CITY OF SURREY
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CORPORATE REPORT

NO: **R132** COUNCIL DATE: **June 7, 2010**

REGULAR COUNCIL

TO: **Mayor & Council** DATE: **June 2, 2010**

FROM: **General Manager, Planning and Development** FILE: **6440-20-2008**

SUBJECT: **Ecosystem Management Study - Update and Public Consultation**

RECOMMENDATION

The Planning and Development Department recommends that Council:

1. Receive this report for information;

2. Authorize staff to present the draft Ecosystem Management Study and mapping, as described in this report and illustrated in Appendix I, at a public open house;

3. Request staff to report back to Council on the input received through the open house and on a finalized Ecosystems Management Study; and

4. Request that a copy of this report be forwarded to the Environmental Advisory Committee as information.

INTENT

The purpose of this report is to:

- Update Council on the status of the Surrey Ecosystem Management Study (the "EMS") and the feedback received to date; and

- Obtain Council's approval to present the draft ecosystem mapping and accompanying report at a public open house for public review and comment before finalizing and then presenting the final EMS report to Council for adoption.

POLICY CONSIDERATIONS

The EMS provides an update and an enrichment of the City's environmental areas mapping as currently identified in the Official Community Plan ("OCP"). Surrey's existing Environmentally Sensitive Areas ("ESA") study was completed in 1991, and classifies (ESAs) in the City as high, medium or low based on a list of OCP policy criteria. The ESAs have been used extensively as a reference in developing NCPs and in reviewing development applications.

The EMS builds on the ESA approach, but expands the focus beyond how development affects identified ESA areas, to the perspective of a City-wide Green Infrastructure Network where all parts of the City have a role to play in the creation and enhancement of ecological processes.

Once approved by Council, the EMS mapping and related policy directions will replace the existing environmental ESA mapping and development permit area guidelines in an updated OCP. The public consultation as recommended in this report will be undertaken in late June 2010 and then concurrently with further OCP update consultation in the fall of 2010.

BACKGROUND

On March 31, 2008 Council received Corporate Report No. R053, entitled "Update of Environmental Inventory for the Official Community Plan Review", and authorized staff to proceed with the EMS. Council endorsed the approach and methodology for the update as detailed in the EMS Terms of Reference attached to that report.

On November 16, 2009 Council received Corporate Report No. R209, entitled "Ecosystem Management Study – Phase 1 Update", and directed staff to provide a presentation at a Council Shirt-Sleeve meeting on the EMS, prior to scheduling a public open house. Staff has provided such a presentation.

The first phase of the EMS, which is now complete, has been undertaken in three stages. The work has been guided by a steering committee made up of key City staff from the Planning and Development Department, Engineering Department and the Parks, Recreation & Culture Department as well as a Stakeholder Committee made up of representatives of the City's Advisory Committees and individuals from a variety of community environmental groups.

Stage I of the EMS assessed data gaps and included a needs assessment. It established the criteria and methods used for the ecosystem inventory and assessment process.

Stage II resulted in a draft set of City-wide Environmental Inventory (EI) maps including:

- Watercourses, Wetlands, Riparian areas, mapped and rated according to ecological significance;
- Vegetation Communities/Habitat Types, mapped and rated according to ecological significance;
- Steep and/or Unstable Slopes, sensitive soils and Groundwater/Aquifer areas, rated according to sensitivity to disturbance; and
- Known and potential sensitive wildlife locations, habitats, and special features.

Stage III resulted in a draft finalized set of City-wide maps at a scale of 1:25,000 showing Ecosystem Management Areas *(Hubs and Sites)* and sub-areas *(Corridors*). It identified opportunities to link hubs and sites to create a Green Network, candidate areas for ecological restoration and enhancement (shown in general form), and it included a finalized EMS report (Appendix I), including a framework for Ecosystem Management Planning and Policy Development. It recognized that all of the lands in the Agricultural Land Reserve (the "ALR") provide opportunities for wildlife movement, while recognizing agriculture as the priority use.

The work of the second phase of the EMS will result in a set of detailed management guidelines for the Ecosystem Management Areas identified in Phase I, which will be applied to the

development of the City within the context of a Green Infrastructure Network and integrate the EMS results as a key foundation in the City's on-going growth.

CONSULTATION

- Stakeholder group meetings were held on March 4, 2009 and March 23, 2009 to present draft EMS mapping materials. Stakeholders included representatives of a variety of environmental organizations and at least one member from each of the Environmental Advisory Committee, the Parks and Community Services Committee, the Development Advisory Committee, the Agricultural Advisory Committee and the Heritage Advisory Commission. Members of the Stakeholder groups are listed in Appendix II.

- On May 13, 2009 an initial public open house was held at City Hall. Members of the public were invited to review the draft Ecosystem Inventory maps, and provide input on the new Green Infrastructure approach to Ecosystem Management. Those in attendance identified incentive measures and education of the development community in correlation with a City wide and regional cooperation as key opportunities for the Green Infrastructure Network success.

- In the spring of 2009, EMS display materials where presented at four open houses in relation to the Major OCP Review. Results indicated that the public was generally pleased at the advances in mapping that have been made by the City in documenting geographic areas and their ecosystem attributes. Comments included the need for clear policy direction in relation to ecosystem protection in the new OCP and in ecosystem management strategies.

- On June 25, 2009 City staff held a workshop with the EMS consultants, as well as planners, experts and creative thinkers from the region to look at specific ways to implement strategies related to the EMS mapping. Outcomes of this brainstorming workshop have been included in an Appendix to the EMS report.

DISCUSSION

The purpose of the Ecosystem Management Study is to update the City's environmental inventory mapping and related policies, and make integrated ecosystem asset management, or Green Infrastructure planning, a pillar of land use planning in Surrey. Green infrastructure provides a critical underlying foundation to support the function and quality of communities and provides many social, economic and environmental benefits close to where people live and work while also supporting the effective functioning of ecological systems. This type of approach is rapidly gaining acclaim locally, provincially and at the national level. Surrey's EMS is providing visionary leadership within Metro Vancouver in relation to strategically planning and managing a Green Infrastructure Network of natural lands, urbanized areas, working landscapes such as the agricultural areas and other green areas within an urbanizing, City context.

In addition to focusing on how to protect significant ecosystems, the City can now use the inventory to help prioritize where to invest in managing ecosystem development and encourage the enhancement of the Green Infrastructure Network.

Green Infrastructure Network Criteria

The EMS identifies a City wide network of "hubs", "sites" and "corridors" that support the quality of communities and sustain ecological processes and their functions. Hubs and sites were identified based on their relative size and the degree of "naturalness" of the vegetation they contained, as identified below:

- "**Hubs**" consist of a contiguous area of 10 hectares or larger and moderate or high naturalness. Examples of "hubs" include large conservation areas, urban forests, regional parks and connected woodlands.

- "**Sites**" are smaller areas of less than 10 hectares and moderate or high naturalness. Examples of "sites" include City parks, remnant woodlands on private properties, riparian corridors, wooded slopes, or ravines. These areas often function as "stepping stones" between larger natural hubs. Sites that are along corridors play an especially vital role in enhancing biodiversity.

- "**Corridors**" provide the most natural route or linkage between hubs. Corridors can be in a natural or semi-natural state, or they can be potential connections that are not yet realized. Examples of existing "corridors" include riparian corridors, streams, greenways, power lines and rights of way. Potential corridors show linkages that can be assembled over time to improve the functioning of the ecosystem.

- **The Matrix** consists of the rest of the land base with varying ecological value generally found in existing urban areas. While these areas are less "natural" they can play a significant role through the provision of "engineered green infrastructure" such as drainage corridors, permeable paving, green roofs and green walls, tree preservation and tree replanting and back-yard "naturescaping" opportunities. Recognizing the role of the Matrix is a key to building a robust and healthy ecosystem.

Green Infrastructure Network Policy Framework

The EMS has revealed that high-value ecosystems are not evenly distributed across the City. They are less prevalent and less interconnected in some of the developed neighbourhoods than in other less urbanized areas. To effectively manage development in all areas of the City using the inventory results, draft Strategies for Ecosystem Management are provided in the EMS report, and include nine high level policy objectives for the Green Infrastructure Network in Surrey, which are introduced below. The order in which the policies are listed is not intended to infer any particular priority.

Proposed Strategies for Ecosystem Management in Surrey

1. Continue to develop programs and information to raise public and development industry awareness and understanding of ecosystem planning and management;

2. When developing Neighbourhood Concept Plans and development applications, work to ensure that the core areas of key remaining large natural areas (hubs) are protected in sufficient scale to be refuges of biodiversity, while having regard to economic and social priorities;

3. Give priority to the protection and/or restoration of effective aquatic and/or wildlife corridors that link hubs and sites together, so that plant and animal species are able to disperse and intermix for genetic diversity and population security;

4. Where possible, integrate smaller natural sites and neighbourhood tree canopy and "naturescape" practices into the general urban matrix;

5. Continue with City strategies that effectively manage stormwater, control sediment and erosion, promote tree cover and minimize harmful emissions, recognizing that clean water and natural stream flow regimes, clean air, and mitigation of climate change are key ingredients in supporting a Green Infrastructure Network;

6. Recognize that agricultural lands, both cultivated and fallow, make a strong contribution to biodiversity and wildlife passage in Surrey, and work co-operatively with the farm community to support this function while recognizing the key role of agricultural land in food production;

7. Provide leadership to and encourage public agencies, both City and other levels of government and utilities, to protect, enhance and restore the Green Infrastructure Network, with priority being given to establishing linkages between hubs and sites, as well as other biodiversity enhancements on their properties;

8. Incorporate protection and restoration of ecosystems and biodiversity into the planning and development processes of the City. Neighbourhood scale planning in particular should incorporate green infrastructure features as a part of any development planning or development application approval process; and

9. Explore mechanisms to facilitate a fair and equitable distribution of costs and benefits related to managing ecosystems and biodiversity in Surrey.

These high level strategies will assist in further integration of ecological systems into developing neighbourhoods and the existing community framework. A variety of conservation and enhancement values and actions will be encouraged in concert with land development, growth management, and green infrastructure planning. This can be done in a way that is complementary to the design of complete urban communities and meets the goals of the Sustainability Charter, the OCP, the Regional Growth Strategy objectives, and other City environmental policies.

SUSTAINABILITY CONSIDERATIONS

The EMS reflects the vision of the City's Sustainability Charter with regard to the Environmental Pillar's direction to demonstrate good stewardship of the terrestrial habitat, aquatic habitat, air, and the built environment, by protecting, preserving and enhancing Surrey's natural areas and ecosystems for current and future generations. In addition, the services of ecological systems and the natural capital stocks that they produce are critical to the City's long term Social and Economic well being. Ecosystem goods (such as food) and services (such as waste assimilation and air/water purification) represent just a few of the many social and economic benefits, directly or indirectly accruing to the city and its growing population from its ecosystems.

The final EMS document will be reviewed for completeness and consistency with the Sustainability Charter's vision, goals and scope items.

CONCLUSION

The current OCP approach to Environmental Management, which is based on an ESAs inventory, has been updated with new mapping using an ecosystem management approach as provided for in the attached EMS (Appendix I). It is proposed that this new, more contemporary approach form an integral part of the new OCP, based on the principles of sustainability outlined in the Sustainability Charter. The EMS will provide the basis for integrated ecosystem management, by setting high level goals, setting priorities for enhancement and restoration of ecosystems, and recognizing that all parts of the City can contribute to a functioning Green Infrastructure Network.

Based on the above discussion, it is recommended that Council:

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General Manager
Planning and Development

DL/MK/saw
Attachments:
Appendix I Report Book 1 - Ecosystem Management Study Report and
Report Book 2 –Ecosystem Management Mapping and Photos
Appendix II EMS Stakeholder Group Members

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Appendix I

Report Book 1 - Ecosystem Management Study Report
and
Report Book 2 –Ecosystem Management Mapping and Photos

(attached as separate document)

Appendix II

Ecosystem Management Study Stakeholder Group Members

Key Stakeholder Members	Organization
Ron Meadley	Semiahmoo Fish and Game Club
Peter Maarsman	Green Timbers Heritage Society
Ray Hudson	Surrey Board of Trade
Roy Strang	Sunnyside Acres Heritage Society
Phillip Milligan	Semiahmoo Fish and Game Club
Rosemary Zelinka	Surrey Sustainable Communities
Frank Canil	RESCUE
Deb Jack	Surrey Environmental Partners
David Riley	Little Campbell Watershed Society
Margaret Cuthbert	Friends of Semiahmoo Bay Society
Advisory Body Members	**Committee/Commission**
Gurpreet Rai	Parks and Community Services Committee
Al Schulze	Environmental Advisory Committee
Mani Deo	Environmental Advisory Committee
Ted Dawson	Development Advisory Commission
Avtar Johl	Development Advisory Commission
Mike Bose	Agricultural Advisory Committee
Barb Paton	Heritage Advisory Commission

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Book 1. Main Report

City of Surrey Ecosystem Management Study

November 2009

DRAFT

HB LANARC

Raincoast Applied Ecology

City of Surrey Ecosystem Management Study
FINAL Draft November 2009

1.0 INTRODUCTION

The City of Surrey has a rich natural environment composed of an interconnected network of streams, wetlands, forests, fields, and shorelines. This network includes regionally important natural areas such as Surrey Bend Regional Park and Green Timbers Urban Forest, neighbourhood scale sites such as Port Kells Park and Redwood Park, and countless forested backyards, urban parks, and agricultural fields. These features together form the "green infrastructure" that helps sustain clean water, recharge groundwater, maintain clean air, and support healthy plant, fish and wildlife communities. The green infrastructure of the City is as essential as the network of roads that allow the movement of goods and people, or the agricultural landscape that provides food and other products.

1.1 Project Purpose

This study uses a science-based approach to identify the Green Infrastructure Network in the City of Surrey. It is the first phase of broader initiative, originating from the City of Surrey's Sustainability Charter (2008), to strategically manage the ecosystems throughout the City. The results of both phases will inform the Official Community Plan update (2009–2010). The second phase of the project will identify management guidelines and strategies to maximize the health and benefits of Surrey's green infrastructure, and integrate it as a key foundation in the City's on-going success.

"Green infrastructure is the ecological framework needed for environmental, social and economic sustainability—in short it is our nation's *natural life sustaining system.*" *Benedict and McMahon, 2002:*

1.2 A New Approach: Green Infrastructure

"Green infrastructure" is a term that is rapidly gaining ground in land use planning, engineering, and site design. In general, green infrastructure is an interconnected network of natural or "green" elements that occur at a variety of scales – site/building, neighbourhood, community-wide, regional, and beyond. Similar to traditional "grey" infrastructure (roads, power, gas and other utilities, etc.), green infrastructure provides a critical underlying foundation to support the function and quality of communities and also supports the function of ecological systems. (Wilkie and Ascroft, 2009).

The concept of integrating green networks in planning is not new, but it is an approach that has not be used for environmental planning in urban areas of the lower Fraser Valley. The term "green infrastructure" was coined as a strategic move by leading practitioners to reposition green features and functions as community necessities, not community amenities (Wilkie and Ascroft, 2009). Green infrastructure also differs from conventional approaches to land use planning because it looks at conservation values and actions in concert with land development, growth management, and built infrastructure planning (Benedict and McMahon, 2002).

A Green Infrastructure assessment uses Geographic Information Systems (GIS) and the principles of landscape ecology and conservation biology to identify a connected network of natural and semi-natural lands most critical to an area's long-term ecological health. Sites can be prioritized for their relative importance within the network. The Green Infrastructure Network approach has been used successfully to identify priorities for environmental management in other jurisdictions at both large (e.g, State of Maryland, State of Florida) and small (e.g., City of Catherine, Ontario, Harlow Area, UK, Kent County, Maryland) scales.

Green infrastructure has definitions depending on the scale and context of the resource management question

Most frequently used with large spatial scales and in non-urban environments. …an interconnected network of natural elements only.

Refers mostly to functional wildlife habitat, watercourses, riparian areas and native vegetation, etc. Less natural elements may be included such as agricultural fields, recreational parks and gardens.

Focuses on low impact development techniques. for stormwater management. …a network of "green" elements to address rainwater management only.

Includes engineered green features as well as natural elements; e.g., stormwater wetlands, green roofs, bioswales, dry ponds.

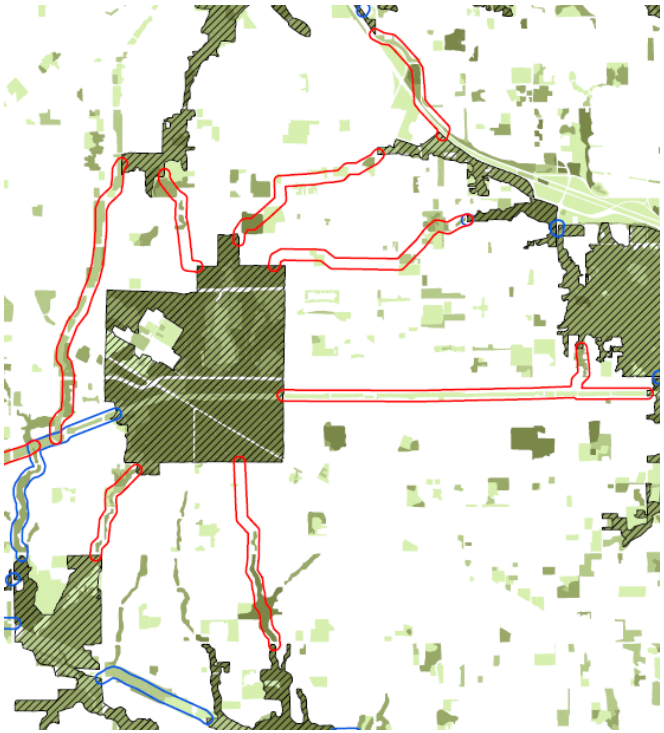
Used mostly in an urban context and the definition that captures the intent of this Ecosystem Management Strategy. … an interconnected network of natural and engineered green elements to maintain ecological function at a variety of spatial scales.

"Green" elements are not limited to land uses – they are green in terms of function and outcomes.; e.g., district energy systems, green buildings, permeable pavement, eco-industrial parks.

(adapted from Wilkie and Ascroft, 2009)

What are the higher level features of a Green Infrastructure Network?

The map below shows a mosaic of significant ecosystem features. The dark green areas have a higher measure of naturalness in terms of less human disturbance. The lighter green areas are landscape features that are mainly natural (undeveloped), but not wild – similar to agricultural areas. The red outlined areas are corridor connections that need to be restored in order to connect the existing natural landscape. The blue outlined areas are functioning corridor connections. The hatching lines indicate significant hubs of natural areas considered to be high priority environmental management areas.



1.2.1 Why Green Infrastructure in Surrey?

In the Surrey context, a Green Infrastructure Network (GIN) approach builds on traditional Environmentally Sensitive Area (ESA) identification and mapping methods. Both approaches address the need to spatially delineate important environmental and natural assets. However, unlike traditional ESA mapping, the GIN approach also emphasizes the structural relationships between natural and semi-natural areas within the landscape and their important functional role in landscape processes, such as sustaining natural flows of water, nutrients, and energy.

Key to this approach is the identification of hubs, the largest intact sites of naturally-functioning ecosystems, and corridors, which provide physical or functional linkages between hubs of similar or different ecosystem types. This approach takes into account the role of natural ecosystems as habitat and movement corridors for biodiversity and in providing clean water and air, flood protection, and slope stability.

1.3 Previous Studies

Several studies provide an important context for environmental inventory and management in Surrey. Environmentally Sensitive Area (ESA) mapping was first completed in 1990 (Abs, et al., 1991) and updated in 1997 (Coast River Environmental, 1997). The purpose of this ESA mapping was to identify features within the City that may be sensitive to human use and development. The focus of past ESA mapping has been to delineate areas that provide important habitat for biodiversity (e.g., wetlands, coastal marshes), protect significant natural features (e.g., watercourses), contain natural hazards (e.g., bluffs, ravines), or are significant heritage sites.

The 1990 and 1997 ESA studies were award winning projects at the time, and were a useful tool to assist with the review of land

development applications and to help identify priority areas for parkland acquisition. However, the mapping is in now out of date, and the ESA approach, which rated ESAs as "high", "medium" or "low", has been replaced by an "Ecosystem Management" approach guided by the City of Surrey's Sustainability Charter. The Ecosystem Management approach shares many of the components of an ESA approach, however, it focuses not just on the protection of existing priority areas, but recognizes that all parts of the City, including developed areas, can contribute to ecological sustainability.

1.4 Links to Other Initiatives

The Biodiversity Conservation Strategy Parnership completed a regional biodiversity mapping project[1] in 2006 to identify regionally-important habitats and the relative biodiversity among different habitat types (Axys, 2006). The regional mapping, while useful at a broad scale, requires more detailed mapping and ground-truthing to be useful for environmental management within the City of Surrey. Metro Vancouver's Regional Biodiversity Conservation Strategy has produced several additional reports to improve collaboration and guide biodiversity conservation in the region.

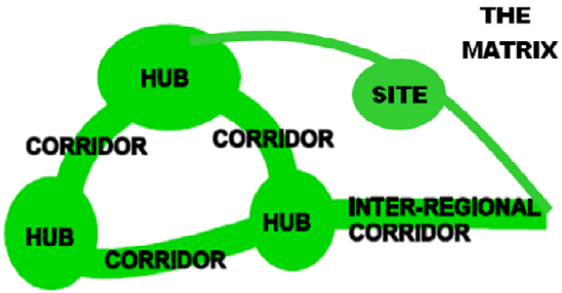
A detailed wildlife habitat mapping and status report[2] has been completed for the Township of Langley in 2005 by Langley Environmental Partners Society (LEPS). It includes detailed mapping of vegetation and habitats throughout the Township. This mapping provides an opportunity to examine linkages between the two municipalities and to examine the natural assets of Surrey within their regional context.

1.5 Fulfilling Surrey's Environmental Goals

The City of Surrey is committed to protecting and enhancing the integrity and diversity of its natural environment. Environmental goals are highlighted in the Sustainability Charter and the Official Community Plan. Other plans and bylaws such as the Surrey Storm Water Drainage Regulation and Charges Bylaw, Tree Protection Bylaw and Soil Conservation & Protection Bylaw echo the ethic to protect, preserve and nurture natural ecological process.

To help achieve this commitment this Ecosystem Management Study focuses on four main elements of Surrey's landscape.

- **Hubs** – large areas of complex ecological processes
- **Sites** – smaller sites of less complex ecological activity
- **Corridors** –pathways that offer species and ecological process connection between hubs
- **The Matrix** – the rest of the land base with varying ecological value



[1] Axys Environmental Consulting. 2006. *Assessment of Regional Biodiversity and Development of a Spatial Framework for Biodiversity Conservation in the Greater Vancouver Region.* Biodiversity Conservation Strategy Partnership, Burnaby, BC.

[2] http://www.leps.bc.ca/programs/mapping-a-inventory

2.0 METHODS

The methods for identifying a Green Infrastructure Network (GIN) for the City of Surrey involved four parts:

(1) Collection and review of existing GIS data;

(2) Mapping of natural and semi-natural vegetation communities;

(3) Delineation of the Green Infrastructure Network; and

(4) An evaluation of the relative ecological significance of hubs and corridors.

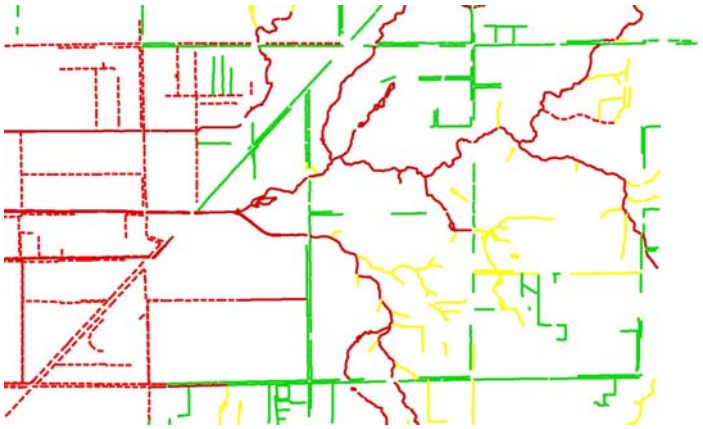
2.1 Collection and Review of Existing GIS Data

The first step in identifying Surrey's GIN was to collect and review existing GIS data. Existing spatial data on the physical (e.g., slopes and watersheds) and biological (e.g., species at risk, wildlife habitat) features was used to characterize the ecological significance of different components of the GIN. Although all available related GIS data was collected for this project, emphasis was given to consistent City-wide datasets. More site specific information, while useful, was difficult to incorporate into the city-wide assessment. Existing environmental data was available on aquatic features such as stream location and fisheries values, steep slopes, watershed boundaries, and some wildlife species including Bald Eagle nests and Great Blue Heron colonies. In general, terrestrial environmental features collected during development planning were less consistently documented and more difficult to use.

Data example: Surrey Watercourse Classification.

The City of Surrey maps watercourses and collects data on their relative value for fish populations. Watercourses range from larger rivers such as the Serpentine and Little Campbell rivers to small roadside ditches that are typically dry in the summer. Watercourses are classified according the presence or potential presence of salmon and trout, the seasonality of fish use, and their contribution of food and nutrients to downstream fish populations. The watercourse classification is used for development planning, operational activities such as emergency works, and for restoration planning. Similar mapping projects have been developed by other municipalities based on Surrey's model.

In the map below; red lines indicate year round presence or potential presence of salmonids, yellow lines indicate streams that provide food and nutrients to downstream fish and green ditches with insignificant food and nutrients.



Existing GIS data layers used for this study are listed below:

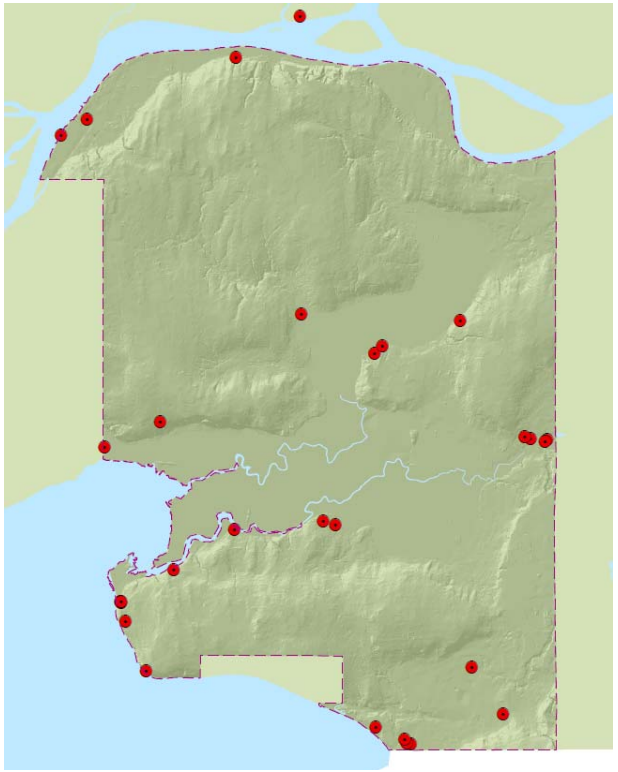
- Watershed boundaries from City of Surrey and Metro Vancouver
- Stream location and fish community classification from City of Surrey (see text box)
- Non-forested wetlands (marshes, shallow open water, etc.) from Canadian Wildlife Service
- Aquifers and groundwater recharge areas from BC Ministry of Environment
- Shoreline habitat mapping and sensitivity coding from Fraser River Estuary Management Program (FREMP) shoreline habitat mapping
- Fish presence from Fisheries Inventory Information System (DFO and MOE)
- Rare species and ecological communities from BC Conservation Data Centre
- Bald Eagle nests from City of Surrey
- Great Blue Heron nest sites (from City of Surrey, Conservation Data Centre, and BC Ministry of Environment)
- Location of raptor nests, amphibian habitats, and other wildlife from City of Surrey and unpublished datasets
- Topography (contour and digital elevation model (DEM) from City of Surrey
- Slope stability and slope failure risk from City of Surrey
- Land cover mapping (2006) from Metro Vancouver
- Cadastral mapping (lot boundaries, road edges, etc.) from City of Surrey
- Road classification and use from City of Surrey
- Land use zoning from City of Surrey

See Map 1. Aquifers, Slopes. Watersheds and Sub-watersheds and Map 2. Sensitive Species in Appendix C - Map Catalogue for a view of Surrey's background environmental setting.

Data Example: Bald Eagle Nests.

Bald Eagles are protected under the BC Wildlife Act and there is increased emphasis on protecting nest and perch trees in developing urban areas. The City of Surrey, in cooperation with the BC Nature Wildlife Tree Stewardship program, maintains a database of nest locations. This is used as a development planning tool and City staff work with landowners to protect nests and perch trees, or mitigate their loss through nest relocation and other methods. The map below should not be presumed as exhaustive and not all Bald Eagle Nests in the City are shown.

In the map below; red dots show a distribution of Bald Eagle trees along shorelines and the edges of valleys. These areas are close enough to food supplies and offer trees large enough for nesting.



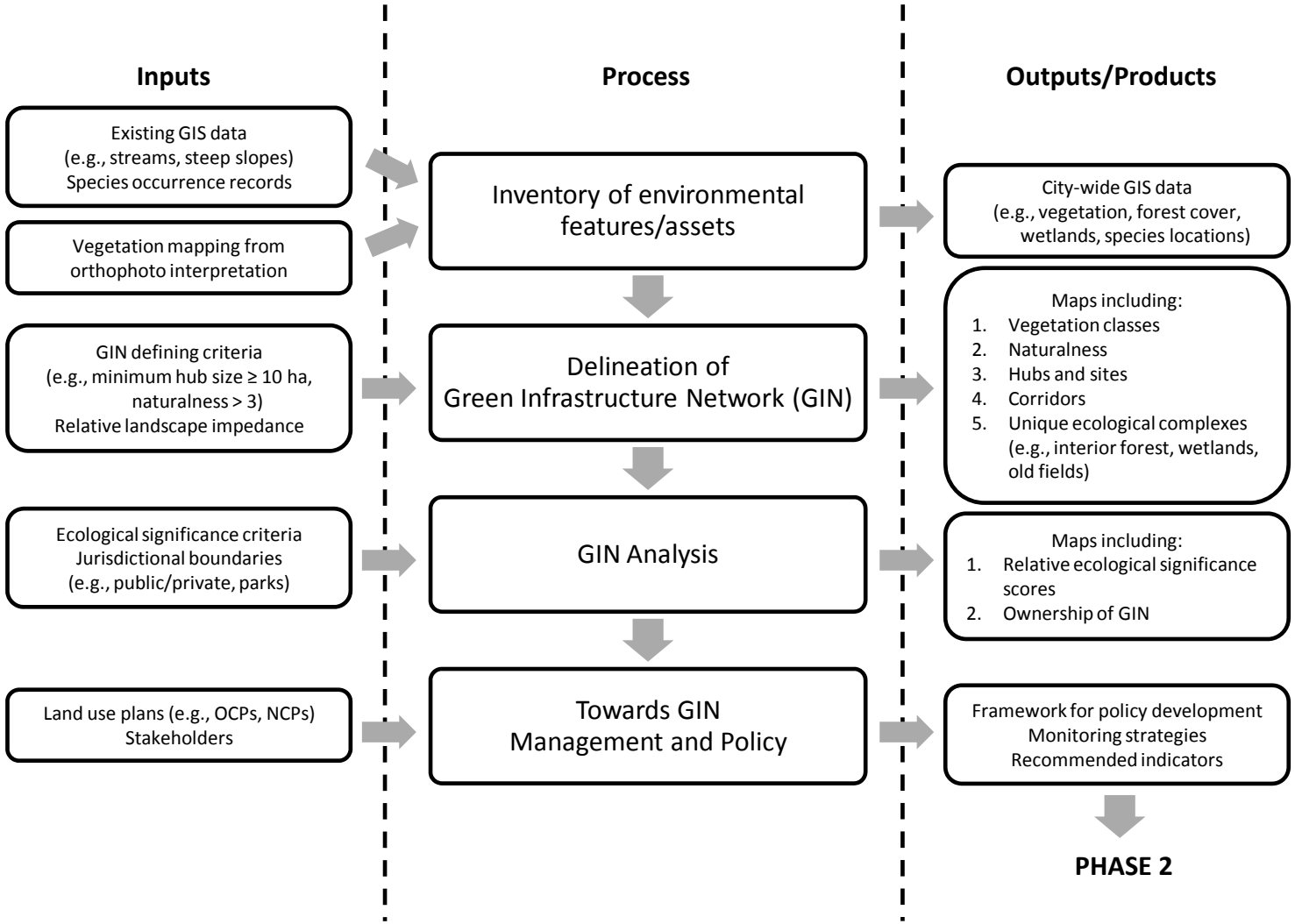


Figure 2.1. Flowchart of general methods used to the Surrey Ecosystem Management Study, including inputs and data products.

2.2 Vegetation Mapping

An important gap in the existing dataset was the lack of consistent City-wide vegetation mapping. Vegetation provides the structure which supports biodiversity and is a key indicator of ecological function. Vegetation can also be mapped consistently using the interpretation of orthophotos (rectified air photos). To fill this gap in existing data, natural and semi-natural vegetation was mapped across the entire City using orthophotos taken in April 2007. Vegetation polygon mapping was conducted in ArcView 3.2 and ArcGIS 9 at a scale of 1:4,000 with a minimum polygon size of approximately 0.1 ha.

The analysis used a modified version of the U.S. National Vegetation Classification (USNVC; The Nature Conservancy 1999) to classify all natural and semi-natural vegetation across the City. The USNVC was selected as the best standardized approach for mapping vegetation in Surrey for several reasons:

- There is no consistent, standardized approach currently being used for urban areas of the lower Fraser Valley;
- Terrestrial Ecosystem Mapping (TEM) is the most standard method in BC, but it is often too coarse for urban areas;
- The USNVC is a documented method that can be further refined to look at specific plant communities of conservation significance; and
- The USNVC is used by the BC Conservation Data Centre and NatureServe (the North American conservation data management system) and future data collected on ecological communities can be used for regional conservation planning.

Why vegetation communities as the basis for identifying hubs and sites?

- Vegetation communities have inherent value that is worth conserving. They encompass a unique set of interactions among species and contribute to important ecosystem functions. Communities can be used as surrogates for species and for ecological process. With a lack of consistent City-wide wildlife species data for Surrey and the complex nature of delineating ecological process, vegetation mapping provides an efficient, accurate and comprehensive method to delineate ecological vitality.
- By protecting vegetation communities, we protect many species not specifically targeted for conservation. This is especially important for poorly known groups such as fungi and invertebrates.
- Monitoring change over time is often most meaningful when done at the level of communities. Changes may be detected:
    - in overall species abundance, including the proportion of non-native species;
    - in structure, such as the development of old-growth characteristics; and
    - in function, such as alterations in nutrient cycling.
- Vegetation communities are an important tool for systematically characterizing the current pattern and condition of ecosystems and landscapes.

From: Maybury, K. P., editor. 1999. Seeing the Forest and the Trees: Ecological Classification for Conservation. The Nature Conservancy, Arlington, Virginia.

The USNVC classifies vegetation into a series of physiognomic (structural) classes based on vegetation type. There are seven physiognomic classes: forest, woodland, shrubland, dwarf-shrubland, herbaceous, non-vascular, and sparse vegetation (see Appendix A). However, Surrey does not contain any woodland or dwarf-shrubland vegetation. Subclasses are used to further divide the classes based on vegetation composition and characteristics, such as leaf phenology. Examples of some subclasses are:

- Forest subclasses: evergreen, deciduous, mixed evergreen-deciduous.
- Herbaceous subclasses: perennial grasslands, perennial forb vegetation, annual grass and forb vegetation, and hydromorphic rooted vegetation.

The analysis also defined some natural areas that do not have vegetation but were important to the study, such as waterbodies, mudflats, or recently cleared sites. To include these, the mapping added one additional class, unvegetated (UV), with two subclasses, unconsolidated material (UC) and water (WA). All classes and subclasses used are shown in Table 2.1.

All terrestrial areas in the City of Surrey were mapped. For coastal areas, the FREMP shoreline habitat mapping polygons were used, but the attributes were modified to correspond with the classification scheme.

Selected field review of vegetation communities was undertaken to better identify polygon boundaries and characterize dominant species in representative sites (see Appendix D for examples). As well, the boundaries and classification of many polygons were reviewed by a second project team member to ensure consistency.

See Map 3. Vegetation Inventory in Appendix C - Map Catalogue for a view of Surrey's vegetation communities.

Table 2.1. Vegetation classes (5) and subclasses (13) used in the Surrey Ecosystem Management Study.

Class	Subclasses
Forest (FO)	Evergreen Forest (FO-EV) Deciduous Forest (FO-DE) Mixed Evergreen-Deciduous Forest (FO-MX)
Shrubland (SH)	Evergreen Shrubland (SH-EV) Deciduous Shrubland (SH-DE) Mixed Evergreen-Deciduous Shrubland (SH-MX)
Herbaceous (HB)	Perennial Graminoid Vegetation (HB-GR) Annual Graminoid or Forb Vegetation (HB-AN) Hydromorphic Rooted Vegetation (HB-HY)
Sparse Vegetation (SV)	Boulder or Cobble Sparse Vegetation (SV-BO) Unconsolidated Material Sparse Vegetation (SV-UC)
Unvegetated (UV)	Unvegetated Unconsolidated Material (UV-UC) Unvegetated Water (UV-WA)

2.2.1 Vegetation Modifiers

To further characterize vegetation, modifiers and submodifiers were added to denote more specific land cover types or uses (e.g., pasture, crops, golf courses, ponds) that affect vegetation management. For forested polygons, forest age was assessed as young, mature, or old-growth. Tables 2.2 and 2.3 summarizes the range of vegetation modifiers used.

Small areas of vegetation were not mapped (e.g., one or few street trees, house lawns, and gardens) in urban or dense suburban areas where natural or semi-natural vegetation was not the dominant land cover type. While they are a part of green infrastructure in the City, mapping efforts focused on the larger areas of vegetation.

2.2.2 Vegetation Naturalness

As part of the vegetation mapping, the study assessed the naturalness of each vegetation polygon, taking into account the history and frequency of human disturbance. Naturalness is an important aspect of vegetation in urban areas because modification includes initial logging, changes to ecological disturbance processes such as reduced flooding, succession, and the establishment of non-native plants. A scale from 1 to 5 was used, where 1 was least natural and 5 was most natural. Table 2.4 provides the naturalness scale used with example habitat types.

See Map 4. Naturalness in Appendix C - Map Catalogue for a view of the range of naturalness that occurs across Surrey's vegetated landscape.

2.2.3 Regional Vegetation Mapping

To assess existing and potential regional linkages between Surrey and other neighbouring areas, the study mapped vegetation in adjacent municipalities. Wildlife habitat mapping was completed for the Township of Langley in 2005 (Township of Langley 2005). This existing vegetation data was translated to fit the GIN classification scheme. For all other adjacent municipal areas, a simplified version of vegetation mapping using fewer polygon attributes was undertaken. This larger regional vegetation layer was used in the subsequent Green Infrastructure Network delineation and analysis steps.

Photos of Representative Vegetation Classes in the City of Surrey

a

b

e

c

d

Figure 1. Photos of representative habitat classes in the City of Surrey: (a) evergreen forest near Little Campbell River; (b) hardhack shrubland in Tynehead RP; (c) old field in south Surrey; (d) sparsely vegetated shoreline at Crescent Beach; and (e) unvegetated mudflats in Boundary Bay. Photos Nick Page and Patrick Lilley 2008.

See Appendix D – Representative vegetation photos for more images.

Table 2.2. Vegetation modifiers (3) and submodifiers (19) used in Surrey Ecosystem Management Study.

Modifier	Submodifier	Modifies	Surrey Examples
Agricultural (AG)	Pasture (AG-PA)	HB-GR	Hay fields and pastures
	Old field (AG-OF)	HB-GR	Unmaintained fields with previous agricultural activity
	Seasonally flooded (AG-SF)	HB-GR	Agricultural fields with seasonal flooding
	Row Crop (AG-RC)	HB-GR, SH	Vegetable fields, blueberry fields
	Corrals (AG-CO)	SV-UC	Corrals, horse riding rings, feed lots
	Bare Ground (AG-BG)	SV-UC	Recently plowed or cleared fields with no evidence of crop
Developed (DV)	Playing Field (DV-PF)	HB-GR	Turf soccer fields
	Lawn (DV-LA)	HB-GR	Developed lawns in parks
	Old fields (DV-OF)	HB-GR	Unmaintained fields without previous agricultural activity
	Garden (DV-GA)	SH, HB	Large residential gardens, parks
	Golf Course (DV-GC)	HB-GR	Grass areas in golf courses
	Bare Ground (DV-BG)	SV-UC	Gravel road, dirt road, and similar clearings
	Road Margin (DV-RM)	HB-GR	Road medians and edges, may be sporadically maintained
	Urban Trees (DV-UT)	FO	Planted hedges, landscaping trees, forest with no natural understory
Aquatic (AQ)	Wetland (AQ-WN)	HB-HY	Freshwater wetlands: fens, marshes, swamps
	Lake/Pond (AQ-LP)	HB-HY, UV-WA	Farm and golf course ponds, natural lakes
	River/Fluvial (AQ-RF)	HB-HY, UV-WA	Larger river channels including the Fraser River
	Marine/Intertidal (AQ-MI)	NV-AL, SV-UC	Mud flats, beaches, river flats with tidal activity
	Ditches (AQ-DI)	UV-WA	Large ditches

Table 2.3. Forest age ratings (3) for Surrey Ecosystem Management Study.

Forest Age	Name	Definition	Examples
Y	Young	Typically 5 to 35 years with canopy closure; often very even in appearance	Young red alder or cottonwood stands
M	Mature	35 to 120 years old; multilayered canopy; more structural diversity	Mature second-growth coniferous, deciduous, and mixed forests
O	Old	>120 years old	Old growth forest (does not occur in Surrey)

Table 2.4. Vegetation naturalness ratings (5) for Surrey Ecosystem Management Study.

Code	Name	Definition	Examples
5	Natural	Undisturbed by direct human activity	Old-growth Forest
4	Mainly Natural	Disturbed historically (logged) by sufficient time to restore native species and structure; eg forests greater than 120 years old	Older forest, saltmarshes; some older deciduous forests
3	Semi-natural	Disturbed vegetation; predominantly native species but lacking some species and structures associated with natural vegetation	Red alder forest
2	Semi-modified	Heavily disturbed vegetation that is often a mix of native and non-native species; may be recovering or rapidly changing	Old fields; hedgerows, shrub communities on cleared sites
1	Modified	Vegetation that is regularly maintained	Crops, pasture, gardens, lawns

2.3 Delineation of the Green Infrastructure Network

The study used several GIS-based analysis methods to identify hubs and corridors. These GIS methods were supplemented with more qualitative assessments of hub boundaries and corridor integrity.

2.3.1 Hub Identification

Hubs were initially defined as contiguous areas of ecological importance at least 10 ha in size. Ten hectares was selected as the size threshold for hubs because it encompasses moderately large natural areas that can support populations of many native wildlife species, particularly if there are other natural areas nearby. Also tested were 15 ha and 20 ha criteria but they excluded some areas we considered to be important ecological features in the City.

GIS analysis was first used to identify and delineate hubs of contiguous or near-contiguous vegetation of naturalness 3 or greater at least 10 ha in size. Polygons with naturalness 3 or greater include young red alder forests, structurally-diverse old fields with shrub development, natural wetlands, and more mature forest types. Less natural communities such as pasture lands and golf courses were excluded.

Second, to the hubs that met this first criterion, the study added any adjacent areas of naturalness 2 or greater. This acknowledged that hub boundaries will likely change over time as some areas are lost to development or other activities while others areas may become more natural through succession. For example, old fields classified as naturalness 2 were added to adjacent hub areas.

Third, the study conducted a manual review of GIS-generated hub boundaries and made minor modifications to eliminate small breaks or holes such as two-lane roads or utility rights-of-way and to remove linear "arms" on hubs which are subject to substantial edge effects.

Finally, the study identified any remaining existing natural park lands and added them either to existing hubs or as new hubs, whether or not they met the 10 ha or naturalness criteria. This was done in recognition of their pre-existing and ongoing role in the Green Infrastructure Network. Blackie Spit Park and Mound

Farm Park were added to the GIN during this step. Less natural portions of the Serpentine Wildlife Area and Colebrook Park were also added to existing hubs delineated using the naturalness criteria.

What is a hub?

Hubs are the largest intact areas of natural or semi-natural vegetation and form the core components of the GIN. They are the important reservoirs of biodiversity and function as major areas for soil replenishment, water filtration, and groundwater recharge. Examples of large hubs in the City of Surrey include Surrey Bend Regional Park, Green Timbers Urban Forest, Tynehead Regional Park, the escarpment forest of north Surrey, and Colebrook Park.

In the map below hubs are shaded in dark green.

2.3.2 Sites

Sites are smaller areas of natural or semi-natural vegetation between 0.25 and 10 ha in size. They are also important to the functioning of the GIN but are too small to be considered hubs. Many neighbourhood parks have areas of forest or shrub vegetation in this size range with significant ecological value.

2.3.3 Assessing Landscape (Hub) Linkage Potential

A corridor suitability layer (Weber & Wolf 2000) was created in order to assess the linkage potential across the landscape between hubs and to identify conduits and barriers for wildlife migration and seed movement. This corridor suitability layer is a landscape assessment of relative impedance to wildlife travel. Several layers were combined in an overlay process to represent lower impedance values for natural features and higher impedance values for human made features such as roads.

The base layer of this raster layer is the mapped vegetation. To the vegetation layer, the study filled in areas not mapped during the vegetation mapping (unvegetated areas, urban areas, areas of dense suburban development) using the Metro Vancouver land cover layer from 2006 to form a single contiguous layer covering the City's entire land area. Then, the study overlaid the City of Surrey's watercourse (creeks buffered to 2 m and ditches buffered to 1 m) and roads as these have the potential to be conduits and barriers respectively, to the movement of animals and plants. As the watercourses were linear (vector-based) features, they are shown at a 1 metre width.

Once all the layers (vegetation, development, watercourses, roads) were combined through overlay, the study assigned an impedance value which measures the degree to which each landscape type inhibits wildlife use and movement. Wildlife, in this context, should be considered a hypothetical species rather than a specific small mammal, bird, or amphibian species. Selected impedance values used for each land cover type are summarized in Table 2.5.

See Map 5. Relative Impedance in Appendix C - Map Catalogue for a view of the range of impedance that influences wildlife use and movement.

Impedence values shown on Table 2.5 are intended to show relative resistance to wildlife migration. Although numerical, the values represent the qualitative judgement of the authors.

Table 2.5. Impedance Values for Surrey Ecosystem Management Study

Type	Category	Feature	Impedance Value
Vegetation	Forest	Coniferous/evergreen	50
		Deciduous or Mixed	75
	Shrubland	Evergreen, Deciduous or mixed	100
		Deciduous Shrubland	100
		Mixed Shrubland	100
	Herbaceous	Graminoid or Forb	150
		Hydromorphic Rooted	100
	Sparsely Vegetated or UnVegetated	Boulder, Cobble, Gravel, or Talus	200
Modifiers	Agriculture	Pasture	150
		Old Field/Rough Pasture	50
		Forage	200
		Row Crop	250
		Corral	300
		Bare Ground	300
	Developed	Playing Field	250
		Lawn	250
		Garden	250
		Golf Course	250
		Gravel/dirt road	300
		Road margin	150
		Urban trees	200
	Aquatic	Wetland, Lake/Pond or River/Fluvial	50
		Creeks and ditches (higher values for channels less supportive of fish life)	50 to 150

Type	Category	Feature	Impedance Value
Other veg	Forest age	Young	add 25
		Mature	add 0
		Old	substract 25
	Forest type	Riparian forest (adjacent to streams 30m)	substract 25
		Interior forest (>100 m from edge)	substract 13
	Naturalness	Natural	substract 20
		Mainly Natural	substract 10
		Semi-natural	add 0
		Altered	add 10
		Cultural	add 20
Urban Areas	Generalized land use	Residential - Rural	500
		Residential - Single Detached/Duplex	1000
		Residential - Townhouse	2500
		Residential - Low-rise Apartment	3500
		Residential - High-rise Apartment	4000
		Residential - Commercial/Mixed, Industrial and other Intensive Uses*	5000
*Note: there are added impedance values to buffers around these land uses (900 for 20m buffer, 500 for 20-50m buffer and 250 for 50-100m buffer)			
Traffic	Roads	Provincial Highway	5000
		Arterial	1000
		Major Collector	500
		Local	300
		Green	100
		Lane	200
		Margin/Lane	200
Terrain	Slopes	0-8% slope	add 0
		9-15% slope	add 2
		16-25% slope	add 5
		>25% slope	add 10

2.3.4 Corridor Identification

A detailed process was undertaken to propose optimum connections between hubs. This process involved using GIS analysis followed by detailed review to find the shortest, most natural route between hubs.

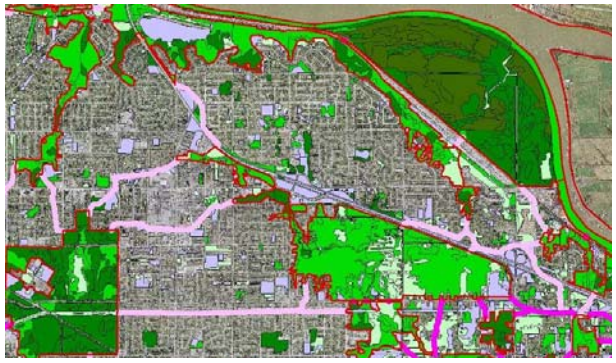
Least-cost path analysis was used to determine the best ecological routes between hubs. Least-cost path analysis is a GIS method used to assess connectivity between habitat sites by examining the condition of the intervening landscape. The analysis identifies pathways between hubs that offer the lowest cumulative resistance to movement by plant and animal species. A manual review of the GIS identified least-cost paths was conducted, leading to minor adjustments to the network to remove errors and merge or remove redundant or closely parallel paths. "Corridor study areas" were then created by buffering the least-cost paths by 50 m on each side for a total width of 100 m.

The term "corridor study area" is used to indicate that these are potential alignments for connection and can be adjusted and changed in terms of width and location to best suit the local area and opportunities.

What is a corridor?

Corridors allow for animal movement and seed dispersal between hubs and other parts of the GIN. They are linear pathways such as stream corridors, however, as Meiklejohn et al. (2009) state: "more recent definitions of corridors reflect a broadened understanding of habitat corridors, which are now described as components of the landscape that facilitate the movement of organisms and processes between areas of intact habitat. Implicit in this definition are two ideas: (1) corridors support the movement of both biotic processes (e.g. animal movement, plant propagation, genetic exchange) and abiotic processes (water, energy, materials); and (2) corridors are process- or species-specific."

In the map below corridor study areas are shaded in pink.



2.4 Network Evaluation

To evaluate the components of Surrey's Green Infrastructure Network, the study developed a scoring system that assesses the relative ecological significance of different hubs and corridors. The scoring system assigns a composite "ecological significance score" out of 100 calculated using 12 metrics that characterize the function and integrity of each hub or corridor. Metrics were chosen based on well-established landscape ecology and conservation biology principles and the availability of data. Example of metrics used in evaluating hubs and corridors include:

- Average vegetation naturalness (area-weighted)
- Number of vegetation polygons with high values of naturalness
- Presence of streams and wetlands
- Number of biodiversity features (rare species occurrences, raptor nests, amphibian habitats)

Metrics unique to hubs include:

- Size
- Area-to-perimeter ratio
- Road density

Metrics unique to corridors include:

- Average vegetation naturalness (area-weighted)
- Corridor length
- Number of hubs within a 1 km buffer
- Number of road or railway crossings

Evaluation of Sites:

The ecological significance of sites has not been calculated in depth as with hubs and corridors. Although sites are not critical components of the Green Infrastructure Network, they present opportunities to increase the success of corridors and provide neighbourhood pockets of natural ecological functioning. In these respects the value of a site can be considered higher when it:

- Is located along a corridor
- Has a higher naturalness value
- Is close to a hub

Each metric's contribution to the final score is weighted based on its importance to ecological function and integrity, relative to the other metrics. For example; factors such as average naturalness, hub size, and corridor length are of greater importance to ecological functioning than other factors, and contribute more significantly to the overall score. The full list of metrics used to calculate the ecological significance scores for hubs and corridors are found in Tables 2.6 and 2.7.

Ecological significance metrics in Tables 2.6 and 2.7, although numerical, represent the qualitative judgement of the authors for purposes of comparing alternative corridors.

Table 2.6. Metrics used to calculate ecological significance scores for hubs.

	Parameter	Range	Value
Vegetation naturalness	Area-weighted average naturalness	0–3.0 3.0–3.5 3.5–5	5 15 25
Habitat size and configuration	Size	20–40 ha 40–60 ha > 60 ha	5 15 25
	Area-to-perimeter ratio	> 0.025 0.015–0.025 < 0.015	1 3 5
	% of interior forest - 50m	0–10% 10–25% >25%	1 3 5
Habitat diversity	# of vegetation classes with naturalness ≥ 3	1 2 3 or more	0 2 4
	Presence of streams	none B or C A or A(O)	0 2 4
	Presence of wetlands	none naturalness < 3 naturalness ≥ 3	0 2 4
	Stream density	> 0.009 m/m2 0.004–0.009 m/m2 < 0.004 m/m2	0 2 4
Habitat integrity	% of habitat with naturalness < = 2	> 40% 20–40% 0–20%	1 3 5
	Road density (km roads/km^2)	> 0.03 km/km2 0.03–0.01 km/km2 < 0.01 km/km2	1 3 5
Biodiversity	# of biodiversity features (rare species occurrences, raptor nests, etc.)	none 1 2 or more	0 2 4
Total Impervious Area	% impervious cover in 100m surrounding buffer	> 50% 30–50% 20–30% 10–20% 5–10% < 5%	0 2 4 6 8 10
	ECOLOGICAL SIGNIFICANCE SCORE (GIS field - hubs_tot)	**34-96**	**out of 100**

Table 2.7. Metrics used to calculate ecological significance scores for corridors.

	Parameter	Range	Value
Vegetation naturalness	Area-weighted average naturalness	0–0.6 0.6-1.0 1.0-5	5 15 25
Habitat size and configuration	Corridor length	>40000m 1000-4000m 0-1000m	5 15 25
	# hubs within 1km buffer	> 0.025 0.015–0.025 < 0.015	1 3 5
	% of interior forest - 50m	0–10% 10–25% >25%	1 3 5
Habitat diversity	# of vegetation classes with naturalness ≥ 3	1 2 3 or more	0 2 4
	Presence of streams	none B or C A or A(O)	0 2 4
	Presence of wetlands	none naturalness < 3 naturalness ≥ 3	0 2 4
	Stream density	> 0.009 m/m2 0.004–0.009 m/m2 < 0.004 m/m2	0 2 4
Habitat integrity	% of habitat with naturalness < = 2	> 40% 20–40% 0–20%	1 3 5
	# of road or railway crossings	> 0.03 km/km2 0.03–0.01 km/km2 < 0.01 km/km2	1 3 5
Biodiversity	# of biodiversity features (rare species occurrences, raptor nests, etc.)	none 1 2 or more	0 2 4
Total Impervious Area	% impervious cover in 100m surrounding buffer	> 50% 30–50% 20–30% 10–20% 5–10% < 5%	0 2 4 6 8 10
	ECOLOGICAL SIGNIFICANCE SCORE (GIS field - hubs_tot)	**26-96**	**out of 100**

3.0 RESULTS

3.1 Vegetation Mapping

A total of 17,039 ha (53.5%) of Surrey's land area was mapped as part of the vegetation inventory. Unmapped parts of Surrey include urbanized areas where vegetation was heavily modified (e.g., backyards, road margins) or sites that were smaller than the minimum polygon size. Mapped polygons range in size from 0.001 ha to 101.3 ha with a mean polygon size of 1.734 ha. Totals and percentages of the different vegetation classes, naturalness values and unique ecological complexes are summarized below and shown in Figures 3.1 & 3.2 and Table 3.1.

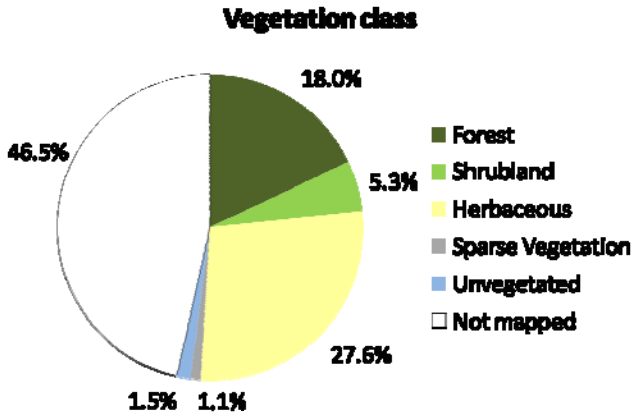
Vegetation Classes

1) Forest cover: Eighteen percent (approximately 5,700 ha) of Surrey's land area is forested: 4% evergreen or coniferous forest composed of western hemlock, Douglas-fir, and other conifer trees, 8% deciduous forest composed of red alder, black cottonwood, or big-leaf maple, and 6% mixed forest which is usually red alder and big-leaf maple mixed with coniferous trees. Of these forested areas 61% is classified as mature forest (35–120 years) years old) and 39% as young forest (5–35 years old). There are no areas of old-growth forest (>120 years old) remaining in Surrey although there are some isolated older trees. Forest cover is highest in the Guildford community (27.5%) and lowest in the City Centre community (5.3%) (Table 3.1).

2) Herbaceous cover and shrub cover: Herbaceous cover is by far the most dominant vegetation cover in Surrey and covers 27.6% of the City's land area. It encompasses fields used for pasture or forage production, turfgrass parks and playing fields, sedge marshes, and old fields with grasses and sedges intermixed with shrubs and tall forbs. Shrub vegetation accounts for another 5.3%. The dominant herbaceous cover is perennial graminoid (e.g. grasses and sedges) and the dominant shrub covers are deciduous species such as hardhack, Himalayan blackberry, or planted crops. Shrub areas are a mix of natural shrub cover and agricultural crops, predominantly blueberries.

3) Sparse vegetation or unvegetated cover: Some small areas of Surrey are only sparsely or entirely unvegetated. This includes beach and mudflat areas within the City's boundary, rocky or riprap shorelines or dykes, gravel pits, recently cleared sites, and waterbodies (lakes, ponds, etc.). Together, they constitute 2.6% of Surrey's total land area.

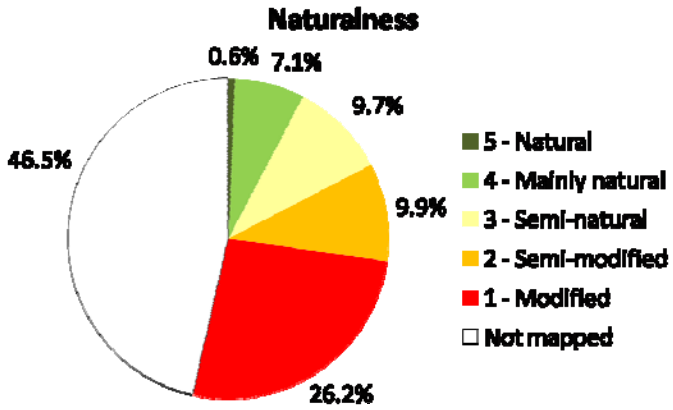
Figure 3.1. Vegetation classes (as a percentage of land area) within the City of Surrey.



Naturalness

Of the 17,039 ha of vegetation mapped in Surrey, over 8,353 ha or approximately 49% is classified with some natural characteristics (Classes 3, 4 and 5). Approximately 2254 ha (13.2%) of vegetation is classified as mainly natural (Class 4). Figure 3.2 shows the naturalness values as a proportion of Surrey's land area (including areas not mapped).

Figure 3.2. Naturalness (as a percentage of land area) within the City of Surrey.



Unique Ecological Complexes

1) Interior forest: The largest contiguous sites of interior forest (50 m from a forest edge) are in Surrey Bend and Tynehead regional parks, Sunnyside Acres Urban Forest, and in Colebrook Park along the escarpment. Large concentrations of interior forest are also found along Fraser Heights Bluffs, in Green Timbers Urban Forest, west of the Campbell Heights Industrial Park, and on the Semiahmoo First Nations Reserve. Interior forest constitutes 1,292 ha (4.1%) of Surrey's land area.

2) Wetlands: In addition to river, estuarine, and foreshore habitats, the largest concentrations of freshwater wetlands in Surrey can be found in the Serpentine Wildlife Area, as part of the Northview Golf & Country Club lakes, and ponds and along middle sections of the

Serpentine River in the agricultural lowlands in the form of seasonally-flooded fields. It is important to note that forested swamps were not mapped during the inventory because of the difficulty interpreting their extent from orthophotos. Freshwater wetlands mapped during this study constitute 697 ha (2.2%) of Surrey's land area.

3) Old fields: The largest concentrations of old field habitat are in Colebrook Park (at the base of the escarpment), north of the Serpentine River between 152 St and 168 St, along the north side of the Nicomekl River between 148 St and 160 St, and along Colebrook Rd between 184 St and 192 St. Old fields constitute 1,669 ha (5.2%) of Surrey's land area. Almost 1,131 ha (68%) of Surrey's old field habitat is found within the Agricultural Land Reserve. Old fields are an complex vegetation community to map because they change rapidly, and vary in terms of ecological value. Some old fields support monotypic reed canary grass and have limited value to wildlife, while others are structurally diverse with shrub sites, hedgerows, and native forbs.

Table 3.1. Amount of forest cover, interior forest, freshwater wetlands, and old fields by City of Surrey community.

	Forest cover		**Interior forest**		**Freshwater wetlands**		**Old fields**	
	Area (ha)	**% of land area**	**Area (ha)**	**% of land area**	**Area (ha)**	**% of land area**	**Area (ha)**	**% of land area**
City Centre	28.9 ha	5.3%	0.02 ha	0.0%	0.03 ha	0.0%	10.4 ha	1.9%
Whalley	493.4 ha	15.8%	124.4 ha	4.0%	9.3 ha	0.2%	60.1 ha	1.9%
Fleetwood	222.3 ha	12.3%	41.1 ha	2.3%	1.8 ha	0.1%	12.6 ha	0.7%
Guildford	1215.1 ha	27.5%	385.4 ha	8.7%	404.6 ha	9.2%	117.4 ha	2.7%
Newton	774.6 ha	13.2%	114.7 ha	2.0%	69.7 ha	1.2%	377.7 ha	6.4%
Cloverdale	506.6 ha	10.3%	70.5 ha	1.4%	87.0 ha	1.8%	425.2 ha	8.6%
South Surrey	2489.3 ha	21.9%	554.2 ha	4.9%	124.2 ha	1.1%	665.0 ha	5.8%
City of Surrey	**5732.7 ha**	**18.0%**	**1292.3 ha**	**4.1%**	**696.7 ha**	**2.2%**	**1668.5 ha**	**5.2%**

Of note, the distribution and quantity of ecosystem vegetation types varies by neighbourhood. For example, City Centre percentages are well below the City of Surrey average, whereas South Surrey percentages are above City averages except for freshwater wetlands.

Establishment of large scale regional and city parks have had a strong influence on the relative percentage of natural areas in Surrey neighbourhoods.

Table 3.2 Data Summary for City of Surrey Vegetation Inventory

Note: Summary includes all mapping completed within the City of Surrey land area boundary and does not include any regional mapping.

Class	Area	Percent
Forest (FO)	**5732.7 ha**	**18.0%**
Evergreen Forest (FO-EV)	1277.5 ha	4.0%
Deciduous Forest (FO-DE)	2547.7 ha	8.0%
Mixed Evergreen-Deciduous Forest (FO-MX)	1907.4 ha	6.0%
Shrubland (SH)	**1696.3 ha**	**5.3%**
Evergreen Shrubland (SH-EV)	9.1 ha	0.0%
Deciduous Shrubland (SH-DE)	1650.1 ha	5.2%
Mixed Evergreen-Deciduous Shrubland (SH-MX)	37.0 ha	0.1%
Herbaceous (HB)	**8796.7 ha**	**27.6%**
Perennial Graminoid Vegetation (HB-GR)	8359.7 ha	26.3%
Annual Graminoid or Forb Vegetation (HB-AN)	315.2 ha	1.0%
Hydromorphic Rooted Vegetation (HB-HY)	121.8 ha	0.4%
Sparse Vegetation (SV)	**341.0 ha**	**1.1%**
Boulder or Cobble Sparse Vegetation (SV-BO)	7.8 ha	0.0%
Unconsolidated Material Sparse Vegetation (SV-UC)	333.3 ha	1.0%
Unvegetated (UV)	**472.1 ha**	**1.5%**
Unvegetated Unconsolidated Material (UV-UC)	273.7 ha	0.9%
Unvegetated Water (UV-WA)	198.4 ha	0.2%
Total	17038.8 ha	53.5%

Naturalness Value	Area	Percent
1 (Cultural)	8352.6 ha	26.2%
2 (Altered)	3144.1 ha	14.4%
3 (Semi-natural)	3084.7 ha	9.7%
4 (Mainly natural)	2254.3 ha	7.1%
5 (Natural)	203.1 ha	0.6%
Not classified	14797.2 ha	42.0%

Forest Age	Area	Percent
Old Forest (O)	0.0 ha	0.0%
Mature Forest (M)	3495.6 ha	11.0%
Young Forest (Y)	2259.1 ha	7.1%

Summary Data	
Total Area of City of Surrey	31836.0 ha
Number of Mapped Polygons	9828
Total Area Mapped (ha)	17038.8 ha
Total Area Mapped (%)	53.5%
Polygon Area Range	0.001 - 101.3 ha
Mean Polygon Area	1.734 ha

3.2 Green Infrastructure Network

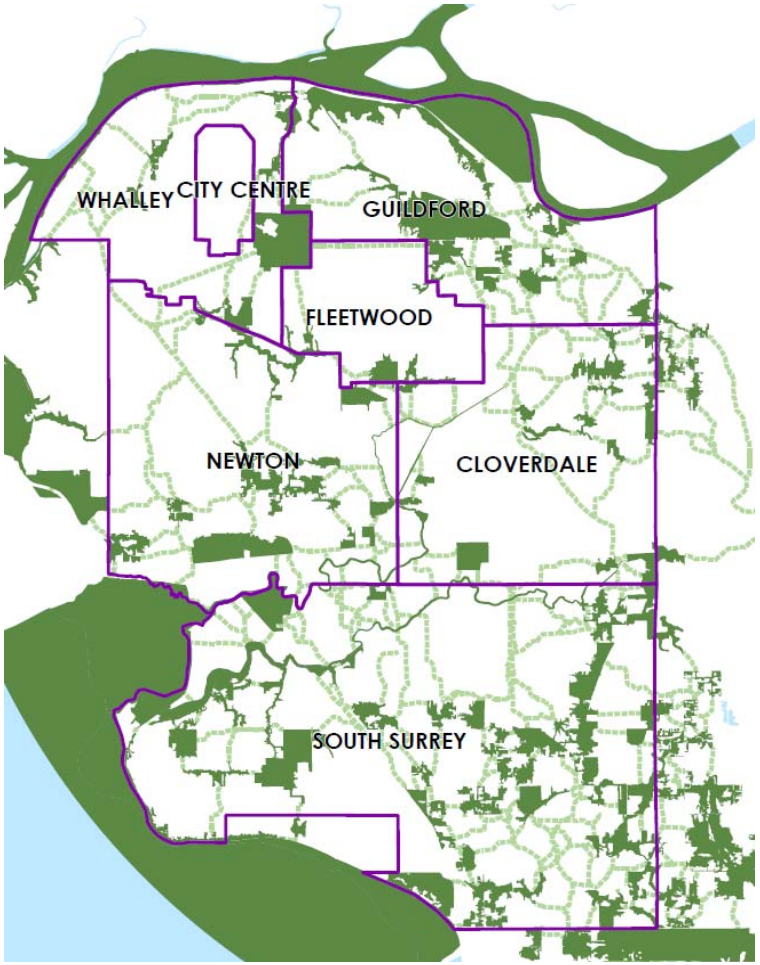
Surrey's Green Infrastructure Network is composed of hubs, sites, corridors, and the surrounding matrix of urban and agricultural lands. All are important for sustaining ecological functions and values in the City. Hubs as larger areas (>10ha) of contiguous natural landscape (semi-natural and better) that support ecological processes. Sites represent other natural areas between 0.25–10 hectares and are included as important stepping stones and neighbourhood-scale ecological pockets. Corridors delineate the connection between hubs that is critical to the long-term function of the overall network. Corridors often incorporate sites and these inter-connections further complements network success. This section describes the important characteristics and patterns of the hubs, sites, and corridors that were identified in this study.

Table 3.3. Surrey's Green Infrastructure Network Opportunities

	Hub	Site	Corridor Study Area	Matrix
Definition	Large areas of natural and semi-natural vegetation	Small areas of natural, semi-natural, and semi-modified vegetation	Linear connections between hubs, variable width when finally established	Urban and other modified areas surrounding hubs, sites, and corridors
Size	>10 ha	0.25–10 ha	100 m wide study area	n/a
Total Area	4854.3 ha	2958.1 ha	2435.8 ha	234,949.7 ha
Percentage	15.2%	3.3%	7.7%	73.8%
Number	88 hubs	852 sites	843 corridors	n/a

See Map 6. Green Infrastructure Opportunities in Appendix C - Map Catalogue for a view of ecological network opportunities within Surrey.

In the following pages components of the Network are summarized based on Surrey Communities. Please refer the map below for geographic orientation.



Hubs

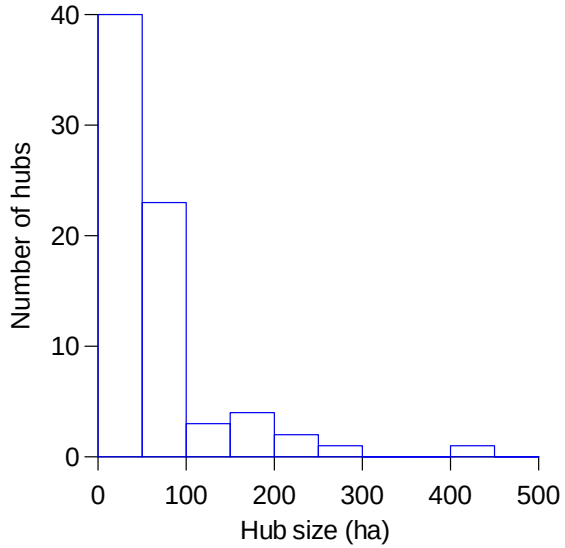
A total of 88 terrestrial hubs falling either fully or partially within Surrey's municipal boundary were identified using the hub delineation criteria. In addition, six large aquatic hubs were identified either within or immediately adjacent to Surrey. Using the regional vegetation mapping, an additional 26 regional hubs (24 terrestrial, 2 aquatic) were also delineated outside of Surrey in neighbouring jurisdictions. Though not part of summary statistics presented here, they were delineated as a means of assessing regional connectivity (see Corridors section). Some of the important details and summary statistics of the hubs identified in Surrey are:

- Hubs range in size from 10.7 ha (two forest sites on east side of Serpentine River west of Cloverdale) to over 428 ha (Surrey Bend). See Figure 3.3 for a size distribution of hubs. Only four hubs are greater than 200 ha in size. The lower boundary is determined by a 10 ha threshold for hubs.

- The five largest hubs within the City of Surrey are: Surrey Bend (428 ha), Tynehead (283 ha), Green Timbers (245 ha), Fraser Heights Bluffs (217 ha), and the Colebrook Escarpment (169 ha).

- A total of 4,854 ha (15.2%) of Surrey's land area is located within hubs.

Figure 3.3. Histogram showing distribution of hub sizes in the City of Surrey.



- The mean hub size is 55.2 ha. This is slightly smaller than the size of Bear Creek Park in Whalley (62 ha) and slightly larger than Crescent Park in South Surrey (52 ha).

- Of the seven communities that make up Surrey, South Surrey has the largest number of hubs with 43 partially or wholly within the community (Table 3.2). This is almost 50% of the hubs found in Surrey. On a per area basis, South Surrey has the largest number of hubs at 1 hub per 2.6 sq. km, closely followed by Guildford with 1

hub per 2.9 sq. km. Guildford has the largest mean hub size (103.8 ha) and contains the greatest land area falling within hubs relative to its size (27.6%). The City Centre does not contain any hubs. Fleetwood contains the next least number of hubs with four (5.8% of land area).

- Many of the large hubs are contained in City Parks. A good portion of mid-size hubs are owned by the City of Surrey or other government agencies. Most of the smaller hubs are located in areas of private ownership.

- The majority of hubs (approximately 62% in number not area – these are small to medium in size) are located on private land. Of the remaining hubs approximately 23% (in number not area) are located across ownership designations with some private, some government and some utility owned. The remaining 15% (in number) are located mostly on City, Regional and Provincial parkland. The parkland hubs are mostly large with some small to medium in size.

- Of the six large aquatic hubs identified within or bordering Surrey's land area, two fall predominantly under Surrey's jurisdiction: the lower Serpentine River and the lower Nicomekl River. Four other important regional aquatic hubs exist on Surrey's perimeter: the Fraser River foreshore, Parson's Channel foreshore (Fraser River channel near Barnston Island), Mud Bay foreshore, and the Ocean Park/Semiahmoo Bay foreshore. These hubs have both regional and global significance as habitat for migratory birds, fish, and other species.

- Ecological significance for the 88 terrestrial hubs ranged from 96 (Surrey Bend, Campbell Heights Northeast) to 34 (Douglas) (Figure 3.4). The mean ecological significance score was 60. The ecological significance score is a measure of the relative importance of the hub within the GIN based on its area, shape, overall average naturalness, presence and amount of high quality habitats (such as interior forest and wetlands), presence of species at risk , raptor nest sites, and streams, road density, surrounding land uses, and other factors.

Table 3.4. Hub statistics by Surrey community.

	Number of hubs[1]	**Total hub area[2] (ha)**	**Mean hub size[2] (ha)**	**% of land area**	**Hubs per unit area**
City Centre	0	0 ha	-	0.0%	-
Whalley	7	576.5 ha	82.4 ha	12.2%	1 hub per 4.5 sq. km
Fleetwood	4	300.0 ha	75.0 ha	5.8%	1 hub per 4.5 sq. km
Guildford	15	1557.4 ha	103.8 ha	27.6%	1 hub per 2.9 sq. km
Newton	17	805.2 ha	47.4 ha	10.6%	1 hub per 3.5 sq. km
Cloverdale	14	614.6 ha	43.9 ha	7.5%	1 hub per 3.5 sq. km
South Surrey	43	2070.4 ha	48.1 ha	16.9%	1 hub per 2.6 sq. km
City of Surrey	**88**	**4854.3 ha**	**55.2 ha**	**15.2%**	**1 hub per 3.6 sq. km**

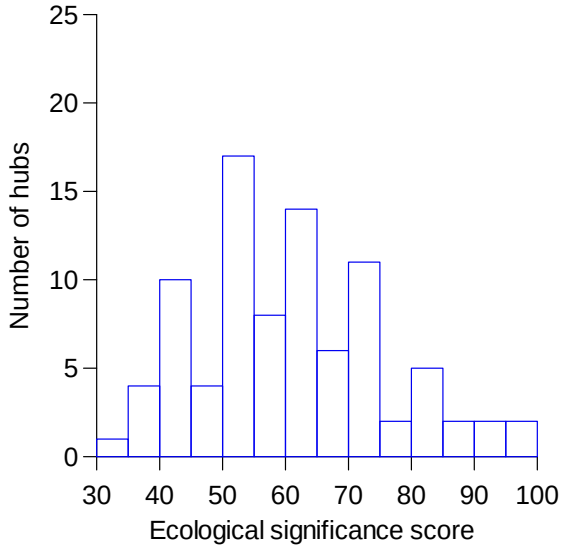
[1]*Hubs that lie across communities boundaries were included in each community total.*

[2]*For hubs that lie across community boundaries, the area of the entire hub were included in the total hub area and mean hub size calculations.*

- The six hubs with the highest ecological significance are: Surrey Bend (96), Campbell Heights Northeast (96; east of the Campbell Heights Industrial Park), Kensington North (90), Campbell Heights West (90; west of the Campbell Heights Industrial Park), Armstrong (86) and the Crescent Park area (86).

See Map 7. Ecological Significance of Hubs in Appendix C - Map Catalogue for a view of the range of ecological vitality found in Surrey's hubs.

Figure 3.4. Histogram showing distribution of the ecological significance scores for hubs in the City of Surrey.



3.4 Sites

A total of 852 terrestrial sites exist within Surrey's municipal boundary. These sites are any contiguous vegetative polygon that has a naturalness value of 3 or greater (semi-natural, mainly natural, and natural). Some of the important details and summary statistics of the sites identified in Surrey are:

- Sites can be smaller than 0.25 ha (small pieces of vegetation along a roadside) to around 10 ha (forest stands in a neighbourhood park). See Figure 3.5 for a size distribution of sites. The majority of sites are less than a hectare and number of sites decreases as the sites area increases.
- 22% of the sites are owned and managed by the City of Surrey and 18% of these exist in dedicated parks.
- 27% of all sites are found along corridors. These sites offer great opportunity as stepping stones for connectivity.

Figure 3.5. Histogram showing distribution of the size of Sites in the City of Surrey.

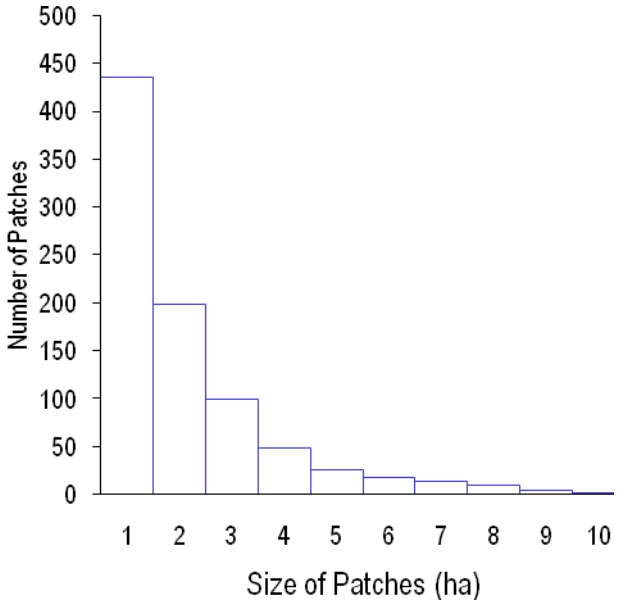


Table 3.5. Site statistics by Surrey community.

	Number of Sites[1]	Total site area[2] (ha)	Mean site size[2] (ha)	% of land area	Sites per unit area
City Centre	18	78.0 ha	1.0	3.3%	1 hub per ha
Whalley	85	3130.5 ha	1.7	5.7%	1.7 hub per ha
Fleetwood	47	86.1 ha	1.8	4.8%	1.8 hub per ha
Guildford	116	176.8 ha	1.5	4.0%	1.5 hub per ha
Newton	226	281.7 ha	1.3	4.8%	1.3 hub per ha
Cloverdale	76	128.3 ha	1.7	2.6%	1.7 hub per ha
South Surrey	296	488.0 ha	1.7	4.3%	1.7 hub per ha
City of Surrey	**852**	**1320.8 ha**	**1.5**	**4.1%**	**1.5 hub per ha**

[1]*Sites that lie across communities boundaries were included in each community total.*

[2]*For sites that lie across community boundaries, the area of each separate potion of the site was included in the total site area and mean site size calculations.*

See Map 8. Sites inside and outside of Corridors in Appendix C - Map Catalogue for a view of sites that offer a stepping stone opportunity for hub connection.

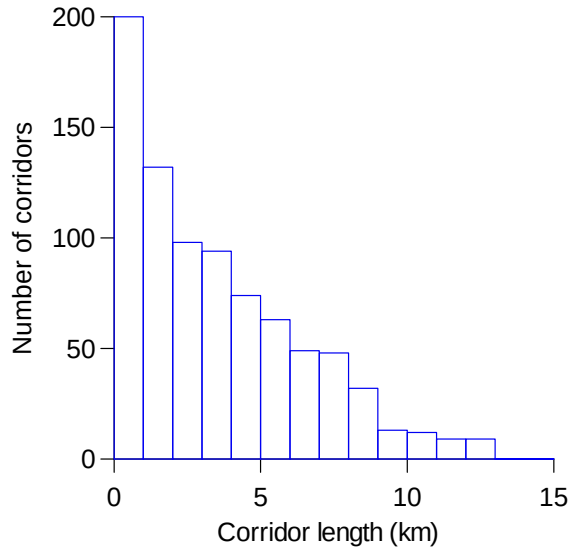
Corridor Study Areas

A total of 917 potential corridors connecting adjacent or near-adjacent hubs were identified. 843 of these corridors lie within Surrey's land area while the rest are with neighbouring municipalities or the US. This includes corridors connecting adjacent hubs within Surrey as well as connections to other regional hubs. The following points summarize some of the key attributes of the corridor network:

- Corridors range in length from 7.5 m (connecting the Campbell Heights Northeast hub to the Fernridge Northwest hub across 196 St, south of 28 Ave) to 12.8 km (connecting Tynehead Park to Port Kells Park via the Serpentine River lowlands). Longer corridors are generally more difficult for animals and plants to move through.

- The mean corridor length for all identified potential corridors is 3.2 km. This is approximately the straight-line distance from Sunnyside Acres Urban Forest to the shoreline of Mud Bay.

Figure 3.5. Histogram showing distribution of corridor lengths in the City of Surrey.



- A total of 2435.8 ha (7.7%) of Surrey's land area falls within one or more corridor study areas – this area calculation will be modified by the determination of corridor widths at more detailed planning levels.
- Of the seven communities that make up Surrey, South Surrey has the highest density of corridor study areas, both on a length per area basis and on an area per area basis (Table 3.3).

Table 3.6. Corridor Study Area statistics by Surrey community.

	Number of corridors[1]	**Total corridor length[2] (km)**	**Total corridor study area[2] (ha)**	**% of land area**	**Length of corridors per unit area (km/km²)**
City Centre	2	1.7 km	17.0 ha	3.1%	3.1
Whalley	35	23.3 km	227.9 ha	7.3%	7.4
Fleetwood	12	6.2 km	62.7 ha	3.5%	3.4
Guildford	248	32.8 km	295.4 ha	6.7%	7.4
Newton	121	48.3 km	443.1 ha	7.5%	8.2
Cloverdale	249	42.7 km	392.7 ha	8.0%	8.7
South Surrey	415	110.1 km	995.1 ha	8.7%	9.7
City of Surrey	**843**	**259.6 km**	**2435.8 ha**	**7.7%**	**6.7**

[1]*Corridors that lie across communities boundaries were included in each community total.*

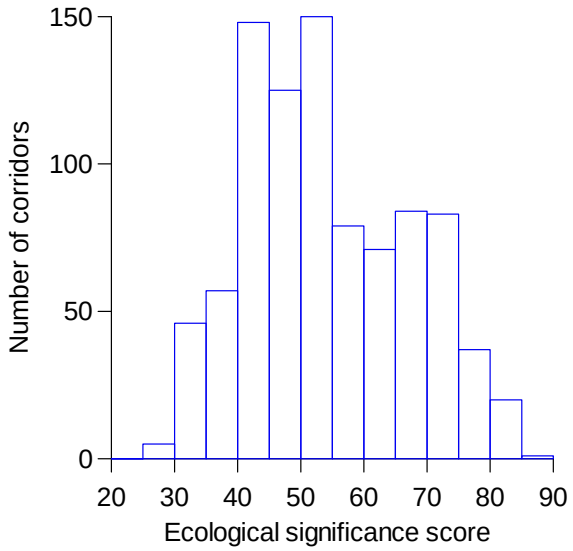
[2]*Final corridor area will be based on variable widths determined during detailed planning. For corridors that overlap, the overlapping length and area was only counted once in the total corridor length and area calculations.*

- Ecological significance for the corridors range from 26 to 86. The mean ecological significance score is 53.6. The ecological significance score is a measure of the relative functioning of the corridor within the green infrastructure network based on its length, overall average naturalness, habitat diversity, proximity to hubs, presence and amount of high quality habitats (such as interior forest and wetlands), presence of species at risk, raptor nest sites, and streams, number of road or railway crossings, and other factors.

- The five highest ranked corridors are: (1) the corridor connecting Campbell Heights Northeast to Campbell Heights Southeast along 196 St; (2) the corridor connecting the east and west portions of the Campbell Heights Northeast hub; (3) the corridor connecting Elgin Heritage Park, Chantrell Creek, and Nicomekl Bluff; (4) the corridor connecting Tynehead Regional Park to Bothwell Park across 96 Ave; and (5) a corridor connecting portions of the Armstrong hub near 186 St and 44 Ave. All five of these corridors have an ecological significance score greater than or equal to 80.

See Map 9. Ecological Significance of Corridors in Appendix C - Map Catalogue for a view of the range of ecological vitality found within Surrey's corridors.

Figure 3.6. Histogram showing distribution of the ecological significance scores for corridors in the City of Surrey



4.0 Conclusions: Ecosystem Management Strategy

Surrey's environmental goals as identified in the Sustainability Charter and Official Community Plan demonstrate good stewardship of the land, water, air and built environment, protecting, preserving and enhancing Surrey's natural areas and ecosystems for current and future generations while making nature accessible for all to enjoy.

An Ecosystem Services approach expands the focus beyond how development affects the environment to include how development depends on ecosystems and a city wide green infrastructure network. In addition to focusing on how to protect significant ecosystems, the City can prioritize how and where to invest in managing ecosystem development and enhancement of the **Green Infrastructure Network** (GIN).

The ecological inventory in Table 3.6 reveals that high-value ecosystems are not evenly distributed across the City. They are less prevalent and less interconnected in some of the developed neighbourhoods of the City than in other more rural areas.

Planning and implementation of future development will need greater effort to integrate ecological systems into neighbourhoods, along with an assessment of conservation values and enhancement priorities in concert with land development, growth management, and infrastructure planning. This should be done in a way that is complementary to the design of leading urban communities that meet the goals in the Sustainability Charter, the Official Community Plan and other city environmental policies.

4.1 Framework for Implementing Ecosystem Management in Surrey

Phase Two of the Ecosystem Management Study will develop a strategy and guidelines for ecosystem management in Surrey that adopts the premise that *all parts of the city matrix can contribute, in varying degrees, to the creation of a GIN comprised of a network of ecological hubs, sites and linking corridors.* To create a framework that will assist Surrey in achieving the GIN, draft strategies and policy topics are introduced below. The order of the policies does not infer any priority.

4.2 Proposed Strategies for Ecosystem Management in Surrey

1. Continue to develop programs and information to raise public and development community awareness and understanding of ecosystem planning and management.
2. When considering Neighbourhood Concept Plans and development applications, work to ensure that the core areas of key remaining large natural areas (hubs) are protected in sufficient scale to be refuges of biodiversity, while having regard to economic and social priorities.
3. Give priority to the protection and/or restoration of effective aquatic and/or wildlife corridors that link hubs and sites together, so that plant and animal species are able to disperse and intermix for genetic diversity and population security.
4. Where possible, integrate smaller natural sites and neighbourhood tree canopy and 'naturescape' practices into the general urban matrix.
5. Continue with City strategies that effectively manage stormwater, control sediment and erosion, promote tree

cover and minimize harmful emissions - recognizing that clean water and natural stream flow regimes, clean air, and mitigation of climate change are key ingredients to support a GIN.

6. Recognize that Agricultural Lands, both cultivated and fallow, make a strong contribution to biodiversity and wildlife passage in Surrey, and work co-operatively with the farm community to support this function while recognizing the key role of agricultural land in food production.
7. Provide leadership to and encourage public agencies, both City and other levels of government and utilities, to protect, enhance and restore the GIN, with priority given to establishing linkages between hubs and sites, as well as other biodiversity enhancements on their properties.
8. Incorporate protection and restoration of ecosystems and biodiversity into the planning and development processes of the City. Neighbourhood scale planning in particular should incorporate green infrastructure features as a part of any development planning or development application process.
9. Explore mechanisms to facilitate a fair and equitable distribution of costs and benefits of managing ecosystems and biodiversity in Surrey.

4.3 Policy and Guideline Topics

The above Strategies will be implemented through policies and guidelines that need to be completed for the following topics:

1. ***Public Information:*** Continue to develop programs and information to raise public and development community awareness and understanding of ecosystem planning and management and the protection, restoration and enhancement of a green infrastructure based on a network of hubs, sites and linking corridors in Surrey.
    a. Develop brochure, web and other materials to communicate the importance of and promote a green infrastructure in Surrey as the City undergoes on-going development.
    b. Target and customize communication materials to key audiences – homeowners, landowners/developers, utility and transportation corridor managers, city staff and consultants.
    c. Create a toolkit of neighbourhood plan and individual parcel solutions in support of a green infrastructure including typical solutions to typical issues such as corridor widths, corridor restoration, hub boundary determination and interface with adjacent land uses, as well as 'naturescape' and street tree canopy approaches that promote biodiversity.
    d. Promote dialogue about ecosystem management among the environmental, agriculture, infrastructure, recreation, design and development organizations active in Surrey.

2. ***GIN Hubs:*** Set as a priority, the protection of key remaining large natural areas (hubs) so that their cores are protected in sufficient scale to be refuges of biodiversity, at the same time recognizing the economic and social needs of development.
    a. Map 6 shows 8 aquatic hubs in Surrey, and these and other stream areas are under various levels of protection. Map 6 also shows 88 opportunities for terrestrial hubs within the City. These relatively large areas with high 'naturalness' are key assets for upland biodiversity. In areas where urban development is permitted adjacent to hubs, the final boundary of the urban development and the hub 'core' should be planned in tandem during the neighbourhood or development planning process.
    b. Defining the 'minimum core' of upland hubs to be retained should continue to be informed by detailed biological studies prior to development planning decisions. In general hub cores that are round and as large as practical are preferred, so that interior habitats are preserved. Streams, wetland areas, and habitats of any threatened or endangered species, and access to both refuge cover and food supply for existing or desired species are features which should be protected.
    c. Where hubs currently exist in close proximity to one another, neighbourhood planning studies informed by detailed biological assessments may determine what configuration of 'core hubs' and 'corridors' are effective at protecting biodiversity while allowing a compatible development in adjacent lands. In such considerations, priority should be given to protecting hubs of higher ecological significance as shown in Map 7.
    d. Map 6 also shows many 'sites' which are smaller areas of natural vegetation with ecosystem values. These sites may be linked or combined with 'hub' areas or corridors to accommodate both biodiversity and adjacent urban development. In other cases, green infrastructure network 'sites' may be traded off for higher density development and protection of a larger 'core' hub.
    e. Public appreciation of the natural values and biodiversity in hubs is important to successful management. Trails, utilities and other access to hubs, however, should be planned in ways that limit disturbance to the species resident in the hub. Trails may be restricted to adjacent lands or outer limits, so that the core is undisturbed.
    f. Agricultural lands -in wildlife terms - are functioning as both a hub and a large corridor – supporting wildlife populations and allowing relatively free movement - which allows wildlife to adapt to agriculture practices and co-exist with active farming. Restricted public access to private agricultural land also provides a refuge for wildlife. Co-operation with the agriculture community to respect and maintain these values is warranted.

3. ***GIN Corridors:*** Protect or restore effective aquatic and/or wildlife corridors that link hubs together, so that species are able to disperse and intermix for genetic diversity and population security.
    a. Map 6 shows opportunities for 'corridors' to connect hubs and sites. These connections are critical to allow species to disperse to new habitats, to avoid inbreeding and lack of genetic diversity, and to provide escape from predation or disease. At least one effective corridor should be provided between each hub. Provision of a second or redundant corridor connection reduces risks to biodiversity. Where choices on which corridor or priority must be made, preference should be given to protecting or restoring continuity of the corridor with higher ecological significance as shown on Map 9.
    b. Utility corridors fill an important role in the development of a network of corridors. Guidelines are required for the management of these corridors while still respecting the utility maintenance function, land ownership and neighbourhood context. In developing areas of the City and in the neighbourhood planning process, continuous corridors between hubs should be planned. While looking for a reasonably direct route between hubs, corridors will likely follow existing watercourse and riparian areas, steep slopes, floodplains and wetlands, wooded sites, and other areas that are constrained to development wherever possible.
    c. Width of corridors will vary and should be determined based on detailed biological studies of the species that are or could use the habitat provided by the linked hubs and the corridor. Wider corridors are preferable with guidelines that reflect this variable width objective but that also set minimums are needed. Corridors in the ALR show only 'conceptual wildlife routes' and are not intended to restrict agricultural practices, in the knowledge that there are a myriad of wildlife connections possible in the agricultural areas. Guidelines for co-operation with the agricultural community which respect the primary agricultural activities are needed.
    d. Barriers to species movement such as road crossings should be minimized in the wildlife corridors. Where roads or other barriers are being constructed or rebuilt, provision for ease of passage of the fish or wildlife species that the corridor serves should be provided. Guidelines for the maintenance and restoration of various corridor types should be developed.

4. ***GIN Sites and the Urban Matrix:*** Integrate smaller natural sites and neighbourhood tree canopy and 'naturescape' practices into the general urban matrix, to complement the core hubs and corridors.
    a. Surrey' green infrastructure must go beyond the hubs and corridors shown in Map 6. Many species such as songbirds, butterflies, bees and amphibians are compatible and popular in urban areas. Smaller natural sites, street trees, green roofs and walls, private tree cover in backyard habitat and naturescaping adds much to the amenity and liveability of the urban area. In keeping with the Sustainability Charter, Surrey maintains the objective of a lush tree and vegetation cover across the City, focused on the values of plantings in the urban and suburban areas.
    b. In some cases, continuous corridors will only be achieved through the development and redevelopment process, as land is dedicated or otherwise acquired for these purposes. Tree and naturescape cover can provide 'stepping stones' that facilitate some wildlife passage in the meantime.

5. ***Existing City Programs:*** Clean water and natural stream flow regimes, clean air, and mitigation of climate change are key ingredients to support biodiversity. The City should continue with strategies that manage stormwater, sediment and erosion control, tree cover and that minimize harmful emissions.
    a. Planning for hubs, corridors and urban habitat should be co-ordinated with existing and evolving City programs on stormwater management, sediment and erosion control, tree protection and replacement, and management of greenhouse gases and other pollutants, to maximize relationships and related policy or practice improvements to respect green infrastructure values.

6. ***Agricultural Lands:*** Recognize that agricultural land, both cultivated and fallow, is making a strong contribution to biodiversity and wildlife passage in Surrey, and work co-operatively with the farm community to support this function.
    a. Whereas agricultural management often is supportive of wildlife, road and utility development crossing the agricultural areas may introduce barriers to wildlife. The City should use its transportation /engineering and advocacy functions to promote wildlife passage through any necessary road / utility extensions across agriculture.
    b. The City should continue its work with the Agricultural Advisory Committee to promote agriculture success in Surrey, and co-operatively resolve conflicts.

7. ***Public and Utility Lands:*** Provide leadership to public agencies, other levels of government and utilities, to protect and restore the identified green infrastructure network and other enhancements on their properties.
    a. Map 10 illustrates the general pattern of land ownership under the Green Infrastructure Network opportunities. Many of the hubs, sites and corridors are Parkland under City, Regional or Provincial jurisdiction. Others belong to the City or institutions for other uses, such as education, health or civic facilities. The City should use both its own land management processes as well as its land use/design influence to build biodiversity into development and management actions for these locations.
    b. As a priority, the City should lead by example in incorporating green infrastructure and ecosystem management measures into its own properties.

8. ***Land Use Planning and Development:*** Incorporate protection and restoration of the GIN into the planning and development processes of the City. Neighbourhood scale planning in particular should incorporate biodiversity features.
    a. Surrey is a rapidly growing community, and if it is to be a model of ecosystem management, it must provide for urban growth in ways that do not reduce the City's environmental sustainability. This must be done on private land that is being developed as well as on public lands. The communication products listed under Strategy 1 will be important to inform about the possibilities.
    b. Map 10 shows private lands that have opportunities for the Green Infrastructure Network. The majority of these private lands are in relatively undeveloped areas of the City. Most will be subject to Neighbourhood Concept Plan or similar plan processes that define the pattern of land use, transportation, parks, greenways and other linkages. It is at this neighbourhood planning scale that the boundaries of hubs, sites and corridors are defined.
    c. The city should continue to require detailed biological studies at the time of neighbourhood planning to determine what species and ecosystem values exist in the study area, how they are distributed, and the key ecological functions that need to be protected. Defining the

boundaries of hubs and corridors should be done simultaneously with planning for land use, densities, transportation, utility and trail alignments. etc. The objective is to find the optimum arrangement of places for all the elements that make up a complete community, included places for nature and biodiversity both within protected hubs and corridors, and where appropriate throughout the neighbourhood.

d. Map 10 shows corridors that are impaired, and are targets for habitat restoration efforts. In some cases it may be defensible to provide some 'site' or 'hub' extremity for development in exchange for intensive restoration efforts on an impaired corridor if that would create a net gain in habitat value overall.
e. A standardization of biological data collection and reporting is advisable to provide a growing information base for ecological management in Surrey. The City should develop Guidelines for data collection and reporting standards.
f. Monitoring of key biological indicators is also required, both for conserved natural areas and for restoration areas, to provide reporting on successes, failures, and related adjustments to the planning and implementation of future projects.

9. ***Equitability:*** Explore mechanism to facilitate a fair and equitable distribution of costs and benefits of managing ecosystems and biodiversity in Surrey.
    a. The city should maximize Green Infrastructure opportunities through the planning and development review process in order to find the balance that would allow development while maintaining ecological function.
    b. In many cases, private lands that are core to the Green Infrastructure Opportunities (Map 6 and 10) will be candidates for dedication as park or greenway at the time of development. In these cases the 'normal' development approval process would apply, with the addition of detailed biological assessments at the time of land use and subdivision planning.
    c. The City should continue to consider the values of a green infrastructure network when making decisions on park acquisition and distribution.
    d. Mechanisms such as density bonus or the transfer or clustering of density, zoning amenity contributions, restrictive covenants, statutory rights-of-way and other tools should be researched and utilized to achieve the integration of green infrastructure values into the planning and development of the City.
    e. Monitor regional, provincial, and federal government and NGOs for grants or programs that would provide support for the Surrey Ecosystem Management effort.

4.4 Opportunities for GIN Protection and Restoration

Continued ecological functioning of the existing Green Infrastructure Network (GIN) depends not only on the long-term protection of key elements from loss or degradation, but also restoration and enhancement to improve the functioning of the GIN. To maximize the effectiveness of protection and restoration efforts, it is recommended that City efforts focus on two general priority areas:

1. growth of the GIN (adding protected areas).
2. restoration and enhancement of GIN elements.

4.4.1 Priorities for Growth of the Green Infrastructure Network

High priority hubs: Map 7 (see Book 2) identifies the relative ecological significance of hubs in the proposed GIN. Ecological significance is an indicator of the importance of the hub as a refuge for biodiversity and habitat, and for sustaining the GIN's ecological function.
It is recommended that hubs with less than 50% protection be considered as high priorities for future acquisition or some other form of protection such as a development permit area designation, a conservation easement agreement, or private land stewardship.

High priority corridors: Map 9 (see Book 2) identifies the relative ecological significance of corridors in the proposed GIN. Ecological significance is an indicator of the importance of the corridor for sustaining the GIN's ecological function.
It is recommended that corridors with less than 50% protection be considered as high priorities for future acquisition or some other form of protection such as a development permit area designation, a conservation easement agreement, or private land stewardship.

4.4.2 Priorities for Restoration and Enhancement

There may be hubs and corridors that are well protected but in which restoration and enhancement activities would improve their ecological functioning as part of the GIN. It is recommended that priorities for restoration and enhancement be placed on hubs and corridors that are already under some form of protection but which are not functioning to their full potential due to low naturalness, fragmentation, degraded imperviousness, significant barriers or other factors.
Opportunities for restoration or enhancement within Surrey's GIN can be considered to fall into six general categories:

a) Riparian habitat enhancement: Riparian areas serve highly important ecological functions, ranging from water purification and erosion protection to habitat for fish and wildlife. Riparian corridors represent good candidate areas for restoration. Some riparian areas remain degraded from past land clearing activities.

b) Urban parkland reforestation: Many municipal parks contain areas that could be reforested to enhance ecological value, as well as store carbon and contribute to rainwater management. Developed parks within or adjacent to high priority hubs and corridors could be replanted with native trees and managed to improve structural diversity and species diversity.

c) Road crossing improvements: Road crossings and associated infrastructure, such as sidewalks, ditches, concrete barriers, and fencing, can act as major barriers to wildlife movement. Both small (e.g., fencing improvements, narrowed roadways, vegetated road medians) and large improvements such as underpasses or replacing culverts with bridges can improve passage of wildlife.

d) Foreshore and wetland function restoration: Surrey's foreshore areas and floodplains are significant interfaces between the terrestrial and aquatic environments. In many areas, dykes have altered hydrologic functioning critical to maintaining rare and important habitats, such as salt marsh along foreshore areas and freshwater wetlands (marshes and swamps) in river floodplain areas. Land development has occurred up to the back of the dyke, leaving little adjacent transition habitats. Even within small areas, dykes can be altered and vegetation can be improved to restore natural hydrologic function while not compromising flood protection.

e) Revegetating utility-rights-of-way: In urban areas, options for establishing corridors are generally limited. Utility corridors offer important linear connections between hubs and sites in these areas. Surrey has many large utility rights-of-way. Although often used as trail corridors for recreational use, these rights-of-way can also be enhanced for wildlife and other ecological values. However, enhancements must be suited to existing uses. For example, corridors with overhead powerlines are ideal locations to manage for old field habitat, rather than reestablishing tree cover.

f) Enhancing urban backyard habitats: Some urban areas of Surrey have limited opportunities for establishing dedicated corridors for wildlife movement. However, in key areas, it may be possible to work with private landowners to encourage the creation of backyard wildlife habitat to act as stepping stone for the movement of some components of wildlife (e.g., songbirds, butterflies).

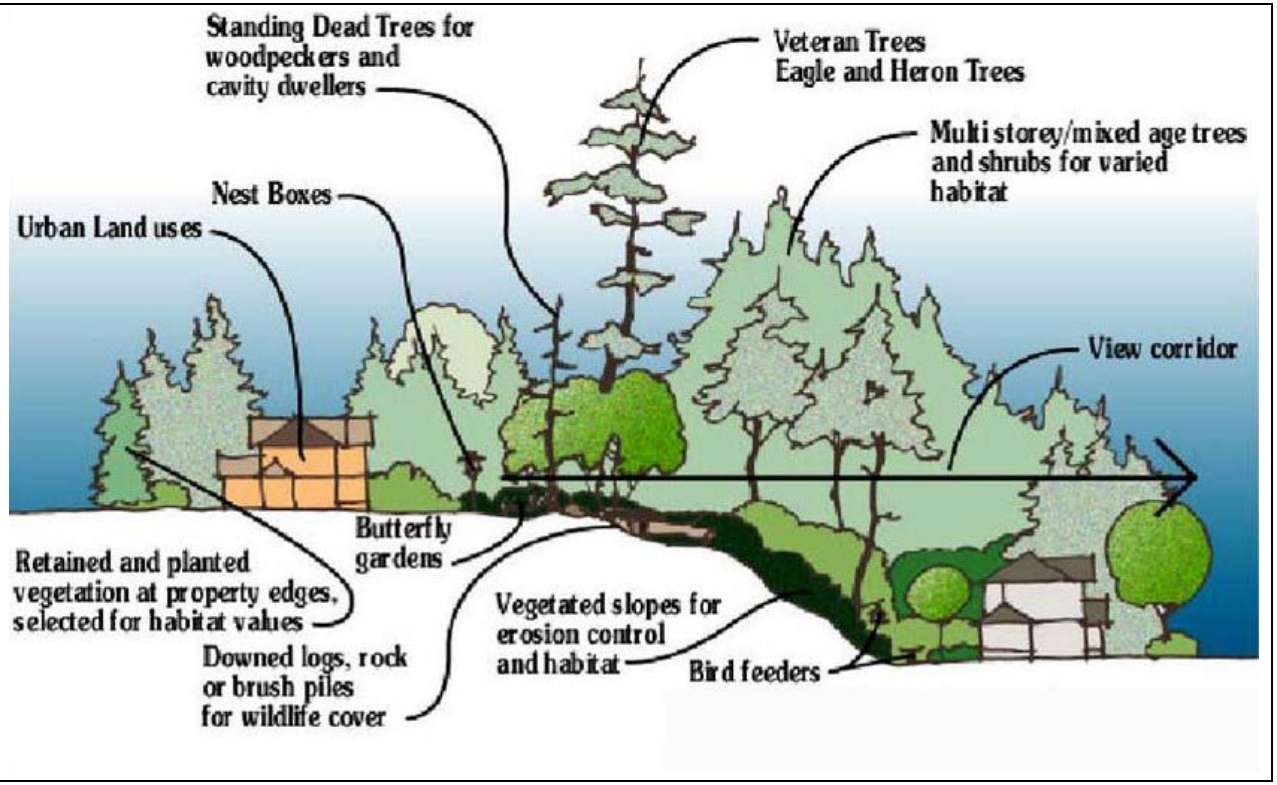
4.5 Examples of Ecosystem Management Approaches for Corridors and Matrix areas

Shown in the next pages are examples of ecosystem management approaches on the ground, both in suburban residential areas and in more urban contexts..

Corridor Connection Example:

Upland Corridor Connectivity:

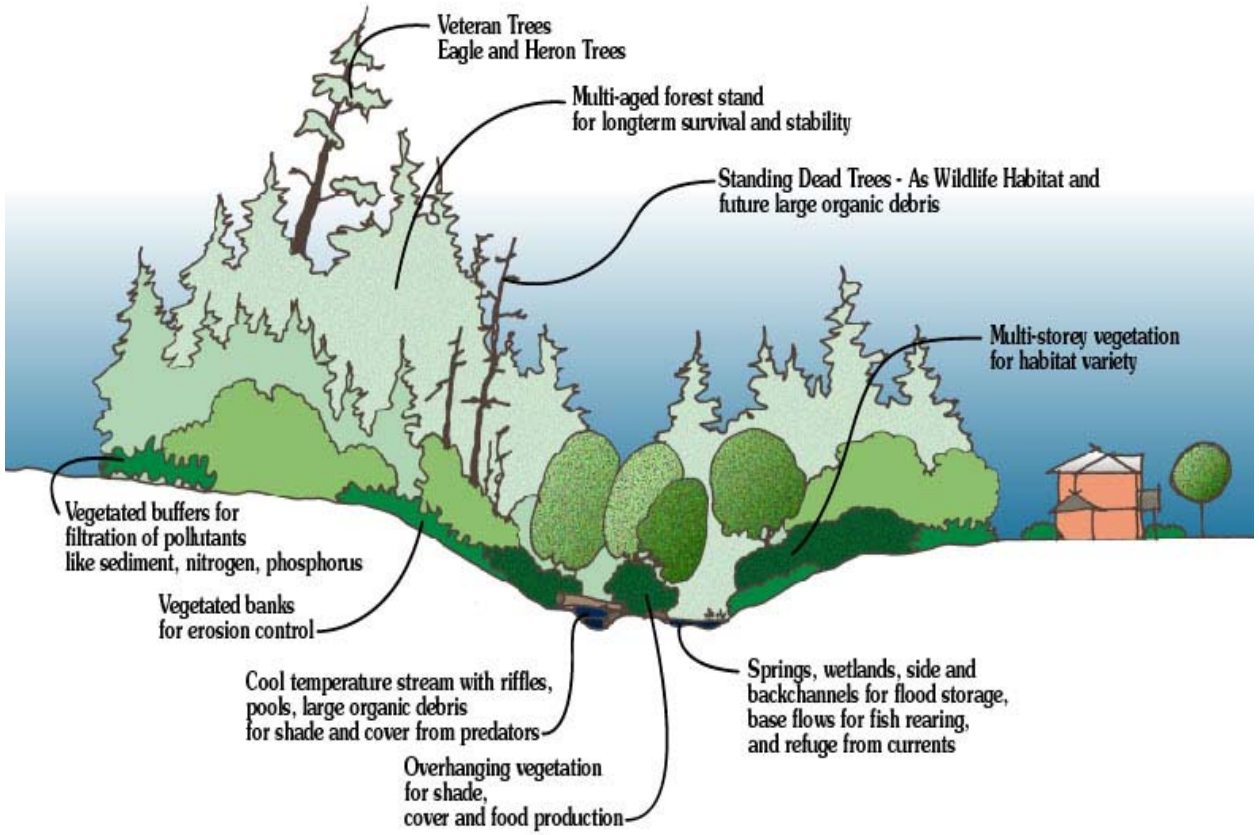
The protection of steep sloped areas offers a wide range of vegetative structure and habitat niches as well as view possibilities that offer complex visuals and wildlife sightings.



Corridor Connection Example:

Stream Corridor Connectivity:

The protection of riparian vegetation corridors offers a wide range of vegetative structure and habitat possibilities.



Portland Green Streets Project

Street side rain gardens:

These landscape planters in the sidewalk filter street runoff, provide habitat, slowly release storm flows and recharge the groundwater. Located on SE Division Street in front of New Seasons Market.

Portland Green Streets Project

Pervious road cover:

These Ecolock pavers in parking strips filter street runoff, slowly release storm flows and recharge the groundwater.

Ecolock Pavers for parking
SE 20th & 21st Ave. between Knapp & Lambert

Ecolock Pavers curb-to-curb
SE Knapp St. from 21st to 22nd Ave.

Porous Pavement
N Gay Ave.

Porous Asphalt
N Gay Ave.

Stormwater Parks

Silver Ridge in Maple Ridge:

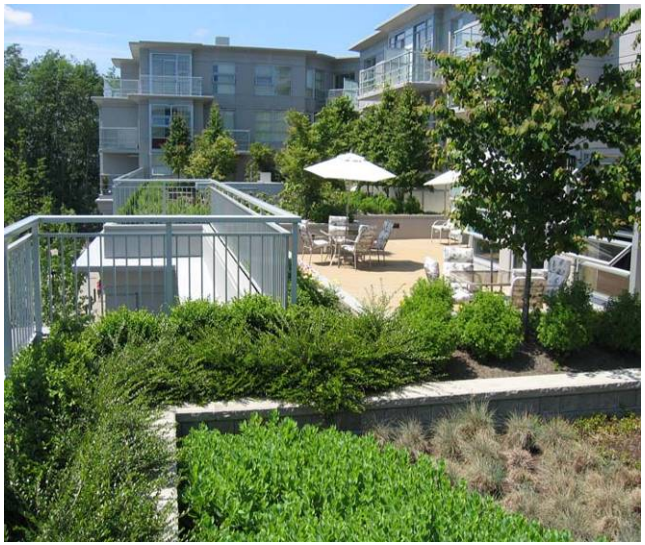
This stormwater park integrates a vegetation corridor with the maintenance of natural water flows.

Multifamily Developments in Natural Setting **Univercity at SFU:** Stormwater surface ponds (before and after) to accommodate the Univercity development provide habitat for a chorus of birds, frogs and other species.		

Multifamily Developments in Natural Setting

Univercity at SFU:

This development achieves high density of residences and natural features.



Landscaping the Single Family Home with Nature in Mind

Naturescape BC:

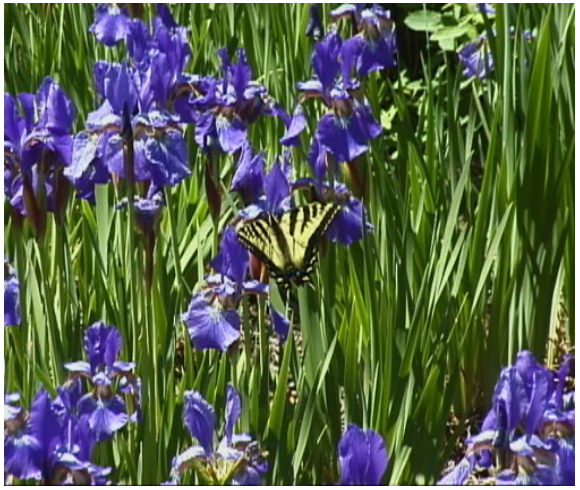
A Naturescape kit includes:

Stage 1

- provincial guide on how to design wildlife habitat for a particular site
- a native plant and animal book that lists indigenous plants and animals by provincial region
- a regional resource book with publications, organizations, gardening clubs and centres and wildlife rehabilitation centres
- a membership card that affords discounts at participating retailers

Stage 2

- a questionnaire to describe the participants outdoor space and rearrangements in support of wildlife
- once this is returned, the participant will receive a Naturescape Participant sign and a regular newsletter



Engaging the Broader Community

City of Edmonton Master Naturalist Program:

This program offers 35 hours of training and field trips in return for 35 hours of volunteer time. The volunteer time can be covered by time spent at any of the following five levels of commitment:

- Steward which involves taking care of an area through ongoing activities
- Volunteer which involves helping City staff and community groups
- Educator which involves providing information at fairs and conferences as well as to students and new volunteers
- Monitor which involves inventory of plants and animals, water quality or wildlife census

Appendix A

VEGETATION CLASSES FOR SURREY ESA (from USNVC)

FOREST: Trees with their crowns overlapping (generally forming 60-100% cover).

WOODLAND: Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarfshrub, herb, and nonvascular cover, respectively.

SHRUBLAND: Shrubs generally greater than 0.5 m tall with individuals or clumps
overlapping to not touching (generally forming more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation dominated by woody vines is generally treated in this class.

DWARF-SHRUBLAND: Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover). Dwarfshrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively

HERBACEOUS: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.

NONVASCULAR: Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover, respectively.

SPARSE VEGETATION: Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).

APPENDIX B

INVENTORY COMPONENTS

The inventory is divided into three groups of features: (1) biological features; (2) physical features; and (3) cultural features. Each is described below with a discussion of existing and new information sources that will be incorporated. It is important to note that there are a variety of limitations posed by the use of existing spatial data. In many cases, information from consultants' reports is difficult to incorporate because it focuses on a single site in a single point in time using undefined methods. Datasets from consistently applied methods that can be used across the entire municipality are much more useful. However, we will be attempting to obtain as much anecdotal or unpublished data from our review of the City's report collection.

Biological Features

1) Vegetation / Habitat

Existing information sources: There is no consistent spatial data on vegetation for the City of Surrey. Consultants' reports and previous park studies contain some information.

New information sources: Mapping natural and cultural vegetation using standard classification and mapping method (USNVC) based on interpretation of existing vegetation in recent (2007) orthophotos. Vegetation within highly developed areas, such as gardens and lawns, will not be mapped. Degree of naturalness will be estimated. Fieldwork will review representative sites and boundaries.

2) Watercourses, Wetlands, and Riparian Areas

Existing information sources: CWS and TRIM existing spatial data for wetlands; City of Surrey / MOE floodplain mapping (200-yr); MOE Little Campbell wetland mapping; City of Surrey drainage features (i.e., detention ponds, etc.); City of Surrey watercourse classification [includes ditches]; City of Surrey riparian policy; *SHIM mapping.*

New information sources: No new mapping of watercourses; mapping and verification of wetlands from orthophotos concurrent with vegetation mapping; mapping of riparian areas based on zonal approach (e.g., 30 m from watercourse with widening in obvious ravine sites); some field review of representative sites.

3) Shorelines and Coastal Habitats

Existing information sources: FREMP habitat mapping; FREMP habitat coding; CSIM mapping?

New information sources: Mapping and verification of intertidal wetlands and other coastal habitats from orthophotos concurrent with vegetation mapping.

4) Species at Risk Occurrences:

Existing information sources: BC Conservation Data Centre occurrence records; consultants' reports; MOTH (Gateway) reports for north Surrey; MOE / South Coast Conservation Program data; CWS data?; anecdotal information?

New information sources: No new information on wildlife habitats or occurrences will be collected using fieldwork.

5) Significant Wildlife Habitats or Occurrences:

Existing information sources: City of Surrey / MOE wildlife tree mapping; CWS or MOE mapping of wildlife habitats; other sources such as amphibian (wetland) habitats; interpretation of some information from consultants' reports (note, we will not be going through consultant reports and transferring all wildlife occurrences; the data is considered too inconsistent or dated to be useful in many cases).

New information sources: No new information on wildlife habitats or occurrences will be collected using fieldwork.

Physical Features

6) Watersheds and Aquifers

Existing information sources: Metro Vancouver or City of Surrey watershed boundaries; MOE developed groundwater aquifer boundaries.

New information sources: No new information on watersheds or aquifer boundaries will be collected.

7) Steep Slopes

Existing information sources: City of Surrey 1 m contour information; TRIM layers, 1997 ESA mapping of steep slopes; regional-scale DEM models.

New information sources: No new contour or slope mapping will be undertaken, however, existing data may be re-interpreted or mapped.

8) Landscape Units

Existing information sources: No existing information available.

New information sources: Mapping of large landscape units (e.g., Serpentine-Nicomekl Lowlands; White Rock / Ocean Park Uplands) based on topography, land use, or ecological units.

Cultural Features

1) Administrative Units (OCP zoning, NCPs)

- Existing information sources: City of Surrey mapping layers.
- New information sources: No new sources will be developed.

2) Public and Private Lands

- Existing information sources: City of Surrey cadastral lot layer.
- New information sources: No new sources will be developed.

3) Parks and Protected Areas

- Existing information sources: City of Surrey mapping layers; Metro Vancouver or provincial datasets from regional and provincial parks, Wildlife Management Areas (etc.).

- New information sources: No new sources will be developed.

4) Agricultural Lands

- Existing information sources: City of Surrey or provincial mapping layers.
- New information sources: No new sources will be developed.

5) Land Use/Land Cover

- Existing information sources: GVRD land use layer using provincial standards (i.e., CLUCS codes; created from 1995 orthophotos, updated in 2001).
- New information sources: No new land use differentiation will be undertaken for urban areas although vegetation mapping will capture land cover in agricultural and natural areas.

6) Roads

- Existing information sources: City of Surrey centerline road network.
- New information sources: No new sources will be developed.

Appendix C

MAP CATALOGUE (see Book 2)

Appendix D

REPRESENTATIVE VEGETATION PHOTOS (see Book 2)

Appendix E

EXAMPLE POLICIES / PROGRAMS / ACTIONS

Appendix E provides a general introduction to a range of tools that could implement the GIN, in concert with on-going research and public / development community outreach. Subsequent studies will need to select and refine the appropriate tools and incentives as part of an evolving implementation strategy.

Guiding points for Table E.1

- The "**Tools**" refer to the range of policy and legislative measures (such as official community plan, zoning bylaw, etc.), procedures (e.g., development review process), programs and activities (e.g., public information, works and services, monitoring and enforcement) that the City could use to meet its goals.
- The "**Example policies, programs, actions**" are not intended to be exhaustive, but rather to provide a sampling of possible implementation measures for staff to consider, modify and add to in subsequent phases of this project.
- The types of lands to which the City can apply its policies, programs and actions include:
    - "City lands" refers to city-owned parks and properties (existing and future) and public spaces under City jurisdiction (e.g., city streets and boulevards).
    - "Other government" refers to properties owned by other levels of government (e.g., offices) or under their jurisdiction (e.g., provincial highways).
    - "Utility ROWs" refers to rights of way owned by Terasen Gas and BC Hydro; it is assumed that the vast majority, if not all, utility ROWs are owned by the respective utility company.
    - "Private existing" refers primarily to residential lands (though could also include commercial and industrial) that are well
    - established and not subject to redevelopment in the near future.
    - "Private development and re-development" refers to private lands that are currently or will soon be subject to development or redevelopment.

-

Table E.1: Example Toolkit and Policy Framework for the Green Infrastructure Network

TOOLS	EXAMPLE POLICIES/PROGRAMS/ACTIONS	Applicable to: CITY LANDS	OTHER GOV'T	UTILITY ROW	PRIVATE – existing use	PRIVATE – Dev't/ Redev't
1. City {Corporate?} Policies	a. Ensure that any City-owned property <u>within</u> a hub, site or corridor is dedicated as park or protected area.	●				
	b. Identify City-owned, undeveloped properties that are <u>adjacent</u> to a hub/site/corridor; consider adding them to the associated GIN element.	●				
	c. Mandate Surrey Development Corporation (SDC) to buy land in hubs/sites/ corridors as they become available, subdivide to retain the GIN portion and sell the rest as developable lands to finance purchases.					●
	d. Set up a land banking and swapping system wherein the City (via the SDC?) would bank developable land, swap for GIN network land.	●				●
	e. Seek Free Crown grants for Crown lands within the GIN.		●			
	f. Consider allowing small sites to be sold/developed in exchange for acquisitions in higher-level hubs and corridors, qualified by recognizing the ecological significance of any given site.	●				
	g. Put the "environment" back in CEPTED; link green infrastructure with safety, health and economic benefits.	●	●	●	●	●
	h. Lobby senior governments to provide legislative support/imperative for local governments to: - regulate land for terrestrial habitat protection (similar to RAR). - negotiate Comprehensive Environmental Agreements. - designate environmental ROWs for purposes of providing Green Infrastructure – would be better than conservation covenants because ROWs give the power to enter onto the property. - grant property tax exemptions for conservation covenants on environmentally significant <u>terrestrial</u> lands (not just riparian/aquatic lands).	●	●	●	●	●

TOOLS	EXAMPLE POLICIES/PROGRAMS/ACTIONS	Applicable to: CITY LANDS	OTHER GOV'T	UTILITY ROW	PRIVATE – existing use	PRIVATE – Dev't/ Redev't
	The Islands Trust has this authority; why not all LGs?					
	i. "Rebrand" Surrey: use the GIN to promote Surrey's green-ness – valuation of GIN components – health advantages of everyone living within X m of the GIN.	●	●	●	●	●
2. Official Community Plans (OCP), Neighborhood Comprehen-sive Plans (NCP)	a. Authorize density bonusing, density transfers and clustering in order to realize additions to or buffers for hubs, corridors or sites.					●
	b. Establish a DPA to apply to all hubs, sites and corridors to manage development on lands within and around the network to meet GIN goals and objectives.	●	●	●	●	●
	c. Add sec.219 covenants as a condition of a DP within the GIN. Could do this on a City-wide in the revision of the OCP or on incremental basis via NCPs (may be more readily accepted).					●
	d. Strengthen/broaden aquatic buffer policies in the OCP, or institute a watercourse protection bylaw, in order to go beyond RAR requirements and to take into account other corridor values.	●	●	●	●	●
	e. Re-distribute density and transportation/utility corridors in NCPs to plan for GIN protection.	●	●	●	●	●
	f. Establish site planning and landscape design guidelines for multi-family, commercial, mixed use development adjacent to GIN ??		●			●
	g. Hwy 1 buffer policy – add rainwater management and wildlife corridor requirements to existing design/aesthetic requirements.	●	●		●	●
	h. Establish recreational corridors alongside GIN corridors as buffers – eases strain on purely environmental motives.	●	●	●	●	●
	i. Practice redundancy – provide more than one connection or ecosystem example if opportunities arise	●	●	●	●	●
3. Zoning Bylaw	a. Include GIN-based provisions in zoning bylaw, such as: larger setbacks adjacent to GIN; improved, naturalized landscaping; smaller building footprints; limits on impervious surface area. Options to do this include: - Add an environmental or GIN section to <u>all</u> zones – acknowledges the environmental imperative of all lands/zones.	●	●	●	●	●

TOOLS	EXAMPLE POLICIES/PROGRAMS/ACTIONS	Applicable to: CITY LANDS	OTHER GOV'T	UTILITY ROW	PRIVATE – existing use	PRIVATE – Dev't/ Redev't
	- Create a new zone dedicated to GIN/ecosystem objectives in which housing/buildings are an ancillary use – rezone as opportunities arise? - Create a CD zone along corridors and around hubs that, e.g., could allow for larger lots and bigger houses with the provision of an environmental ROW.					
	b. Avoid up-zoning to a higher use/density of land in hubs, site, corridors unless the GIN objectives can be met in the re-zoning.					●
	c. Allow building mass to move (reduce setbacks) to allow greater corridor or buffer width.		●		●	●
	d. Revisit parking requirements on lands adjacent to GIN – e.g.: reduce requirements if there is good transit service.					●
	e. Create 'green parking lot' design guidelines (landscaping, LID drainage alternatives, etc.).	●	●			●
4. Development review process	a. Develop an acquisition property list for development compensation and/or amenity purposes based on identified hot spots or pinch points in the GIN.		●			●
	b. Acquire portions of properties immediately adjacent to a GIN element as dedicated park, acquire any riparian and ravine areas to add to GIN.		●			●
	c. Create incentives to preserve and extend GIN in new and redevelopment by reducing applicable Development Costs Charges (DCCs; e.g., stormwater).					●
	d. Create an ecological credit system; e.g., if dedicate >5% land that falls within GIN, get credits that can sell to City or other developers.					●
	e. Add to sustainability checklist: "if your property is in or adjacent to the GIN, what will you do to protect or enhance the network?" – allocate points					●
	f. Guildford redevelopment: showcase GIN-friendly design by generating detailed design guidelines to optimize corridor width and show how to rebuild and restore the corridor, while still providing for viable building envelopes. Consolidate on-site services and amenities to also meet ecological needs – e.g., treating drainage	●				●

TOOLS	EXAMPLE POLICIES/PROGRAMS/ACTIONS	Applicable to: CITY LANDS	OTHER GOV'T	UTILITY ROW	PRIVATE – existing use	PRIVATE – Dev't/ Redev't
	via biofiltration. Use GIN-based measures as a selling point.					
5. Works and Services	a. Review and revise current road network plan and strengthen policies to avoid GIN components.	●				
	b. Focus on quiet local roads as possible GIN corridors – acquire or preserve additional right-of-way (ROW) width as fronting easements for green corridor.	●				
	c. Develop GIN-based Design ??that recognize multiple-corridor use of road ROW; revise road standards to incorporate GIN standard for roads that lie within the GIN.	●				
	d. Establish standards for wildlife bridges/crossings of dry land (roads, highways, etc.) as necessary to maintain viable terrestrial corridors.	●	●			
	e. Incorporate GIN-based standards into road DCCs – offset with reduced stormwater DCCs if justifiable.	●				
	f. Incorporate GIN-sensitive design into all City facilities; e.g., future recreation centre at 151st Street – provide room and landscaping to allow birds and other small wildlife access to nearby GIN. Focus on native species and naturalistic planting arrangements that support habitat purposes.	●				
6. Monitor and enforce-ment	a. Operationalize monitoring and enforcement of GIN - prioritize hubs/sites/ corridors then monitor boundaries on priority basis, contacting landowners who are encroaching into or 'violating' the GIN.	●	●	●	●	●
	b. Improve inspection and enforcement of existing landscaping standards and any new GIN-related standards.					●
7. Public involvement	a. Work with farmers on "environmental farm plans" that support the goals and objectives of the GIN.				●	
	b. Promote the linking and "greening" of courtyards, back and front yards, etc. as secondary connectors.	●	●		●	
	c. Create "give away" programs to plant vegetation (trees, shrubs, etc.) to complement the GIN – ongoing information, training (e.g., property owner gets free tree(s) if takes a Saturday morning course on importance, planting and				●	

TOOLS	EXAMPLE POLICIES/PROGRAMS/ACTIONS	Applicable to: CITY LANDS	OTHER GOV'T	UTILITY ROW	PRIVATE – existing use	PRIVATE – Dev't/ Redev't
	maintenance and signs a 'pledge' – see Seattle) and follow-up monitoring required. Focus on species that are appropriate for urban yard as well as habitat value.					
	d. Provide incentives to landowners to protect green infrastructure on their property: e.g., canopy rebate program: if property has >X% tree canopy cover, gets $Y rebate on utility bill. Test GIS techniques to measure canopy by parcel, and pilot along specific corridors.				●	
8. Operation -al Plans	a. Limit amount of clearing and pesticide/herbicide use to bare minimum (none) where feasible.	●				
	b. Enhance vegetation and habitat features; e.g., bird boxes in utility corridors.	●				
	c. Landscaping: focus on native species or habitat-supportive species, planting arrangements that support habitat purposes.	●				
9. Manage-ment agree-ments	a. Where the Ministry of Transportation (MOT) acquires and restores land to natural habitat in compensation for habitat lost due to road development: i) encourage such acquisitions/ restorations to occur within the GIN; and ii) acquire the right to manage and maintain the site as part of the GIN.		●			
	b. Work with utility companies to develop management guidelines for use of ROW as habitat corridor – e.g., discourage use of ROW as parking lots.			●		
	c. Limit amount of clearing and pesticide/herbicide use to bare minimum (none) where feasible.			●		
	d. Provincial highways: negotiate to acquire first option on any disposition of MOT lands adjacent to corridors.		●			
	e. Because it is not fenced, the rail line is less of a linear barrier than highways because wildlife can get across more safely than highways (lower and slower traffic volume). Discourage any fencing.		●			

Book 2. Appendix C&D

Map Catalogue: Representive Vegetation Photos

August 2009

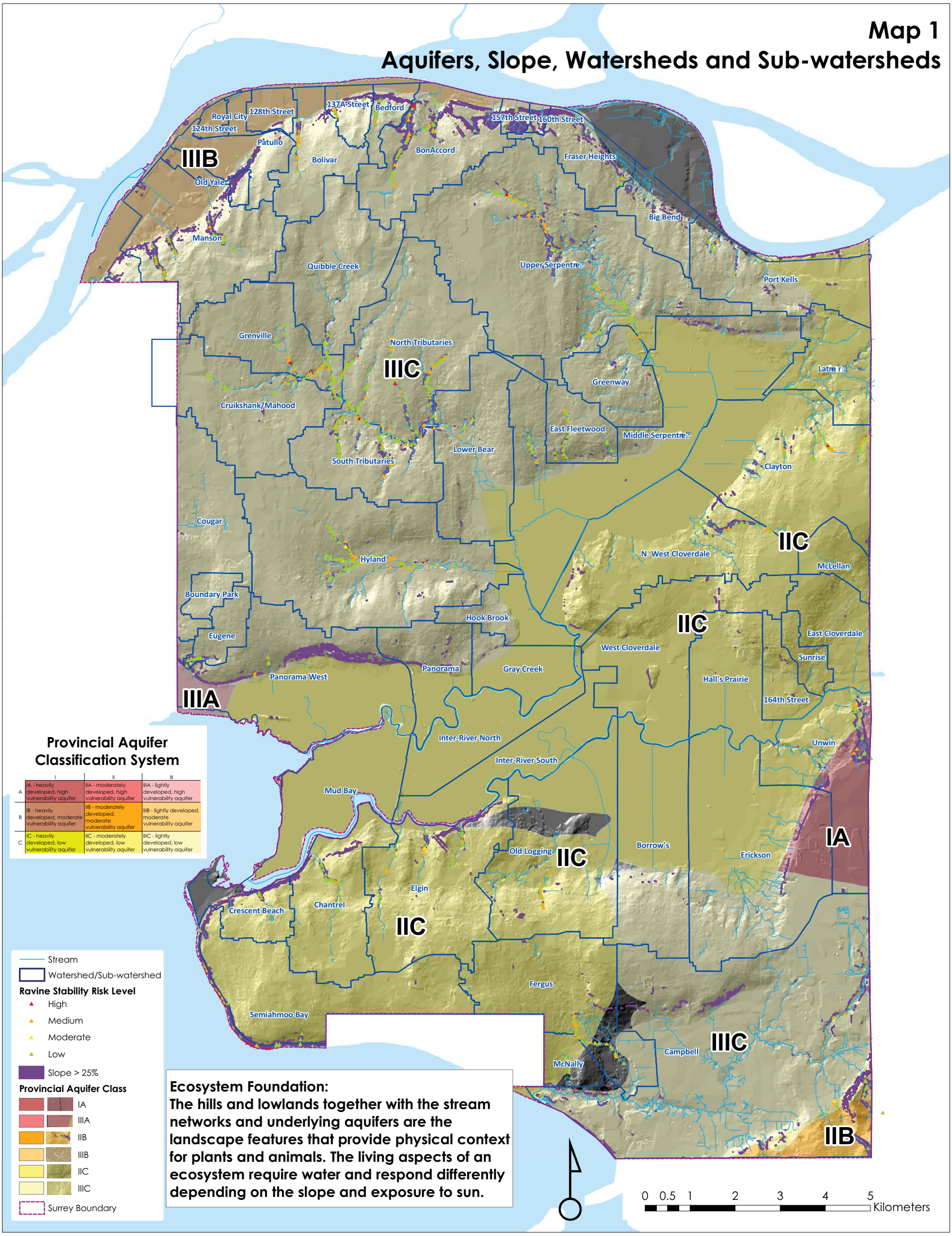


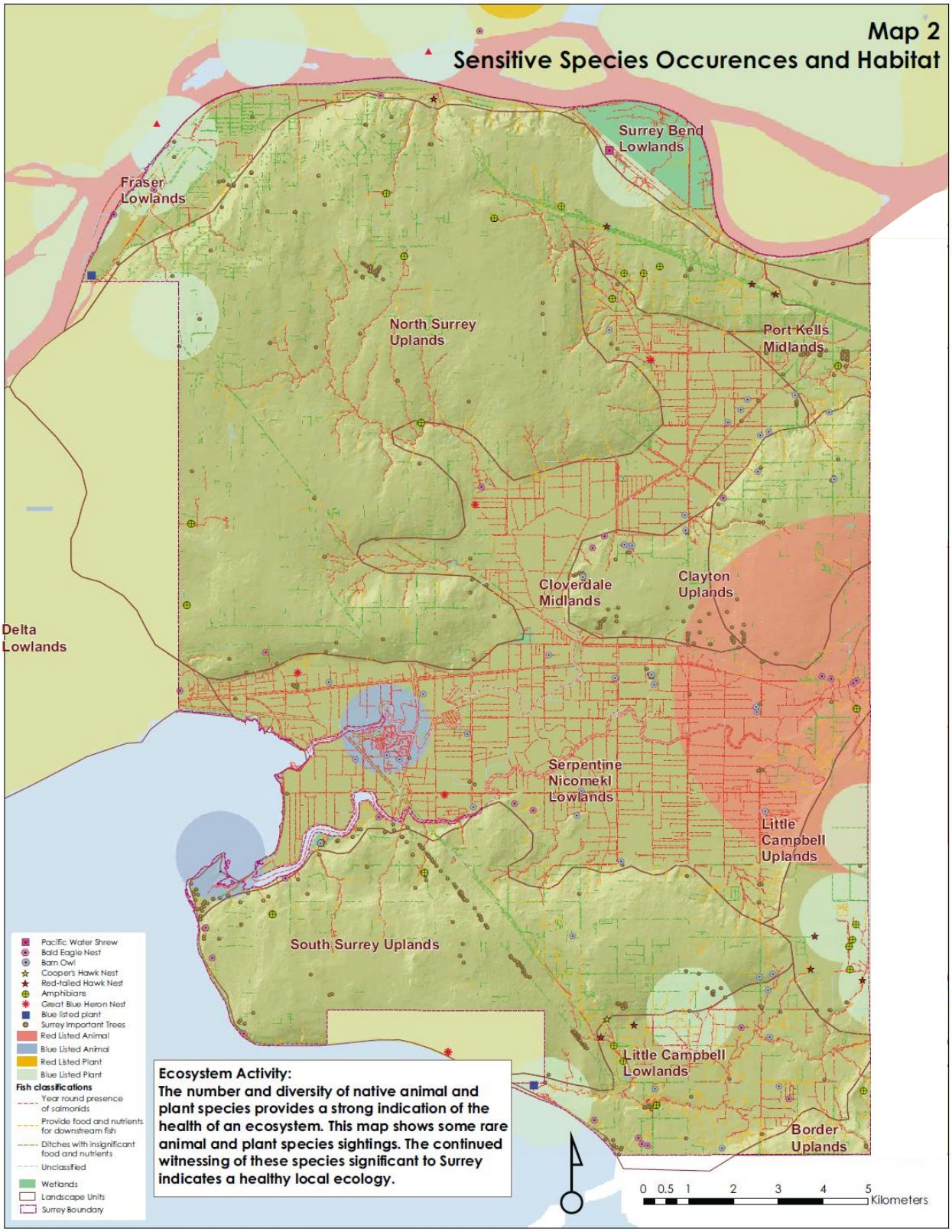

DRAFT

HB LANARC

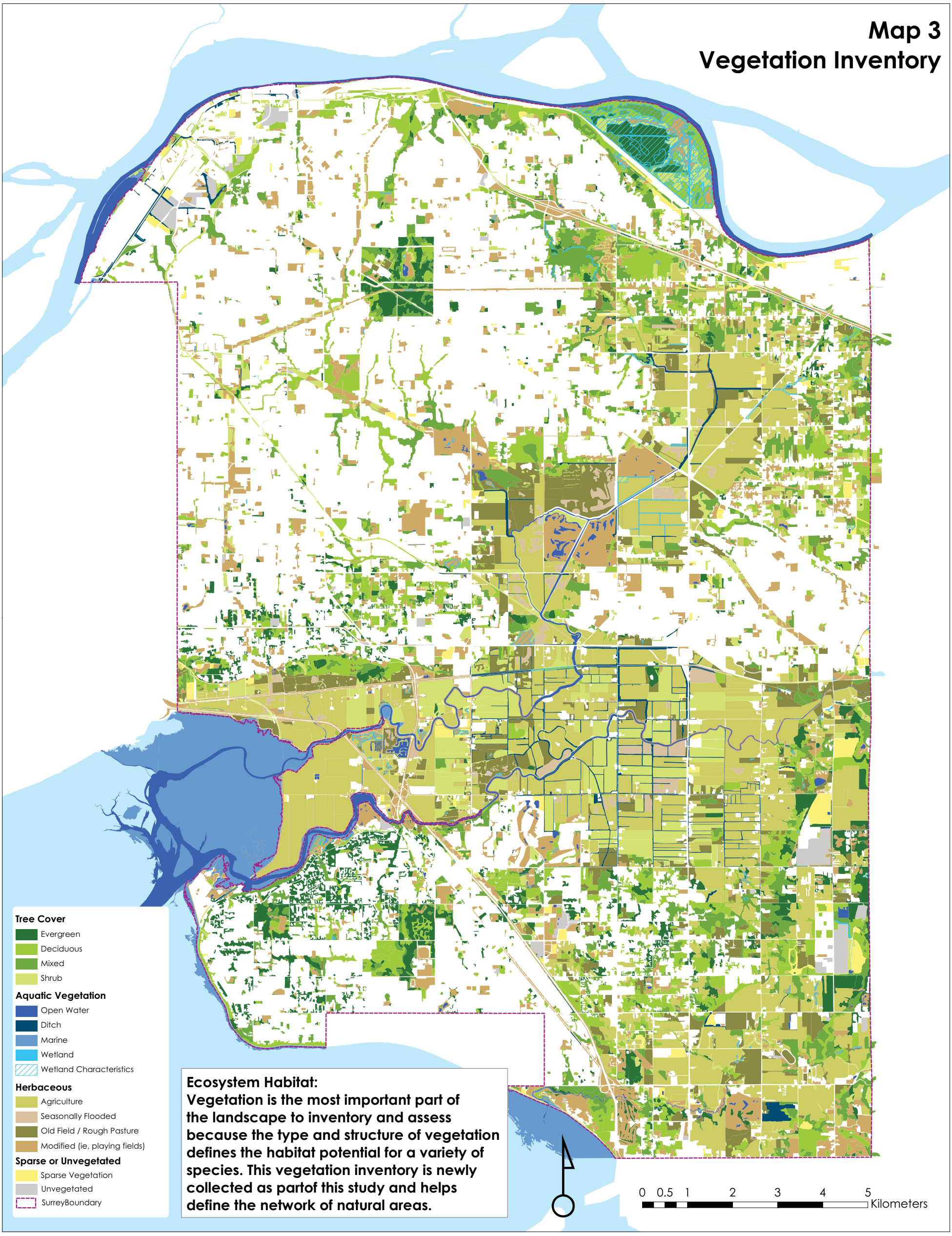
Raincoast Applied Ecology

Map 1
Aquifers, Slope, Watersheds and Sub-watersheds




Map 2
Sensitive Species Occurences and Habitat
Surrey Bend Lowlands
Fraser Lowlands
North Surrey Uplands
Port Kells Midlands
Cloverdale Midlands
Clayton Uplands
Delta Lowlands
Serpentine Nicomekl Lowlands
Little Campbell Uplands
South Surrey Uplands
Little Campbell Lowlands
Border Uplands
Pacific Water Shrew
Bald Eagle Nest
Barn Owl
Cooper's Hawk Nest
Red-tailed Hawk Nest
Amphibians
Great Blue Heron Nest
Blue listed plant
Surrey Important Trees
Red Listed Animal
Blue Listed Animal
Red Listed Plant
Blue Listed Plant
Fish classifications
Year round presence of salmonids
Provide food and nutrients for downstream fish
Ditches with insignificant food and nutrients
Unclassified
Wetlands
Landscape Units
Surrey Boundary
Ecosystem Activity:
The number and diversity of native animal and plant species provides a strong indication of the health of an ecosystem. This map shows some rare animal and plant species sightings. The continued witnessing of these species significant to Surrey indicates a healthy local ecology.
0 0.5 1 2 3 4 5
Kilometers

Map 3
Vegetation Inventory

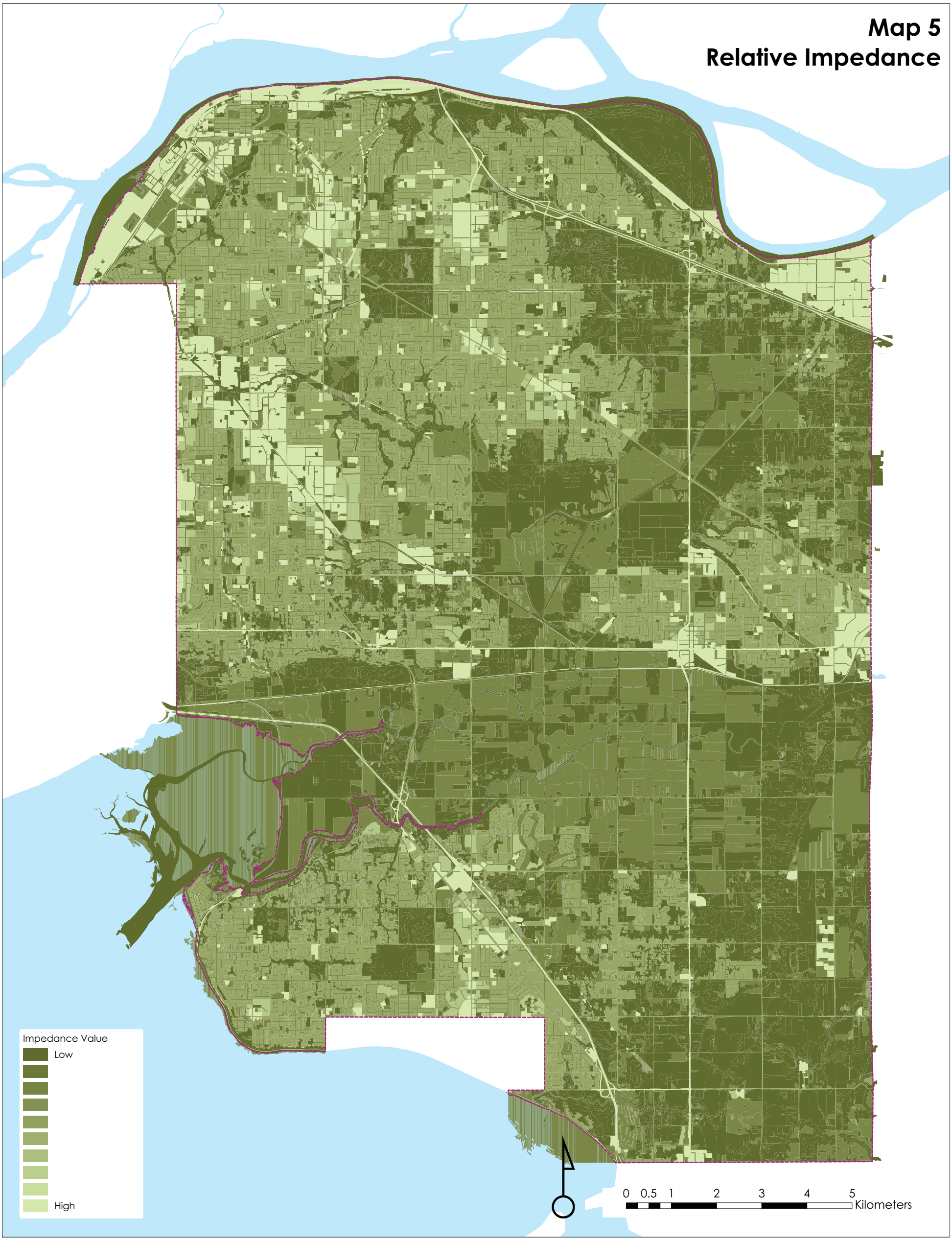


Map 4
Naturalness

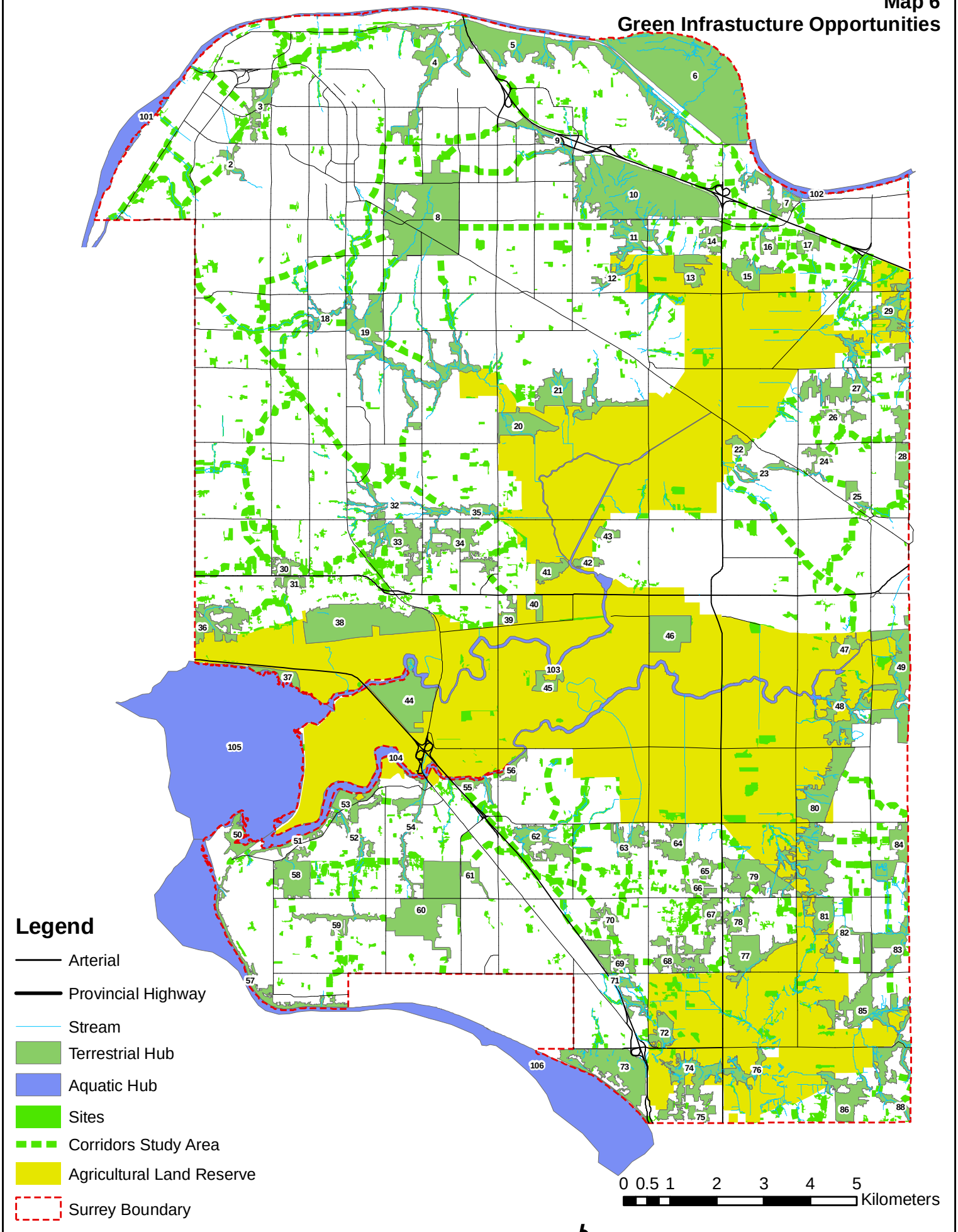
Natural
Mainly natural
Semi-natural
Semi-modified
Modified
Surrey Boundary

0 0.5 1 2 3 4 5
Kilometers

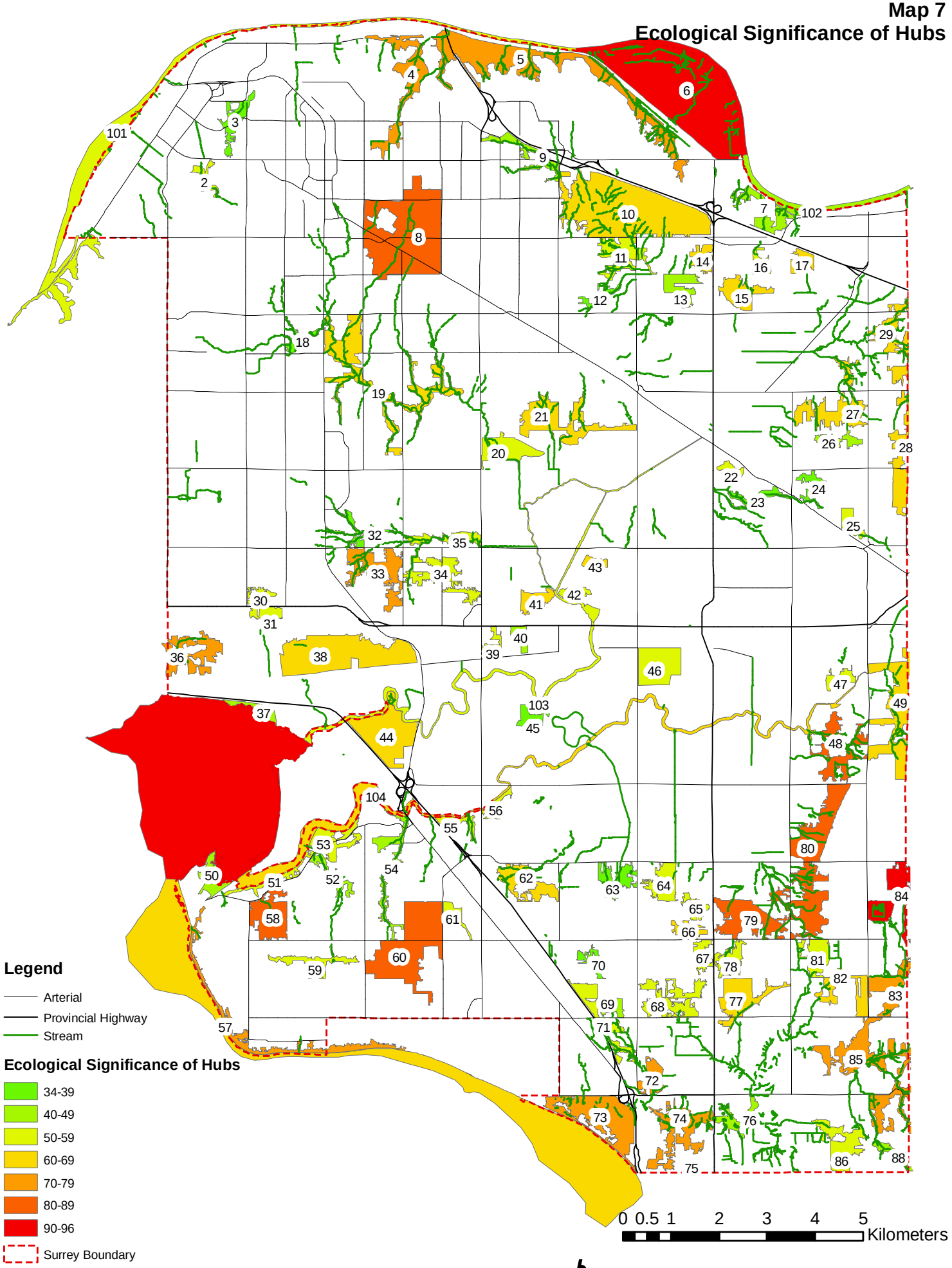
Map 5
Relative Impedance



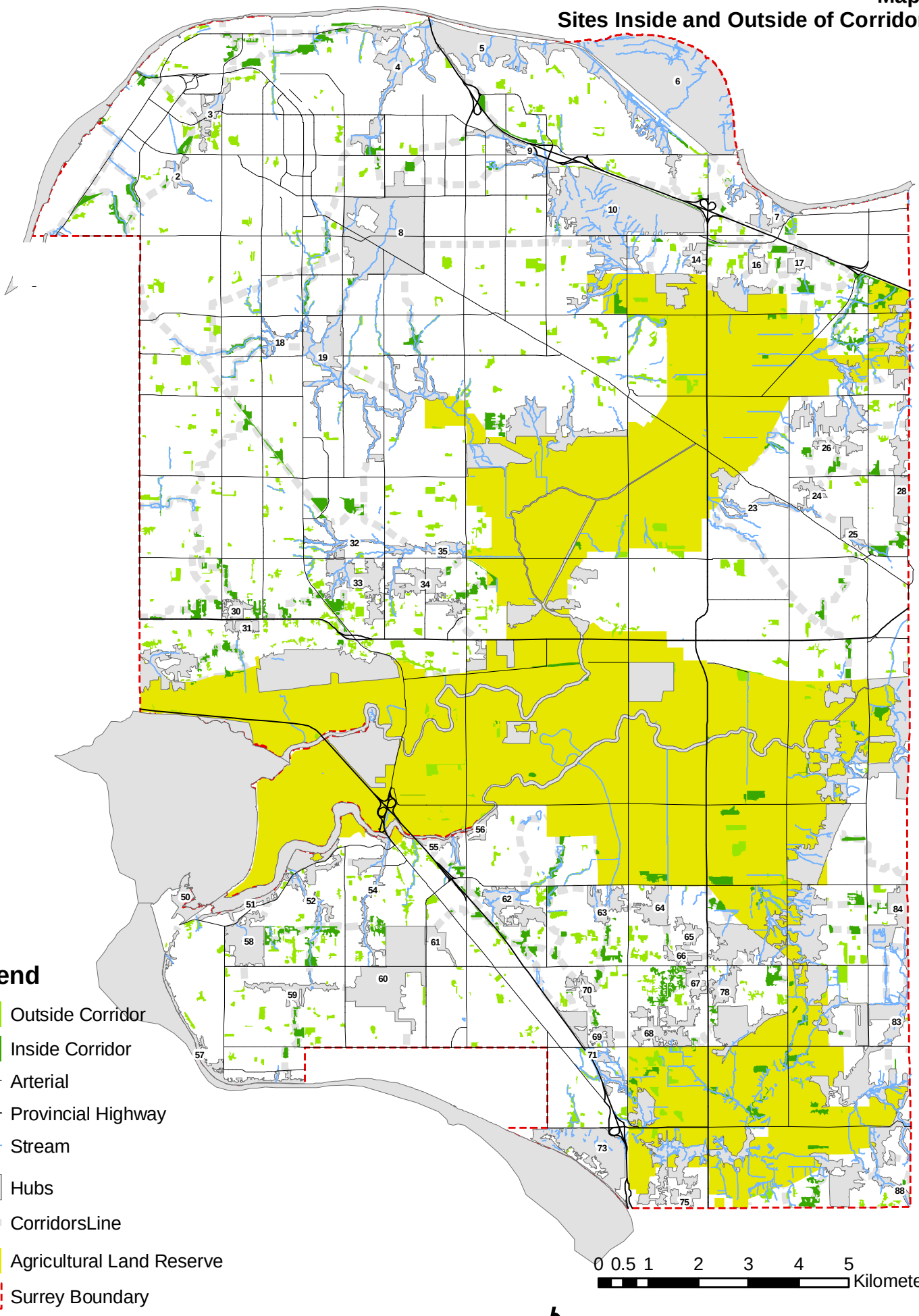
Map 6
Green Infrastucture Opportunities



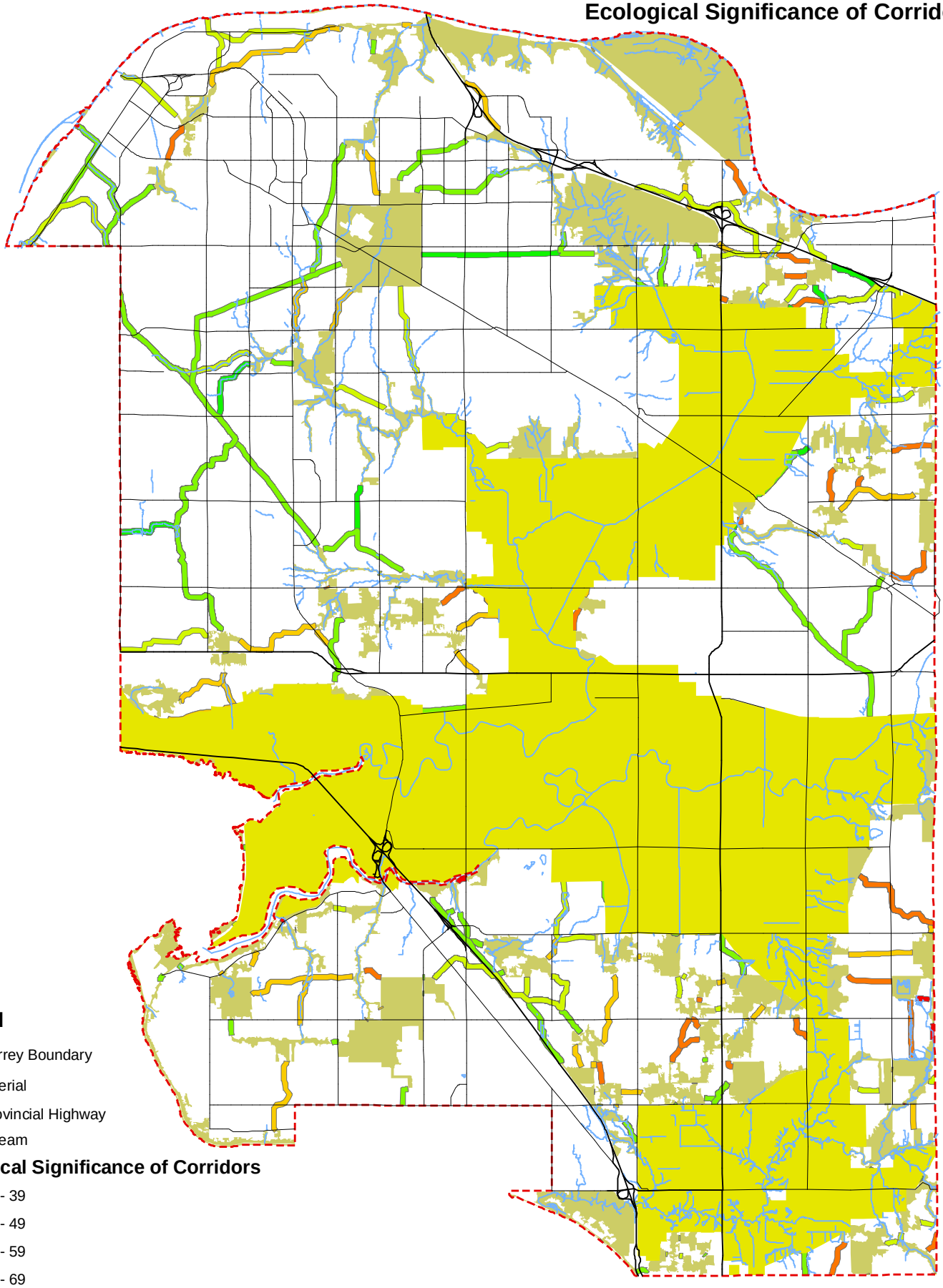
Map 7
Ecological Significance of Hubs



Map 8
Sites Inside and Outside of Corridors



Map 9
Ecological Significance of Corridors



Legend

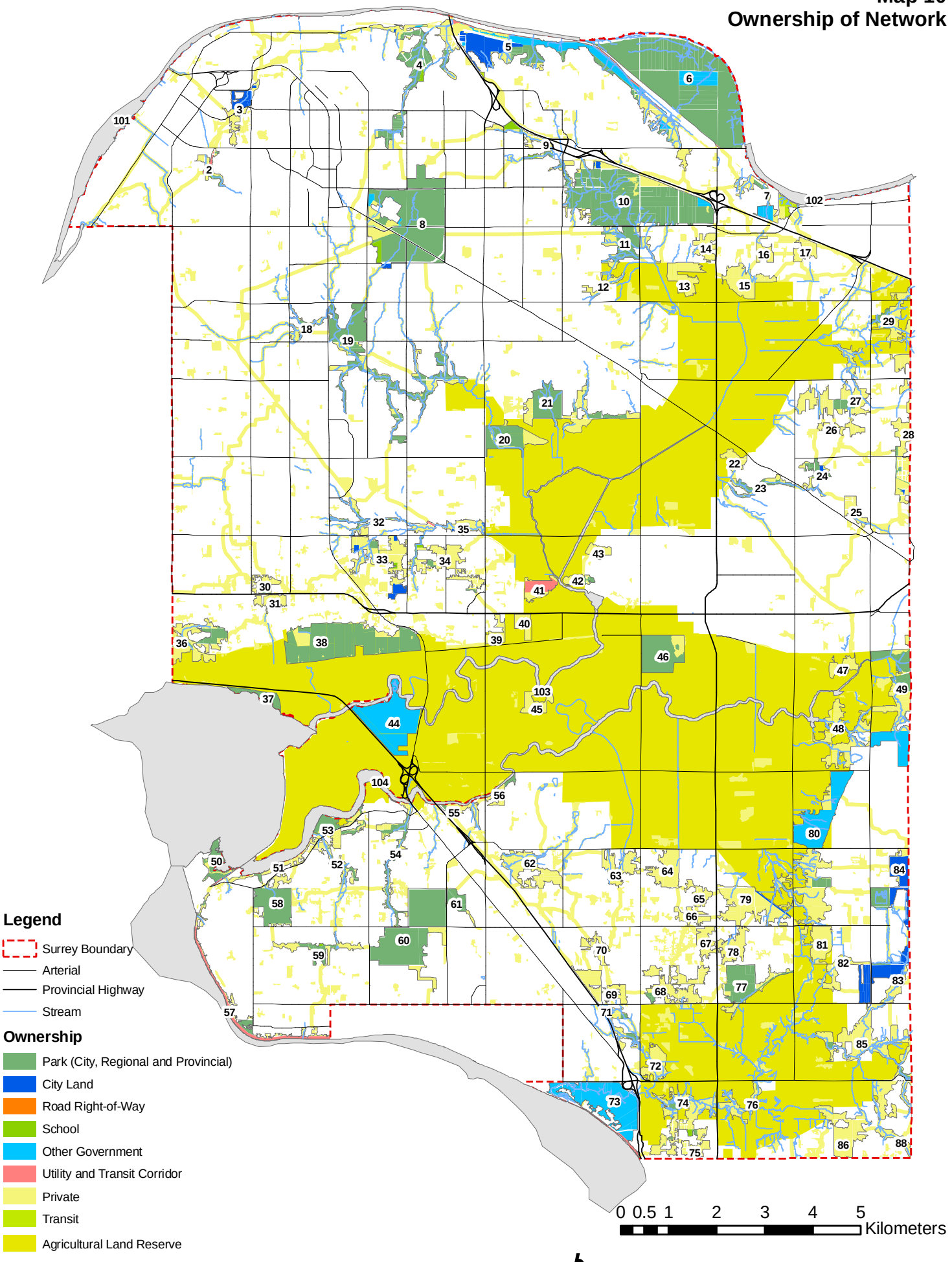
- Surrey Boundary
- Arterial
- Provincial Highway
- Stream

Ecological Significance of Corridors

- 26 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 - 79
- 80 - 86
- Agricultural Land Reserve

0 0.5 1 2 3 4 5 Kilometers

Map 10
Ownership of Network



Map 11
Representative Photo Index


Forest


Forest


Shrubland


Herbaceous


Sparsely Vegetated


Unvegetated Mudflat

YDF-2
MDF-2
DV-1
SH-3
OF-2
RIP-1
MEF-1
DV-2
MMF-2
UV-3
DV-4
MDF-1
SH-1
AG-2
AG-1
WET-3
UV-1
OF-1
SH-2
WET-2
AG-4
AG-3
UV-2
YDF-1
WET-1
SV-1
MMF-1
MEF-2

0 0.5 1 2 3 4 5
Kilometers

Mature Evergreen Forest (MEF-1)

Class/Subclass: FO-EV
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5447532, E513283
Green Timbers Urban Forest

Mature Evergreen Forest (MEF-2)

Class/Subclass: FO-EV
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5428862, E519739
Along Little Campbell River in South Surrey

Mature Deciduous Forest (MDF-1)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5438605, E509051
Joe Brown Park in South Newton

Mature Deciduous Forest (MDF-2)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5450529, E513212
Invergarry Park

Mature Mixed Forest (MMF-1)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5433053, E510115
Crescent Park in South Surrey

Mature Mixed Forest (MMF-2)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: M
Naturalness: 4

Waypoint: N5446443, E513187
Green Timbers Urban Forest

Young Deciduous Forest (YDF-1)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: Y
Naturalness: 2

Waypoint: N5433053, E510115
Elgin Heritage Park in South Surrey

Young Deciduous Forest (YDF-2)

Class/Subclass: FO-DE
Modifier/submodifer: none
Age: Y
Naturalness: 2

Waypoint: N5451096, E513626
Southwest corner of 115A St and Roxburgh Rd
(near Port Mann Bridge)

Natural Shrubland (SH-1)

Class/Subclass: SH-DE
Modifier/submodifer: none
Age: n/a
Naturalness: 2

Waypoint: N5438543, E514567
Abandoned field on northeast corner of Colebrook Rd and 152nd St

Shrub Hedgerow (SH-2)

Class/Subclass: SH-DE
Modifier/submodifer: AG
Age: n/a
Naturalness: 2

Waypoint: N5437030, E512112
Serpentine Wildlife Area

Natural Wet Shrub Swamp (SH-3)

Class/Subclass: SH-DE
Modifier/submodifer: AQ-WN
Age: n/a
Naturalness: 5

Waypoint: N5448957, E519361
Surrey Bend Regional Park

Old Field (OF-1)

Class/Subclass: HB-GR
Modifier/submodifer: AG-OF
Age: n/a
Naturalness: 3

Waypoint: N5437168, E510237
Mud Bay Park

Old Field (OF-2)

Class/Subclass: HB-GR
Modifier/submodifer: AG-OF
Age: n/a
Naturalness: 3

Waypoint: N5447654, E513115
Field area north of lake at Green Timbers Urban Forest

Corn Field (AG-1)

Class/Subclass: HB-AN
Modifier/submodifer: AG-RC
Age: n/a
Naturalness: 1

Waypoint: N5438018, E510713
Corn field along Colebrook Rd, west of King George Hwy

Grapes/Vineyard (AG-2)

Class/Subclass: SH-DE
Modifier/submodifer: AG-RC
Age: n/a
Naturalness: 1

Waypoint: N5438483, E515400
Vineyard along Colebrook Rd, east of 152nd St

Blueberry Field (AG-3)

Class/Subclass: SH-DE
Modifier/submodifer: AG-RC
Age: n/a
Naturalness: 1

Waypoint: N5435775, E513937
Blueberry field along 40th Ave, east of 156th St

Pasture/Hay Field (AG-4)

Class/Subclass: HB-GR
Modifier/submodifer: AG-PA
Age: n/a
Naturalness: 1

Waypoint: N5436622, E512595
Hay field adjacent to Serpentine Wildlife Area

Playing Field and Park (DV-1)

Class/Subclass: HB-GR
Modifier/submodifer: DV-LA
Age: n/a
Naturalness: 1

Waypoint: N5449346, E513720
Holly Park in West Guildford

Utility Right-of Way (DV-2)

Class/Subclass: HB-GR
Modifier/submodifer: DV-PL
Age: n/a
Naturalness: 1

Waypoint: N5446984, E513660
BC Hydro/Terasen Gas Right-of-Way crossing 148th St, south of 96th Ave

Golf Course (DV-3)

Class/Subclass: HB-GR
Modifier/submodifer: DV-GC
Age: n/a
Naturalness: 1

Waypoint: N5441180, E517010
Northview Golf Course

Sparsely Vegetated Shoreline (SV-1)

Class/Subclass: SV-UC
Modifier/submodifer: AQ-HY
Age: n/a
Naturalness: 3

Waypoint: N5433213, E508387
Shoreline at Crescent Beach

Unvegetated Mudflat (UV-1)

Class/Subclass: UV-UC
Modifier/submodifer: AQ-MI
Age: n/a
Naturalness: 4

Waypoint: N5437104, E510062
Mudflats in Mud Bay

River Channel (UV-2)

Class/Subclass: UV-UC
Modifier/submodifer: AQ-RF
Age: n/a
Naturalness: 3

Waypoint: N5435170, E512836
Nicomekl River west of Highway 99

Lake (UV-3)

Class/Subclass: UV-UC
Modifier/submodifer: AQ-WN
Age: n/a
Naturalness: 3

Waypoint: N5442843, E514769
Surrey Lake

Coastal Saltmarsh (WET-1)

Class/Subclass: HB-HY
Modifier/submodifer: AQ-WN
Age: n/a
Naturalness: 4

Waypoint: N5434049, E508976
Coastal saltmarsh at Blackie Spit

Freshwater Wetland (WET-2)

Class/Subclass: HB-HY
Modifier/submodifer: AQ-WN
Age: n/a
Naturalness: 3

Waypoint: N5437011, E512056
Freshwater wetland at Serpentine Wildlife Area

Agricultural Ditch (WET-3)

Class/Subclass: HB-GR
Modifier/submodifer: AQ-DI
Age: n/a
Naturalness: 2

Waypoint: N5438029, E510932
Roadside ditch along south side of Colebrook Rd

Natural Riparian Forest (RIP-1)

Class/Subclass: FO-MX
Modifier/submodifer: none
Age: n/a
Naturalness: 3

Waypoint: N5447483, E517344
Along Serpentine River through Tynehead Regional Park

Appendix II

Ecosystem Management Study Stakeholder Group Members

Key Stakeholder Members	Organization
Ron Meadley	Semiahmoo Fish and Game Club
Peter Maarsman	Green Timbers Heritage Society
Ray Hudson	Surrey Board of Trade
Roy Strang	Sunnyside Acres Heritage Society
Phillip Milligan	Semiahmoo Fish and Game Club
Rosemary Zelinka	Surrey Sustainable Communities
Frank Canil	RESCUE
Deb Jack	Surrey Environmental Partners
David Riley	Little Campbell Watershed Society
Margaret Cuthbert	Friends of Semiahmoo Bay Society
Advisory Body Members	**Committee/Commission**
Gurpreet Rai	Parks and Community Services Committee
Al Schulze	Environmental Advisory Committee
Mani Deo	Environmental Advisory Committee
Ted Dawson	Development Advisory Committee
Avtar Johl	Development Advisory Committee
Mike Bose	Agricultural Advisory Committee
Barb Paton	Heritage Advisory Commission

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