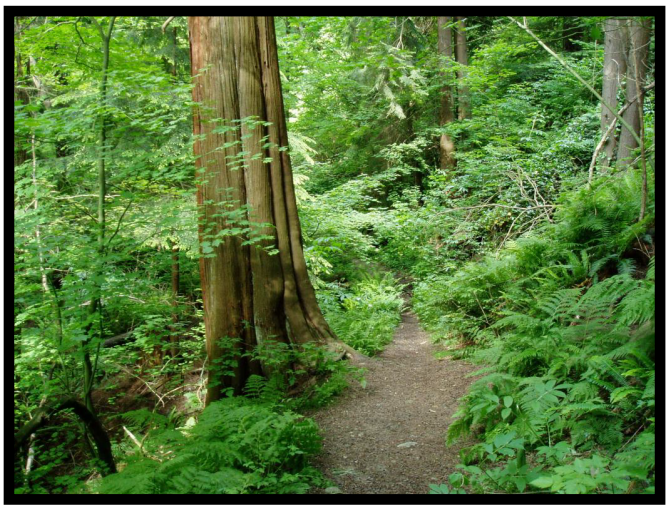
City of North Vancouver

URBAN FOREST MANAGEMENT PLAN

Technical Report



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1.0 Introduction

The protected natural areas and parks within our urban centres are being put under increasing pressure as our population base continues to grow. Development is removing more of our natural ecosystems making the proper management of the protected areas critical for the preservation of ecological biodiversity on a regional and provincial scale. A variety of user groups, pursuing a diversity of activities and experiences, are also using these natural areas. This often leads to conflicts with the natural environment and can threaten the integrity of these ecosystems. For this reason, it is important to identify the pressures put on these protected areas and to develop policies and guidelines for their management that can satisfy a number of interest groups in an ecologically sensitive and sustainable way.

In municipal parks, disturbances and influences such as urban expansion, recreation, habitat fragmentation, wildfire suppression, pest and diseases and the introduction of non-native species are among some of the factors that have been changing the natural processes of these ecosystems. This has led to both biological and physical stresses which challenge the managers of these areas to meet the demands for recreation while protecting a diversity of biological values and ecological systems.

The City of North Vancouver (City) is committed to sustaining their parks and their associated environment in as natural a state as possible. It is recognized that their parks cannot be classified as "wilderness" and therefore the natural resources and recreation activities must be managed to protect the ecological integrity of the parks. The City has asked for the development of an Urban Forest Management Plan that will help to address this concern. It will be a strategic document that will provide direction to the City to maintain the health and vigour of their Park's ecosystems. This project includes three components: the development of a detailed ecological inventory, the development of management prescriptions to sustain forest health, and a wildfire management plan.

The City has identified a number of Parks that are to be managed as natural areas. These include about 14 continuous areas that cover a total of about 78 ha (Figure 1).

Figure 1. Overview of natural area locations within the City of North Vancouver.

2.0 Methodology

The overall objective of this project is to complete a detailed analysis of the natural resources within the 14 Parks and to provide clear and prioritized recommendations for managing these areas in both the short and long term. The project is divided into three distinct components. The first is the collection and compilation of a detailed ecological inventory.

The study area was delineated into ecotype polygons with similar stand and ecological characteristics based on air photo analysis and a detailed walk through of the Parks. Within each unique polygon, ground plots were placed strategically in representative areas. The inventory included detailed assessment of the plant communities including tree species composition, stocking density, diameters and heights, age classes, live crown ratios, number and type of snags per hectare and the total crown closure. An inventory of the understory vegetation was recorded including the estimated coverage of each species present by layer. As a part of the understory vegetation analysis and inventory the presence of all non-native species was documented.

An assessment of the physical terrain was completed including a description of the topography, soil class, bedrock type and description of features that might influence park management. A soil pit was dug at each plot and information was collected including parent material, soil texture, coarse fragment content, humus type, and soil moisture and nutrient regime. This assessment information was used to classify the site according to the Biogeoclimatic Classification System of BC.

In addition, information regarding the health of the forest was collected including forest pest and diseases, and abiotic damage. During the field assessment, special care was taken to look for the presence of any sensitive or unique ecological features, endangered plants or plant communities. Also the locations of areas that have been degraded by human activity such as dumping, unauthorised trails and removal of understory were noted and mapped. This inventory was compiled into a GIS database and then used as the foundation for all management recommendations.

The second component includes the development of prescriptions that park managers can follow to meet the natural areas management objectives for these Parks. In each Park, the significant features were summarised as well as the key issues of concern. Treatment recommendations were then developed.

The treatment recommendations were prioritised based on their ability to meet the natural areas management objectives, using the professional judgement of the project team. An estimated operation cost was also provided for each treatment. These were summarised in a database allowing the Park managers to sort and update them as required.

The third portion of the project includes wildfire management plans for these Parks that will address the risks and liabilities with respect to the values at risk adjacent to the Parks. The methodology and findings of this component have been included as a separate document in Appendix A.

3.0 Natural Areas Management Objectives

The Parks provide a unique environment for people to enjoy a diverse number of nature-based activities. Legitimate access and recreation must be planned and provided for in suitable areas, while protecting the ecology, in order to meet the needs of the general public. It is critical that this plan is consistent with all higher-level plans and objectives set forth by the City. The following is a summary of the objectives for natural areas park management that have been considered and incorporated into this plan. The purpose of these objectives is to provide general guidance to the tourism industry, recreation organizations and the community as to how the City intends to facilitate access to public land for appropriate recreation in such a way that protects the values of public land for the future. These objectives have been used as a framework for the development of all management recommendations.

1. Preserve and protect the integrity of the naturally functioning ecosystems

The ecosystem of the Parks provide critical habitat for many different plants and animals and contain environmentally sensitive areas. In cases where ecological values may be significantly compromised, access and recreation must be controlled, limited or even prohibited. Opportunities should be explored for biodiversity maintenance, rehabilitation and enhancement.

2. Provide access and recreational uses in the Parks that meet the needs of the City's residents of all abilities

The Parks provide a unique environment for people to enjoy a diverse number of nature-based activities. Legitimate access, recreation, and accessible trails must be planned and provided for in suitable areas, while protecting the ecology, in order to meet the needs of the general public.

3. Provide and maintain appropriate recreation and tourism services and facilities on public land to foster visitor enjoyment and education and to ensure visitor safety

4. Encourage, facilitate and promote opportunities for appropriate recreation and tourism use on public land through research, communication and stakeholder consultation

4.0 Overview

The 14 Parks that were assessed are listed in Table 1.

Table 1. Parks included in study.

Park	Area (ha)[1]
Heywood Park	11.49
Hyak Park	0.50
Mahon Park	16.02
Mosquito Creek Park	10.57
Wagg Creek Park	3.06
Tempe Heights Park	1.74
Greenwood Park	11.66
Kealy Woods Park	0.72
Loutet Park	6.35
Eastview Park	2.73
Sunrise Park	5.44
Moodyville Park	4.34
Lynnmouth Park	1.93
Lots 1-18, bl17, Dl1552	1.49
Total	**78.10**

[1] Areas calculated from CNV GIS database

The Parks assessed for this report are spread across the City. On a local scale these natural areas represent a small portion of the land base. The City is densely developed with residential and commercial areas and the proportion of protected natural area is relatively low in relation to the density of the population. This puts a significant amount of recreation pressure on these natural areas making their management critical for long-term preservation.

4.1 Terrain

These Parks cover a wide range of terrain from flat gentle slopes to steep broken areas. The Parks are generally south facing with slopes ranging from about 0 to 70% and averaging 25%. The parent material is predominantly morainal till. The soils are generally sandy loams with coarse fragment content averaging 35%. The most prominent humus types are mors and moders and the majority of soils are classified as Podzols.

4.2 Terrestrial Ecology

These Parks are located within the Dry Maritime Coastal Western Hemlock Subzone (CWHdm) of the Biogeoclimatic Ecosystem Classification System of BC (BEC). This subzone is characterized by warm, relatively dry summers and moist, mild winters with little snowfall. Soil moisture and nutrient regimes vary across the Parks based on terrain and soil conditions.

Within the BEC system, subzones are further categorized into units called site series according to the level of available moisture and nutrients in the soils. Plant and tree species have certain moisture and nutrient ranges in which they are able to survive and compete. For this reason, each site series is characterized by a distinct plant community. Due to the location of the majority of the developed portions of the lower mainland within this BEC zone, most of the plant communities found within this zone are threatened or endangered.

The most common ecosystem classification found in the Parks was site series 05 and 07 with lesser components of 01, 02, 03, 06, 10 and 12. Their presence and distributions are summarized in Table 2 and Figure 2 and illustrated in Figure 3. As can be seen, there is little diversity of plant communities found within the City's Parks. This information should be used in the future to help identify ecosystems to recreate or for future park acquisitions.

Table 2. Summary of site series.

Site Series	Site Series Name	Soil Moisture Regime 0 (driest) to 7 (wettest)	Soil Nutrient Regime A (very poor) to E (very rich)	Area (ha)	Relative Percent (%)
01	*Western hemlock – Flat moss*	3-4	A-C	3.9	5.3
02	*Douglas-fir/ lodgepole pine – Cladina*	0	A-C	0.3	0.4
03	*Douglas-fir/ western hemlock – Salal*	1-2	A-C	1.5	2.0
04	*Douglas-fir – Sword fern*	1-2	D-E	<0.1	<0.1
05	*Western redcedar – Sword fern*	3-4	D-E	38.0	51.5
06	*Western hemlock/ Western redcedar – Deer fern*	5-6	A-C	0.2	0.3
07	*Western redcedar – Foamflower*	5-6	D-E	27.4	37.1
10	*Black cottonwood – Willow*	5-7	C-E	0.4	0.5
12	*Western redcedar/ sitka spruce – skunk cabbage*	7	C-E	2.2	2.9
TOTAL				73.9	100

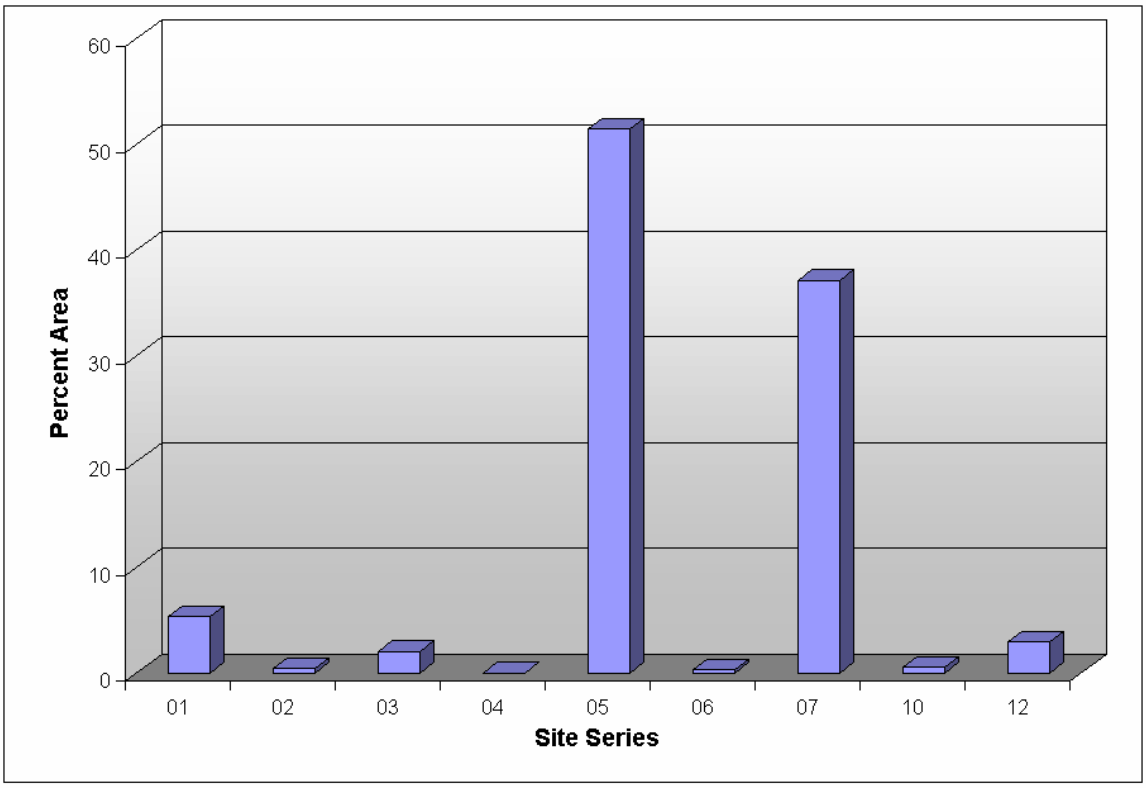

Figure 2. Distribution of site series.

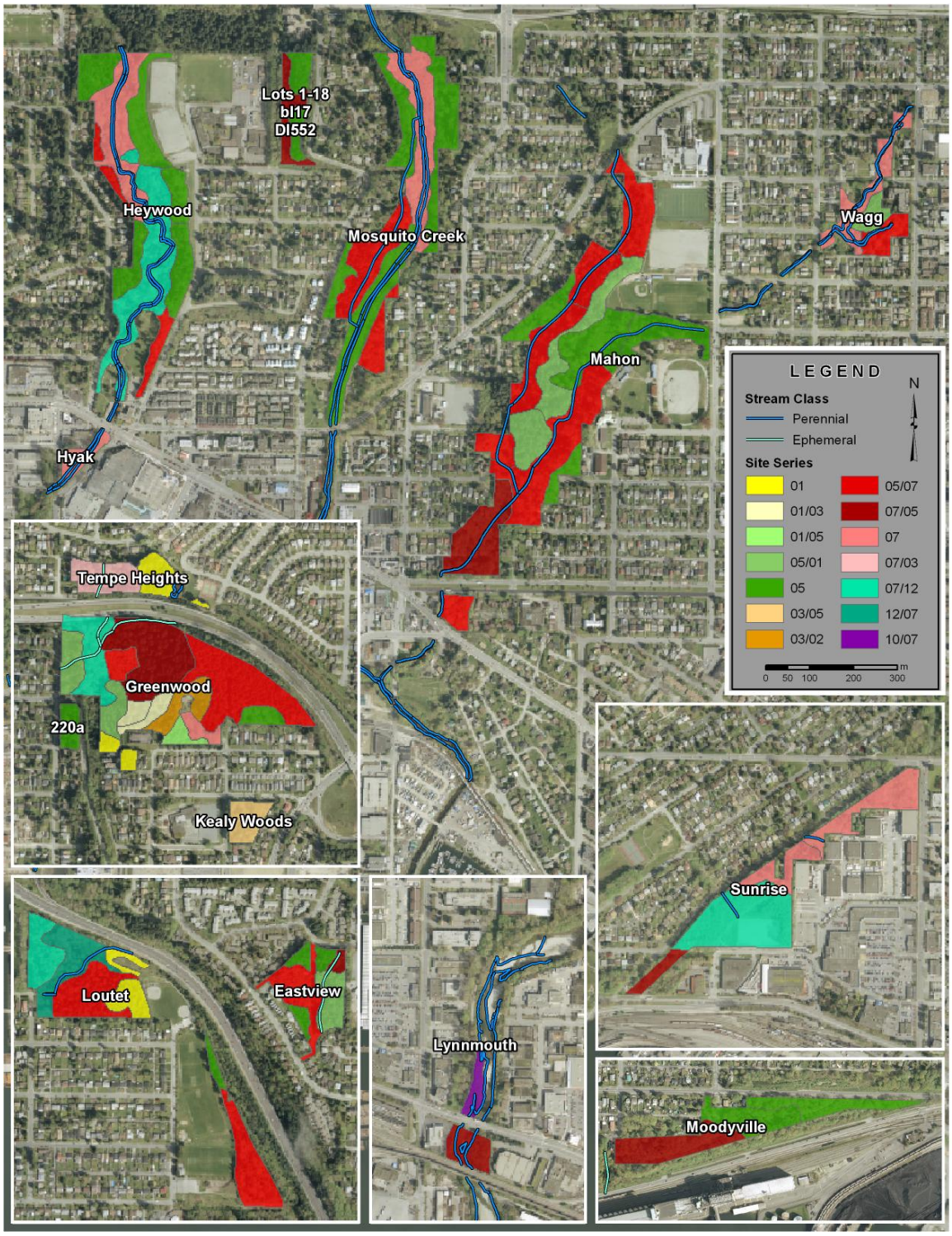

Figure 3. Dominant site series within each Park.

4.3 Stand Types

There are numerous stand types found in the Parks ranging from young, dense pioneer deciduous stands to mature, multi-storied coniferous stands. Scattered old growth trees remain, however no

stands are considered original old growth. The age class ranges from 20 years to 160 years with the most common age averaging 70 years (Figure 4). The majority of the stands have established following logging that occurred at the early part of the 1900s. Many of the stands were subsequently broadcast burned. Most stands are moderately dense ranging in density from 100 to 1000 stems/has and averaging 270 stems/ha. Crown closure ranges from 15% to 80% and averages 47%. The majority of mature trees are about 30 m tall and 50cm in diameter with the tallest trees reaching heights of up to 55 meters and 100cm in diameter.

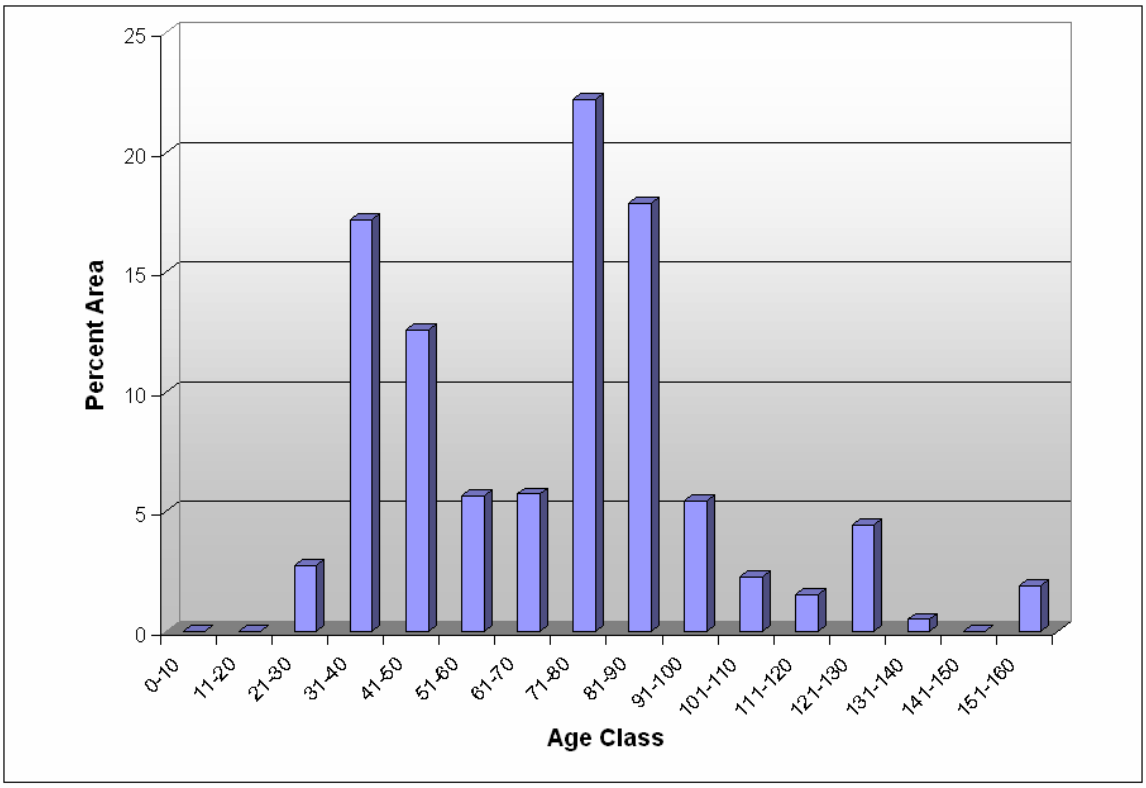

Figure 4. The age class distribution of stand types found in the forested Park area.

The stands can be roughly divided into three categories: deciduous forest, mixed mature forest and mature coniferous forest.

4.3.1 Deciduous Forests

The deciduous forests include young, dense stands that have established following recent disturbances in the Parks as well as mature deciduous stands that established following harvesting 40 to 70 years ago. Most of these stands consist primarily of red alder with lesser components of black cottonwood and bigleaf maple. Many of these stands have established in riparian areas and wetter ecosystem types. The brush layer in these areas is generally very dense. Many deciduous trees are decaying and falling to the forest floor because of their mature age. Consequently, gaps in the canopy bring light to the understory vegetation. The forest floor has a rapid rate of decomposition on these sites due to the large input of deciduous litter. There is a rich and moderately dense brush layer. There are generally few wildlife trees and very little downed coarse woody debris.

4.3.2 Mature Mixed Coniferous/Deciduous Forests

Many of the mature stands consists of a mix of deciduous and conifer species. These stands are

generally more open with scattered canopy gaps. They consist of a mix of conifers including mostly western hemlock, Douglas-fir and western redcedar. The deciduous species include red alder and bigleaf maple with lesser components of black cottonwood. These stands generally have scattered wildlife trees, dense understory vegetation and moderate amounts of downed coarse woody debris.

4.3.3 Mature Coniferous Forests

Generally on the drier sites, many of which were burned following harvesting, stands are dominated by coniferous species. These include a mix of western hemlock, Douglas-fir and western redcedar. These stands are generally even-aged with dense canopies and high live crowns. The canopy often impedes light from reaching the forest floor and therefore the understory vegetation is less developed. There are generally few wildlife trees and moderate amounts of downed coarse woody debris.

5.0 Rare and Endangered Plant Communities

Plant communities are defined as units of vegetation with a relatively uniform plant species composition and physical structure. The study area has been stratified into polygon units based on BEC to the site series level. This mapping has been used to identify all rare and endangered plant communities according to the Conservation Data Centre (CDC). Table 3 lists the red and blue listed plant communities found in the Parks. Figure 5 show the location of polygons containing red listed plant communities.

Table 3. CDC ranked plant communities found in the study area.

Scientific name	Common name	Biogeoclimatic Ecosystem Classification Unit	Provincial List
Pseudotsuga menziesii - Pinus contorta / Holodiscus discolor / Cladina spp.	Douglas-fir - lodgepole pine / oceanspray / reindeer lichens	CWHdm/02	Red
Pseudotsuga menziesii / Polystichum munitum	Douglas-fir / sword fern	CWHdm/04	Red
Pseudotsuga menziesii - Tsuga heterophylla / Gaultheria shallon Dry Maritime	Douglas-fir - western hemlock / salal Dry Maritime	CWHdm/03	Blue
Tsuga heterophylla / Plagiothecium undulatum	Western hemlock / flat moss	CWHdm/01	Blue
Thuja plicata / Polystichum munitum	Western redcedar / swordfern	CWHdm/05	Blue
Thuja plicata / Tiarella trifoliata Dry Maritime	Western redcedar / three-leaved foamflower	CWHdm/07	Blue
Thuja plicata - Picea sitchensis / Lysichiton americanus	western redcedar - Sitka spruce / skunk cabbage	CWHdm/12	Blue

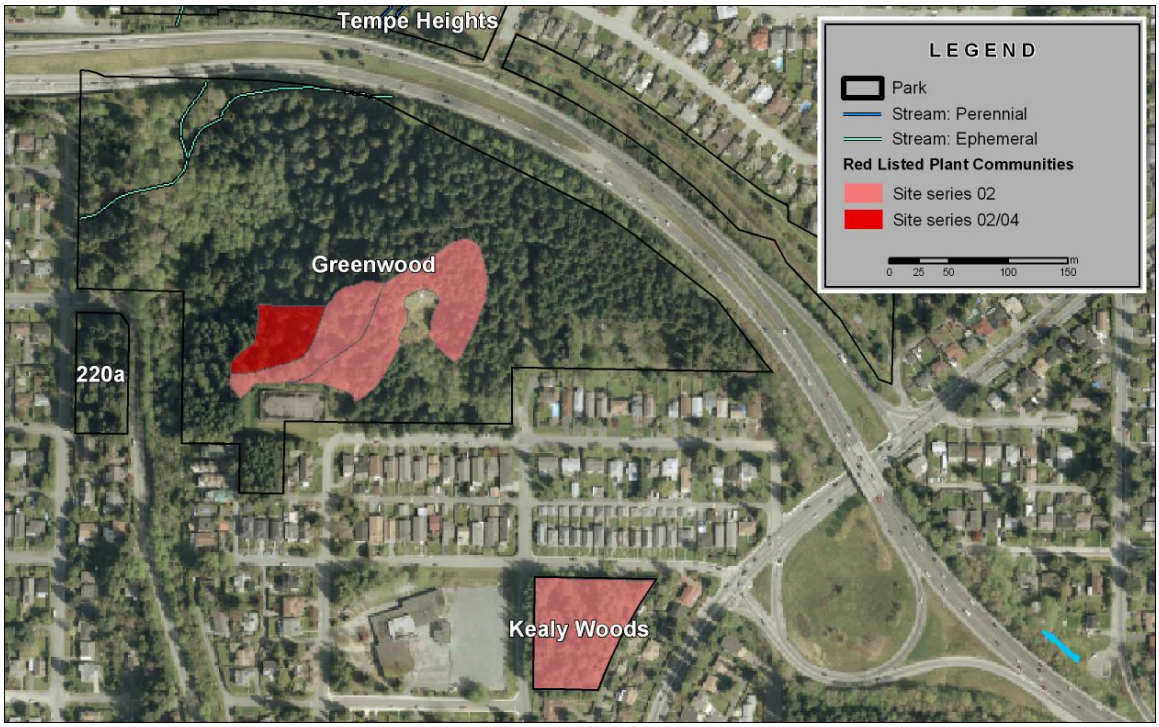

Figure 5. Polygons containing red listed plant communities.

6.0 Forest Health

Forest insects and diseases are a natural and healthy component of forest ecosystems. They generally provide small-scale disturbances that help improve the biodiversity in forest stands. Parks, however, are islands of natural landscapes and once an insect or disease outbreak reaches a significant size, they should be assessed for their ecological and social impacts.

There were no signs of significant forest health concerns within the Parks at the time of the assessment. There are normal levels of insects and diseases including: defoliators, sucking insects and woody tissue feeders, root diseases, dwarf mistletoes, rusts, cankers and stem decays. However, Park managers should be aware of pests that pose the greatest risk to the forest and monitor their levels regularly (see Table 4).

Risk ratings for pests in each climatic zone have been determined by forest health specialists from the Ministry of Forests and Forestry Canada. They are a function of occurrence, intensity and impact. A high-risk rating indicates that the pest can do a significant amount of damage in forests of the CWHdm biogeoclimatic subzone.

Table 4. Insect and disease risk by tree species in forests of the CWHdm.

Pest and disease risk by species*	Forest Pest Risk
Douglas-fir	
Laminated root rot (*Phellinus*)	High
Armillaria root rot	Medium
Black stain disease	Low
Western hemlock	
Hemlock dwarf mistletoe	High
Annosus root rot	Low
Armillaria root rot	Low
Laminated root rot (*Phellinus*)	Low
Western redcedar	
Armillaria root rot	Low

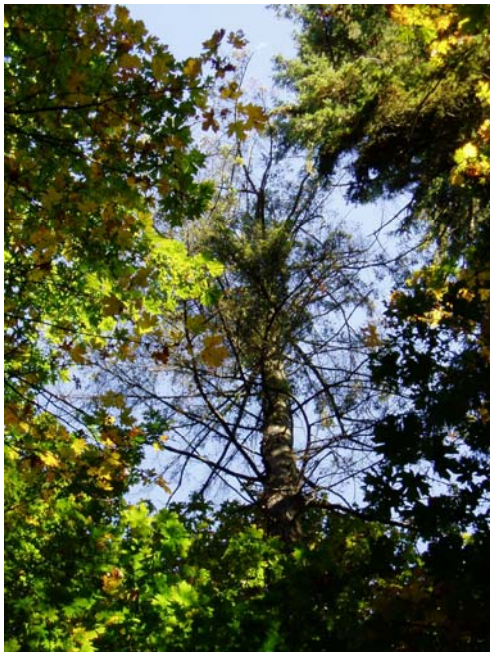

Figure 6. *Phellinus* root rot.

7.0 Ecosystem Succession

An ecosystem is a broad term used to describe the interaction of living organisms with the physical environment (Meidinger and Pojar 1991). The nature of an ecosystem is influenced by the climate, the local physiography and the physical and chemical properties of the soil parent material. Over time, the ecosystem reaches a condition of dynamic equilibrium called the climax ecosystem. In a climax ecosystem, a balance is reached between the living components and the physical environment. The plant species are self-perpetuating and can be found in all stages of their life cycles. Ecosystems reach this climax state through a process known as ecological succession. This is a process of change where a site is occupied by a series of distinct plant communities through time, known as seral stages. Each of these seral stages is composed of species best adapted for the existing conditions. Each seral stage alters its surrounding environment until another, better adapted seral stage takes over.

Eventually the climax seral stage is reached. Each seral stage provides certain habitat features required by various animal and plant species. Maintaining a natural and healthy distribution of these seral stages across the landscape ensures a high level of biodiversity and habitat for a variety of wildlife and plant species.

8.0 Disturbances Regimes and Succession

All ecosystems are influenced by periodic disturbances that vary in size, severity and occurrence. Examples of common disturbances include: wildfire, windthrow, ice and freeze damage, water, landslides, insect and disease outbreaks and human caused events such as logging and development. These disturbances change the progress of an ecosystem along its successional pathway. Usually the ecosystem is altered to an earlier stage but occasionally a disturbance can forward its progress towards its climax state.

The City's parks are located within an ecological subzone that naturally experiences infrequent stand-initiating events. These are classified as natural disturbance type 2 (NDT2) in the Forest Practices Code Biodiversity Guidebook. The most common stand initiating events in these ecosystems are wildfires that range in size from 20 to 1000 ha and occur on average every 200 years. These burns result in large areas of even aged forests with scattered veteran trees and small remnant patches that survived the fire.

There are no forested areas left in the Parks that are at their climax state (considered old growth). Most of the Park areas have been affected by one or more disturbances over the past century. There have been a number of different disturbance agents varying in severity including forest harvesting, slash burning, infrastructure development, landfill creation and recreational activities. Consequently, the forest is composed of a variety of species of varying ages. Although none of these stands are considered old growth, the varied stand structure and composition provides a good distribution of habitat types.

Table 5 and Figure 7 compares the age class distribution within the forested portion of the Parks to a natural forested landscape one would expect to find within the CWHdm subzone that has not been unduly influenced by human activity. It is important to note that regular disturbance patterns in this subzone occur over a much larger area and the natural proportions are based on a much larger and continuous landscape. This type of analysis would be useful to complete in co-operation with adjacent landowners like the Districts of North and West Vancouver and the GVRD.

Table 5. Current and natural age class distribution in forested ecosystems.

Age class (years)	Area within the Parks (ha)	Proportion of age classes within the Parks (%)	Proportions based on the natural disturbance patterns (%)
1 (1-20)	0	0	10
2 (21-40)	14.7	20	8
3 (40-60)	13.5	18	8
4 (61-80)	20.7	28	7
5 (81-100)	17.2	23	6
6 (101-120)	2.8	4	6
7 (121-140)	3.6	5	5
8 (141-250)	1.4	2	21
9 (>250)	0	0	29

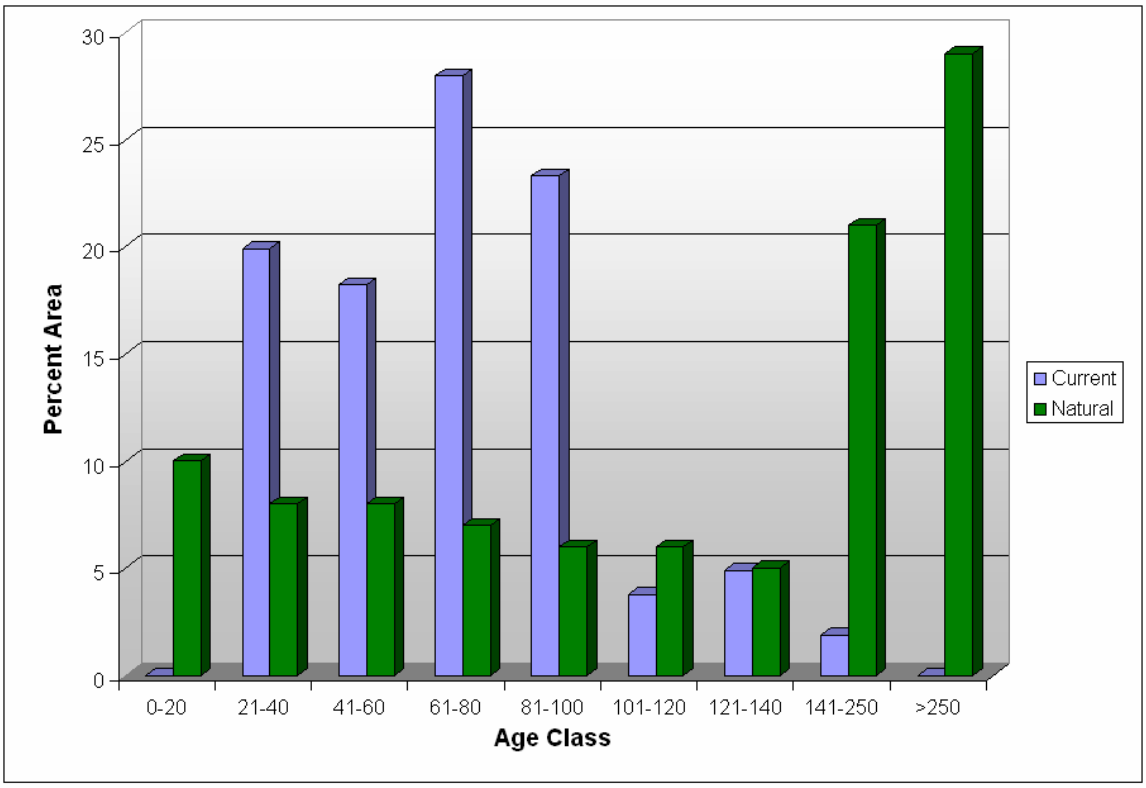

Figure 7. Current and natural distribution of age classes in the Parks.

As expected, there are younger age classes in the Parks than one would expect to find in a natural landscape. It will take about 150 years for any of the forests to reach an age where they can be classified as old growth forest or age class 9. Management of the forest should attempt to enhance the attributes of old growth forests such as uneven aged stand structure, an abundance of wildlife trees and large coarse woody debris.

9.0 Ecological Biodiversity

It is difficult to determine the level of biological diversity in a forested area because the term implies a general measure of the number of species supported by an ecosystem. The greatest degree of biological diversity is usually found in the earliest and latest stages of stand development. Young shrub communities contain a diverse composition of herbs and shrubs that form a complex structural habitat and abundant food sources for many species. As the forest ages into a young stand, the tree canopy closes and the understory is shaded out, causing the structural and species diversity to decline. After about 80 years in this type of ecosystem, the biodiversity level increases again as the trees reach a larger size, scattered wildlife trees are created and gaps form in the canopy admitting light to the forest floor.

The Parks generally contains young and mature forest types. Most of the forested areas consist of closed, even-aged stands between 60 and 80 years old. Well-developed shrub communities have established in the wetter ecosystems under the open deciduous stands. Additionally, there are young dense deciduous forests in more recently disturbed sites.

All of these forested ecosystems contain habitat for a variety of species. None of these stands have

reached an age that can be classified as old forest. However, some of the mature conifers stands are reaching an age and structure where they will soon exhibit features of old growth forests. Characteristics such as multiple canopy layers, canopy gaps, large trees with large limbs and numerous standing dead trees will become apparent.

According to the Forest Practices Code Biodiversity Guidebook, landscapes with a high level of biodiversity contain specific distributions of seral stages. For NDT2 ecosystems this includes <27% of forest under 40 years old, >13% of the forest as old growth and the rest (>51%) as mature forest (Table 6). In the Parks there is currently too high a proportion of forest in early seral stages and not enough mature and old growth forests to sustain a level of maximum biodiversity.

Table 6. Current and recommended seral stage distribution to maximize biodiversity in NDT 2 ecosystems.

Seral stage	Recommended proportion to emphasize high biodiversity (%)	Current distribution (%)
Early seral stages	<27%	66
Mature seral stage	>51%	34
Old growth	>13%	0

In order to support a variety of wildlife species, efforts must concentrate on preserving a wide range of habitat types. On a landscape level this includes a range of seral stages and ecosystem types including young to old seral stages and dry to wet ecosystems types. In general, ecosystem features that support the greatest diversity of wildlife include streams, lakes and wetlands and their associated riparian zones, dense brush communities, as well as older, uneven-aged mixed stand types.

Certain structural attributes are critical in order to support the widest range of wildlife species in a forested ecosystem. These include:

1) A diverse stand structure and composition
2) The presence of wildlife trees
3) An abundance of downed coarse woody debris
4) The presence of quality understory vegetation

The preservation and enhancement of these stand features should be considered at all levels of park planning.

9.1 Stand structure and composition

A diverse stand structure provides more habitat and cover at all canopy levels. Vertical diversity is usually found in stands with a variety of tree species and ages. This provides habitat cover and food sources at all canopy layers from the lower brush layer to the tallest dominant tree species. Horizontal structure diversity provides gaps in the canopy for light to reach the forest floor, encouraging patches of dense understory brush. In general, habitat diversity increases with the variety of age classes and tree species present.

9.2 Wildlife trees

Dead standing trees form one of the most important habitat features of forests and are critical for maintaining a high level of biodiversity (Figure 8). They provide important roosting sites for many predator bird species and nesting and foraging habitat for a wide range of primary and secondary cavity nesting birds and mammals. A variety of bats and amphibians use the space between the bark

and the bole of the tree for roosting and thermal habitat.

The value of dead standing trees as wildlife habitat are affected by their diameter, tree form, bark condition, tree species, and height. The most valuable wildlife trees include large coniferous species as they do not decay as quickly and will remain standing for a long period of time. The habitat potential is also greatly increased if the tree retains some bark.

Wildlife trees are an important habitat feature found in most old growth forests. Their removal from the landscape through harvesting practices has drastically impacted at least 26 red and blue listed vertebrate species that are dependant on them for all or part of their life history.

Figure 8. An example of a valuable wildlife tree found in the City's parks

9.3 Downed woody debris

Dead woody material on the forest floor provides varied microclimates, cover, food and breeding habitat for a wide variety of small organisms. Wood boring insects create entry points for fungi and bacteria that decay the wood and are in turn eaten by invertebrates and small mammals, becoming an important part of the food web.

Additionally, downed woody debris provides important cover from predators and a safe place for breeding and shelter. Smaller cracks in logs and bark provide habitat for amphibians, small mammals and rodents while hollowed out logs are used as shelter by larger mammals. These logs also act as nurse logs for young trees, add nutrients to the soil and help stabilize soils, thus reducing erosion.

9.4 Understory vegetation

In forested ecosystems, the understory vegetation provides critical cover, forage and nesting habitat for a variety of birds, small mammals, amphibians and rodents. The quality of this habitat generally increases with the density and diversity of understory species. An older, uneven-aged stand structure provides canopy gaps through which light reaches the forest floor allowing shade intolerant species

to compete. Riparian areas generally contain the most dense and varied brush community providing cover adjacent to critical water sources (Figure 9).

Figure 9. Riparian areas provide excellent wildlife habitat as they usually contain dense understory vegetation as well as critical water source.

10.0 Aquatic Systems

Fish habitat is defined as the spawning grounds, rearing, food supply and migration areas that fish require to survive. This is not limited to only watercourses but also includes areas such as adjacent ditches, ponds, wetlands, and riparian areas. Adjacent vegetation provides critical woody debris input, stabilizes creek banks and maintains microclimate conditions. Vegetation buffers streams from increased surface flow and sedimentation, contributes food and nutrients in the form of insects and litter fall, and provides cover for wide variety of wildlife. In order to adequately protect these fish streams, the watercourses feeding these creeks and their associated riparian areas should be protected from any disturbances.

Riparian areas are the vegetated ecosystems adjacent to aquatic systems. They are defined as areas that contain elements of both terrestrial and aquatic ecosystems. The abundance of water and high nutrient input in these areas make them highly productive and important habitat for a wide variety of species. They provide an abundance of water and nutrients that support a diverse, dense shrub layer. This in turn provides food source and cover for wildlife as well as critical access to water sources. The rich vegetation creates a dense root mat that stabilizes the creek banks and protects the creek from soil erosion and sedimentation. This keeps aquatic temperatures cool and reduces water losses from the ecosystem. The riparian vegetation also provides an important source of coarse woody debris. Trees that fall across the river create pools and back water channels. They create creek structure and dissipate the creek energy helping to trap sediments and gravels.

Many of the Parks have been established around significant creeks that run from the North Shore mountains down to Burrard Inlet. The most significant creeks include Mackay, Mosquito, Mahon, Mission, Lynn and Wagg Creeks (Figure 10). These creeks have linear park systems established around them to help protect their integrity. All of these streams are perennial and have grades that

allow for the support of fish life. The lower reaches of Mackay, Mosquito, and Lynn Creeks in particular are very important as they allow for salmonid spawning from the Burrard Inlet.

There are also smaller streams and associated wetlands found in most of the other Parks (Figure 10). The majority of these are ephemeral creeks and do not likely support fish life. They still, however, provide critical water and wildlife habitat features.

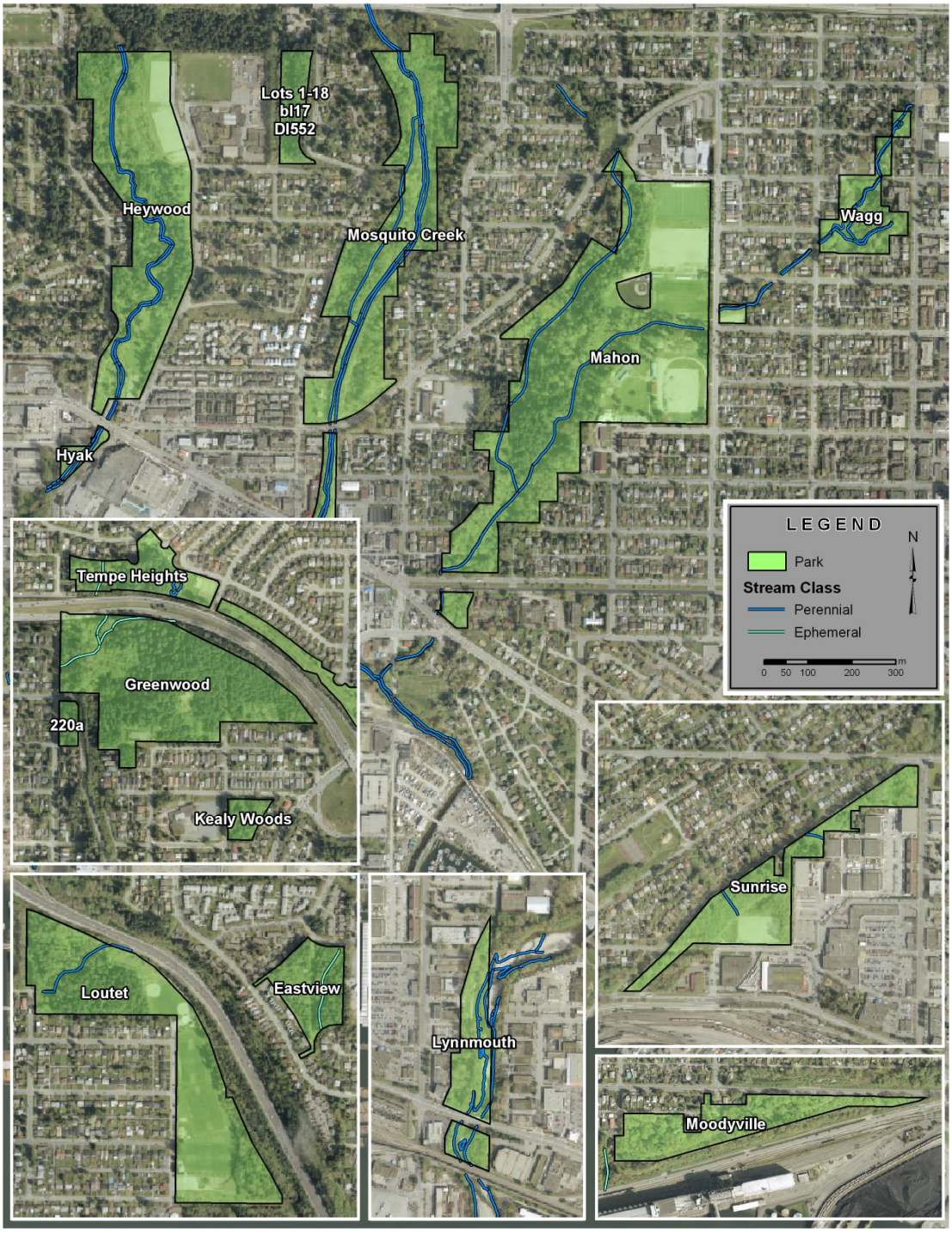

Figure 10. Perennial and ephemeral streams within the study area.

11.0 Management Concerns

These Parks currently face a number of biological and physical stresses. These stresses are disturbing their ecological integrity and/or limiting safe and adequate recreation for the public. Specific treatment recommendations have been made for each Park; however there are a number of issues that reoccur throughout the Parks system. These can be grouped into the following categories:

1. Forest structure and function
2. Degradation from human activity
3. Invasive species management
4. Aquatic/riparian systems
5. Recreation trails and facilities
6. Hazard tree management

11.1.1 Forest structure and function

In general the forested areas of the Parks are relatively healthy with natural levels of pathogens typically found in this region. There were no large-scale outbreaks of insects or diseases that require special management at this time. However, park managers should be aware of those pests that pose the greatest risk to the forest and monitor their levels regularly.

One of the main concerns with the stands in these Parks is the low level of natural regeneration of climax conifer species that will replace the existing trees as they age and decay. After a disturbance, pioneer tree species will regenerate and grow quickly competing for light and resources. These stands are generally even-aged and dense. Climax species including western hemlock and western redcedar are shade tolerant and over time will establish in the understory of these pioneer species. Once the original stands open up, providing light to the forest floor these climax species will grow up and replace the pioneer species.

The lack of understory regeneration in identified areas is due in part to the lack of adjacent seed trees as well as dense understory vegetation that out-competes any seedlings that do establish. In these areas it is recommended that trees be planted in the understory. Target density for understory regeneration should be about 100 stems/ha. In general the most common species that should be planted will include the climax species of western hemlock and western redcedar. In wetter areas, sitka spruce can be planted and along stand edges the shade intolerant Douglas-fir can be planted.

Trees should be a minimum of 1 meter tall to compete with understory vegetation, however it is not recommended that trees greater than about 1.5 meters be planted unless they are in areas with high moisture regimes. Ecosystem polygons with poor regeneration have been identified. Draft planting prescriptions have been developed for each area based on the stand conditions and ecosystem dynamics.

In many of the areas where understory planting is recommended, the stands are even-aged and very dense with high crowns allowing little light to reach the understory (Figure 11). Dense, even-aged stands can be thinned out and gaps created to provide a greater horizontal and vertical structural diversity. This allows more light to reach the understory, therefore improving the understory vegetation and encouraging a secondary succession tree layer. It also allows the remaining trees to grow faster and encourages the growth of strong lateral branching.

Figure 11. Stand with even-aged, close canopy and resulting low understory vegetation cover.

There are a number of steeper areas throughout the Parks that pose a concern for slope stability. Many of the areas below residential housing have already been assessed and have rehabilitation plans underway. There are also many trails that are starting to erode. In many areas they are starting to slide and pose a risk to watercourses (Figure 12). It is recommended that a qualified professional assess all trails to identify areas that pose a risk of eroding.

Figure 12. Areas exhibiting trail erosion.

11.1.2 Degradation from Human Activity

The majority of the Parks support healthy forests with a dense and lush understory layer of herbs and shrubs. There are some areas, however, in which the understory has been degraded by human activity where very little vegetation cover remains (Figure 13).

Figure 13. Degraded understory.

It is recommended that in these areas, the areas or trails be rehabilitated back to a natural state. This involves closing off the area for rehabilitation and replanting it with native species. The species that are planted should be those that naturally occur on that site series (for example western hemlock and western redcedar). Signage should be used to advise of closure and educate the public.

The primary source of non-native species within the Parks is plants that spread or seed from residential gardens and, in particular, plants spreading from the dumping of garden refuse. A number of well-used dumping sites were found within the Parks (Figure 14) and are identified on individual park maps in section 12.0. These are areas that are used by local residents to dump their garden waste as well as areas where garbage is dumped. The existing garbage and waste should be removed from these areas and signage installed to educate the public.

Figure 14. Yard waste dumping sites.

11.1.3 Invasive Species Management

Invasive species were found throughout the study area and are a significant concern for the health of these ecosystems. They were found predominantly along the Park perimeters near residential developments. These species are aggressive, displace native vegetation and negatively impact natural ecosystem dynamics. English ivy (*Hedera helix*), Japanese knotweed (*Polygonum cuspidatum*) and Himalayan blackberry (*Rubus discolor*) are the most common invasive species found in the Parks. There are also scattered patches of holly (*Ilex aquifolium*), laurel (*Prunus laurocerasus*), goutweed (*Aegopodium podagraria*), lamium (*Lamium maculatum*), Giant Hogweed (*Heracleum mantegazzianum*),

periwinkle (*Vinca minor*) and Clematis (*Clematis vitalba*). There are a number of other non-native species that were identified but are not present to a level that is a significant concern.

Figure 15. Invasive species (Japanese knotweed, left; English ivy climbing trees, right).

The species of greatest concern include those that are shade tolerant and spread to a density that displaces native species. From our field assessment, the species of greatest concern are English Ivy, Lamium and. Japanese knotweed. These have the potential to take over large areas and are very difficult to remove as they are shade tolerant and very resilient.

Giant Hogweed is of significant concerns as it is toxic. It poses a safety concern for the public and is therefore a priority for management. Himalayan blackberry is also a great concern, however it is restricted to stand edges and openings. It is also very difficult to remove. Due to its thorns, however, it also acts to restrict access into Parks and prevent illegal dumping. Therefore it is not as high a priority to remove except where it is covering large areas in stand openings.

Management of these species has been made a priority as they have the ability to establish quickly and spread rapidly. In Parks that are relatively small such as those in the City, these invasive species can have devastating impacts on ecosystem dynamics.

Treatment options for these invasive species depend on the species in question, the level of infestation and the ecology of the site. Generally the plants are removed as completely as possible and the area is planted with aggressive native species that can compete with the invasives. Shade intolerant species are best managed by removal and planting of a rapidly growing, dense canopy cover that will shade out the invasive. Shade tolerant species are more difficult to remove.

There is currently an active invasive species management program underway in Mahon Park as well as a City wide program to manage Giant Hogweed (*Heracleum mantegazzianum*). Most locations of invasive species have been mapped. Areas of concerns have been reemphasized in this report.

11.1.4 Aquatic/Riparian Systems

Streams, their riparian areas and wetlands provide the most critical habitat for both wildlife species and rare and endangered plant species (Figure 16). These aquatic systems and their associated riparian areas form a critical foundation for the functioning of these ecosystems. Their protection should be made a priority.

Figure 16. Streams and riparian areas.

Fish bearing perennial streams should be protected in Parks by designating a reserve zone that extends 30 meters on either side of the stream. Non-fish bearing streams and wetlands should be protected by designating a reserve zone that extends 15 meters on either side of the stream. The intention of these reserve zones is to protect the integrity of the stream channels and their associated riparian zones. Trails and facilities should not be located within these areas whenever possible. Opportunities should be explored to reroute any existing trails out of this reserve zone if they are causing a high level of degradation. Where trails must enter these zones the following protective measures should be followed:

- Establish fencing (posts with large diameter wire) on either side to prevent off trail use
- Build boardwalks where the soils are damp for most of the year
- Build long term bridges where trails cross over streams
- Post signage indicating the sensitivity of these areas
- There should be 'no net loss of habitat' when working in any of these riparian zone reserves

In many areas fencing has been constructed along popular trails and is effectively protecting riparian areas. However, it was noted that wherever there was a break in the fence, dogs in particular were entering the riparian area and degrading the stream (Figure 17). It is recommended that wherever the trails are within the designated riparian area, fencing be constructed and that no gaps or openings be left in the fences.

Figure 17. Existing fencing with gaps leading into the riparian area.

11.1.5 Recreation trails and facilities

There are many areas in these Parks where unsanctioned trails have developed. Also in some cases bike ramps have been built (Figure 18). These all cause degradation of the understory vegetation and in some cases increase soil erosion. These trails and bike stunt structures should be closed and rehabilitated. The following recommendations should be followed to close the identified trails:

1. Utilize the debris from hazard tree treatments to physically block access to the trail. Place large rocks along the pathway if they are readily available.
2. Install a discreet sign at or near the trail entrance indicating that the surrounding habitat is an ecologically sensitive area that is being rehabilitated.
3. Plant native species along the unauthorized trail. It is recommended that armed plants be used where ecologically suitable (salmonberry and rose species). These plants would make travel through the brush more difficult and uncomfortable.
4. If the trail continues to be used over time, it is recommended that a two layered wood fence barrier to a height of 1.3 meters be installed to block access.

Figure 18. Bike stunt structures.

There are some trails that are not used frequently and are in poor condition with inadequate stream crossings and slope stability concerns. In some cases these trails should be closed permanently instead of attempting to restore them. In addition, there are many trails that run adjacent to riparian areas that could potentially be rerouted away from the stream. This will provide better long-term protection for the stream and riparian area. The trail system should be analyzed in each Park and sections that are causing degradation of stream and riparian areas as well as those that are showing signs of erosion should be identified and relocation options explored.

11.1.6 Hazard Tree Management

Mature stands such as those found in many of the Parks usually contain tree hazards that are natural for stands of that age. These include dead trees, stem decay, dead and weak branches, broken tops etc. (Figure 19). Many older deciduous trees are prone to disease and decay as they reach maturity. Coniferous trees die for a variety of reasons including pathogens and changes to site conditions. Many of these trees also develop structural defects that pose a risk of failure.

These types of tree hazards pose a risk to Park visitors as well as structures and vehicles adjacent to the Parks. In addition, trees falling on power lines can cause outages as well as ignite a wildfire. All trees within striking distance of all official trails, recreation facilities, power lines, roads and residential developments should be assessed every year by a certified danger tree assessor. Mitigation prescriptions should be developed to retain as much ecological value from these trees as possible.

Figure 19. Potential hazard trees.

12.0 Inventory Results and Management Recommendations

The inventory for each park has been compiled and has been provided to the City as a GIS database. The following is a brief summary the significant features, key areas of concern and management recommendations within each park. Each recommendation has been designated a priority ranking based on professional judgment to meet the higher-level natural areas objectives. These priority rankings were created with the goal of protecting the natural integrity of the Parks while providing for recreation as a secondary priority. Rankings were made without consideration for costs.

An estimated cost has been provided for each recommendation. These have been calculated based on rough unit pricing and a number of assumptions. These management recommendations have been provided in a database so they can be sorted by category and updated on a regular basis.

12.1 Heywood/Hyak

Heywood Park is a long, linear park that follows MacKay Creek. It is located at the northwest portion of the City to the north of Marine Drive. There is a grassy recreation area that is maintained at the south end of the Park. The majority of the Park contains by a mature forest of mixed coniferous and deciduous species. There is a young forest of red alder that has established on an old landfill site at the northeast corner next to the school. MacKay Creek is perennial and fish bearing.

There are numerous trails that run through this Park, however, many are unsanctioned and in poor condition. Many of the trail structures (boardwalks and bridges) are broken and require replacing.

Hyak Park is a small natural area located just south of Marine Drive surrounding the continuation of MacKay Creek. This is a deciduous stand that is highly disturbed by invasive species and human activity. There is one short trail and bridge running across the creek.

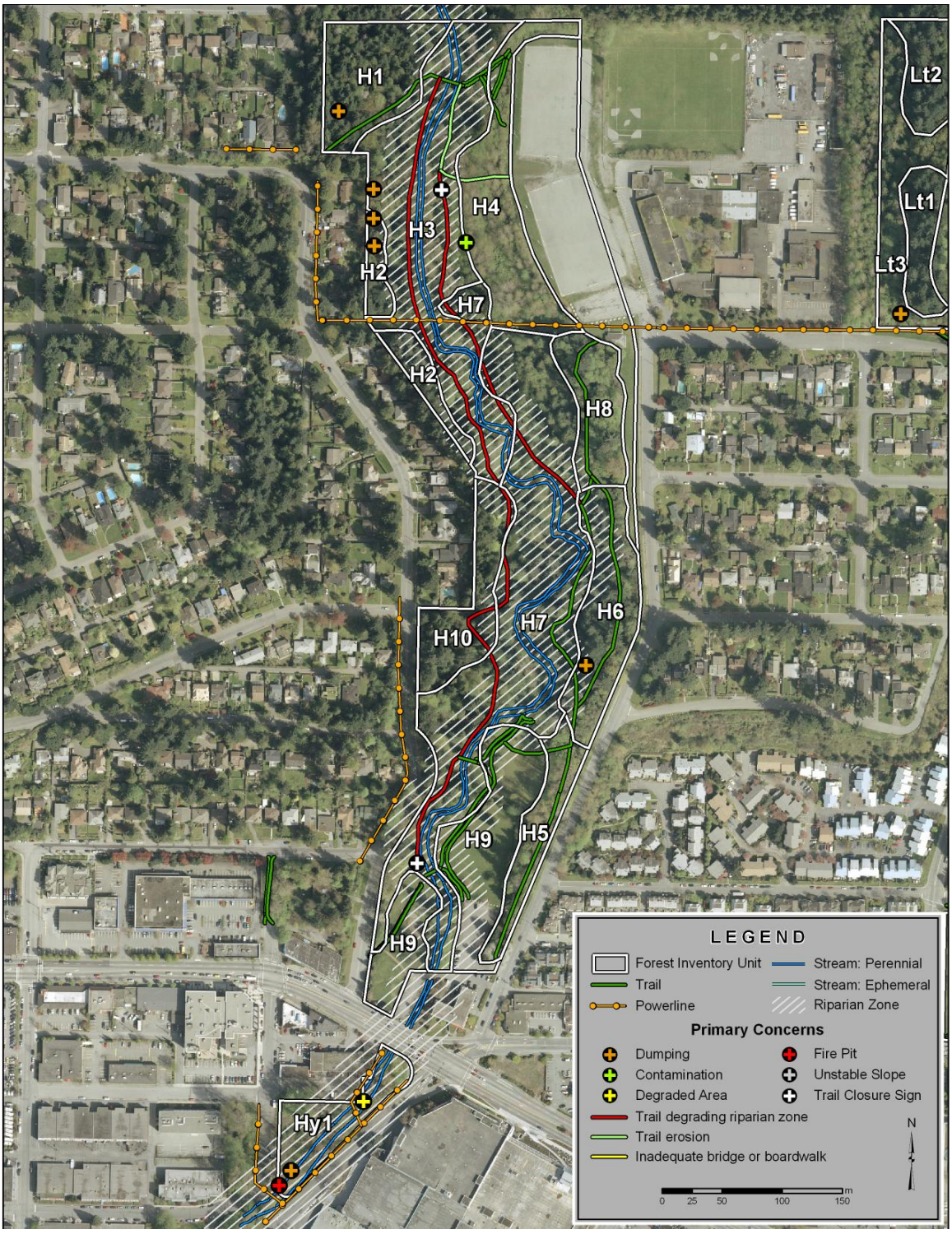

Figure 20. Overview map: Heywood/Hyak (H/Hy)

12.1.1 Significant Features

- MacKay Creek and associated riparian area.
- Diverse wildlife habitat provided by uneven-aged, open stand structure.
- Significant number of wildlife trees.
- Diverse and lush understory vegetation.

12.1.2 Primary Concerns

Invasive Species

- English ivy is present at moderate levels in Hy1, H1, H2, and H7 (south western edge of Park). It is present at high levels in H3, H4 and H10. It has been treated in Hy1 and along the edges of H6 and H8 but is beginning to climb again.
- Japanese knotweed is scattered along the creek in H3 and H7 at low levels. Several large patches exist at the south end of H7 adjacent to H9.
- There are high levels of blackberry throughout H4 and under the powerline (running through H3 and H4). Blackberry is also prominent along the eastern edge of H8, the western edge and southern end of H5, the western edge of H10 and throughout Hy1.
- There is a prominent patch of lamium along the western edge of H2.

Stand Regeneration

- There are low levels of understory tree regeneration in H1, H2, H6, H8, H10 and Hy1.
- The understory tree regeneration in H4 is not adequately distributed.

Recreational Issues

- Trails running through H4 are eroding due to water flow.
- There are unsanctioned braided trails leading to the riparian zone in H3 and H7.
- Many sections of the two trails immediately adjacent the east and west sides of MacKay Creek are too close to the creek and causing degradation within the riparian zone. The trail closure signs on these two trails are ineffective in that they are only installed at one end of each of these trails. Park users may enter the trails from the opposite direction and be unaware that the trails are officially closed.
- There are numerous bridges and riparian crossings that are rotten or broken in H7 making parts of the trail treacherous and potentially leading to future damage of the riparian zone.

Other issues

- There is dumping of yard waste and refuse in H1, H2 and Hy1. The dumping in H2 is causing the introduction of invasive species.
- There is iron-coloured seepage along the trail on the southwestern edge of H4 that is flowing into the creek and riparian zone. This is coming from the old landfill site.

Figure 21. Invasive species (H3, H4 and H9).

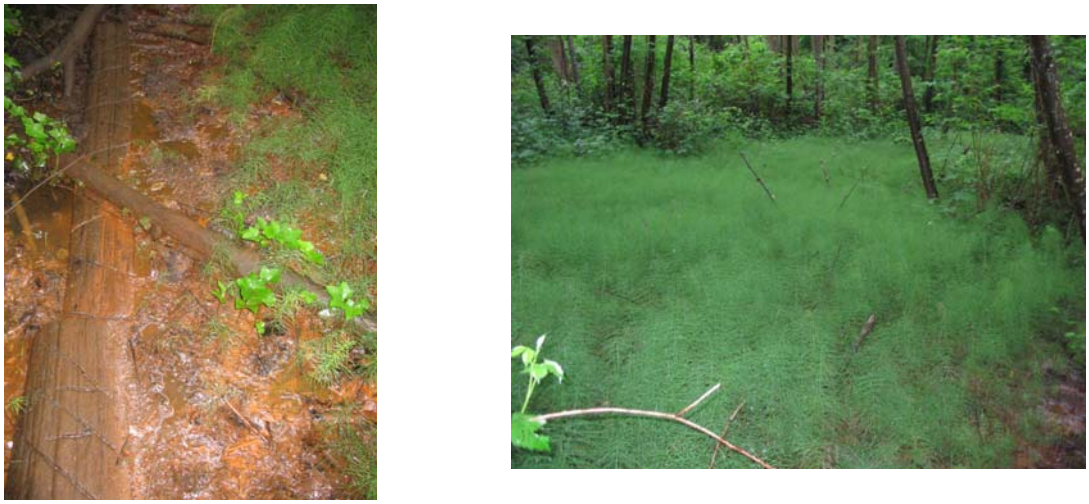

Figure 22. Area containing possible contaminated seepage (H4).

Figure 23. Dumping of refuse and yard waste (H2 and H6).

Figure 24. Broken boardwalks (H7).

12.1.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Aquatic Systems	H4	Investigate suspected contaminated seepage flowing toward riparian zone	1	$5,000.00
Forest structure and function	All Polygons	Have a Qualified Engineer assess slope stability along trails and residential neighborhoods	1	$5,000.00
Aquatic Systems	H3, H7, Hy1	Rehabilitate degraded areas in riparian zone	2	$5,410.24
Aquatic Systems	H7	Upgrade and add bridges within riparian areas and wet areas	2	$3,000.00

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Aquatic Systems	H3, H7, Hy1	Remove invasive species along the 30 meter riparian zone	3	$5,410.24
Aquatic Systems	H3, H7	Reroute trail outside of riparian area where degradation occurs	4	$4,000.00
Recreation trails and facilities	H3	Re-establish official trail and rehabilitate unsanctioned braided trails	4	$1,824.10
Aquatic Systems	Hy1	Fence off entire park along trail, and stand edges to restrict access	5	$26,000.00
Invasive Species	H1, H2, H3, H4, H7, H9, H10	Remove ivy and Japanese knotweed	5	$14,008.87
Recreation trails and facilities	H4	Rehabilitate water eroded trails	5	$425.87
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$15,207.57
Degradation by human activity	H1,H2,H3,H6, Hy1	Remove dumped refuse and inform residents about its adverse effects	7	$1,250.00
Invasive Species	H4	Remove blackberry	7	$4,045.77
Forest structure and function	H4, Hy1	Plant understory with shade tolerant conifer species	9	$3,148.91

* 1 = Highest, 10 = Lowest

12.2 Lots 1-18, bl17, Dl1552

These park zoned lots are located in the northeast portion of the City. They are bordered by a school to the west and residential areas to the south and east. The stands are mature with mixed deciduous and coniferous species. There is one well-used trail that runs along the western perimeter.

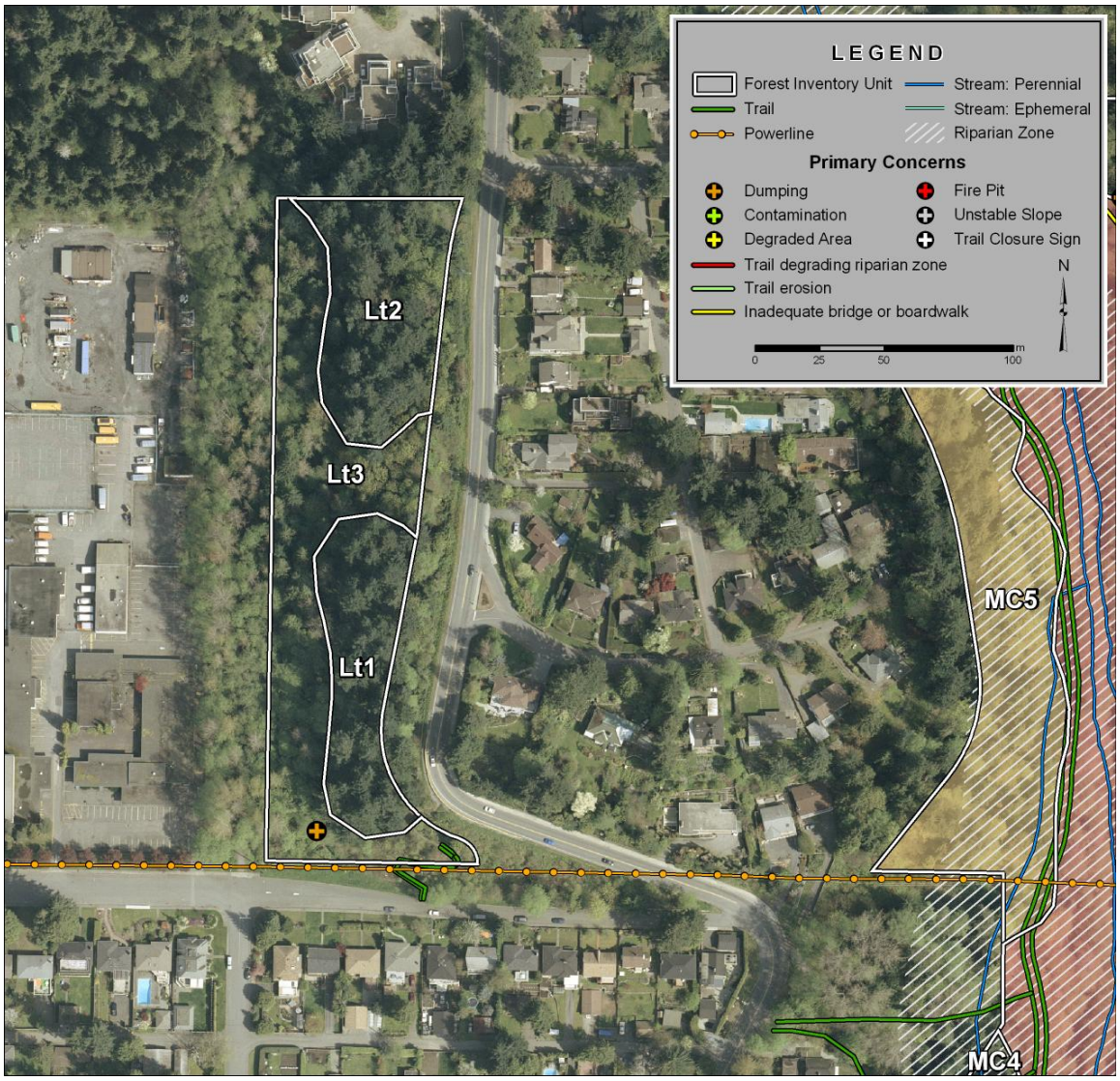

Figure 25. Overview map: Lots 1-18, bl17, Dl1552 (Lt)

12.2.1 Primary Concerns

Invasive Species

- English ivy is present at moderate to high levels at the south ends of Lt1 and Lt3.
- There are significant patches of blackberry and Japanese knotweed along the eastern edge of Lt2.
- There is a significant patch of blackberry along the southern edge of Lt3.
- There are moderate levels of holly and lamium in Lt2.

Stand Regeneration

- There are low levels of understory tree regeneration in Lt2 and Lt3.

Other Issues

- There is dumping of yard waste along the southern edge of Lt3.

Figure 26. Invasive species (Lt2 and Lt3).

Figure 27. Dumping of yard waste (Lt3).

12.2.2 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	Lt1, Lt2, Lt3	Remove dumped refuse and inform residents about its adverse effects	8	$750.00
Invasive Species	Lt1, Lt2, Lt3	Remove invasive species along southern and eastern edge of Park	9	$297.73

* 1 = Highest, 10 = Lowest

12.3 Mosquito Creek

This is a long, linear park that follows Mosquito Creek. It is located at the western portion of the City to the north of Marine Drive. There is a grassy recreation area with a playground that is maintained at the south end of the Park. The majority of the Park contains mature forest of mixed coniferous and deciduous species. There is a side channel of Mosquito Creek that runs to the west edge of the creek. The creek and its side channels are perennial and fish bearing

The main trail along the western edge of the creek is heavily used by a wide range of recreation groups and is currently fenced on both sides to protect the riparian areas. There are a number of nature trails that are restricted to low impact recreation that run adjacent to some of the side channels. The north end of the trail along the eastern side of the creek has been recently closed due to slope stability concerns below the residential area.

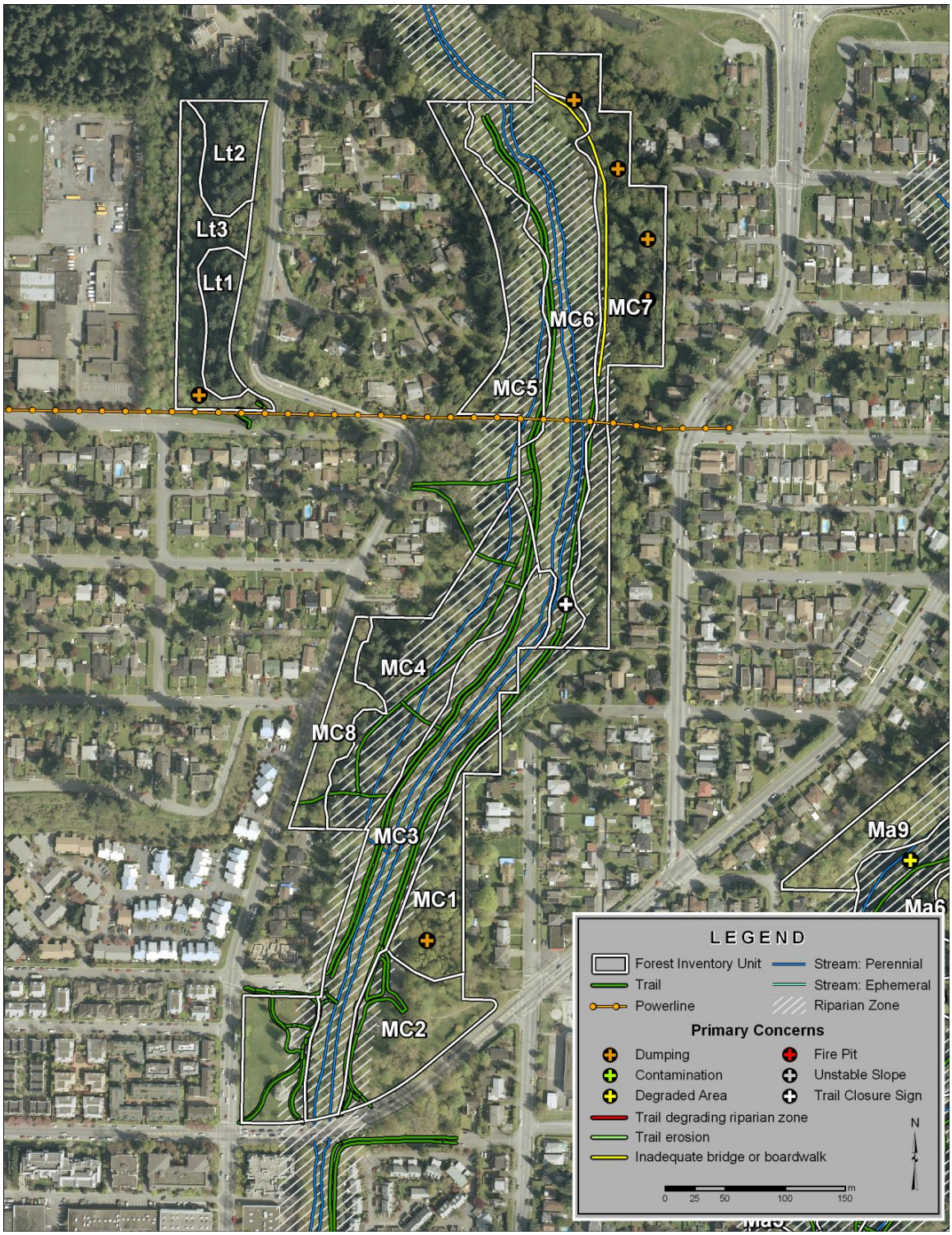

Figure 28. Overview map: Mosquito Creek (MC)

12.3.1 Significant Features

- Mosquito Creek, side channels and associated riparian zone
- Significant number of wildlife trees.
- Trees of significant size and age (MC4 and MC5).

12.3.2 Primary Concerns

Invasive Species

- English ivy is present at high levels in MC3 (adjacent to residences), MC6 and MC7 and at moderate levels in MC1. Low levels of ivy are present in MC4 and MC5.
- There are significant patches of blackberry in MC2 and MC6 (northeast corner).
- Numerous goutweed patches are present along the creek in MC3, MC4 and MC6.
- Moderate levels of clematis are climbing trees in MC2.
- Large patches of lamium are present adjacent to the residences in MC3.

Forest Health

- Hemlock mistletoe is present in MC5 causing some failures. The eastern edge of MC5 is within range of the trail.

Stand Regeneration

- Conifers have been planted along the trail in MC3 but are lacking further into the stand.

Riparian Issues

- Numerous unsanctioned braided trails leading to riparian zone and creek (MC3, MC6). Some degraded area along riparian zone.
- All riparian areas that have breaks in fencing are heavily used by dogs. In particular at the northern end of MC6 and the southern end of MC3.

Recreational Issues

- Park is heavily used by dog owners. Dog waste found along trail and in stands.
- Boardwalks along the trail in MC6 and MC7 are broken or inadequately protecting the edge of the riparian zone (this area is currently closed due to slope stability concerns).
- MC1 contains remnants of a fort.

Other Issues

- There is dumping of refuse in MC1, MC6 (including remains of a vehicle) and MC7.
- There are slope stability concerns below the residential houses along the northeast edge of the Park.

Figure 29. Invasive species (MC2, MC6, MC7).

Figure 30. Broken or inadequate boardwalks (MC6 and MC7).

Figure 31. Dumping of refuse, including a vehicle (MC1 and MC6).

Figure 32. Hemlock mistletoe (MC5).

12.3.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Rank*	Estimated Cost
Aquatic Systems	MC3,MC6	Rehabilitate degraded areas in riparian zone	2	$4,195.62
Recreation trails and facilities	MC6,MC7	Close and rehabilitate trail along east side of creek in northern portion of park. This area is currently closed due to slope stability concerns.	2	$2,075.71
Aquatic Systems	MC3,MC6	Remove invasive species along the 30 meter riparian zone	3	$839.12
Aquatic Systems	MC3, MC6	Continue building riparian fencing along entire course of Mosquito Creek including the south and north end. Fill in all small breaks in fencing.	4	$46,150.00
Invasive Species	MC3, MC6, MC7, MC1.	Remove of ivy	5	$1,478.26
Degradation by human activity	MC2, MC3, MC4, MC6	Provide dog waste disposal (bags and bins) along trails	6	$2,500.00
Forest structure and function	MC3,MC6	Plant understory with shade tolerant conifer species	6	$5,107.92
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$2,299.92
Degradation by human activity	MC1, MC7, MC6	Remove dumped refuse and inform residents about its adverse effects. Remove abandoned vehicle at the north end of MC6.	7	$925.00

* 1 = Highest, 10 = Lowest

12.4 Mahon

Mahon Park is located at the eastern side of the City north of Marine Drive. It is an elongated park that runs adjacent to Wagg and Mission Creeks. There are large sport fields and grassy recreation areas along the eastern sides of the Park. The Park supports a range stand types the most common being mixed mature stands of coniferous and deciduous species. There are some old growth trees in the northern end of the Park. Both creeks are perennial and fish bearing.

There are numerous sanctioned and unsanctioned trails running throughout this Park. There are many areas that have been invaded by invasive species. An active control program is underway to re-establish native plant communities in these areas.

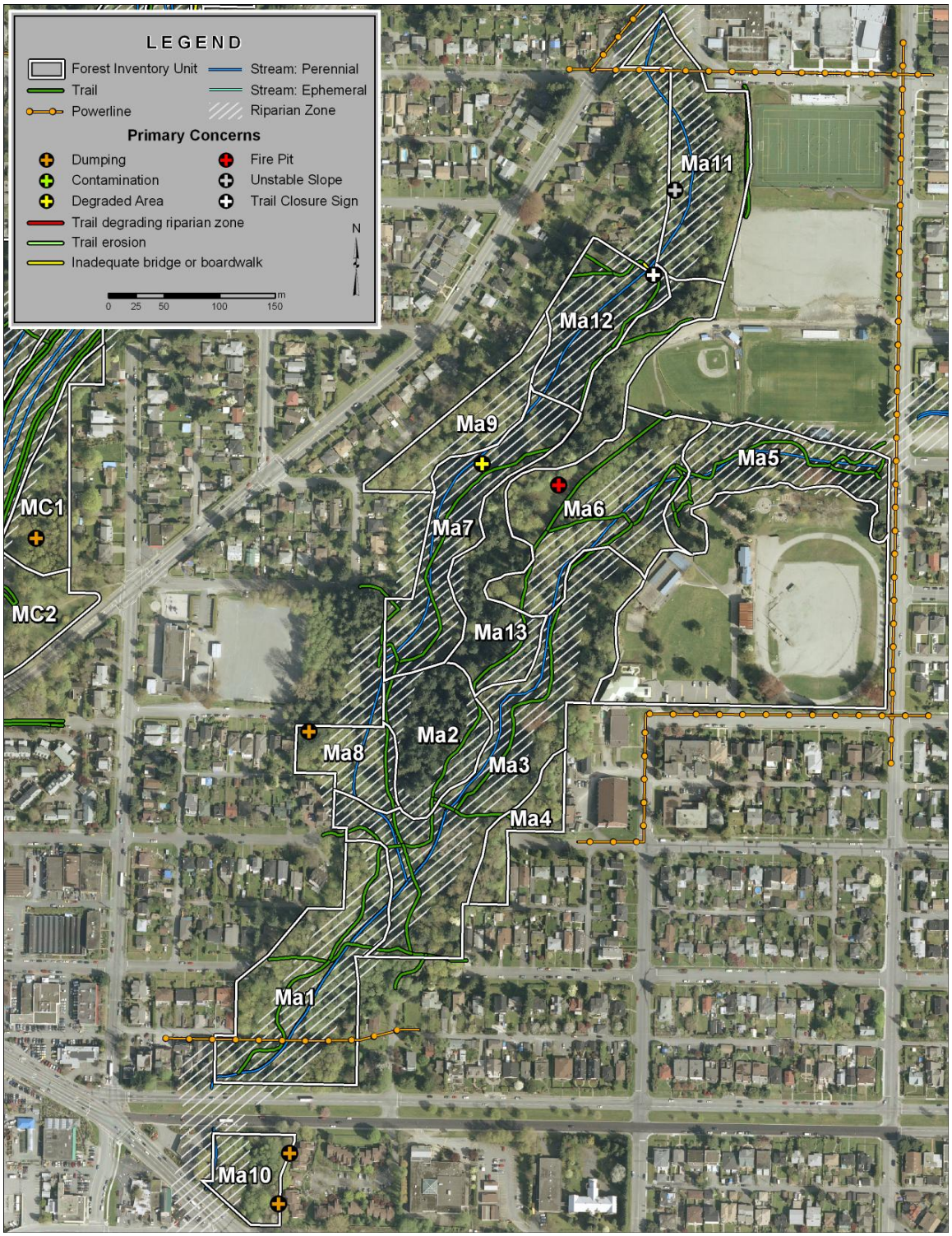

Figure 33. Overview map: Mahon (Ma)

12.4.1 Significant Features

- Wagg Creek, Mission Creek and associated riparian zones.
- Diverse wildlife habitat provided by uneven aged, open stand structure.
- Significant number of wildlife trees.
- Diverse and lush understory.
- Trees of significant size and age including some that are classified as old growth (Ma7, Ma11, and Ma12).
- Stand structure and features expressing old growth attributes (Ma11, and Ma12).

12.4.2 Primary Concerns

Invasive Species

- English ivy is present at low to moderate levels in Ma1, Ma2, Ma3, Ma6, Ma8, Ma9 and Ma12. Most commonly it is climbing trees adjacent to residences. It is particularly bad in Ma10.
- There are significant patches of blackberry in Ma3, Ma4, Ma7, Ma11 and Ma10.
- Large patches of goutweed follow the creek and creekside trails in Ma1, Ma3, Ma5, Ma6 and Ma9.
- Low to moderate levels of clematis are present in Ma1 and Ma9. Clematis is particularly bad in Ma4.
- There are a few large patches of Japanese knotweed along the creek in Ma7 and Ma11.
- Large patches of periwinkle are present along the western edge of Ma9.
- There are moderate levels of holly in Ma10.

Forest Health

- Some older western hemlocks have significant hemlock mistletoe and decay in Ma6, Ma7 and Ma12. There are some recently fallen western hemlocks in Ma7 and Ma6.

Stand Regeneration

- There is a lack of conifer regeneration in Ma1, Ma8, Ma9, Ma10, Ma11 and Ma12.

Riparian Issues

- Numerous unsanctioned braided trails leading to riparian zone and creek (Ma7, Ma8, Ma11).
- There is a large degraded area with erosion concerns adjacent to Mission Creek in Ma7, which requires rehabilitation.
- Sub-standard creek crossing in Ma12.

Recreational Issues

- Unsanctioned braided trails (Ma2, Ma5, Ma6).

Fire Risks

- There is a fire pit in the grass meadow on the east side of Ma6.

Other Issues

- There is dumping of refuse and yard waste in Ma10 and Ma8.
- Slope stability concerns in Ma3, Ma6, and Ma11.

Figure 34. Invasive Species (Ma4, Ma5, Ma8 and Ma9).

Figure 35. Degraded area in riparian zone (Ma7).

12.4.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	Ma6	Remove fire pit	1	$200.00
Forest structure and function	Ma11	Have a Qualified Engineer assess slope stability in Ma11, Ma2, Ma3	1	$4,000.00
Aquatic Systems	Ma7	Rehabilitate degraded area along creeks	2	$525.64
Aquatic Systems	Ma12	Close and rehabilitate creek crossing at Ma12	2	$567.48
Aquatic Systems	Ma11, Ma12, Ma7, Ma8, Ma1, Ma2, Ma3, Ma6, Ma5	Remove invasive species along the 30 meter riparian zone	3	$1,913.54
Aquatic Systems	Ma11, Ma12, Ma7, Ma8, Ma1, Ma2, Ma3, Ma6, Ma5	Continue building riparian fencing along Mahon and Mission Creek where trail comes within 30 meters of creek	4	$85,995.00
Invasive Species	Ma1, Ma2, Ma3, Ma6, Ma7, Ma8, Ma9, Ma10, Ma12	Remove ivy and Japanese knotweed	5	$2,736.79
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$4,344.95
Recreation trails and facilities	Ma2, Ma7, Ma8, Ma11	Re-establish official trails and rehabilitate unsanctioned braided trails	6	$1,480.67
Degradation by human activity	Ma10	Remove dumped refuse and inform residents about its adverse effects	7	$375.00
Forest structure and function	Ma1, Ma8, Ma10, Ma11 and Ma12	Plant understory with shade tolerant conifer species	7	$8,928.66

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Recreation trails and facilities	Ma11, Ma12	Close and rehabilitate trails north of junction in Ma12 on both sides of creek. Also close unsanctioned trails in Ma11	7	$1,401.07

* 1 = Highest, 10 = Lowest

12.5 Wagg

Wagg Park runs adjacent to Wagg Creek and a short unnamed creek in the southeast corner. It is located in the middle of the City. There are a variety of stands in this Park from open cultured areas to mature coniferous stands and mixed deciduous stands. The creeks are heavily modified and disturbed. There are four areas adjacent to Wagg Creek that are maintained as cultured recreation areas with playgrounds and picnic sites.

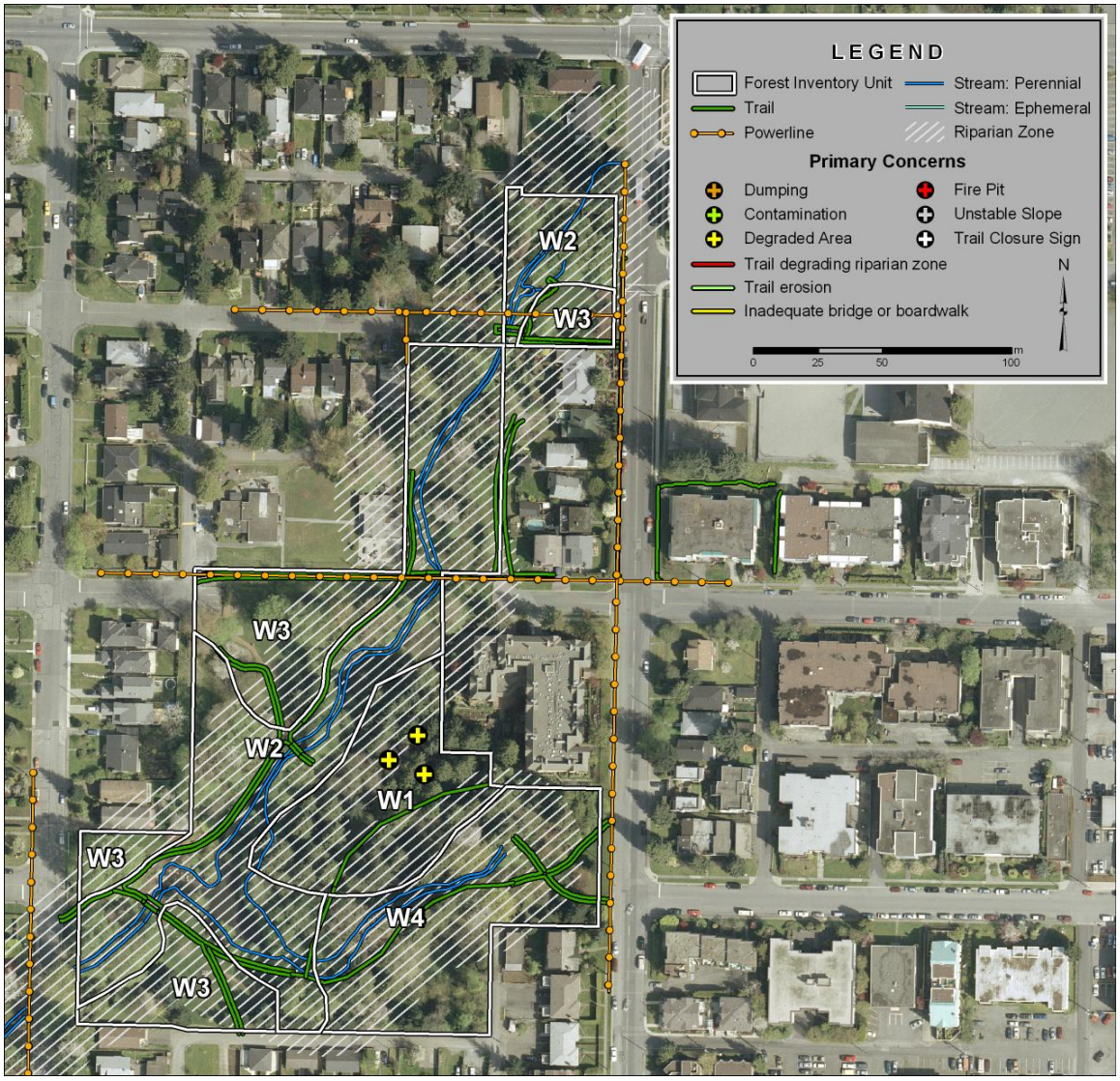

Figure 36. Overview map: Wagg (W)

12.5.1 Significant Features

- Wagg Creek, unnamed Creek (southeast corner) and their associated riparian zone.

12.5.2 Primary Concerns

Invasive Species

- W2 has significant invasive problems including blackberry, Japanese knotweed, goutweed, holly, bamboo, gunnera, morning glory and grass.
- W1 has a low level of English ivy. A resident has been removing the ivy and holly.

Forest Health

- There are scattered dead cherry and bigleaf maple in W1.

Stand Regeneration

- There is a lack of conifer regeneration in W1 and W4.

Riparian Issues

- There are unsanctioned braided trails leading to Wagg Creek throughout the Park.
- Many portion of the creek contain refuse

Recreational Issues

- The northern portion of W1 has been degraded due to human activity with low understory vegetation coverage.

Other Issues

- There is litter scattered throughout W2 and W3.

Figure 37. Invasive species (W2).

Figure 38. Unsanctioned braided trails (W1 and W2).

Figure 39. Degraded area (W1).

12.5.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Aquatic Systems	W2	Rehabilitate degraded areas in riparian zone	2	$1,050.11
Aquatic Systems	W2	Remove invasive species along the 30 meter riparian zone	3	$2,121.66
Aquatic Systems	W2	Install riparian fencing along side of trail	4	$19,500.00
Aquatic Systems	W2	Discuss management of riparian zone with residents along east side of creek (2100 block of Chesterfield)	5	$800.00
Degradation by human activity	W1	Rehabilitate degraded areas	5	$555.23

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	W1	Plant understory with shade tolerant conifers species	5	$925.38
Degradation by human activity	W2, W4	Remove dumped refuse and install waste bins	7	$375.00

* 1 = Highest, 10 = Lowest

12.6 Moodyville

Moodyville is located at the southeastern portion of the City. This Park is a thin strip of mature predominantly deciduous trees that runs north of the industrial waterfront and south of a residential area. There is a cultured playground area that is located in the northeast corner. The GVRD sewer right-of-way is used as a walking trail running through the Park.

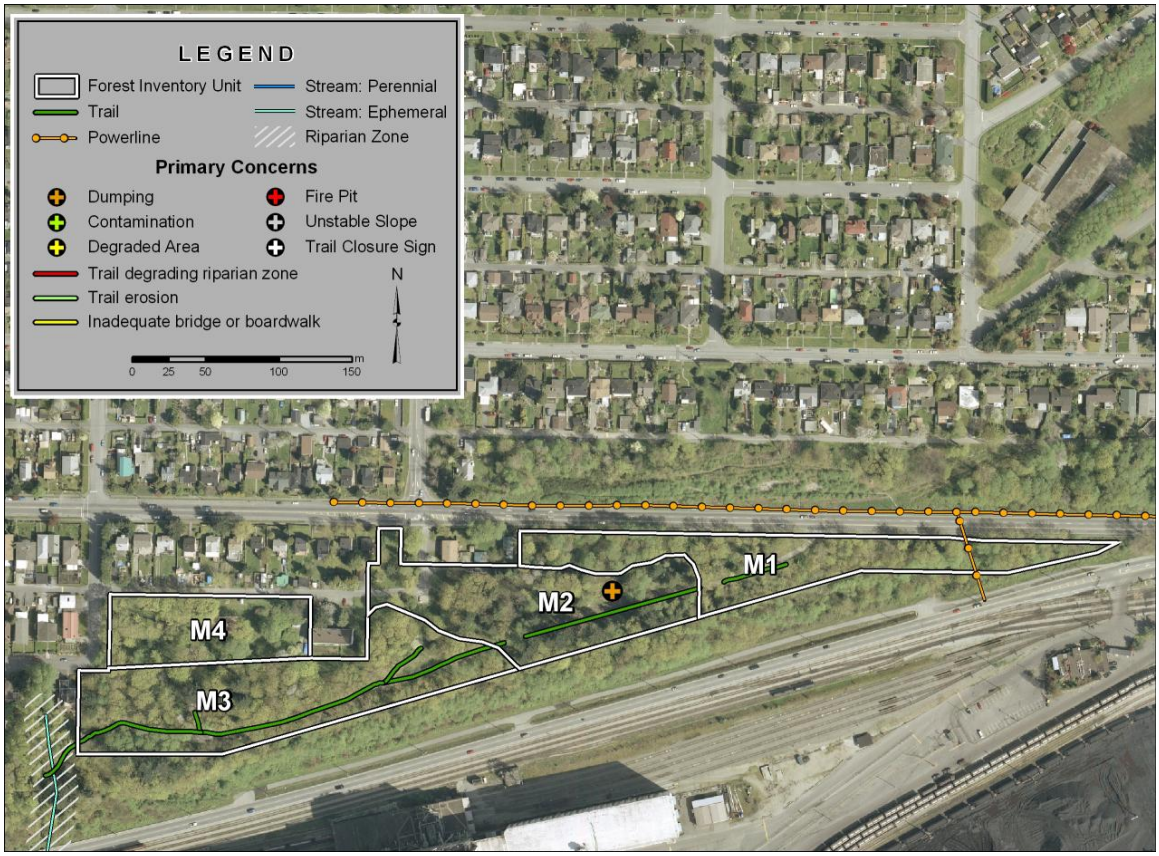

Figure 40. Overview map: Moodyville (M)

12.6.1 Significant Features

- Douglas-fir of significant size (M2 and M3).

12.6.2 Primary Concerns

Invasive Species

- English ivy and blackberry at moderate to high levels throughout M1, M2, and M3.
- Blackberry is present at the base of trees in M4.

Forest Health

- There are several dead western hemlock and bigleaf maple in M1 and M2.
- There are several western redcedar with dead tops in M2.

Stand Regeneration

- There is a lack of tree regeneration in M1, M2, and M3.

Other Issues

- Slope stability is an ongoing concern along the lower road (southern perimeter of Park).
- There is dumping of refuse in M2.

Figure 41. Invasive species (M1 and M2).

Figure 42. Dumping of refuse (M2).

12.6.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Forest structure and function	M1,M2,M3	Have a Qualified Engineer assess slope stability along lower road	1	$4,000.00
Forest structure and function	M1,M2,M3	Plant understory with shade tolerant conifer species	6	$7,417.90
Degradation by human activity	M2	Remove dumped refuse and install waste bins	7	$125.00
Invasive Species	M1,M2,M3	Remove ivy	7	$2,317.98
Invasive Species	All Polygons	Remove other invasive species throughout park	9	$2,444.29

* 1 = Highest, 10 = Lowest

12.7 Sunrise

Sunrise Park is located at the southeastern edge of the City to the south of a residential area and north of an industrial area. It is a narrow stand of mostly mature deciduous trees. There are two small creeks that run through this stand and one trail that runs down to a playing field below. There is a small nature trail that runs through a wetland area to the northwest of the playing field.

Figure 43. Overview map: Sunrise (S)

12.7.1 Primary Concerns

Invasive Species

- English ivy at high levels in S1, S2 and S3.
- Blackberry and other invasive species present along most sections of the Park perimeter.

Riparian Issues

- There are nature trails with inadequate crossing of wetland area to the northwest of the playing field.

Stand Regeneration

- There is a lack of regeneration throughout the Park.

Other Issues

- There is dumping of yard waste and refuse along the northern road edge.

Figure 44. Invasive species (S1 and S2).

Figure 45. Dumping of yard waste (S2).

12.7.2 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	All Polygons	Install fencing and signage along road edge to prevent further dumping	6	$1,300.00
Invasive Species	S1, S2, S3	Remove ivy	6	$3,887.28
Degradation by human activity	All Polygons	Remove dumped refuse and install waste bins	7	$475.00
Invasive Species	All Polygons	Remove other invasive species throughout park	7	$4,207.60
Forest structure and function	All Polygons	Plant understory with shade tolerant conifer species	8	$10,885.67

* 1 = Highest, 10 = Lowest

12.8 Lynnmouth

This is a narrow park that runs adjacent to the mouth of Lynn Creek. It is bordered on both sides by industrial/commercial areas. The stands in the Park are deciduous and dominated by red alder and bigleaf maple. There is a well-used trail that runs through the open, cultured western portion of the Park alongside Lynn Creek.

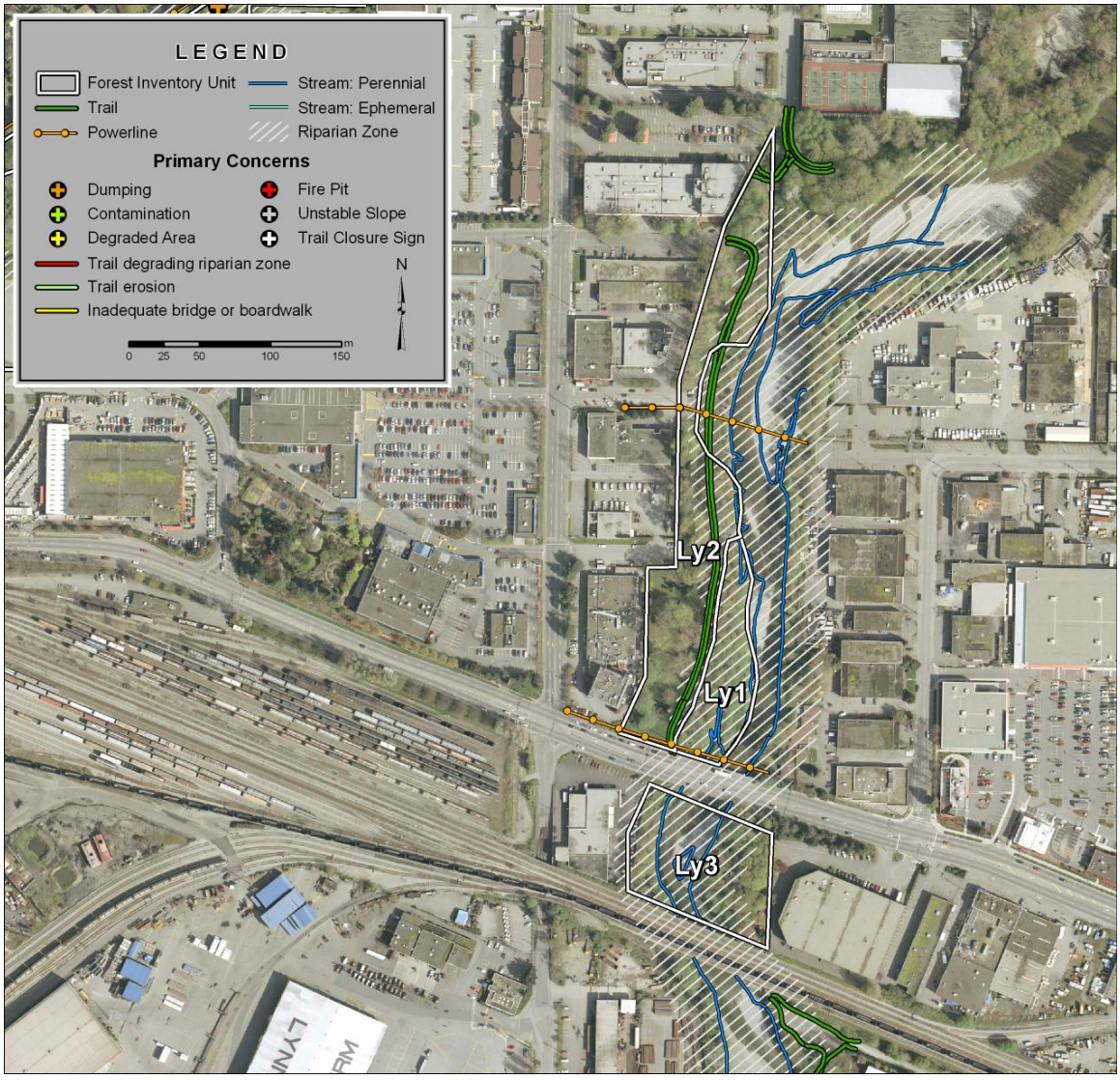

Figure 46. Overview map: Lynnmouth (Ly)

12.8.1 Special Features

- Lynn Creek and associated riparian zone including a floodplain bench.

12.8.2 Primary Concerns

Invasive Species

- English ivy at high levels in Ly3.

- Significant patches of Japanese knotweed (Ly1).
- Blackberry at perimeter of Park along north and south ends (Ly2).

Stand Regeneration

- There is a lack of young conifers to replace the aging deciduous trees in Ly2.

Riparian Issues

- Unsanctioned braided trails leading through riparian zone to creek throughout the Park.

Figure 47. Invasive species (Ly1 and Ly3).

Figure 48. Unsanctioned braided trails (left) and under-vegetated creek bank (Ly1 and Ly2).

12.8.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking	Estimated Cost
Aquatic Systems	Ly1, Ly2	Rehabilitate degraded areas in riparian zone including braided trails	2	$2,483.67
Aquatic Systems	Ly1, Ly3	Remove invasive species along the 30 meter riparian zone	3	$3,548.10
Aquatic Systems	Ly1, Ly2	Build riparian fencing along side of trail	4	$22,425.00
Invasive Species	Ly1, Ly2	Remove Japanese knotweed	5	$774.68
Invasive Species	Ly1, Ly2, Ly3	Remove other invasive species throughout park	5	$2,803.41

* 1 = Highest, 10 = Lowest

Eastview

Eastview Park is located at the eastern edge of the City. It is bordered by residential areas as well as a school to the east. The Park contains both mature coniferous stands and a mixed deciduous stand. There is one ephemeral stream and associated riparian zone located on the eastern side of the Park.

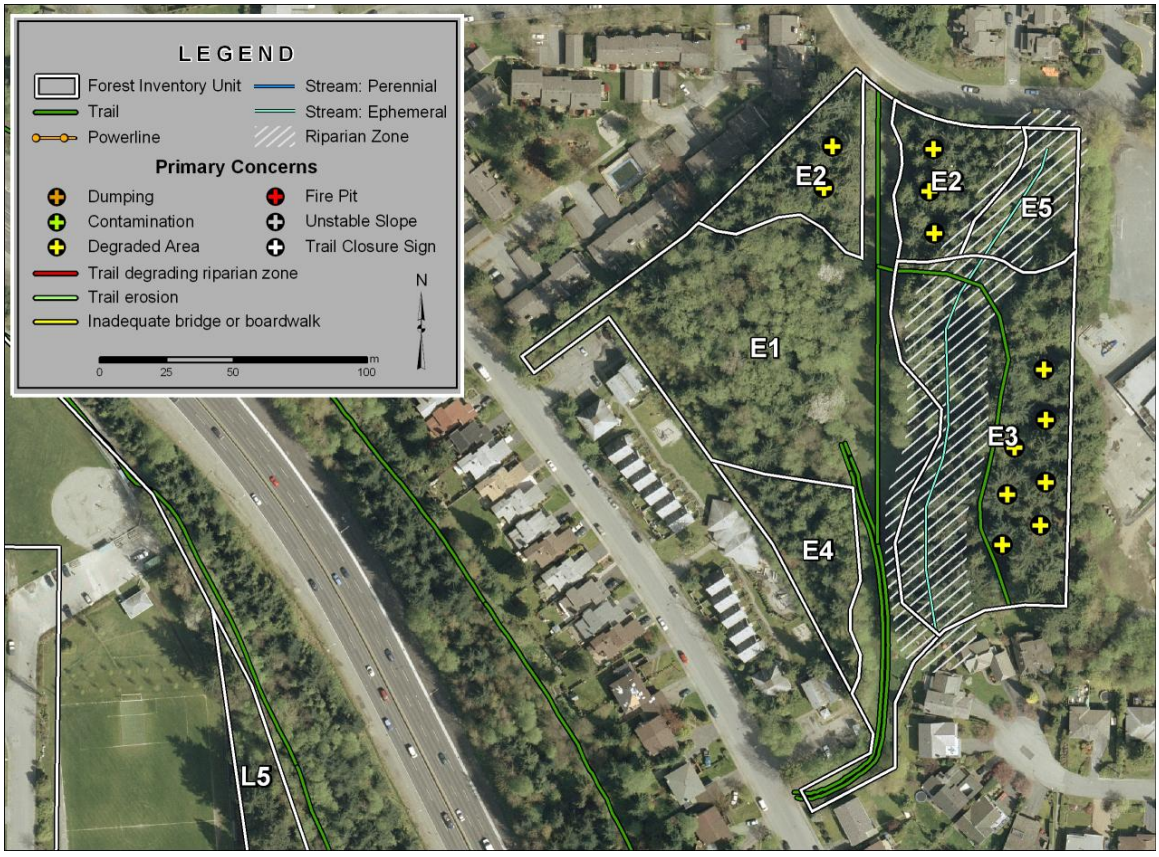

Figure 49. Overview map: Eastview (E)

12.8.4 Special Features

- Ephemeral stream and associate riparian zone.

12.8.5 Primary Concerns

Invasive Species

- Low levels of invasive species are scattered throughout the Park.
- The edges of E2 and E4 adjacent to residences have moderate levels of invasive species.
- There are patches of blackberry at the south end of E3.

Forest Health

- Some western hemlock in E2 have significant hemlock mistletoe.

Stand Regeneration

- E2 and E3 have very little tree regeneration.

Riparian Issues

- Unsanctioned braided trails leading to the wetland and riparian zone in E3.

Recreational Issues

- There are tree forts in E1 and E4.
- E1, E2, and E3 have large areas degraded by human activity. The area behind the school in E3 is particularly degraded.
- The east side of the trail in E2 requires rehabilitation.
- There are several unsanctioned braided trails throughout the Park.

Figure 50. Degraded areas with a shortage of conifer regeneration in the understory (E2 and E3).

12.8.6 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Aquatic Systems	E3	Rehabilitate degraded areas in riparian zone including braided trails	2	$1,222.24
Degradation by human activity	E2, E3	Rehabilitate degraded areas	5	$2,853.23
Recreation trails and facilities	All Polygons	Establish official trail and rehabilitate unsanctioned trails throughout park	8	$1,521.14
Forest structure and function	E2, E3	Plant understory with shade tolerant conifer species	9	$2,379.38

* 1 = Highest, 10 = Lowest

12.9 Loutet

Loutet Park is located in the northeastern corner of the City. It is bordered by Highway 1 to the north and east and residential areas to the southwest. There are a number of well-used playing fields. There is one small creek and associated wetlands that run through the northern portion of the Park.

Figure 51. Overview map: Loutet (L)

12.9.1 Significant Features

- Creek, associated riparian zone and wetland (L1).

12.9.2 Primary Concerns

Invasive Species

- There are patches of blackberry at the south end of L1 and along the western edges of L5 and L6.
- Large patches of Japanese knotweed are present in L1, in particular at the southern end.
- There are moderate levels of English ivy along the south end of L3 adjacent to residences as well as the southern end of L5 and throughout L6.

Forest Health

- There is some decay in the western hemlock in L2 and the northern section of L3, but it is typical of hemlocks at this age.
- The trees in L2 and the northern section of L3 have shallow roots due to a high water table.

Stand Regeneration

- There is no conifer regeneration in L4 and a lack of regeneration in L1 and L7.

Riparian Issues

- There is an unsanctioned trail adjacent to the creek in L1 causing degradation to the riparian zone.

Recreational Issues

- There are unsanctioned braided trails adjacent to the residences in L3.
- The understory and trail is degraded in L4 due to human activity.

Fire Risks

- There is a fire pit on the edge of the field adjacent to the eastern corner of L3.

Figure 52. Invasive species (L3 and L6).

Figure 53. Left: degraded area with a shortage of conifer regeneration (L4). Right: Stand with hemlock mistletoe (L2).

Figure 54. Riparian zone along stream requiring closure of unsanctioned trail.

12.9.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	L4	Remove fire pit	1	$200.00
Aquatic Systems	L1	Close and rehabilitate unsanctioned trail running adjacent to creek through L1	2	$1,099.24
Degradation by human activity	L4	Rehabilitate degraded area	5	$994.88
Invasive Species	L1, L3, L5, L6	Remove ivy and Japanese knotweed	5	$1,809.73
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$2,079.46

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Forest structure and function	L4	Plant understory with shade tolerant conifer species	9	$1,243.60
Recreation trails and facilities	L3, L4	Close and rehabilitate unsanctioned trails	9	$1,528.45
Forest structure and function	L4	Implement biodiversity thinning in closed stand	10	$3,500.00

* 1 = Highest, 10 = Lowest

12.10 Kealy Woods

Kealy Woods is a small park surrounded by residential areas and a school to the west. It supports a multistoried stand of predominantly western hemlock and western redcedar.

Figure 55. Overview map: Kealy Woods (K)

12.10.1 Significant Features

- Trees of significant age (125 years).

12.10.2 Primary Concerns

Forest Health

- There are several large dead western hemlock trees.
- Numerous western hemlock show signs of crown dieback, have hemlock mistletoe or decay.
- There is a high risk of wind throw in this stand.

Fire Risk

- Accumulations of downed woody debris could pose a fire hazard.

Figure 56. Hemlock mistletoe (K1).

Figure 57. Accumulation of woody debris (K1).

12.10.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Forest structure and function	K1	Treat dead trees and fuel accumulations to reduce tree hazards and fire risk	4	$2,500.00

* 1 = Highest, 10 = Lowest

12.11 Greenwood/220A

Greenwood Park is located in the northeastern corner of the City bordered by Highway 1 to the north and residential areas to the south and west. There is one small creek and wetland. There are a number of moderately used trails running through the Park.

Figure 58. Overview map: Greenwood/220A (G/2)

12.11.1 Significant Features

- Trees of significant size and age, approximately 140 years (G11 and G12).
- Small creek with associated wetland with side channels (G6, G7).
- Rocky bluffs and crevasses providing unique habitat (G2).

12.11.2 Primary Concerns

Invasive Species

- There is English ivy present along the edges of G4 (severe), G1, G13 and 21 adjacent to residences and starting to climb trees. There are moderate levels of ivy in G5.
- Blackberry patches are present along Park edges and openings.
- Large patch of Japanese knotweed in G7.
- Significant patch of lamium (G13)
- A variety of invasive species are present at low levels throughout the Park.

Forest Health

- Hemlock mistletoe is present in low to moderate levels in G4, G5 and G6.
- Older western hemlocks have typical age related decay throughout the Park.
- G1 and G2 have scattered dead stems from out-competition in the intermediate layer.
- G6 and 21 have numerous large dead western hemlock.

Stand Regeneration

- There is a lack of regeneration in G1, G2, G4, G7, G10, G11, G13 and G14.

Hazard Trees

- Hazard tree mitigation is required in G6 and 21.

Riparian Issues

- The culvert adjacent to the road in G7 is 40% full of sediment and requires cleaning.
- There is a well-used trail running along the creek in G7, which requires rehabilitation.

Recreational Issues

- There are some small mountain bike ramps and structures in G1 and G2, significant bike structures in G4 and a Frisbee golf course in G1 and G2. As a result of human activity and low light, the understory is degraded and being prevented from healthy establishment. Very sparse understory tree regeneration.
- Erosion from poor trail drainage control in G3.

Fire Risks

- Fire pit in G8.

Other Issues

- There is a dumping site at the south end of the trail in G4 as well as behind residences in G13

Figure 59. Invasive species (G4 and G13).

Figure 60. Frisbee golf and bike jumping structures (G1 and G4).

Figure 61. Dumping of refuse and yard waste (G4 and G13).

12.11.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	G8	Remove fire pit	1	$200.00
Aquatic Systems	G7	Close and rehabilitate unsanctioned trail running to creek and clean out culvert	2	$1,034.18
Aquatic Systems	G7	Install riparian fencing along side of trail for 10 meters for either side of trail	3	$1,300.00
Degradation by human activity	G1	Rehabilitate degraded area	5	$1,705.21
Invasive Species	G1, G4, G5, G7 and 21	Remove ivy and Japanese knotweed	5	$1,518.09
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$2,462.59
Degradation by human activity	G4, G13	Remove dumped refuse and inform residents about its adverse effects	7	$550.00
Recreation trails and facilities	G3	Install ditching and culverts to control water down this trail	7	$350.00
Forest structure and function	G1, G2, G4,	Plant understory with shade tolerant conifer species	8	$7,991.73
Recreation trails and facilities	G1, G2, G4,	Close and rehabilitate unsanctioned trails	9	$2,166.75
Forest structure and function	G1, G2	Implement biodiversity thinning in closed stand	10	$3,500.00
Recreation trails	G4	Remove bike ramps	10	$500.00

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
and facilities				
Recreation trails and facilities	G1, G4, G5, G7 and 21	Remove frisbee golf course	10	$250.00

* 1 = Highest, 10 = Lowest

12.12 Tempe Heights

Tempe Heights Park is located in the northeastern portion of the City. It is border by residential areas and Highway 1 to the south. There is a cultured area to the east with tennis courts, a playground and pond.

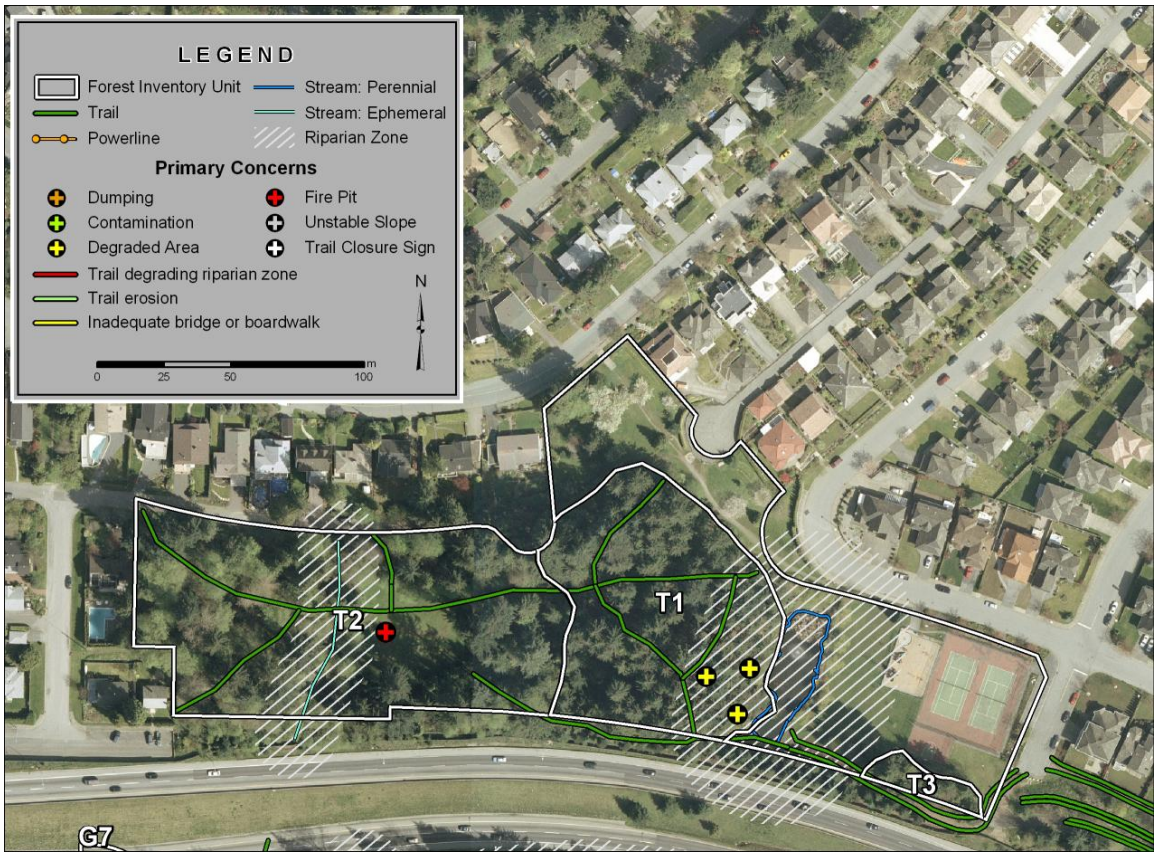

Figure 62. Overview map: Tempe Heights (T)

12.12.1 Significant Features

- Pond and riparian area

12.12.2 Primary Concerns

Invasive Species

- There is blackberry along the stand and meadow edges in T1 and T2.
- There is a moderate level of holly in T1.

- English ivy and clematis are particularly severe in T2.

Forest Health

- There are moderate amounts of hemlock mistletoe in T1.

Hazard Trees

- There are scattered hazard trees to be removed in T1.

Riparian Issues

- There are some degraded areas along the man-made pond adjacent to T1, which require rehabilitation.

Fire Risks

- There is a fire pit in the meadow in T2.

Recreational Issues

- There are numerous unsanctioned braided trails in T1.
- The understory is degraded in the southeast corner of T1 and requires rehabilitation.

Figure 63. Invasive species (T2).

Figure 64. Degraded area (T1).

12.12.3 Treatment Recommendations

Category	Polygons	Recommendations	Priority Ranking*	Estimated Cost
Degradation by human activity	T2	Remove fire pit	1	$200.00
Aquatic Systems	T1	Rehabilitate degraded area adjacent to pond	4	$541.36
Invasive Species	T2	Remove ivy and clematis	5	$643.95
Invasive Species	All Polygons	Remove other invasive species throughout park	6	$569.90
Recreation trails and facilities	T1	Close and rehabilitate unsanctioned trails	8	$406.02

* 1 = Highest, 10 = Lowest