^2	34	6	40
Butterfly bush	131 m^2	43	1	44

* Includes patches of this species which were cut in 2011.

** Includes only some of the giant hogweed removed in 2011.

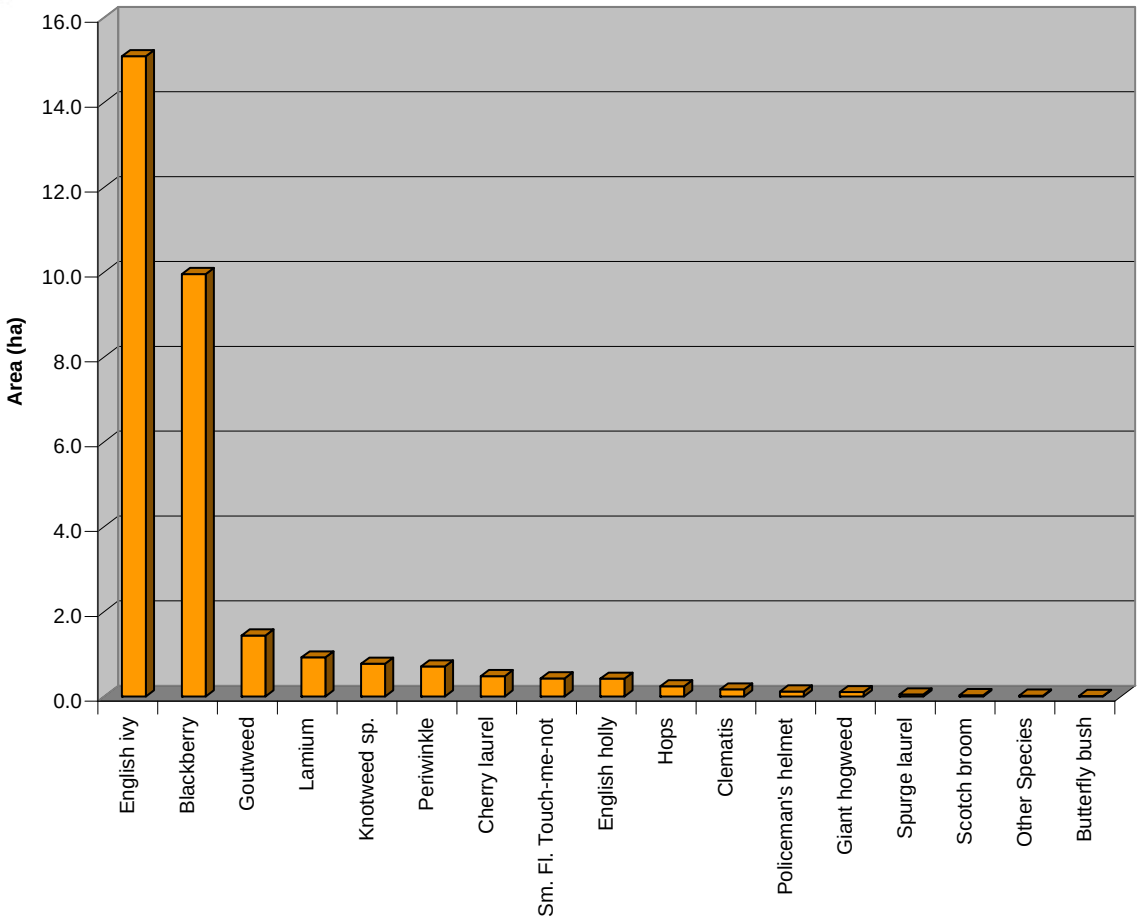


Figure 3. Total area of infestation by invasive species inventoried in City of North Vancouver parks.

English ivy was by far the most abundant species (15 ha inventoried). Ninety percent of the area affected by ivy had vines climbing trees to some degree. The next most abundant species was Himalayan blackberry (10 ha inventoried) followed by goutweed (1.4 ha). Total infestation size for each remaining species was less than 1 hectare. The least prolific species out of the 16 species inventoried was butterfly bush with only 43 locations inventoried (131 m^2) the vast majority of which were found in Kings Mill Walk Park. There was also relatively little Scotch broom (342 m^2) or spurge laurel (501 m^2).

Six additional species were inventoried under the classification 'Other Species' (241 m^2). These may be new emergent invasive plants and are discussed in Section 3.2.1. Butterfly bush, Scotch broom and these six other species may be candidates for eradication since their infestations are very small, with minimal dispersal. At this point in time they almost always occur as single plants and have not yet undergone patch expansion. Spurge laurel, however, is widely dispersed across the City and therefore would be difficult to eradicate.

3.1 Dispersal Patterns and Associations

Invasive plant species in the City are growing primarily in park areas that exist in a somewhat natural state. All parks have been historically disturbed through harvesting at the turn of the century. Subsequent clearing and disturbances have taken place. Most areas have regenerated naturally with little management. Invasives are rare in manicured, landscaped, grassed, playground, or sport field areas. The vast majority of invasive plants inventoried within these areas have established in planting beds or were intentionally planted as part of the landscaping (e.g. cherry laurel and English ivy).

Invasive plants tend to be more common and abundant adjacent to residential, commercial and industrial areas compared to undeveloped areas. They also tend to be more prevalent along access routes such as trails, roads, railways, utility rights-of way (hydro and gas), and park edges. In the City of North Vancouver many parks are linear and narrow in shape or relatively small. These parks are surrounded by developed area and easily accessed by extensive trail networks. For these reasons invasive plants are widely dispersed throughout City parks with virtually no areas unaffected to some degree.

Dispersal patterns vary depending on species. Table 3 summarizes dispersal patterns and associations observed in the City.

Table 3. Dispersal patterns and associations observed in the City of North Vancouver.

Species	Dispersal patterns within CNV	Associations with habitat types or other species
Butterfly bush	Common in Kings Mill Walk; very rare but present in Mosquito Creek, Wagg Creek, Greenwood, Moodyville and two landscaped parks (Crickmay and Rodger Burnes)	Open sites, vegetation edges
Cherry-laurel	Widely dispersed; common in all natural areas and frequently planted in landscaped parks	Varied (not common on very wet or very dry sites)
Clematis species	Majority located in Heywood, south Mosquito Creek, Mahon, Tempe Heights and Kings Mill Walk; present but rare in Larson, Greenwood, Loutet, Sunrise, High Place and Moodyville; absent from landscaped parks.	Forested (shaded) areas (but will grow fully exposed)
English holly	Very widely dispersed; common in all natural areas and often planted as specimen trees in landscaped parks	Varied
English ivy	Very widely dispersed; common in all natural areas and often planted in landscaped parks	Varied
Knotweed species	Most abundant along MacKay Creek (Heywood); emergent small patches scattered through all natural areas; very rare but present in Kings Mill Walk, Greenwood, Loutet, Eastview, and landscaped parks	Riparian and seepage sites (but will grow anywhere)
Giant hogweed	Widely dispersed; common in all riparian areas; most prolific in Mahon, Wagg Creek, and Tempe Heights; very rare or absent from Kings Mill Walk, Eastview, Greenwood and Loutet	Riparian areas; moist and wet sites; recently disturbed sites
Goutweed	Widely dispersed; primarily growing along stream, trail and park edges; notably absent from interior portion of Mahon, Greenwood and Loutet; present in several landscaped parks	Riparian, shaded sites (but will grow fully exposed)
Himalayan	Widely dispersed including in	Open areas; rare under closed

Species	Dispersal patterns within CNV	Associations with habitat types or other species
blackberry	landscaped parks	canopies; often growing on recently disturbed sites and along exposed vegetation edges
Hops	Confined to south-eastern parks (Moodyville, High Place, Sunrise, and Lynnmouth); one location in Mahon and Wagg Creek	Primarily growing in association with blackberry
Lamium	Widely dispersed; most common near dump sites or where residences are directly adjacent park boundary; present in several landscaped parks	Forested (shaded) areas; often in same vicinity as periwinkle
Periwinkle	Widely dispersed; common where residences are directly adjacent park boundary; present in several landscaped parks	Shaded areas (including under overstory vegetation such as blackberry); often in same vicinity as lamium
Policeman's helmet	Primarily in Mahon and Wagg Creek; additional locations in Heywood, Mosquito Creek, Westview, Larson, Sunrise and Moodyville	Riparian and seepage areas (moist and wet sites); often in same vicinity as small flowered touch-me-not
Scotch broom	Widely dispersed; absent from parks north of Highway 1 with one exception in Tempe; absent from landscaped parks	Drier, open sites; often growing on recently disturbed sites and forested edges; absent from shaded areas
Small flowered touch-me-not	Primarily in Heywood, Mosquito Creek and Lynnmouth; additional locations in Mahon, Westview, Moodyville, Sunrise and Loutet	Often growing along vegetation/trail edges in forested and riparian areas; intermixes with goutweed
Spurge laurel	Widely dispersed; notably absent from large interior portions of Heywood, Mosquito Creek, Mahon, Greenwood and Loutet; in several landscaped parks	Varied

3.2 Invasive Species Dynamics

The introduction of invasive plant species is a dynamic process that occurs on both temporal and spatial scales. Invasive species spread by rapid growth, abundant seed production, widespread seed dispersal and vigorous vegetative growth. Understanding these mechanisms and implementing control and eradication measures that interfere with these processes will maximize the effectiveness of management strategies.

There are three stages of plant invasion. During the introduction stage the species occurs at relatively low levels of infestation. Populations are small and consist mainly of individual plants. Eradication at this stage is usually feasible through removal and monitoring. Species at this phase are often referred to as locally emergent. The second stage of invasion is known as colonization, during which the plant begins to spread (patch expansion) and disperse over short distances. Relative infestation size increases. At this stage, eradication is more difficult, but control measures are feasible to contain infestations and prevent further spread. The third stage, naturalization, occurs when the species disperses over long distances and becomes abundant across the landscape. The infestation size is

large and widespread and may require a long term strategy of containment and control measures to manage.

Table 4 approximates the current stage of invasion of each of the inventoried plant species. These designations consider not only total infestation size, but also the number and distribution of locations across the City. For example, the size of infestation of policeman's helmet is larger than giant hogweed, however there were only 77 locations of the plant found versus 300+ locations of giant hogweed.

Table 4. Stage of invasion of inventoried species in the City of North Vancouver.

STAGE OF INVASION		
Introduction (emergent species)	**Colonization**	**Naturalization**
Butterfly bush	Spurge laurel	English ivy
Hops	Clematis	Himalayan blackberry
Policeman's helmet	Periwinkle	English holly
Scotch broom	Lamium	
Yellow flag iris	Giant hogweed	
Japanese butterbur	Knotweed species	
Comfrey	Small flowered touch-me-not	
	Cherry laurel	
	Goutweed	

3.2.1 New Emergent Species

Several non-native species were noted as possible new emergent invasive plants. Not all non-native species will become invasive, nor will all necessarily have negative impacts. Some of these species are known to be invasive and are problematic in other jurisdictions. The table below summarizes the dispersal patterns and recommendations for six non-native species which may be emergent invasive plants. The area inventoried does not necessarily represent all existing infestations.

Table 5. Potential emergent invasive plants in the City of North Vancouver.

Species	Area Inventoried (m^2)	Dispersal pattern and site type	Comment/Recommendation
Bamboo spp.	36	Mosquito Creek and Mahon; always on park edges, usually spreading from a residence; additional 129 m^2 noted in landscaped areas	**MONITOR:** gradual vegetative spread; not presently considered to be a threat; difficult to remove.
Comfrey (*Symphytum officinale*)	20	Along perimeter edge at south end of Mahon adjacent Keith Road	**REMOVE:** annual herb, likely easily removed but may have seed bank
Himalayan knotweed (*Persicaria wallichii*)	262	Wagg Creek and Heywood; perimeter of park parcels	**REMOVE**: included in the knotweed inventory; listed as a species to contain by IPCMV;
Japanese butterbur (*Petasites japonicus*)	93 (22 locations)	Riparian and seepage areas in Heywood, Mahon and Wagg Creek	**REMOVE**: starting to disperse in riparian areas; removal method unknown
Morning glory (*Calystegia sepium*)	N/A	Not inventoried but noted to be growing in newly restored plantings and landscape beds	**MONITOR:** ensure that it isn't impeding growth of plantings in restored areas;

Species	Area Inventoried (m^2)	Dispersal pattern and site type	Comment/Recommendation
			listed as a species to control by IPCMV;
Yellow flag-iris (*Iris pseudacorus*)	2	Riparian areas in Wagg Creek and Sunrise	**REMOVE**: difficult to remove; prefers slow moving stream edges, rich seepage areas and lake/pond margins; listed as a species to control by IPCMV;

There are numerous other non-native species that were found growing in City parks including creeping buttercup, common tansy, purple deadnettle, spiraea sp. and burdock. None of the species were found in any significant abundance or dispersal. They were commonly associated with ditches and recently disturbed sites. None are considered a significant threat to City natural areas at this time.

3.3 Biogeoclimatic Site Series

Terrestrial Ecosystem Mapping (TEM) was carried out in the majority of City natural area in 2006. In total 73 ha were mapped and classified.

Table 6 summarizes the distribution of invasive plant infestations by leading site series. The TEM classification can be useful to managers for developing future site specific restoration prescriptions. Appendix I provides habitat restoration template prescriptions for each biogeoclimatic site series.

Table 6. Total area of invasive species infestation by leading site series in the City of North Vancouver.

Site Series/Site Class	BC Status	Infestation Area (ha)	Relative %
CWHdm/05 – Western redcedar - Sword fern	Blue	9.7	55%
CWHdm/07 – Western redcedar - Foamflower	Blue	7.3	42%
CWHdm/01 – Western hemlock - Flat moss	Blue	0.3	2%
CWHdm/03 – Douglas-fir - Western Hemlock - Salal	Blue	0.1	1%
CWHdm/12 – Western redcedar - Sitka spruce - Skunk cabbage	Blue	757 m^2	<1%
CWHdm/10 – Black cottonwood - Willow	Blue	592 m^2	<1%

Over half (55%) of the affected area was classified as CWHdm/05 (representing slightly dry to fresh soil moisture regimes and rich to very rich soil nutrient regimes), while another 42% was classified as CWHdm/07 (representing moist to very moist soil moisture regimes and rich to very rich soil nutrient regimes). The distribution fairly closely matches the area distribution of each site series within the City.

The BC Conservation Data Centre (CDC) has identified BC's most vulnerable plant communities, each of which is assigned to a provincial red, blue or yellow list according to their provincial conservation status rank. All of the affected planting communities are blue listed. Blue-listed communities are considered vulnerable to human activity and natural events.

3.4 Infestation Sources and Methods of Dispersal

The majority of invasive species found in the City are commonly grown garden ornamentals. They have entered park natural areas either by seed dispersal, unintended direct growth from adjacent

gardens or by green waste dumping. A total of 103 green waste dumping sites were recorded during the inventory. All piles contained one or more invasive species spreading out into the surrounding park. The most common invasive species found spreading from dump sites were ground covers (lamium, English ivy and periwinkle). Dump sites were typically located directly behind residential properties adjoining natural areas or along adjacent laneways. Occasionally short trails were found leading from the edge of a park to very large piles of green waste likely used by multiple residents. Often dump sites were observed in close proximity to City 'no dumping' signs.

Table 7 summarizes the number of green waste dumping sites recorded per park parcel. A map of locations can be found in Appendix IV. Green Waste Dumping Sites. Sunrise, High Place, Moodyville and Mahon had the greatest number of dump sites representing 60% of the total found. The parks found to be the most severely impacted by dump sites (i.e. where infestations have spread extensively from the dump sites) were High Place, Moodyville (western segment), Loutet (parcel north of Highway 1), and Westview.

Table 7. Summary of green waste dumping sites recorded.

Park Name	Number of Dump Sites Recorded	Ratio (Number of sites/park area)
Moodyville Park	20	2.0
High Place Park	16	7.7
Sunrise Park	12	2.0
Mahon Park	12	0.5
Loutet Park	8	0.6
Wagg Creek Park	8	2.3
Heywood Park	7	0.5
Westview Park	7	8.0
Greenwood Park	3	0.2
Larson Park	2	1.9
Tempe Heights Park	2	0.5
013-391-356	1	12.5
Kealy Woods Park	1	1.4
Lots 24/W, BL9, DL272	1	7.1
Lynnmouth Park	1	0.3
Mac Leod Park	1	3.3
Mosquito Creek Park	1	0.1
Total	103	103

Dispersal via water movement is evident when examining the extent of any riparian-related invasive species. This particularly applies to knotweed, giant hogweed, the impatiens (policeman's helmet and small flowered touch-me-not), and goutweed. Once these species enter a waterway, they can quickly spread and impact the entire downstream watershed. This creates a challenge for the City since all watercourses extend upstream to areas under the governance of other jurisdictions (Metro Vancouver and the District of North Vancouver).

Seed dispersal by birds and wildlife is likely the cause of spread of many of the most widely dispersed species including English holly, Himalayan blackberry and cherry-laurel. Aggressive vegetative growth is the primary factor in the spread of ground cover species such as English Ivy, lamium, and periwinkle.

Soil movement and disturbance also play a role in invasive dispersal. Any time soil is imported or disturbed for park development, restoration works, landscaping or fill there is a high risk of dispersing invasive plants. It is impossible to obtain soil that is guaranteed invasive free. Most

invasive plants are aggressive pioneer species that establish quickly on newly exposed mineral soil. This impedes the regeneration of native pioneer species. The area in the northeastern corner of Heywood Park (adjacent the large parking lot) is a good example. This area was disturbed and filled years ago. Today it has nearly 100% cover by invasive plants (primarily blackberry and English ivy).

Transportation corridors provide another common source of infestation. Rail lines and major highways in the Lower Mainland are common culprits in the dispersal of invasives. In the case of the City however, Highway 1 and the rail lines don't appear to be playing a significant role in plant dispersal.

4.0 MANAGEMENT STRATEGIES

Management strategies and tools are discussed by individual species as well as using an ecosystem level approach. At the species level, recommendations are made for developing a City management strategy, control options (including costs and timing), and management profiles by species. Ecosystem level management includes consideration for novel ecosystems and a departure from historic conditions as well as the development of a prioritization strategy.

4.1 Species Level Management

4.1.1 Risk Analysis

Due to the size and distribution of invasive species found across the City, a long term, phased management approach is recommended. The risk associated with each species should be quantified to justify an appropriate and cost effective response. Risk is defined as a measure of the probability of an incident occurring and its expected consequence. The probability of an incident occurring can be equated to the current stage of infestation (abundance and dispersal) which has been well documented in the inventory. This can be used to compare the feasibility of eradicating a species as compared to control and containment measures.

The consequences of these infestations include negative ecological, economic and social impacts. Table 8 lists examples of impacts within each consequence category. Impacts are inter-related and often result in consequence to all categories (e.g. soil failure can have ecological, safety and economic consequences).

Table 8. Consequences of invasive plants.

Category	Example Impacts
Ecological	Outcompeting native vegetation
	Inhibiting natural plant community succession including understory regeneration
	Changes to soil properties creating undesirable conditions for native vegetation
	Negative impacts to fish habitat (changes to riparian plant communities and water quality)
	Destabilizing soils and/or increasing erosion and slope failure susceptibility
	Tree failure due to increased loading/wind sail caused by prolific vine growth
	Decrease in biodiversity
	Loss or alteration of sensitive/rare ecosystems and key habitat features
Social/Health	Exposure to toxins
	Impeding recreation access
	Aesthetic values
Economic	Cost of removal and restoration
	Impact on recreation and tourism
	Impact on fisheries
	Decreased property value

Category	Example Impacts
	Destruction of infrastructure

Quantifying the consequence of invasive species is subjective and depends on the priorities and objectives of the City. Based on discussions with City management, the relative consequence of each invasive species has been rated on a four level scale from low to very high. Table 9 summarizes stage of infestation and the relative consequence rating for each species. Figure 4 graphically approximates the relative stage of infestations of each species along the X-axis and the relative consequence on the Y-axis.

Table 9. Summary of relative infestation levels and consequence.

Stage of Infestation	Common Name	Relative Consequence	Comments on Consequence
Introduction	Butterfly bush	High	Threat to sensitive ecosystems and open shrub communities; relatively easily removed
	Common hops	Moderate	May cause tree failure
	Policeman's helmet	Moderate	Riparian threat; easily removed annual; seed bank lingers
	Scotch broom	High	Threat to sensitive ecosystems and open shrub communities; seed bank lingers for long term
	Yellow flag iris	Very High	Riparian threat; riparian disturbance caused by removal
	Japanese butterbur	High	Riparian threat; riparian disturbance caused by removal
	Comfrey	Moderate	Unknown
Colonization	Clematis species	Moderate	May cause tree failure
	Spurge laurel	High	Toxic (skin and ingestion); can become shrub mono-culture
	Periwinkle	High	Prolific ground cover; inhibits herb and shrub layer
	Giant hogweed	Very High	Very toxic (skin); riparian threat
	Goutweed	Moderate	Riparian threat; difficult to eradicate; inhibits herb layer
	Cherry-laurel	Low	Wide dispersal by wildlife
	Knotweed species	Very high	Riparian threat; extremely difficult to remove; inhibits all vegetation layers; riparian disturbance caused by removal
	Small flowered touch-me-not	Moderate	Riparian threat; easily removed annual; seed bank lingers
	Lamium	High	Prolific ground cover; difficult to eradicate; inhibits herb and shrub layer
Naturalization	English holly	Low	Wide dispersal by wildlife
	Himalayan blackberry	Moderate	Inhibits herb and shrub layer; beneficial in some circumstances to restrict access to sensitive areas
	English ivy	Very high	Can cause tree failure; prolific ground cover

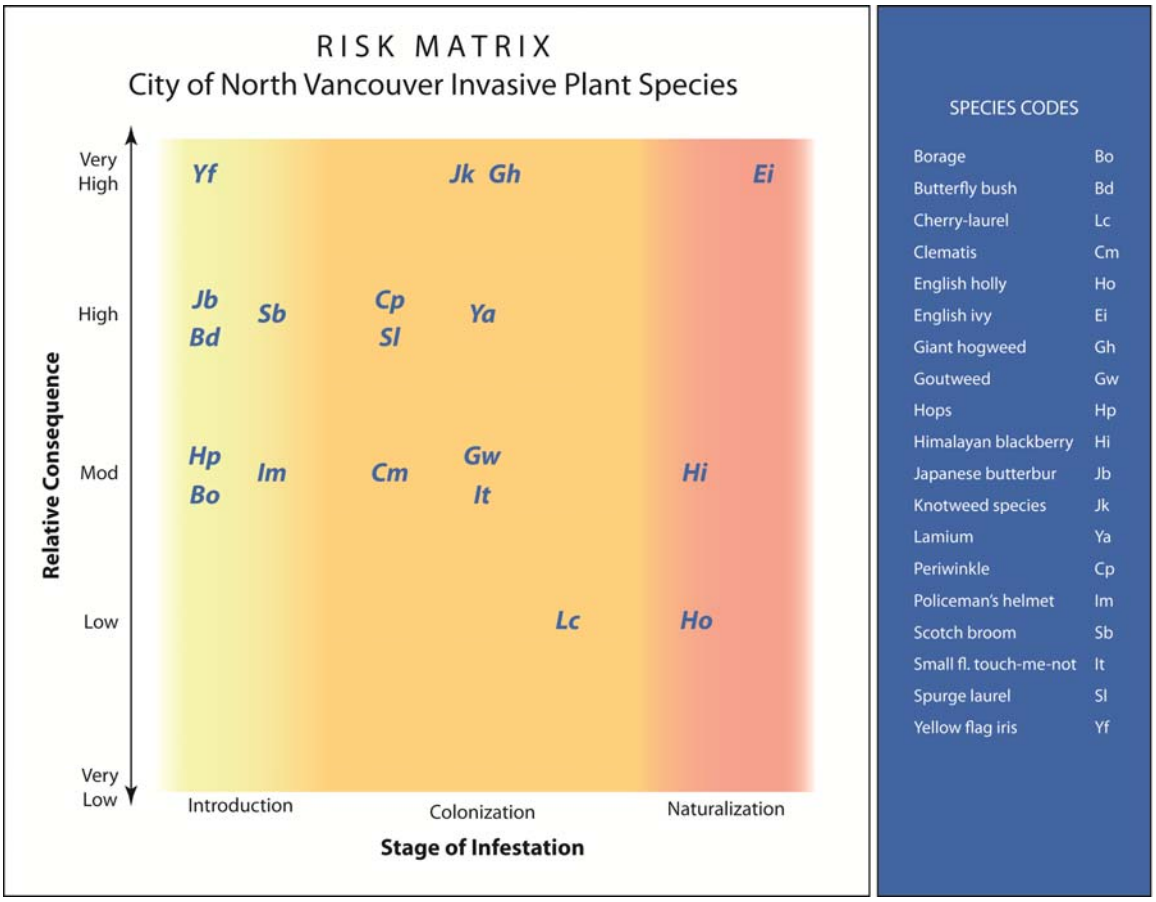


Figure 4. Risk matrix for invasive species in the City of North Vancouver.

The risk matrix can be used as a tool for planning and management decisions. It aids in comparing the relative risk of species in relation to one another. Short term eradication may be a realistic goal for species with very low incidence and high consequence, whereas a long-term management approach may be most appropriate for species with high incidence and high or very high consequence. The matrix can be adjusted as inventory changes and/or depending on differing opinions of the consequence ratings.

4.1.2 Control Options, Costs and Timing

Three broad categories of control can be considered for the management of invasive species: manual removal, chemical application and biological agents. Manual methods are the most common means of removal and include cutting, soil and/or root removal and surface covering. Chemical application of herbicides, including spraying or stem injection, can be an effective means of control. However this application requires consideration of environmental sensitivities and municipal and provincial legislation. Biological control agents, such as herbivorous insects or fungal pathogens, have been met with mixed success to date. They do provide potentially cost effective alternative means of control for certain species. Such measures exist for purple loosestrife, scotch broom and hedge bindweed, as identified on the *Biocontrol Agents & Host Plants in BC* list provided by the Ministry of Forests and Range.

The effectiveness and costs associated with these control methods need to be considered when developing a long term invasive species program. The City of Surrey has a well established invasive species management program. They have calculated the average unit cost of both chemical and manual control methods. They utilize private contractor crews who dispose the material at the Surrey works yard on a daily basis (disposal is an 'in house' expense). They have calculated the average unit cost of removal by species (summarized in Table 10). These should be considered very rough estimates as actual costs are highly variable. Cost is dependent on the experience and efficiency of the crew as well as terrain, access, weather, and job complexity (e.g. when native species are intermixed with the target species it creates greater complexity). Another major factor not incorporated into cost estimates is logistics (e.g. time to travel between sites). Planning, scheduling and organizing can significantly add to costs.

The manual cost of removal is driven by the dispersal pattern of the species and the ease of removing roots and stems (i.e. hand pulling versus digging or cutting using tools). The high manual cost of removing English holly is due to its wide dispersal as single stems or small groups. The unit cost of having a crew search for and remove scattered stems is relatively high compared to a crew tackling often easily accessible, large, contiguous patches of invasives such as ivy or blackberry. The lower costs of removing policeman's helmet, periwinkle or English ivy compared to scotch broom, blackberry or lamium are due to the fact that these species can be easily and efficiently hand pulled. Certain species respond well to chemical methods making this option more cost effective as compared to manual removal. The effectiveness of removal methods are discussed in the next section 'Management Profiles by Species'.

Table 10. Comparison of the costs associated with manual and chemical removal of invasive species (data provided by the City of Surrey, 2009).

Species	Manual Cost ($/m²)	Chemical Cost ($/m²)
English holly	40.67	-
Himalayan blackberry	8.71	1.71
Lamium	8.12	0.41
Scotch broom	7.28	-
English ivy	6.12	-
Periwinkle	5.90	-
Knotweed species	-	3.09
Policeman's helmet	0.91	-

The total estimated cost of operational removal treatments for the City of North Vancouver have been calculated by species (Table 11). Where chemical treatment is a viable option, the costs have been included for comparison. The values were derived from the unit costs provided by the City of

Surrey and the data was extrapolated to species with similar requirements for removal. These should be considered rough estimates and:

- do not account for the cost of follow up treatments, monitoring or restoration;
- do not account for overlapping infestations by different species (potentially creating greater complexity);
- do not account for site complexity or disposal costs;
- are based on the cost of contractor crews (city crews or volunteers will have different costs); and,
- are not meant to recommend the use of a particular treatment type.

Table 11. Comparison of the estimated costs associated with manual and chemical removal of invasive species in the City of North Vancouver (preliminary data provided by the City of Surrey, 2009).

Species	Manual Unit Cost ($/m²)	Manual Treatment Total cost ($)	Chemical Unit Cost ($/m²)	Chemical Treatment Total cost ($)
Himalayan blackberry	$8.71	$867,400	$1.71	$170,300
English ivy	$6.12	$923,800	-	-
English holly	$40.67	$170,700	-	-
Cherry-laurel*	$40.67	$196,300	-	-
Lamium	$8.12	$74,900	$0.41	$3,800
Knotweed species	-	-	$3.09	$23,900
Scotch broom	$7.28	$2,500	-	-
Common hops	$6.12	$14,700	-	-
Policeman's helmet	$0.91	$1,100	-	-
Periwinkle	$5.90	$41,800	-	-
Small flowered touch-me-not*	$0.91	$3,900	-	-
Spurge Laurel*	$30.00	$15,000	-	-
Clematis species*	$6.12	$10,308	-	-
Butterfly bush*	$7.28	$1,000	-	-
Goutweed*	$8.12	$116,800	$0.41	$5,900
Giant hogweed**	-		$12.15	$12,700

* No historic data, cost estimated based on other similar species and professional judgment.
** Only includes plants located during inventory and a small portion of plants already removed in 2011

Table 12 outlines optimal timing of for removal of each invasive species. The table also shows the bird nesting season in the Lower Mainland. Precautions should be taken when removing invasive species during this window, particularly with English holly, English ivy, cherry laurel, and Himalayan blackberry. This table is a general guide as plant emergence and seed development varies annually.

Table 12. Optimal timing for removal of invasive species, distinguishing between mechanical (M) and chemical (C) measures.

Invasive Species	Jan	Feb	Mar	Apr*	May*	Jun*	Jul*	Aug*	Sept	Oct	Nov	Dec
Butterfly bush					M	M						
Cherry-laurel	M	M	M	M	M						M	M
Clematis				M								
English holly	M,C	M,C	M,C	M,C	M,C						M,C	M,C
English ivy	M	M	M	M	M	M	M	M	M	M	M	M
Giant hogweed			M,C	M,C	M,C							
Goutweed			M	M	M				M	M		
Himalayan blackberry					M,C	M,C	M					
Hops				M	M	M						
Knotweed species			M,C	M,C	M,C	M,C	M,C	M,C	M,C	M,C		
Lamium	M	M	M,C	M,C	M,C	M,C	M	M	M	M	M	M
Periwinkle	M	M	M	M	M	M	M	M	M	M	M	M
Policeman's helmet			M	M	M							
Scotch broom	M,C	M,C	M,C	M,C	M,C						M,C	M,C
Small flowered touch-me-not			M	M	M							
Spurge laurel	M	M	M								M	M
Yellow flag-iris				M	M	M						

* Bird nesting season occurs from April through to August in the Lower Mainland. Precautions should be taken when removing invasive species during this window, particularly for English holly, English ivy, cherry-laurel, and Himalayan blackberry.

Optimal removal time

Less optimal: during this period, care must be taken not to spread seeds

4.1.3 Management Profiles by Species

Brief profiles of each inventoried species have been developed summarizing their preferred habitat, reproduction, abundance and spatial distribution, inventory comments, consequence rating, control method and timing constraints. Estimated treatment costs have also been provided assuming all areas identified are targeted. This does not however account for cost of follow up treatments or monitoring.

Butterfly bush (*Buddleja davidii*)

Butterfly bush grows in a wide range of habitats, including relatively moist to dry, disturbed areas. It is a deciduous shrub that blooms and produces viable fruits after a single year. It reproduces predominantly by seed and a single flower cluster of some varieties can produce over 40,000 seeds that can remain dormant in the soil for many years. It does not reproduce vegetatively but it can be grown from cuttings.

- **Consequence Rating**. High
- **Control Method**. Small plants can easily be removed by hand. More established specimens can be cut at the base. New shoots should be removed until the rootstock dies. Care should be taken to limit soil disturbance to prevent regeneration from the seed bank.
- **Timing of Removal**. Removal is best conducted when the shrubs are coming into flower but before they have produced seeds (May to August).
- **Total Cost Manual**. $1,000

Cherry-laurel (*Prunus laurocerasus*)

Tolerant of a range of light, soil and moisture conditions, cherry-laurel prefers moist, well-drained and acidic soil. The evergreen shrub produces flower clusters in the mid-spring and berries in the summer. It reproduces predominantly through seeds, but can also grow new shoots from cut stems and in the right conditions it will also layer. Cherry-laurel is considered to be at the early stages of invasion in many parks and is therefore a good target for 'early detection and rapid response' strategies.

- **Consequence rating**. Low.
- **Control Method**. Hand pulling is recommended for small seedlings but due to the plants extensive rooting system, removal of larger plants causes significant soil disturbance. Cutting mature plants can be effective when combined with long-term monitoring for re-growth.
- **Timing of Removal**. Recommended to occur between November and May, minimizing work done when the plants are fruiting.
- **Total Cost Manual**. $196,300

Clematis (*Clematis vitalba*)

Clematis is a perennial, climbing vine that can reproduce and spread vegetatively and by seed. It prefers highly fertile soils with good drainage and full sun but can tolerate moderate shade. Flowers are visible throughout the summer and seeds are produced throughout the winter after one to three years. Stems can grow 20 to 30 meters in length and are capable of blanketing trees over 20 meters in height.

- **Consequence rating**. Moderate.
- **Control Method**. Manual removal including cutting the stems above the ground, leaving the vines and foliage to die. Roots are shallow so they can be pulled and monitored, with continual removal of seedling re-growth.
- **Timing of Removal**. Clematis species are best removed during the dormant period (November to March).
- **Total Cost Manual**. $10,308

English holly (*Ilex aquifolium*)

A hardy shrub that grows in moist soils, preferring sandy or gravelly loam with good drainage. It prefers shade but will tolerate sun. It reproduces by seeds, suckering and layering. Seeds are viable and can germinate after they have been removed from the tree and are often dispersed by birds.

- **Consequence rating**. Low.
- **Control Method**. Young plants growing in moist soil can easily be removed by hand. Mature trees should be cut at ground level, taking care to remove seeds and monitor the stump for plant re-growth.
- **Timing of Removal**. Removal is recommended from November through to May, minimizing removal activity when berries have developed.
- **Total Cost Manual**: $170,700

English ivy (*Hedera helix*)

English ivy and closely related ivy species can be found in moist to dry soil conditions and in full sun to full shade, growing an average of 22 cm per month in the growing season. Juvenile stages of ivy spread vegetatively while mature plants spread by rhizomes, layering and seeds. Flowering occurs from August to October and berries are produced in the late winter.

- **Consequence rating**. Very high.
- **Control Method**. Manual removal is the most effective method. Plants can be left in trees if a 1m section is cut from the stems at the trees base. A three to five year plan of manual removal and monitoring tends to be effective on most patches. Herbicide application is not successful because of the waxy leaves.
- **Timing of Removal**. Removal of English ivy can be conducted throughout the year. Cut stems can be left on site to decompose as long as they are isolated from the soil.
- **Total Cost Manual**. $923,800

Giant hogweed (Heracleum mantegazzianum)

Giant hogweed is a large perennial plant that prefers rich, damp soil and can grow in varied light conditions. Plants take two to four years from germination to first flower, at which point they can reach heights of up to 5 meters. Each plant can produce up to 100,000 winged seeds that can remain viable in the soil for up to 15 years. The plant contains a phototoxin that causes the skin to be hypersensitive to sunlight (WorksSafe BC has issued a Toxic Plant Warning that should be consulted prior to removal).

- **Consequence rating**. Very high (due to toxicity).
- **Control Method**. Manual removal is effective if the entire root system is removed from the soil. However, there is a high risk due to the plants toxicity. Mowing is not effective and tends to stimulate plant growth. Foliar herbicide applications are effective on actively growing plants. Stem injections have been effective on mature plants. It is recommended that due to the high risk posed by this plant that chemical stems injection be used. Treatment efforts should be monitored for at least three years to catch seed germination.
- **Timing of Removal**. Efforts should be concentrated at the beginning of the growing season, from March through to May.
- **Total Cost Chemical**. $12,700

Goutweed (*Aegopodium podagraria*)

Goutweed is an herbaceous perennial that thrives on moist soil and in light to moderate shade, although it is highly shade tolerant. It spreads predominantly by vegetative means, through the extension of a rhizome system. Sometimes leaves are variegated. The plant flowers mid-summer and produces fruit in late summer, though the seeds require significant cold to germinate. Seedlings generally require recently disturbed soil and significant light to survive, thus the establishment of seedlings in the shade is rare. Goutweed is considered to be at the early stages of invasion and is therefore a good target for 'early detection and rapid response' strategies.

- **Consequence rating**. Moderate.
- **Control Method**. Manual removal can be effective if care is taken to remove all underground stems. Periodic monitoring should occur over several years to remove new growth.
- **Timing of Removal**. Since reproduction is primarily through vegetative means, removal efforts can be conducted at any time during the growing season.
- **Total Cost Manual**. $116,800

Himalayan blackberry (*Rubus armeniacus*)

Himalayan blackberry is found predominantly on disturbed sites, preferring full sunlight with rich and well-drained soils but it can tolerate a wide range of soil pH and textures. A biennial plant that reproduces vegetatively and by seed, it flowers from June to August. It can grow up to seven meters in a single season and dense thickets can produce 7,000 – 13,000 seeds per square meter, which are viable for several years. Fruiting stems generally die back at the end of the season but non-fruiting stems may persist for several years before producing fruit.

- **Consequence rating**. Moderate.
- **Control Method**. Manual removal through cutting and/or root removal are the recommended methods of control.
- **Timing of Removal**. Removal should take place when plants begin to flower as reserve food supplies are taxed and seeds have not yet been produced. Optimal removal period is May through July.
- **Total Cost Manual**. $867,400

Common hops (*Humulus lupulus*)


Diamond Head Consulting Ltd.

Hops may be an emergent invasive plant in BC. It is a herbaceous perennial bine which can grow 20 to 50 cm per week but dies back to the rhizome in the winter. It reproduces both vegetatively and by seed. Flowering occurs in late summer. There are four varieties, one of which is native to Eastern North America. The varieties are difficult to identify. E-Flora states that further work is required to identify the varieties in BC and determine their invasive status. To date it has primarily been observed growing in association with blackberry and salmonberry. It has been observed growing aggressively up trees and could pose a risk to their structural stability.

- **Consequence rating**. Moderate.
- **Control Method**. Unknown. Likely requires removal of rhizomes.
- **Timing of Removal**. Unknown. Likely best to remove early in growing season and avoid disturbance once seeds have set in late summer.
- **Total Cost Manual**. $14,700.

Knotweed species (*Fallopia spp.*and hybrids)


Diamond Head Consulting Ltd.

Optimal conditions for knotweed species include moist soil and partial shade to full sun. It can reproduce by seed but the predominant mode of spread is vegetative reproduction from rhizomes and roots. Root fragments as small as 1 centimeter can form new plant colonies. Rhizomes can spread 20 meters from the parent plant and can penetrate 3 meters into the soil. Large and dense colonies are quickly formed, as knotweed species can grow up to 8 centimeters a day. Flower clusters bloom in July and August, forming seeds by mid-August.

- **Consequence rating**. Very high.
- **Control Method**. Manual treatment has been attempted however it has been found that cutting, mowing and pulling of knotweed stimulates shoot growth and is ineffective. Herbicide treatment (glyphosate) through stem injection and/or foliar application has been found to be the most effective method of control, with reports of up to 90% effectiveness in the first year. All stems need to be injected which is only possible in stems over ½ inch in diameter. Small diameter stems are treated by foliar spray. Follow-up treatment by foliar application is required regardless of initial treatment type used (stem injection or foliar). Targeting new growth in early spring with foliar application has been found to be highly effective and less time consuming than stem injection. Currently Agriculture and Agrifood Canada (AAFC) is developing a bio-control agent using a psyllid. They don't anticipate field release until 2013 at the earliest.
- **Timing of Removal**. Efforts should be conducted during the entire growing season, with particular efforts concentrated in early spring (foliar target of new growth) and/or in late summer/fall (when plant is sending energy into rots for over wintering), continuing until the first frost.
- **Total Cost Chemical**. $23,900

Lamium (*Lamiastrum galeobdolon*)

Lamium can tolerate a wide range of soil, water and shade conditions and has been documented to grow up to 1 meter per year. Small, yellow flowers grow in clusters from April to June, with each plant producing approximately 800 seeds that are typically dispersed by insects. Lamium can propagate both by seed and vegetatively.

- **Consequence rating**. High
- **Control Method**. Manual and chemical methods are effective options. Hand removal must be done carefully to ensure that all parts of the plant are removed as rooted fragments will regenerate. Manual treatment requires that the site be revisited for two years. Treated areas should be covered with cardboard (overlapping pieces) as well as a 10-20 cm layer of bark mulch. Replant through holes in cardboard after 1 or 2 years. Leave cover on site to decompose. Alternatively black plastic can be used as a cover. After one year pull a segment of plastic back. Leave for 1 to 2 months (during spring) to monitor for regrowth. If no regrowth appears, remove plastic entirely and plant. Using mulch alone as a cover is also an option. Chemical treatment is effective and if applied properly does not require follow up.
- **Timing of Removal**. Manual removal should be conducted during the fall through to early spring, allowing for removal to be conducted before the seeds set in. Chemical treatment should take place March to June.
- **Total Cost Manual**. $74,900
- **Total Cost Chemical**. $3,800

Periwinkle (*Vinca minor*)

Periwinkle is an evergreen groundcover predominantly found in shaded forest understories. It grows in sandy to clay soils, both well-drained and moist and prefers partial shade. It spreads solely by rooting stolons and produces pale blue to lavender flowers that bloom in the spring and intermittently throughout the summer.

- **Consequence rating**. High.
- **Control method**. Due to its limited reproduction and spreading mechanisms, repeated manual removal tends to be an effective method. Particular success has been observed when removal is conducted down to the root level and the site is heavily mulched and re-planted. Same cover method as described for Lamium should be followed.
- **Timing of Removal**. As an evergreen invasive that does not spread by seed, removal can be conducted throughout the year.
- **Total Cost Manual**. $41,800

Policeman's helmet (*Impatiens glandulifera*)


Diamond Head Consulting Ltd.

Policeman's helmet is an aggressive invader of wetlands and streams, tolerant of many soil types and can grow in full sun as well as partial shade. Reproduction and spread occurs primarily by seed but can also occur vegetatively. As an annual plant, flowers are present from approximately June to October and seed production begins in late summer through fall until first frost. Up to 2500 seeds can be produced per plant, which are dispersed from explosive seed capsules that can send the seeds up to 3.5 meters away. Seeds can be viable in the soil for up to 18 months.

- **Consequence rating**. Moderate.
- **Control method**. Manual removal of the entire plant including the root system is easy and effective. If the plants are in flower, a bag should be placed around the entire flower head cluster to prevent the seeds from escaping. Plants should not be disturbed or removed once seeds are dispersing to avoid transporting seeds and creating new infestations.
- **Timing of removal**. Removal is best conducted in the spring or early summer before the plants go to seed.
- **Total Cost Manual**. $1,100

Scotch broom (*Cytisus scoparius*)


King County

Scotch broom thrives in full sun and prefers sandy, well-drained soil conditions but can tolerate moist soil and partial shade. Plants grow rapidly with seed production beginning after two to three years. The main flowering season is February to June and seed dispersal can occur as early as mid-July. Up to 18,000 seeds can be produced annually from a single plant and the seeds can remain viable up to 80 years. Once broom has established at a site, it will take 20 or more years of management to deplete the seed bank. Scotch broom can fix atmospheric nitrogen into the soil, changing the ecosystem composition.

- **Consequence rating**. High.
- **Control method**. Seedlings and small plants can be manually removed, especially effective on plants less than 1" in diameter. Mature plants should be cut at the base, taking care to minimize soil disturbance as this encourages germination of dormant seeds. Mechanical treatments may need to be repeated over a three to five year period. Cutting mature plants can be effective when combined with long-term monitoring for re-growth and/or the application of herbicide to the stump to prevent future growth. Early removal of young broom is the best prevention.
- **Timing of removal**. Removal efforts should be conducted between November and January, minimizing disturbance of plants that have gone to seed.
- **Total Cost Manual**. $2,500

Small flowered touch-me-not (*Impatiens parviflora*)

This is an annual herbaceous plant that thrives in moist soil conditions and partial to full shade. Reproduction occurs primarily by seed, which are dispersed from explosive seed capsules.

- **Consequence rating**. Moderate.
- **Control method**. Manual removal can be effective if care is taken to remove all underground stems. Periodic monitoring should occur over several years to remove new growth.
- **Timing of removal**. Removal should be conducted before the plant goes to seed.
- **Total Cost Manual**. $3,900

Spurge laurel (*Daphne laureola*)

Spurge laurel is an evergreen shrub that prefers well-drained locations and can grow in full to partial shade. It spreads by seed and lateral roots, flowering in its second year and first producing fruit in its fourth year. Flowers are produced in winter to early spring, producing fruit in the early summer. It is thought that spurge laurel can alter the soil chemistry and acidity, preventing the re-establishment of native plant species. This plant produces toxins that are located in the bark, sap and berries (WorksSafe BC has issued a Toxic Plant Warning that should be consulted prior to removal).

- **Consequence rating.** High (due to toxicity).
- **Control method**. Seedlings and young plants can by removed by hand, removing as much root mass as possible to reduce resprouting. Older plants should be cut at soil level as resprouting from roots appears to be less common, especially when it is in flower or the fruits are still green.
- **Timing of removal**. Efforts should be made to remove plants between November and March, when energy is being put towards flowering and the fruit have not yet established.
- **Total Cost Manual**. $15,000

Yellow flag iris (*Iris pseudacorus*)

Yellow flag iris is an aquatic perennial that grows in standing water or next to it on saturated soils, preferring silty, sandy or rocky soil. It spreads by seed and vegetatively by rhizomes, taking three years to mature before flowering (April to June). Seeds are viable in the soil for an extensive period of time, thus removal of seed pods may help to control population expansions.

- **Consequence rating**. Very high.
- **Control method**. Yellow flag iris is difficult to control, due to the extensive rhizome systems and seed banks. Hand removal is recommended, though this process is difficult and requires persistence. Continuous mowing or cutting over several years may be effective and cutting of the flowers will stop seed dispersal.
- **Timing of removal**. Removal should be conducted before the seeds germinate in the late summer. The plant is most easily identified when it is flowering.

4.2 Ecosystem Level Management

Ecological value or integrity can be measured in terms of genetic and species diversity. Many invasive plants have the potential to alter the biotic composition of an ecosystem enough to negatively impact diversity. However it is difficult to predict with absolute certainty the extent of this impact considering the rapid abiotic influences (climate change, human impact) on these ecosystems.

As an ecosystem departs from what is considered a natural state it may eventually reach a novel state (Figure 5). A novel ecosystem is one in which species occur in combinations and abundances not previously known (Hobbs *et al.* 2006). They are both indirectly and directly the result of human impacts and actions. Between the historic and novel state is a hybrid state in which some original characteristics remain.

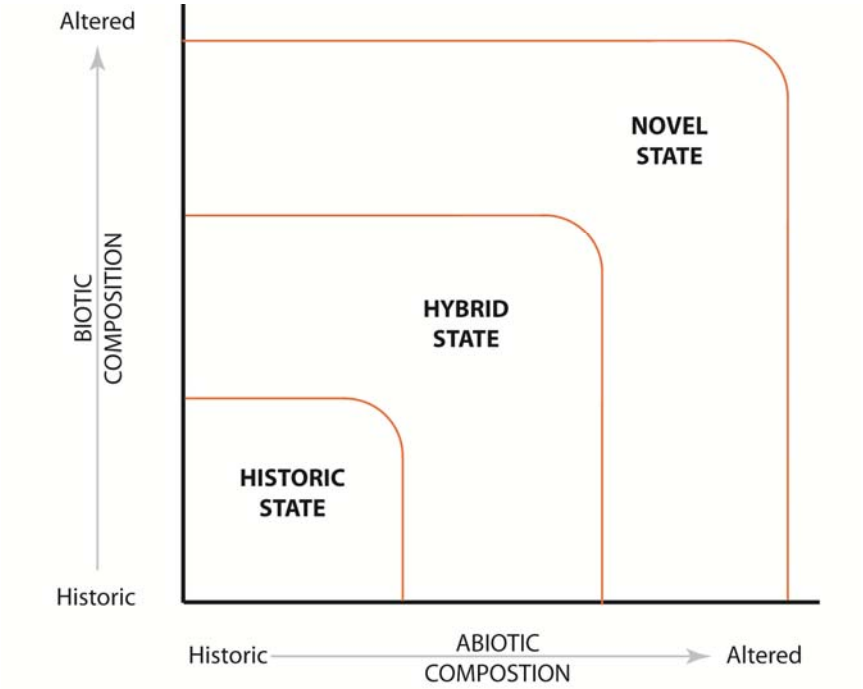


Figure 5. Historic, hybrid and novel ecosystems.

Even with our potential ability to manipulate biotic factors (such as species composition), many abiotic factors are beyond our control. For natural areas heavily impacted by invasive species, it is sometimes unfeasible to alter biotic composition enough to restore them to their historic state (Seastedt *et al.* 2008). However, it may be possible to restore some functionality (Figure 6). In the case of hybrid ecosystems, it may be feasible and realistic to alter the biotic composition and restore them to their historic conditions.

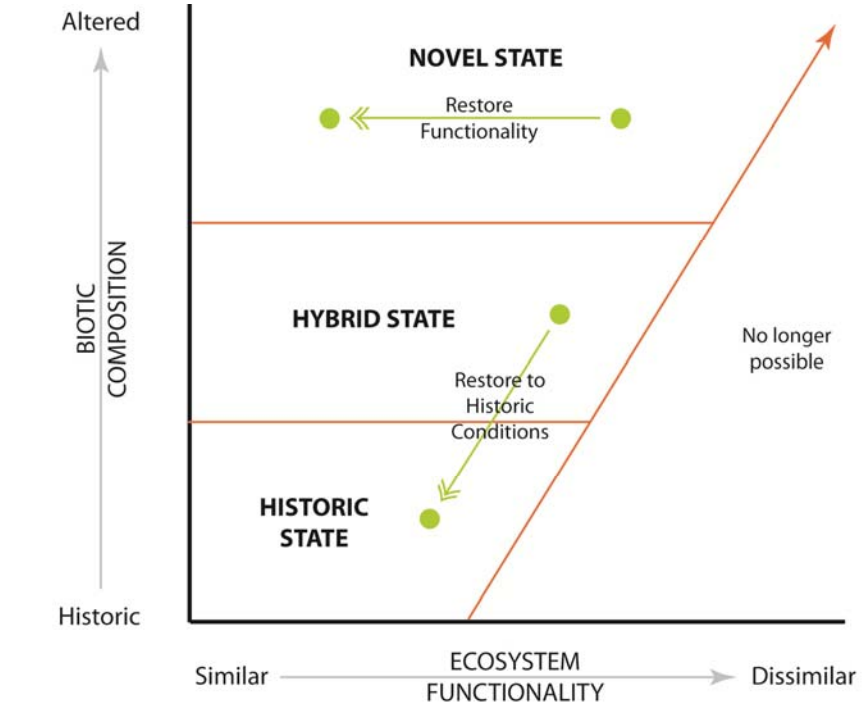


Figure 6. Ecosystem restoration pathways.

We have attempted to employ the concepts of novel, hybrid and historic conditions combined with ecosystem function in order to better understand the current state of City parks. Park area has been very loosely classified into three categories: Historic state, hybrid state and novel state (Figure 7).

Areas classified as "historic state" have a biotic composition similar to what would be expected based on site characteristics. There are few invasive plants all of which are in an emergent stage (on a site scale). It is expected that these sites best represent ecosystem remnants from before urbanization.

Areas classified as "hybrid state" are still recognizable in terms of ecosystem type. It is possible to define their historic conditions. These areas tend to have intact native tree and shrub layers, while their herb layers are starting to be impacted by invasive plants in the emerging and colonizing stages. Depending on the invasive species types and stage of infestation it may be possible to restore these areas to their natural state.

Areas classified as "novel state" are highly impacted. It is no longer possible to fully recognize their historic conditions. Invasive plants have naturalized and altered ecosystem processes and function. These areas have typically been dramatically disturbed by humans. In the City, very small park parcels, exposed edges and narrow park belts have often reached a novel state. Ideally the goal is to restore an ecosystem to its historic state but it may not be feasible to accomplish this goal. When deemed unfeasible, strategies should be considered that will restore certain aspects of ecosystem function and contain infestation to prevent them from spreading further or acting as source populations.

Figure 7. Ecosystem condition class distribution in the City of North Vancouver (numbers are for polygon identification purposes).

Developing a long term invasive species management program focuses largely on the effective use of available resources. The estimated treatment costs provided in this report illustrate the importance of assessing feasibility. The categorization of areas based on their ecosystem condition class can be used as a tool to help prioritise management actions. For example, the removal of English ivy from an area in a historic or hybrid state may be a better use of resources as opposed to attempting to completely remove it from an area in a novel state. A cost effective use of resources in a novel state ecosystem may focus on the removal of climbing vines from trees to preserve a functional tree canopy and/or understory tree planting to promote forest succession.

5.0 SUMMARY OF RECOMMENDATIONS

5.1 Implementation

This report offers a variety of approaches for managing invasive species. Before an operational program is adopted, the City should define its own values (with regard to the risk matrix) and objectives. This will provide a solid basis/justification for prioritizing management actions and resources.

A critical factor to the success of the City's invasive plant management strategy will be coordination with neighbouring North Shore jurisdictions within and adjacent to the municipality (District of North Vancouver, Metro Vancouver, and the Squamish Nation). This is particularly important for the successful treatment of water transported invasive plants. The recommended approach within a watershed is to focus efforts in the upper most reaches of the watershed and work progressively down towards the outlet.

Before adopting a wide scale invasive plant management program, it is recommended that pilot projects be conducted for target invasive species. This is critical for testing treatment method effectiveness, establishing monitoring and restoration protocols, training operations crews and to evaluate costs and resources.

Preliminary recommendations have been provided for each species and at an ecosystem level. These must be considered together when developing a long term operational program. Recommendations are also provided for inventory maintenance and record keeping, and prevention strategies. A phased implementation plan is outlined in Table 13.

Table 13. Proposed implementation plan.

Phase	Task	Ongoing Task
1a	Develop an invasive plant management strategy and operational plan (this report may form the basis of the plan but City should define its own values and objectives)	• Communicate and coordinate plans with neighbouring jurisdictions • Keep informed on new invasive plant management strategies • Annually assess invasive plant management program in terms of feasibility, efficiency, changing priorities, new knowledge, etc.
1b	Develop protocol for inventory maintenance and record keeping	
2	Carry out strategic pilot projects	
3a	Use information learned from pilot projects to begin City wide invasive plant management program incorporating objectives at the species level and ecosystem level	
3b	Develop prevention strategies	

5.2 Species Level

Species specific recommendations are provided in Table 14. This is primarily to prioritize species which may be candidates for eradication or aggressive containment measures. These recommendations are not meant to imply that low priority species should not be removed. They may be removed as part of site specific restoration projects or strategically contained as part of ecosystem level strategies.

Table 15. Priority rank and summary of species level recommendations.

Priority	Species	Action
1	Giant hogweed	Continue the City's aggressive giant hogweed removal program indefinitely. Use manual and/or herbicide treatment on all inventoried locations
	Himalayan knotweed	Chemically treat all inventoried locations (emerging variety of knotweed)
	Knotweed	Commence trial removals by herbicide application prioritizing Mosquito Creek and Mahon; pulling or digging of larger sized patches is not recommended as it has been found to be ineffective, may stimulate growth and transport/disposal may inadvertently lead to new infestations.
	English ivy	Cut vines climbing on trees to preserve tree canopy
	Hops	Trial removal, then attempt city-wide eradication; initially carryout removal at a test site to determine best removal technique
2	Butterfly bush	Attempt eradication; threat to sensitive habitat types at a Regional scale
	Scotch broom	Attempt eradication; threat to sensitive habitat types at a Regional scale
	Japanese butterbur	Trial removal, then attempt city-wide eradication; emergent in riparian habitats; initially carryout removal at a test site to determine best removal technique, minimizing disturbance to riparian areas
	Policeman's helmet	Attempt eradication; in early stages of infestation
	Comfrey	Attempt eradication; emergent species
	Yellow flag-iris	Attempt eradication; emergent species; city has minimal habitat that would support this species
	Clematis	Passively manage: City crews clip climbing stems and pull roots whenever a plant is found to preserve tree canopy
3	Spurge laurel	No species specific action; too widely dispersed to eradicate
	Himalayan blackberry	Hand removal and overplant where it is affecting more than just a stand edge.
	Periwinkle	No species specific action; when periwinkle is removed, monitor closely for re-growth: manual removal may be found to be ineffective; chemical or cover (plastic/cardboard/mulch) method may be required.
	Lamium	No species specific action; when lamium is removed, handpulling alone is not recommended due to ineffectiveness: treatment must be combined with either chemical or cover (plastic/cardboard/mulch) method.
	English holly	No species specific action; too widely dispersed to eradicate
	English laurel	No species specific action; too widely dispersed to eradicate
	Goutweed	No species specific action; too widely dispersed to eradicate
	Small flowered touch-me-not	No species specific action

5.3 Ecosystem Level

Ecosystem level strategies recommended within each condition class are as follows:

- Historic conditions: Monitor for emerging infestations and changes to ecosystem function. Take immediate action to maintain historic conditions.
- Hybrid conditions: Take feasible actions to remove target invasive plants, restore historic condition, and maintain ecosystem function. Prevent spread into adjacent historic condition areas.
- Novel conditions: Contain invasive plants (prevent from spreading into adjacent areas); if not be feasible to restore to historic condition then maintain and improve ecosystem function.

5.4 Pilot Projects/Test Sites

Six pilot project locations have been recommended to aid the City in developing their invasive plant management program. Carrying out trial treatments will provide valuable information about the effectiveness and costs of a City wide program. Pilot project locations have been recommended that are easy to access and have safe terrain to train operational crews. Regular and frequent monitoring of pilot project sites is critical in order to understand treatment effectiveness. Location maps for each proposed pilot project are included in Appendix 0.

Treatment cost estimates are based on a subcontractor crew of four at $1200/day (includes labour, tools and vehicle). Cost has only been estimated for the initial treatment and does not include follow-up treatments. Restoration planting estimates are based on the same subcontractor rate and assume a production rate of 400 plants/day. The minimum estimate for a planting job is 4 hours to account for delivery, plant placement and clean-up. Efficiencies are realized when multiple sites are planted the day. Restoration costs do not include plant material. Costs assume that entire site will need planting. Note that restoration planting is not always required or may not be required for the entire site.

1. **Knotweed (~400 m^2)**
    a. Location: Loutet (eastern end of park adjacent to stream)
    b. Treatment Method: In early spring (March or early April), apply glyphosate to new shoots when <20 cm tall. If early treatment window is missed, use 'cut and insert' stem injection method once stems reach appropriate size. Hand dig stems within 1m from the creek.
    c. Monitoring: Biweekly. When new growth reaches 20 cm, reapply glyphosate.
    d. Restoration: Template 8; can occur once site has been knotweed free for one growing season.
    e. Comments: Contained knotweed patch; easy access; uniform flat terrain. Follow regulations regarding pesticide application near water. Stem injection and cut & insert can be up to 1 m from high water mark. Foliar application must be 2 to 6 m from high water mark (use discretion).
    f. Estimated Cost:
        i. Treatment: 1 day - $1200 (variable depending on application method)
        ii. Restoration: 1 day - $1200

2. **Lamium (~100 m^2) and periwinkle (~420m^2)**
    a. Location: Mahon (off alley beginning at corner of Fir and Wolfe Streets)

b. Treatment Method: Experiment with digging versus cut & cover. Digging method attempts to remove all roots. Cut & cover involves cutting the plant back then covering the area with cardboard and mulch (or plastic). See Lamium profile for complete description of cover method.
c. Monitoring: For non-covered sites, monitor every two months during growing season. For covered sites, monitor twice during growing season and once in March to ensure cover has not been disturbed.
d. Restoration: Template 5; Year 2: plant through holes in cardboard while leaving cover in tact to decompose. For plastic cover, remove a small section in spring. If no regrowth after two months, remove cover and plant.
e. Comments: Small to moderate sized patches; easy access.
f. Estimated Cost:
    i. Treatment: 3 days - $3600
    ii. Restoration: 1.5 day - $1800

3. Giant hogweed (~75 m^2)

a. Location: Mosquito Creek (between 2nd Avenue and Bewicke)
b. Treatment Method: Opportunity to compare herbicide treatment versus hand removal.
c. Monitoring: Every two months during growing season.
d. Restoration: Template 9; can occur once site has been hogweed free for one growing season. Plant only if disturbed area is sizeable and there is concern that adjacent native vegetation will not re-colonize.
e. Comments: High concentration of hogweed.
f. Estimated Cost:
    i. Treatment: 1 day - $1200 (all chemical)
    ii. Restoration: 4 hours - $600

4. Policeman's helmet (~20 m^2)

a. Location: Mosquito Creek (near 17th Ave, north of paved courts)
b. Treatment Method: Hand pull plant in spring or early summer prior to seed formation.
c. Monitoring: Once in late summer in case plants germinated after initial pull. Follow up treatment in year 2 and 3 to ensure no germination from seedbank.
d. Restoration: Template 6; can occur immediately after initial treatment. Plant only if disturbed area is sizeable and there is concern that adjacent native vegetation will not re-colonize.
e. Comments: Patch is manageable size, on flat terrain and easy to access. Another pilot project location for policeman's helmet is in Larson Park (along north edge of grass area).
f. Estimated Cost:
    i. Treatment: 2 hour - $300
    ii. Restoration: 4 hours - $600

5. Hops (~10 m^2)

a. Location: Sunrise (along Heywood)
b. Treatment Method: Remove plant and dig roots in spring or early summer prior to seed formation.
c. Monitoring: Once in late summer in case plants germinated after initial pull. Follow up treatment in year 2 and 3 to ensure no new germination from seedbank or rhizomes.

d. Restoration: Template 6; can occur once site has been hops free for one growing season. Very unlikely to require restoration. Plant only if disturbed area is sizeable and there is concern that adjacent native vegetation will not re-colonize.
e. Comments: Easy access; small infestation. One much larger patch is growing along Heywood to the southwest, in vicinity of hydro lines. This patch could be added to the pilot project.
f. Estimated Cost:
    i. Treatment: 1 hour - $150
    ii. Restoration: 4 hours - $600

6. Japanese butterbur (~30 m²)

a. Location: Wagg Creek (on 19th Street between Jones and Mahon)
b. Treatment Method: Remove plant and dig roots in spring or early summer prior to seed formation.
c. Monitoring: Once in late summer in case plants germinated after initial pull. Follow up treatment in year 2 and 3 to ensure no new germination from seedbank or rhizomes.
d. Restoration: Template 12; can occur once site has been butterbur free for one growing season. Plant only if disturbed area is sizeable and there is concern that adjacent native vegetation will not re-colonize.
e. Comments: Easy access; small infestation. Two additional plants upstream in Wagg Creek Park (~2 m²) which can be targeted as part of this pilot project.
f. Estimated Cost:
    i. Treatment: 1 day - $1200
    ii. Restoration: 4 hours - $600

A key consideration in the pilot project phase is to ensure that treatment methods are not inadvertently causing new invasive plant infestations. This can occur in several ways. Plant parts (seeds, roots, plant fragments) may escape during transport off site and en-route to a disposal site. Plant parts can also be carried on the clothing, tools and vehicles used by the crew. Site disturbance caused by accessing the site and during the removal operations may make the site vulnerable to new infestations. Restoration materials (mulch, soil and plants) may be contaminated with invasive plant seed. In some case invasive plants alter soil properties in such a way that conditions are less favorable for native plants but more favorable to other non-native species. This emphasizes the need for determining whether restoration plantings are needed as well as frequent monitoring to ensure that new infestations aren't given the chance to establish. All of these factors must be carefully considered and scrutinized.

5.5 Inventory Maintenance and Record Keeping

The inventory represents a 'snap-shot' picture in time of the dispersal and abundance of specific invasive species in the City. Inevitably over time dispersal and abundance will gradually change and new emergent invasive species may appear. This inventory can likely be considered adequately accurate for the next 3 to 5 years. This will vary between species as some disperse and spread more quickly than others. The greatest agent of change in this time frame will be removal and restoration operations. Since these operation works are undertaken by a variety of people (City staff, City organized volunteer groups, and avid local citizens) it is important that they be tracked accurately.

An efficient and user friendly system will ensure that appropriate sites are chosen (based on labour capability), knowledge is shared about treatment effectiveness, proper monitoring occurs, and most importantly that location and operational details are consistently recorded. It is recommended that the City consider the use of smartphone applications which record geographical location, site photos and details about the operation. This information can then be sent to the City and incorporated into

a constantly updated, spatially referenced file. The present inventory can remain unaltered to provide a measurable starting point. Managers and crew supervisors can use ArcMap to view the inventory and the operations records as two separate, overlapping spatial coverages.

The information collected in the smartphone application should include:

- Park name
- Date
- Supervisor name
- Number of crew/volunteers
- Species targeted
- Size of patch removed or volume removed
- Removal method
- Recommended monitoring date and frequency
- Lessons learned
- Comments

5.6 Prevention

Prevention of invasive plant infestations is far less costly then dealing with a species once it has become established. The ability of City crews to recognize emerging invasive plant species as well as species that are not yet present in Metro Vancouver will enable the City to carry out Early Detection and Rapid Response (EDRR) of new invasive plants. The IPCMV website has a list of target species including those categorized as 'Prevent' which are present in neighbouring jurisdictions such as Washington State and the Fraser Valley (http://www.ipcmv.ca/target-species).

Given that most invasive species originate as garden ornamentals, public education is an effective tool for preventing or minimizing re-introductions and new infestations. Much of the public are likely unaware of the extent of the problem. An education campaign (such as the City of Coquitlam's 'Bad Seed' program) can help people understand the risks associated with non-native invasive species, learn to identify key species and offer gardeners alternative non-invasive plant options. Requiring local nurseries and garden centers to stop selling the most common invasive plants will also help prevent further infestations and increase public awareness.

The dramatic impact of green waste dumping in the City was noted throughout the inventory. It is recommended that all known dump sites be removed and restored with native vegetation, and that actions be taken to prevent further dumping including:

- Targeted door to door education for residents living adjacent park parcels
- Signage designed to discourage dumping by detailing the negative impacts on the ecology and park aesthetics.
- Signage on restored dump sites explaining why restoration was carried out.
- Restrict access using barriers (i.e. fencing, logs or boulders).

6.0 HABITAT RESTORATION GUIDELINES

Many invasive species establish as a dense monoculture, outcompeting most native species. Once they are removed from a site, there is often very little native plant cover remaining. The site is then susceptible to the re-establishment of invasive species and exposed mineral soil is at risk of erosion. As an integral part of the invasive species mitigation program, sites that are denuded of native vegetation cover should be restored. To facilitate this program a set of restoration templates

(provided in Appendix I) have been developed that specify ecologically suitable species and planting densities.

Plant communities are specific to climatic and soil characteristics. Restoration templates are therefore based on site series of the Biogeoclimatic Ecosystem Classification. In addition, light exposure influences species selection. The templates have been developed for each site series identified during the inventory as well as light exposure type (open or shaded). Due to environmental variability, it was not possible to develop detailed prescriptions for all restoration scenarios in the City. Therefore, these templates should be considered as guidelines to be amended when site specific prescriptions are developed.

6.1 Erosion and Sediment Control Measures

For all sites, restoration should consider soil stabilization prior to planting. This is of particular concern in areas with steep slopes, especially those associated with riparian areas and water systems. Specific thresholds and erosion control measures are difficult to prescribe because the risks are dependent on the characteristics and dynamics of an individual site. It is recommended that all sites be monitored for risk of erosion while invasive species are being removed. Strategies to be implemented include stabilizing slopes and implementing surface erosion control measures.

The following practices should be implemented for all restoration sites:

- Minimize the area of disturbed soil and retain existing native vegetation where possible;
- Avoid work during predictable periods of wet weather;
- Coordinate restoration activities to minimize the amount of time that soils are subject to erosion.

Most invasive species removal projects will not destabilize a slope, however the risk of surface erosion should be addressed. Surface erosion can be controlled quickly and effectively by the application of surface treatments, including the placement of straw and/or granular materials. Straw is widely available and frequently used as mulch that can be applied by hand over small areas. Although it has limited longevity, straw adds organic matter into the soil, provides a surface layer for moisture retention, and aids in germination. Straw should only be used as a temporary erosion control strategy until native plantings are established. Other surface treatment methods include the application of wood chips or wood fibre. Collectively, mulches protect the soil surface from rain impact, promote runoff infiltration, decrease runoff velocity, prevent soil compaction, and conserve soil moisture.

A wide range of synthetic and fabricated geosynthetic textiles are manufactured for erosion control practices. Erosion control blankets provide immediate soil protection, similar in effect to applying a mulch but they provide a more stable and durable system. Fabricated systems also provide an organic layer, help retain moisture in the topsoil, and are intended to biodegrade over time. They are typically used on steep slopes, erosive soils or where downslope impacts from erosion and sedimentation are of significant concern. Erosion control blankets are effective but they can be costly, include materials that are not biodegradable, and require ongoing maintenance and monitoring. Subsequently, this method of erosion control should only be considered if other surface treatments are not feasible.

6.2 Planting Specifications

All inventoried invasive species sites have been classified according to the Biogeoclimatic Classification System of BC. Planting templates have been developed for each site series and light exposure type. All of the City of North Vancouver is within the Dry Maritime Coastal Western Hemlock Subzone (CWHdm). The site series identified included 01, 05, 07, 09, and 12. Wetland classifications include Ws50/51 - swamp wetland and Wm - marsh wetland. Template planting

prescriptions have been developed that specify the density of plantings and well as composition of shrub and tree species.

The success of a plantation is dependent on an appropriate planting prescription and the quality of the plants that are installed. All planted species should meet the standards of the BC Landscape Association. They should be well rooted in the container but not root bound. Plants should be healthy and free of disease or insect damage. All plants should be checked when delivered and those not meeting the most recent Landscape Standards should be sent back to the delivering nursery.

In general, survival is related to the root to shoot ratio of the stock planted and the soil moisture and nutrient availability on site during the growing season. Larger stock plants have the advantage of having a large stem to obtain light; however, they often have a lower proportional root system. In addition, larger stock often requires a higher moisture availability to establish in the first two growing seasons. Shrubs and ferns should be well established in #1 or #2 pots for the restoration prescription provided. Ferns should be at least 30 cm tall and shrubs should be at least 50 cm tall. Smaller containers are not recommended for most shrubs and ferns due to poor survival rates. Trees should be well established in #2 or #5 pots and be at least 50 cm tall. In areas that were occupied by reed canary grass, Himalayan blackberry or knotweed, it is recommended that only large stock (>1.5m tall) of aggressive trees of tall shrubs be planted at high densities.

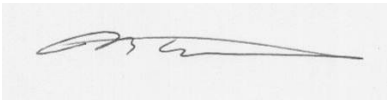
It is recommended that planting be completed at high densities to help prevent the re-establishment of invasive species and to reduce the risk of erosion. Shrubs and trees are prescribed at densities of 2500 – 5000 stems/ha. This is the equivalent of one plant for every two to four square meters. Fall planting is recommended for all planting stock. Planting should take place following the end of the last drought period (September to October). This allows for two periods of root growth (fall and early spring) before the flush of foliage.

6.3 Monitoring and Maintenance

Monitoring and maintenance of restoration sites is a critical component to ensure long term success. This includes fill planting where there is mortality and the removal of invasive and competing vegetation. Regular inspections and maintenance is recommended at all sites for the first three years. Sites should be inspected approximately one month following flushing of new vegetation in the spring. If survival of the planted stock is <85%, fill plant to the original density. Also, if competing vegetation is causing mortality, it should be brushed out as necessary. Any invasive species that are establishing should be removed before they are able to re-establish as a monoculture.

7.0 CONCLUDING REMARKS

Control and management of invasive species within parks and green spaces has become a long-term, on-going issue faced by municipalities. Many invasive species are beyond the level where eradication is an option and are now established populations requiring on-going management to control and prevent new infestations. Although in some instances it may be possible to eradicate emergent invasive species, there will always be a possibility of re-introduction. The baseline inventory, management recommendations and habitat restoration guidelines provided in this report offer the City of North Vancouver key components for the development of a city-wide comprehensive invasive plant management program.



Fiona Steele, R.P.Bio. Mike Coulthard, R.P.Bio., R.P.F.

Phone: 604-733-4886
Fax: 604-733-4879
Email: fiona@diamondheadconsulting.com or mike@diamondheadconsulting.com
Website: www.diamondheadconsulting.com

8.0 WORKS CITED

Hobbs, R.J., S. Arico, J. Aronson, J.S. Baron, P. Bridgewater, V.A. Cramer, P.R. Epstein, J.J. Ewel, C.A. Klink, A.E. Lugo, D. Norton, D. Ojima, D.M. Richardson, E.W. Sanderson, F. Valladares, M. Vila, r. Zamora, and M. Zobel. 2006. Novel ecosystems: theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography*. 15, 1-7

Seastedt, T.R., R.J. Hobbs, and K.N. Suding. 2008. Management of novel ecosystems: are novel approaches required? *Frontiers in Ecology and the Environment*. 10.1890/070046

9.0 APPENDIX I – HABITAT RESTORATION TEMPLATES

Habitat restoration templates are designed to be used as guidelines when developing site-specific prescriptions.

Key to Restoration Templates: The major division in the key of restoration templates is the Biogeoclimatic site series or wetland site class, and light exposure type.

Template	Site Series/Site Class	Exposure Type
1	CWHdm/01	Shade
2	CWHdm/01	Open
3	CWHdm/03	Shade
4	CWHdm/03	Open
5	CWHdm/05	Shade
6	CWHdm/05	Open
7	CWHdm/07	Shade
8	CWHdm/07	Open
9	CWHdm/09 or 10	Shade
10	CWHdm/09 or 10	Open
11	CWHdm/12	Shade
12	CWHdm/12	Open

9.1 Restoration Template 1 – Site series 01 – Shade exposure

Slightly dry to fresh soil moisture regime and medium soil nutrient regime. Completely or partially shaded.

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	60
Tsuga heterophylla	Western hemlock	10
Thuja plicata	Western redcedar	30
Shrub/Herb Layer		
Gaultheria shallon	Salal	20
Symphoricarpos albus	Snowberry	20
Oemleria cerasiformis	Indian plum	20
Acer circinatum	Vine maple	10
Polystichum munitum	Sword fern	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple that is a min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Ferns min 0.3m tall. Well established, nursery grown, dense, uniform plant.

9.2 Restoration Template 2 – Site series 01 – Open exposure

Slightly dry to fresh soil moisture regime and medium soil nutrient regime. Open exposure

Scientific Name	Common Name	Density (% coposition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	20
Alnus rubra	Red alder	30
Pseudotsuga menziesii	Douglas-fir	30
Thuja plicata	Western redcedar	20
Shrub/Herb Layer		
Gaultheria shallon	Salal	20
Symphoricarpos albus	Snowberry	20
Rosa gymnocarpa	Baldhip rose	10
Oemleria cerasiformis	Indian plum	20
Acer circinatum	Vine maple	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple and red alder that are a min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

9.3 Restoration Template 3 – Site series 03 – Shade exposure

Dry soil moisture regime and poor to medium soil nutrient regime. Completely or partially shaded

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	50
Thuja plicata	Western redcedar	50
Shrub/Herb Layer		
Gaultheria shallon	Salal	60
Menziesia ferruginea	False Azalea	20
Rosa gymnocarpa	Baldhip rose	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple that is a min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

9.4 Restoration Template 4 – Site series 03 – Open exposure

Dry soil moisture regime and poor to medium soil nutrient regime. Open exposure

Scientific Name	Common Name	Density (% coposition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	20
Pseudotsuga menziesii	Douglas-fir	30
Thuja plicata	Western redcedar	20
Shrub/Herb Layer		
Gaultheria shallon	Salal	40
Symphoricarpos albus	Snowberry	30
Rosa gymnocarpa	Baldhip rose	10
Ribes sanguineum	Red flowering currant	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple that are a min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

9.5 Restoration Template 5 – Site series 05 – Shade exposure

Slightly dry to fresh soil moisture regime and rich soil nutrient regime. Completely or partially shaded

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	40
Tsuga heterophylla	Western hemlock	10
Thuja plicata	Western redcedar	40
Picea sitchensis	Sitka spruce	10
Shrub/Herb Layer		
Symphoricarpos albus	Snowberry	10
Oemleria cerasiformis	Indian plum	20
Corylus cornuta	Beaked hazelnut	20
Acer circinatum	Vine maple	20
Polystichum munitum	Sword fern	30

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Ferns min 0.3m tall. Well established, nursery grown, dense, uniform plant.

9.6 Restoration Template 6 – Site series 05 – Open exposure

Slightly dry to fresh soil moisture regime and rich soil nutrient regime. Open exposure

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Thuja plicata	Western redcedar	30
Acer macrophyllum	Bigleaf maple	20
Alnus rubra	Red alder	20
Pseudotsuga menziesii	Douglas-fir	30
Shrub/Herb Layer		
Symphoricarpos albus	Snowberry	10
Oemleria cerasiformis	Indian plum	20
Corylus cornuta	Beaked hazelnut	20
Acer circinatum	Vine maple	40
Polystichum munitum	Sword fern	10

Planting Specs	**Trees:** 1 tree/10 m², min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple and red alder that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m², shrubs min 0.5 m tall, #1 or #2 pots. Ferns min0.3m tall. Well established, nursery grown, dense, uniform plant.

9.7 Restoration Template 7 – Site series 07 – Shade exposure

Moist to very moist soil moisture regime and rich soil nutrient regime. Completely or partially shaded

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Acer macrophyllum	Bigleaf maple	10
Tsuga heterophylla	Western hemlock	30
Thuja plicata	Western redcedar	50
Picea sitchensis	Sitka spruce	10
Shrub/Herb Layer		
Corylus cornuta	Beaked hazelnut	20
Acer circinatum	Vine maple	20
Polystichum munitum	Sword fern	40

Planting Specs	**Trees:** 1 tree/10 m², min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only bigleaf maple that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m², shrubs min 0.5 m tall, #1 or #2 pots. Ferns min 0.3m tall. Well established, nursery grown, dense, uniform plant.

9.8 Restoration Template 8 – Site series 07 – Open exposure

Moist to very moist soil moisture regime and rich soil nutrient regime. Open exposure

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Thuja plicata	Western redcedar	30
Populus balsamifera spp. trichocarpa	Black cottonwood	20
Pseudotsuga menziesii	Douglas-fir	30
Alnus rubra	Red alder	20
Shrub/Herb Layer		
Rubus spectabilis	Salmonberry	20
Oemleria cerasiformis	Indian plum	20
Acer circinatum	Vine maple	30
Polystichum munitum	Sword fern	30

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only red alder that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Ferns min 0.3m tall. Well established, nursery grown, dense, uniform plant.

9.9 Restoration Template 9 – Site series 09, 10 floodplain sites – Shade exposure

Moist to very moist soil moisture regime and rich soil nutrient regime, bordering streams formed from sediment deposited during flooding events. Under the influence of periodic flooding. Completely or partially shaded

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Thuja plicata	Western redcedar	30
Populus balsamifera spp. trichocarpa	Black cottonwood	70
Shrub/Herb Layer		
Rubus spectabilis	Salmonberry	100

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only black cottonwood that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

9.10 Restoration Template 10 – Site series 09, 10 floodplain sites – Open exposure

Moist to very moist soil moisture regime and rich soil nutrient regime, bordering streams formed from sediment deposited during flooding events. Under the influence of periodic flooding. Open exposure

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Thuja plicata	Western redcedar	30
Populus balsamifera spp. trichocarpa	Black cottonwood	60
Shrub/Herb Layer		
Salix spp	Willow	40
Cornus stolonifera	Red osier dogwood	20
Rubus spectabilis	Salmonberry	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only black cottonwood that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

9.11 Restoration Template 11 – Site series 12 – Shade exposure

Wet soil moisture regime and medium to rich soil nutrient regime. Completely or partially shaded

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Thuja plicata	Western redcedar	70
Picea sitchensis	Sitka spruce	30
Shrub/Herb Layer		
Rubus spectabilis	Salmonberry	60
Polystichum munitum	Sword fern	40

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Ferns min 0.3m tall. Well established, nursery grown, dense, uniform plant.

9.12 Restoration Template 12 – Site series 12 – Open exposure

Wet soil moisture regime and medium to rich soil nutrient regime. Open exposure

Scientific Name	Common Name	Density (% composition)
Tree Layer		
Betula paryrifera	Paper birch	20
Thuja plicata	Western redcedar	30
Populus balsamifera spp. trichocarpa	Black cottonwood	50
Shrub/Herb Layer		
Rubus spectabilis	Salmonberry	20
Spirea douglasii	Hardhack	20
Salix spp	Willow	40
Cornus stolonifera	Red osier dogwood	20

Planting Specs	**Trees:** 1 tree/10 m^2, min 0.5 m tall, #1 or #2 pots. If aggressive invasives present plant only black cottonwood that is min of 1.5m tall at a density of 5000 stems/ha.
	Shrubs: 1 plant/1.5m^2, shrubs min 0.5 m tall, #1 or #2 pots. Well established, nursery grown, dense, uniform plant.

10.0 APPENDIX II. INVASIVE PLANT INVENTORY BY PARK PARCEL.

Table 16. Area (m^2) of infestation by invasive plant species summarized for each park parcel.

Park Parcel	% park area impacted	Total impacted area (m^2)	Butterfly bush	Cherry laurel	Clematis	English holly	English ivy	Giant hogweed	Goutweed	Himalayan blackberry	Hops	Japanese knotweed	Lamium	Other	Periwinkle	Policeman's helmet	Scotch broom	Sm. Fl. Touch-me-not	Spurge laurel
			BD	LC	CM	HO	EI	GH	GW	HI	HP	JK	YA	OTH	CP	IM	SB	IT	SL
009-867-520	10%	27	0	1	0	4	20	0	0	1	0	0	0	0	0	0	0	0	1
009-868-054	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010-217-185	2%	5	0	0	0	0	2	0	0	1	0	0	0	0	2	0	0	0	0
010-217-436	12%	30	0	10	0	3	4	0	4	7	0	0	2	0	0	0	0	0	0
010-221-221	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
010-221-891	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
012-234-800	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
012-235-555	4%	11	0	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
012-286-192	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
013-391-356	14%	115	0	0	0	3	81	0	0	30	0	0	0	0	0	0	0	0	1
Bewicke Park	1%	10	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Chief August Jack Park	2%	18	0	2	0	0	0	0	0	0	0	0	8	0	8	0	0	0	0
Chief Dan George Park	2%	25	0	0	0	0	9	0	0	6	0	0	0	10	0	0	0	0	0
Chief Mathias Joe Park	1%	16	0	0	0	1	0	0	2	8	0	0	5	0	0	0	0	0	0
Chris Zuehlke Park	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cloverley Park	5%	712	0	2	0	22	307	0	0	341	0	8	2	0	11	0	0	0	1
Crickmay Park	6%	143	1	93	0	2	4	0	33	2	0	0	0	0	8	0	0	0	0
Derek Inman Park	2%	89	0	20	0	1	3	0	0	7	0	48	0	10	0	0	0	0	0
Eastview Park	3%	862	0	24	0	39	207	0	6	155	0	6	323	0	99	0	0	0	2
Emerald Park	14%	583	0	0	0	6	481	0	0	49	0	0	26	8	9	0	0	0	4
Grand Boulevard	3%	3,349	0	2,900	0	31	495	10	28	74	0	0	0	0	16	0	0	0	3
Greenwood Park	13%	17,153	2	175	45	785	7,202	7	264	5,693	0	203	1,144	0	1,782	0	100	0	43

Park Parcel	% park area impacted	Total impacted area (m^2)	Butterfly bush	Cherry laurel	Clematis	English holly	English ivy	Giant hogweed	Goutweed	Himalayan blackberry	Hops	Japanese knotweed	Lamium	Other	Periwinkle	Policeman's helmet	Scotch broom	Sm. Fl. Touch-me-not	Spurge laurel
			BD	LC	CM	HO	EI	GH	GW	HI	HP	JK	YA	OTH	CP	IM	SB	IT	SL
Hamersley Park	18%	855	0	22	0	2	785	0	0	30	0	7	0	7	0	0	0	0	2
Heywood Park	22%	29,216	0	153	38	273	16,681	19	540	8,628	0	3,002	798	29	773	94	10	385	46
High Place Park	59%	12,340	0	5	0	30	4,613	3	241	7,444	699	230	797	0	134	0	6	0	28
Hyak Park	70%	3,566	0	5	0	16	2,098	0	0	1,495	0	52	0	0	4	0	0	0	1
Jack Loucks Court	0%	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kealy Woods Park	12%	888	0	24	0	92	387	0	5	289	0	0	562	0	2	0	0	0	0
Kings Mill Walk Park	4%	1,270	108	45	28	0	212	0	0	835	0	6	6	0	0	0	65	0	3
Larson Park	53%	5,576	0	91	2	20	4,262	18	363	242	0	6	338	8	148	83	0	0	4
Lot 1, 18th & William	2%	58	0	1	0	2	18	0	0	36	0	0	0	0	1	0	0	0	0
Lots 1/2, BL9A	3%	28	0	0	0	0	0	0	26	2	0	0	0	0	0	0	0	0	0
Lots 1-18, BL17, DL552	11%	1,646	0	10	0	125	1,079	0	0	360	0	0	60	0	26	0	3	0	9
Lots 13/13, BL230A, DL546	58%	475	0	2	0	20	106	0	78	126	0	0	36	0	126	0	0	0	12
Lots 21/22, BL237, DL546	70%	523	0	0	0	1	0	6	34	309	0	123	44	0	26	0	0	0	1
Lots 24/W, BL9, DL272	54%	763	0	3	0	44	335	0	0	85	0	200	166	0	12	0	0	0	2
Loutet Park	11%	14,973	0	150	5	367	8,107	12	44	5,364	0	443	349	0	91	0	101	10	45
Lynnmouth Park	14%	5,143	0	54	0	8	1,855	5	14	2,999	3	380	0	0	11	0	1	307	1
Mac Leod Park	44%	1,414	0	46	0	12	1,139	0	74	200	0	0	62	0	16	0	0	0	4
Mahon Park	14%	36,487	7	317	443	625	20,916	358	5,800	5,731	4	530	583	71	1,252	559	5	145	35
Mc Dougall Park	0%	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Mc Evoy Park	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moodyville Park	52%	52,125	6	12	54	188	22,355	17	440	29,449	1,609	206	499	12	149	4	5	24	38
Mosquito Creek Park	30%	44,900	6	192	854	306	23,329	153	3,833	11,450	0	400	1,616	14	935	70	29	3,128	83
Norseman Park	0%	22	0	0	0	0	2	0	0	20	0	0	0	0	0	0	0	0	0
Ottawa Gardens	3%	178	0	1	0	2	132	0	0	40	0	0	0	0	0	0	0	0	3
Rey Sargent Park	0%	5	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Rodger Burnes Park	0%	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Park Parcel	% park area impacted	Total impacted area (m^2)	Butterfly bush	Cherry laurel	Clematis	English holly	English ivy	Giant hogweed	Goutweed	Himalayan blackberry	Hops	Japanese knotweed	Lamium	Other	Periwinkle	Policeman's helmet	Scotch broom	Sm. Fl. Touch-me-not	Spurge laurel
			BD	LC	CM	HO	EI	GH	GW	HI	HP	JK	YA	OTH	CP	IM	SB	IT	SL
Sam Walker Park	1%	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Semisch Park Park	7%	268	0	20	0	1	160	0	4	30	0	0	27	16	8	0	0	0	2
Shipbuilder's Square	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
St Andrews Park	0%	8	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Stella Jo Dean Plaza	0%	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Sunrise Park	54%	32,353	0	222	2	571	22,622	95	512	8,819	56	1,103	321	1	89	5	11	2	58
Sutherland	4%	202	0	6	0	6	117	0	2	66	0	0	4	0	0	0	0	0	1
Tempe	66%	1,014	0	7	0	14	39	3	9	233	2	0	74	0	713	1	4	0	15
Tempe Heights Park	32%	13,017	0	39	213	160	5,146	312	401	6,043	0	469	100	0	113	0	0	0	26
Victoria Park	0%	24	0	16	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Wagg Creek Park	26%	8,783	0	47	0	390	3,445	28	1,555	2,367	21	280	662	26	409	326	1	0	18
Waterfront Park	2%	452	0	74	0	0	30	0	11	285	0	0	12	40	0	0	0	0	0
Westview Park	40%	3,496	0	14	0	16	2,159	2	58	223	0	28	597	0	115	46	0	302	9

11.0 APPENDIX III. POINTS OF NOTE (INCLUDING CHALLENGING ACCESS).

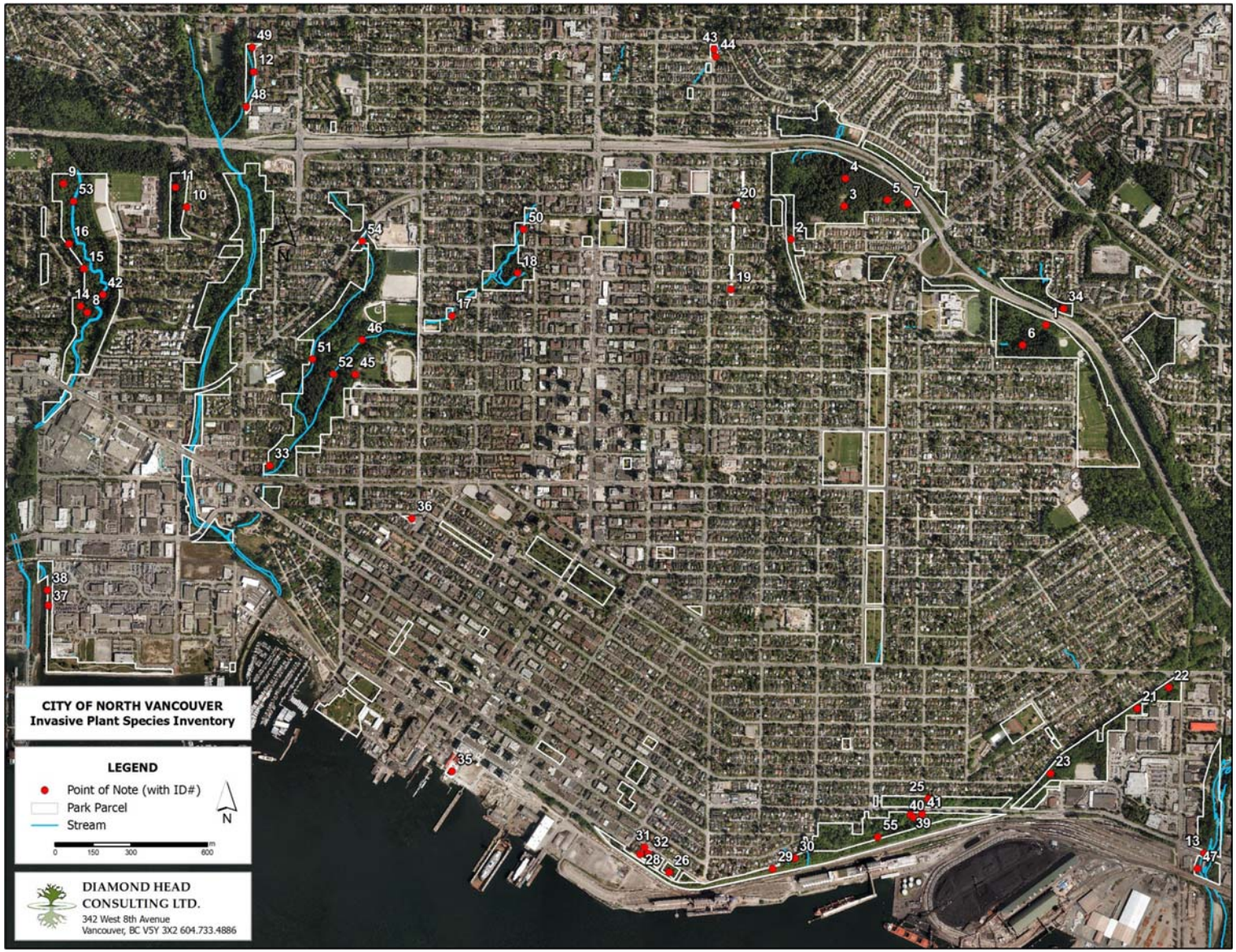
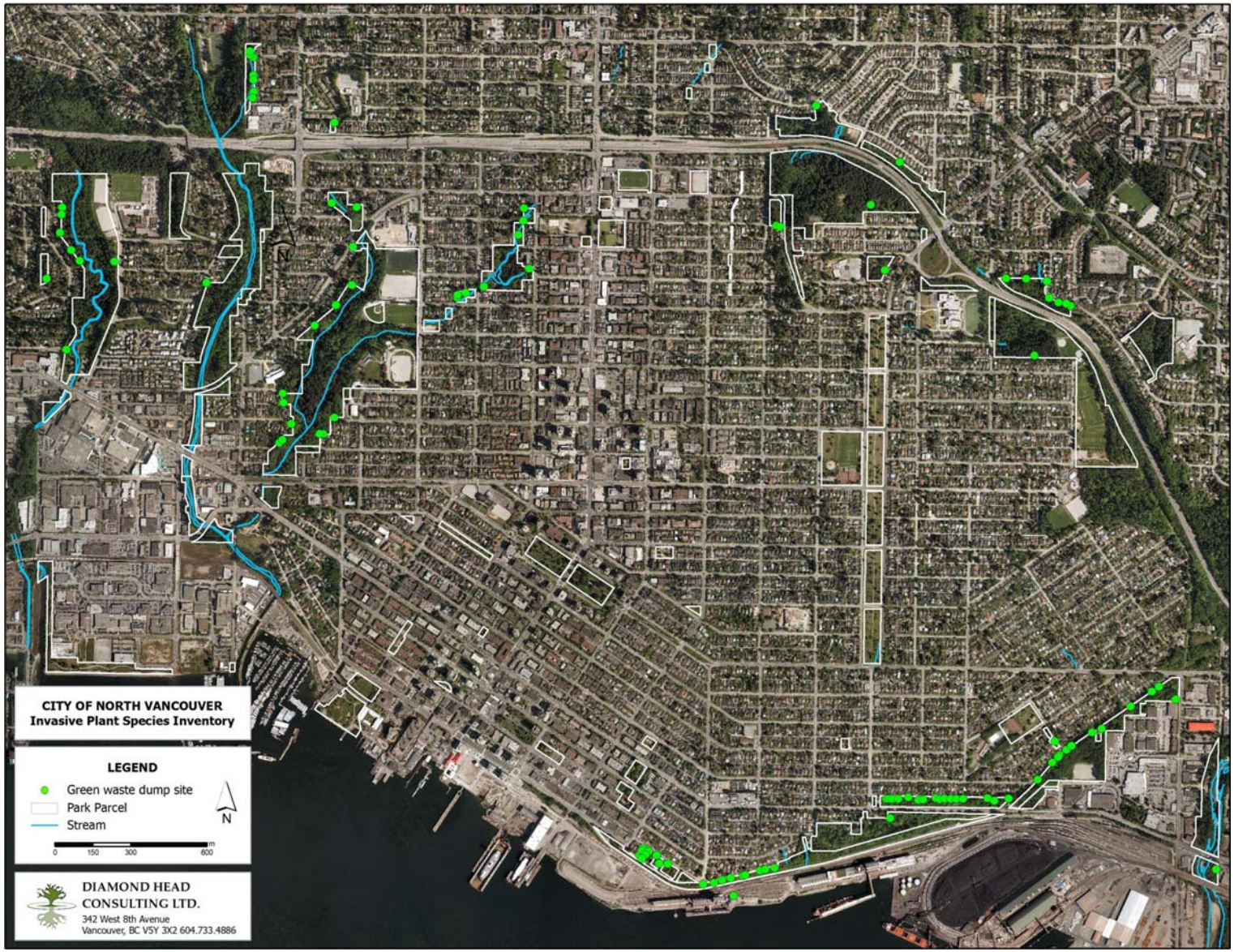


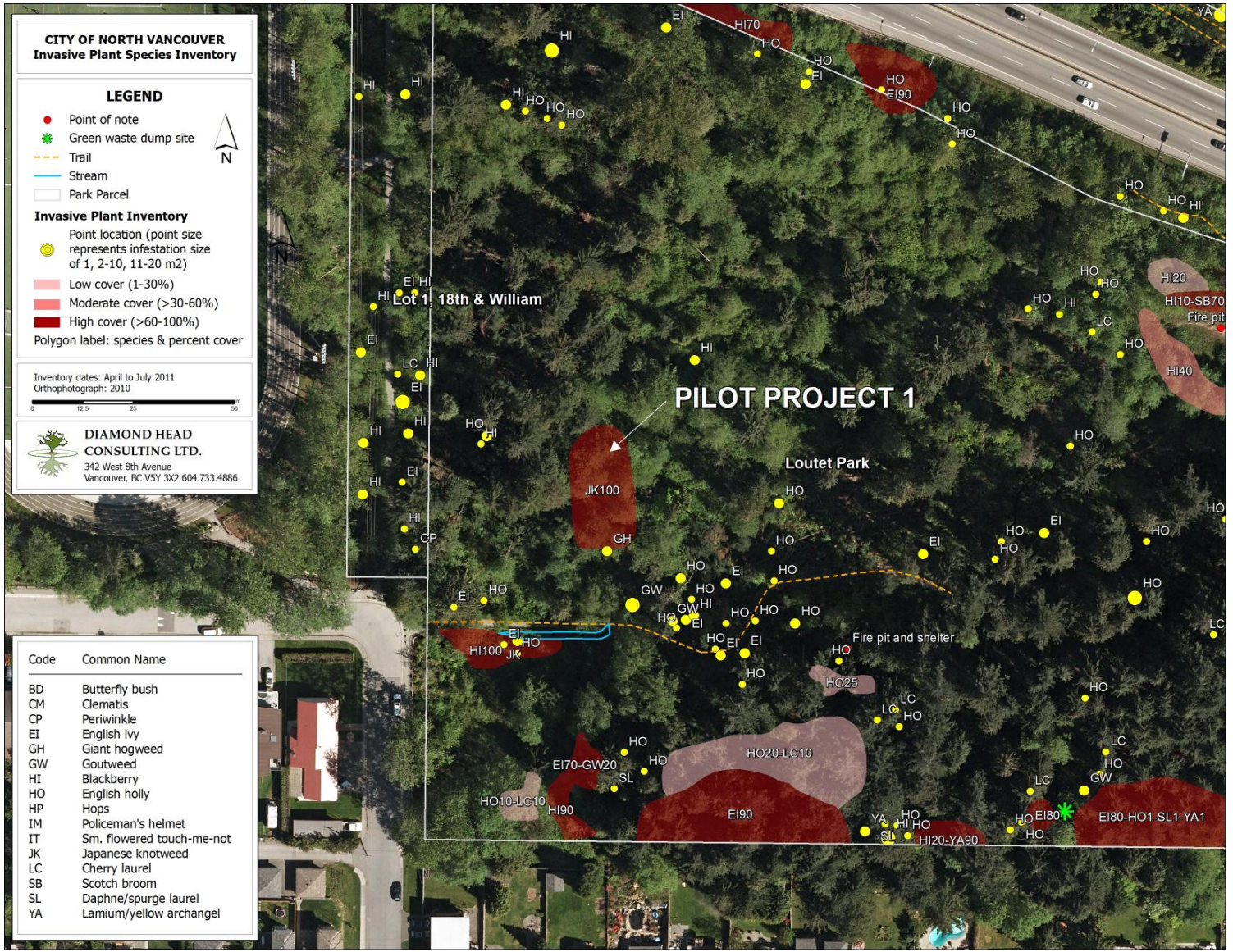
Table 17. Points of Note (areas with challenging access are highlighted).

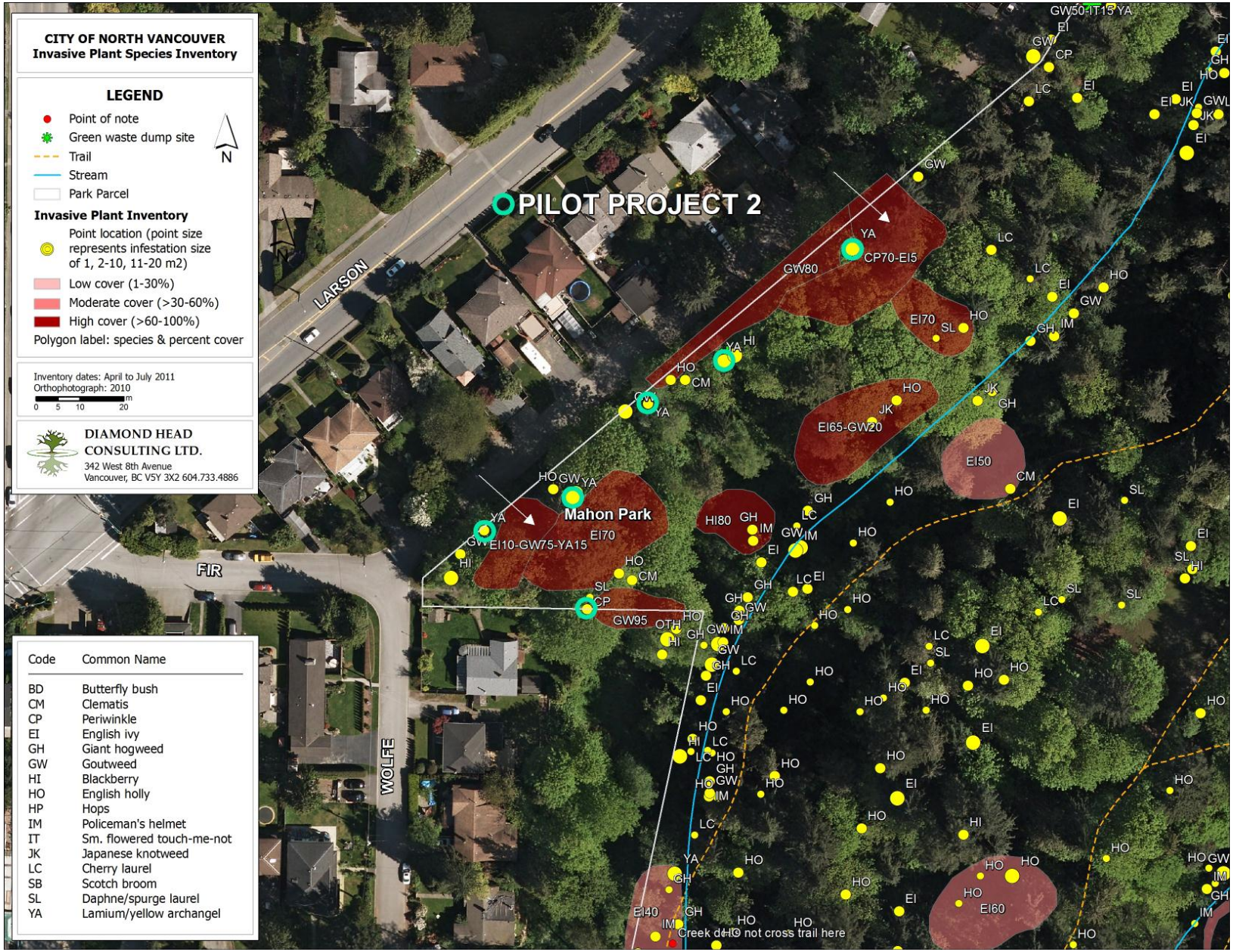
ID #	Comment	ID #	Comment
1	Fire pit	28	Garden expanded into park
2	Garden expanded into park & trampoline	29	Garden within park
3	Party area and fire pit	30	Garden expanded into park
4	Fire pit	31	Shed
5	Shelter	32	Garden expanded into park
6	Fire pit and shelter	33	Debris
7	Widen & upgrade trail to contain large infestation	34	Paintball field
8	Homeless debris - 2 piles	35	No invasives
9	Garbage pile	36	No invasives
10	Debris down bank incl grocery cart	37	Fire pit
11	Bike jumps	38	Active beaver
12	Slope failure	39	Tent camp
13	Shelter and debris under bridge	40	Camp
14	Shelter debris	41	Tent camp
15	Slope failure	42	Fire pit and grocery cart (recent 2011)
16	Debris sliding down bank	43	Storing building material in park
17	Yard expanded into park	44	Garden expanded into park
18	Toy swing	45	Shelter
19	Garden expanded into park	46	Creek mapping not correct
20	Resident to east has fenced off park access	47	Inaccessible - mapped from across creek
21	Not mapped: guard dogs in pen	48	Dangerous cliff
22	Shelter debris	49	Slope sloughing - dangerous
23	Shelter debris	50	Garden expanded into park - bamboo, gunnera
24	Garden within park	51	Creek does not cross trail here
25	Garden within park	52	Creek mapping not correct
26	Tree fort	53	Creek mapping not correct
27	Garden expanded into park	54	Steep cliff
		55	Steep cliff (entire bank)

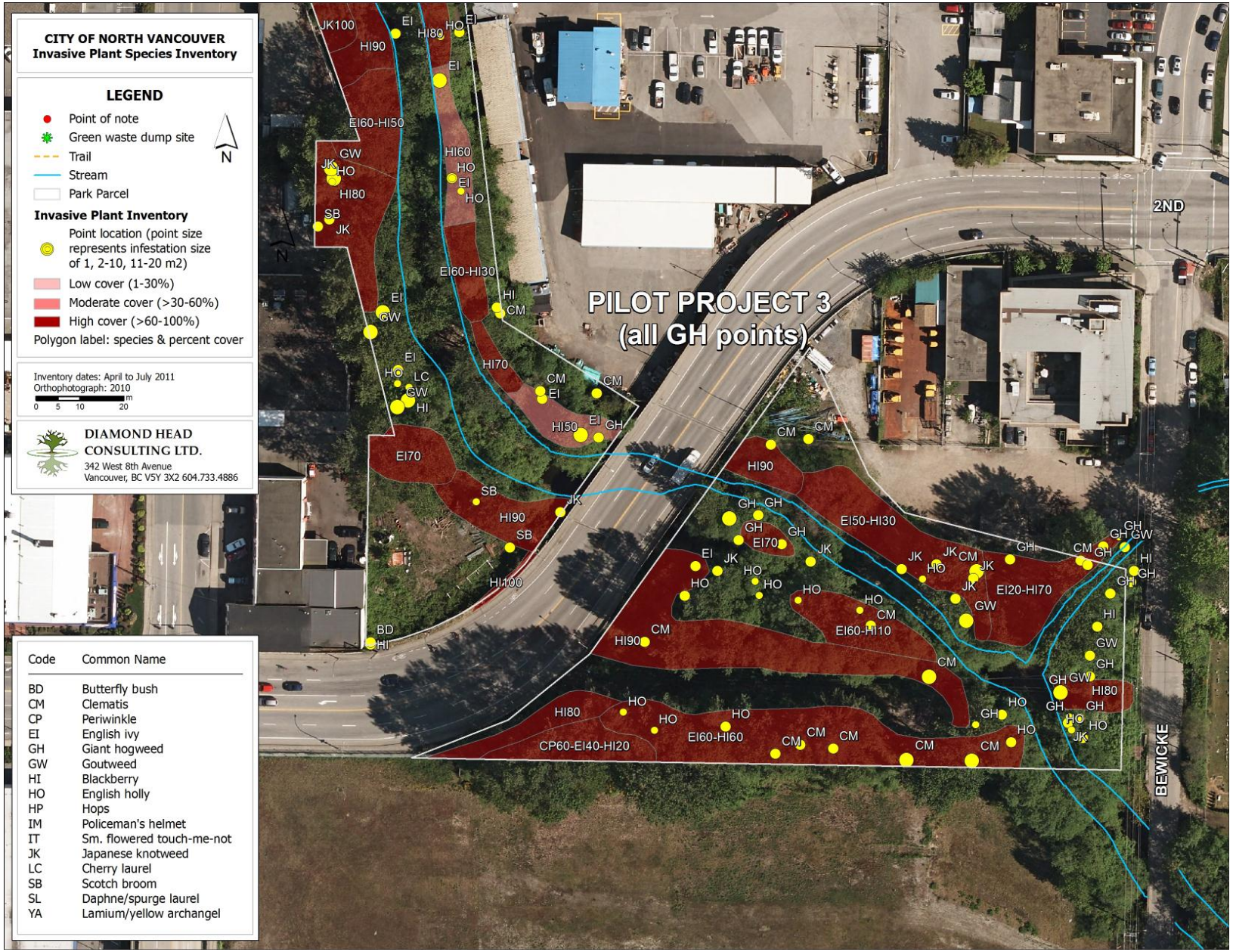
12.0 APPENDIX IV. GREEN WASTE DUMPING SITES.

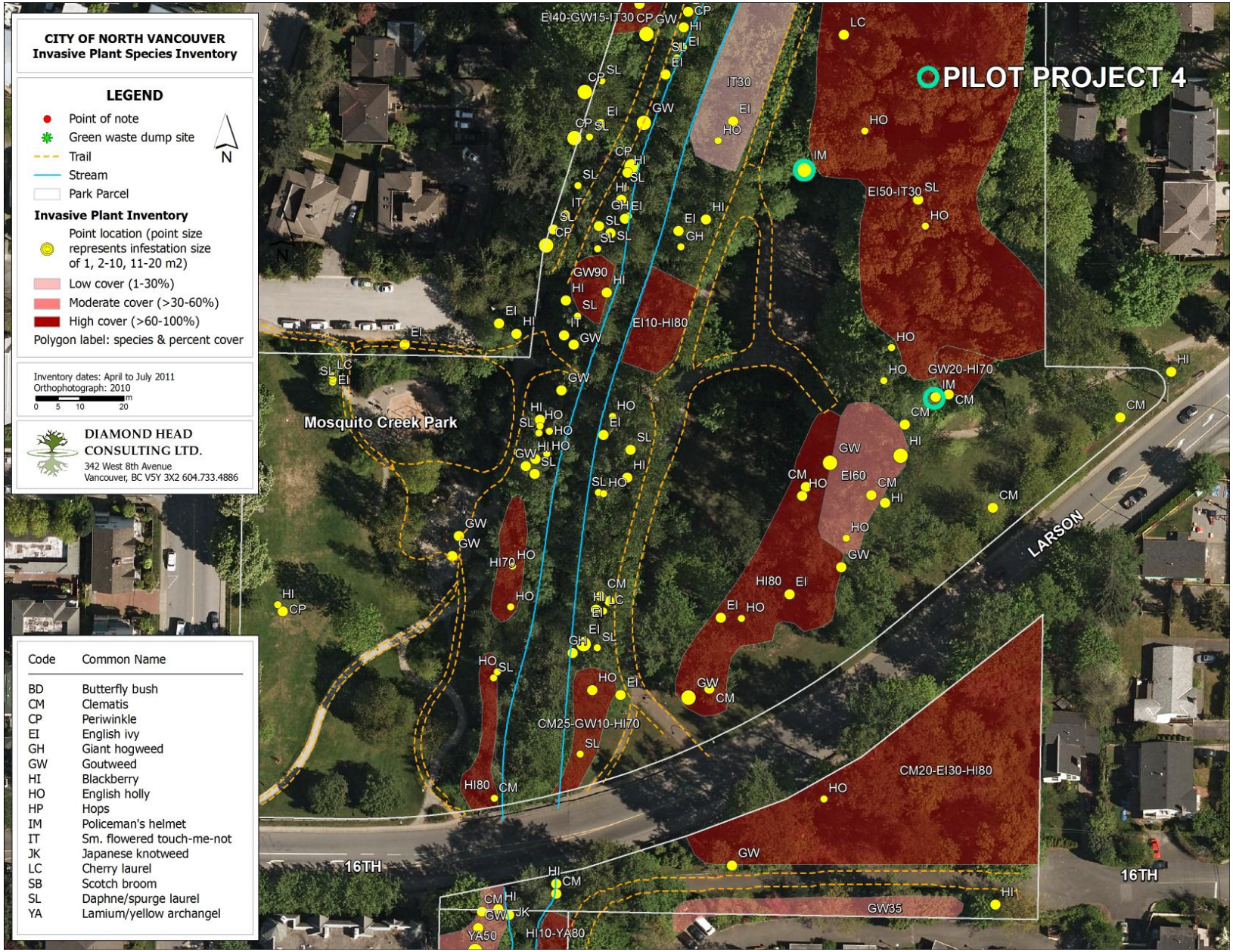


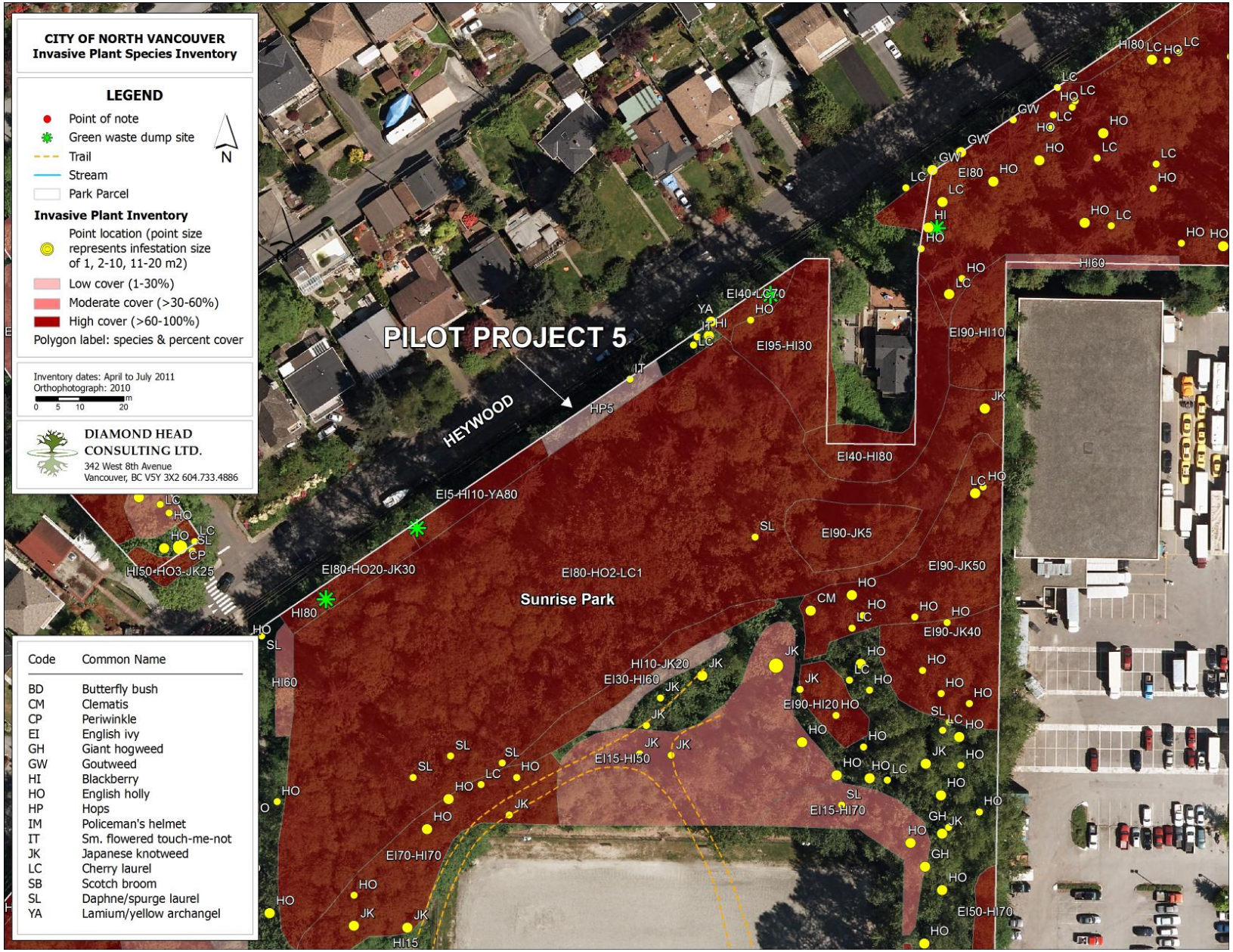
APPENDIX V. PILOT PROJECT LOCATION MAPS.

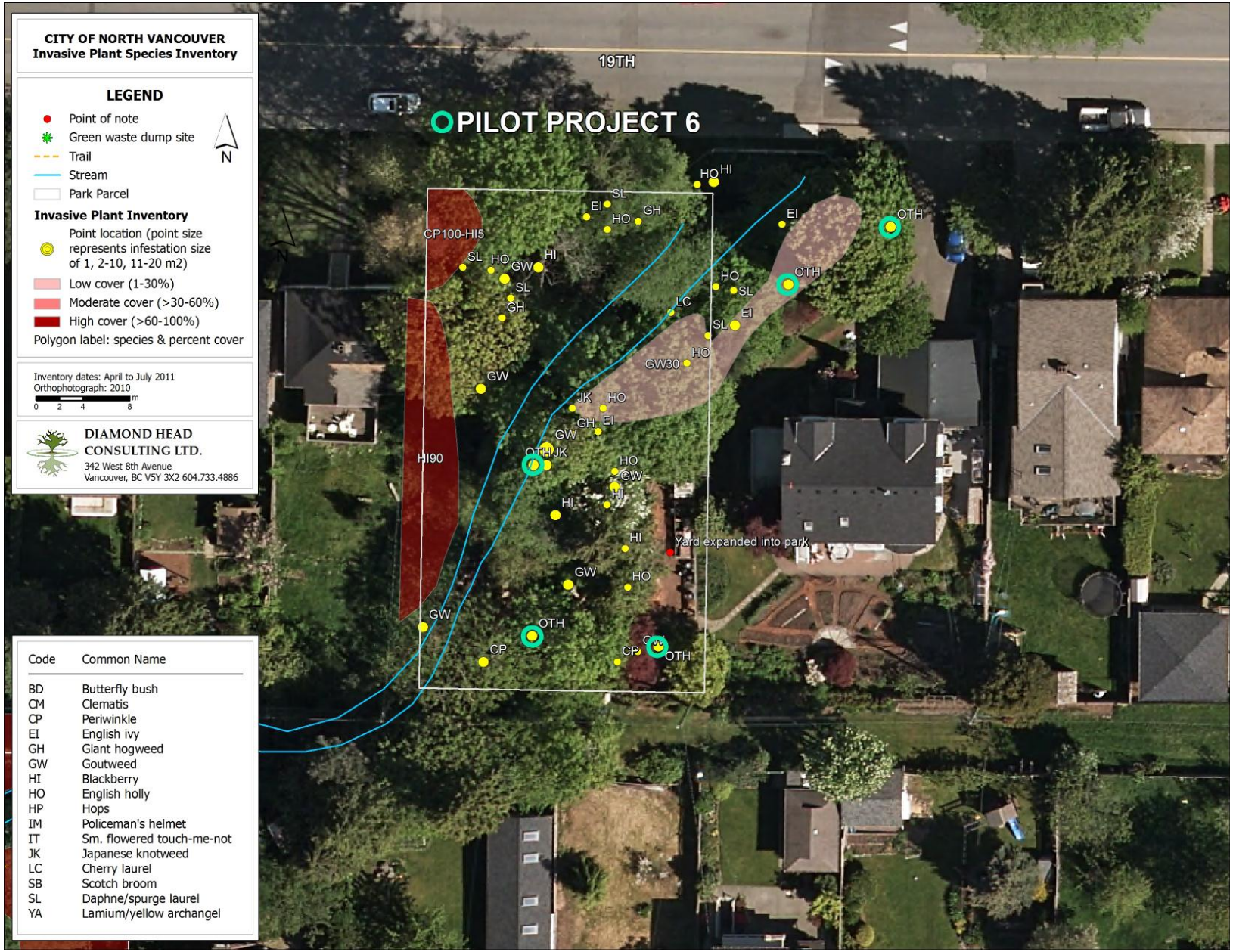



CITY OF NORTH VANCOUVER
Invasive Plant Species Inventory
LEGEND
Point of note
Green waste dump site
Trail
Stream
Park Parcel
Invasive Plant Inventory
Point location (point size represents infestation size of 1, 2-10, 11-20 m2)
Low cover (1-30%)
Moderate cover (>30-60%)
High cover (>60-100%)
Polygon label: species & percent cover
Inventory dates: April to July 2011
Orthophotograph: 2010
0 5 10 20 m
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2 604.733.4886
N
PILOT PROJECT 2
Mahon Park
LARSON
FIR
WOLFE
GW80
CP70-EI5
EI70
SL
EI65-GW20
EI50
HI80
EI10-GW75-YA15
GW95
EI40
EI60
Creek does not cross trail here
Code Common Name
BD Butterfly bush
CM Clematis
CP Periwinkle
EI English ivy
GH Giant hogweed
GW Goutweed
HI Blackberry
HO English holly
HP Hops
IM Policeman's helmet
IT Sm. flowered touch-me-not
JK Japanese knotweed
LC Cherry laurel
SB Scotch broom
SL Daphne/spurge laurel
YA Lamium/yellow archangel


CITY OF NORTH VANCOUVER
Invasive Plant Species Inventory
LEGEND
Point of note
Green waste dump site
Trail
Stream
Park Parcel
Invasive Plant Inventory
Point location (point size represents infestation size of 1, 2-10, 11-20 m2)
Low cover (1-30%)
Moderate cover (>30-60%)
High cover (>60-100%)
Polygon label: species & percent cover
Inventory dates: April to July 2011
Orthophotograph: 2010
0 5 10 20 m
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2 604.733.4886
N
PILOT PROJECT 3
(all GH points)
2ND
BEWICKE
Code Common Name
BD Butterfly bush
CM Clematis
CP Periwinkle
EI English ivy
GH Giant hogweed
GW Goutweed
HI Blackberry
HO English holly
HP Hops
IM Policeman's helmet
IT Sm. flowered touch-me-not
JK Japanese knotweed
LC Cherry laurel
SB Scotch broom
SL Daphne/spurge laurel
YA Lamium/yellow archangel


CITY OF NORTH VANCOUVER
Invasive Plant Species Inventory
LEGEND
Point of note
Green waste dump site
Trail
Stream
Park Parcel
Invasive Plant Inventory
Point location (point size represents infestation size of 1, 2-10, 11-20 m2)
Low cover (1-30%)
Moderate cover (>30-60%)
High cover (>60-100%)
Polygon label: species & percent cover
Inventory dates: April to July 2011
Orthophotograph: 2010
0 5 10 20 m
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2 604.733.4886
PILOT PROJECT 4
Mosquito Creek Park
LARSON
16TH
16TH
EI40-GW15-IT30
IT30
EI50-IT30
EI10-HI80
GW90
GW20-HI70
EI60
HI70
HI80
CM25-GW10-HI70
CM20-EI30-HI80
GW35
HI10-YA80
YA50
Code Common Name
BD Butterfly bush
CM Clematis
CP Periwinkle
EI English ivy
GH Giant hogweed
GW Goutweed
HI Blackberry
HO English holly
HP Hops
IM Policeman's helmet
IT Sm. flowered touch-me-not
JK Japanese knotweed
LC Cherry laurel
SB Scotch broom
SL Daphne/spurge laurel
YA Lamium/yellow archangel


CITY OF NORTH VANCOUVER
Invasive Plant Species Inventory
LEGEND
Point of note
Green waste dump site
Trail
Stream
Park Parcel
Invasive Plant Inventory
Point location (point size represents infestation size of 1, 2-10, 11-20 m2)
Low cover (1-30%)
Moderate cover (>30-60%)
High cover (>60-100%)
Polygon label: species & percent cover
Inventory dates: April to July 2011
Orthophotograph: 2010
0 5 10 20 m
N
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2 604.733.4886
PILOT PROJECT 5
HEYWOOD
Sunrise Park
HP5
EI40-LC70
EI95-HI30
EI90-HI10
EI40-HI80
EI5-HI10-YA80
EI90-JK5
EI90-JK50
EI80-HO20-JK30
EI80-HO2-LC1
HI50-HO3-JK25
EI90-JK40
HI10-JK20
EI30-HI60
EI90-HI20
EI15-HI30
EI15-HI70
EI70-HI70
EI50-HI70
HI60
HI80
HI15
Code Common Name
BD Butterfly bush
CM Clematis
CP Periwinkle
EI English ivy
GH Giant hogweed
GW Goutweed
HI Blackberry
HO English holly
HP Hops
IM Policeman's helmet
IT Sm. flowered touch-me-not
JK Japanese knotweed
LC Cherry laurel
SB Scotch broom
SL Daphne/spurge laurel
YA Lamium/yellow archangel


CITY OF NORTH VANCOUVER
Invasive Plant Species Inventory
LEGEND
Point of note
Green waste dump site
Trail
Stream
Park Parcel
Invasive Plant Inventory
Point location (point size represents infestation size of 1, 2-10, 11-20 m2)
Low cover (1-30%)
Moderate cover (>30-60%)
High cover (>60-100%)
Polygon label: species & percent cover
Inventory dates: April to July 2011
Orthophotograph: 2010
0 2 4 8 m
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2 604.733.4886
19TH
PILOT PROJECT 6
CP100-HI5
HI90
GW30
Yard expanded into park
Code Common Name
BD Butterfly bush
CM Clematis
CP Periwinkle
EI English ivy
GH Giant hogweed
GW Goutweed
HI Blackberry
HO English holly
HP Hops
IM Policeman's helmet
IT Sm. flowered touch-me-not
JK Japanese knotweed
LC Cherry laurel
SB Scotch broom
SL Daphne/spurge laurel
YA Lamium/yellow archangel