



City of Richmond

Report to Committee

To: Public Works and Transportation Committee

Date: April 3, 2014

From: John Irving, P. Eng.
Director, Engineering

File: 10-6000-01/2014-Vol
01

Re: Richmond's Ecological Network Management Strategy

Staff Recommendation

That the Ecological Network Management Strategy, as described in the report from the Director, Engineering, titled "Ecological Network Management Strategy – Phase 1" dated April, 2014, be endorsed for the purposes of public consultation.

John Irving, P. Eng.
Director, Engineering
(604-276-4140)

Att. 1

REPORT CONCURRENCE		
ROUTED TO:	CONCURRENCE	CONCURRENCE OF GENERAL MANAGER
Community Social Development	<input checked="" type="checkbox"/>	
Parks Services	<input checked="" type="checkbox"/>	
Policy Planning	<input checked="" type="checkbox"/>	
Development Applications	<input checked="" type="checkbox"/>	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	INITIALS:	APPROVED BY CAO

Staff Report

Origin

On November 19, 2012 Council adopted the *Richmond 2041 Official Community Plan (OCP)*. Chapter 9 of the OCP entitled “Island Natural Environment (an Ecological Network Approach)” provides direct support for the development of an Ecological Network in Richmond through Objective 1: “Protect, enhance and expand a diverse, connected and functioning Ecological Network.”

Several policies provide direction to meet this objective including the identification of a framework to better manage the City’s ecological resources and prioritize possible acquisition, enhancement and protection strategies.

The purpose of this report is to present the *Ecological Network Management Strategy (ENMS)* – Phase 1 (Attachment 1) and a recommended public and stakeholder consultation process. In addition, this report directly relates to the achievement of the following Council 2011-2014 Term Goal #8 Sustainability: 8.1 (*Continued implementation of the City’s Sustainability Framework*).

Analysis

The ENMS – Phase 1 provides a framework for managing and guiding decisions regarding the City-wide system of natural areas in Richmond and the ecosystem services they provide on City, public and private lands. This Strategy, intended to be opportunistic and collaborative, will set out priority areas, initiatives and projects for the on-going and long-term implementation of the Ecological Network (EN). There are many City actions, initiatives and projects currently underway that are supported by a range of regional and City policies, regulations and plans. The Strategy, when completed, will seek to complement, align and, where appropriate, inform the current planning and regulatory context in order to strengthen and enhance Richmond’s natural spaces.

The Phase 1 Strategy was informed by several consultation sessions with staff across City departments. Through these sessions, the following vision for the EN was developed:

The Ecological Network is the long-term ecological blueprint for the collaborative management and enhancement of the natural and built environments throughout the City, within neighbourhoods, and across land-uses and development types in order to achieve ecologically connected, livable and healthy places in which residents thrive. (Part 3 of the ENMS)

Four goals for improving and strengthening the EN overtime guide actions identified in the Strategy:

1. Manage and Enhance our Ecological Assets
2. Strengthen City Green Infrastructure (e.g. drainage, flood mitigation, water filtration, erosion and public amenity)
3. Create, Connect and Protect Diverse and Healthy Spaces
4. Engage through Stewardship and Collaboration

The ENMS is presented in three parts:

- Part 1: What is Richmond's Ecological Network;
- Part 2: Mapping Richmond's Ecological Network; and
- Part 3: Vision, Goals and Strategy Areas

Part 1: What is Richmond's Ecological Network?

An Ecological Network is an inter-connected system of natural areas across a landscape that is composed of terrestrial, marine shoreline and marine intertidal areas. In Richmond, areas such as the Richmond Nature Park, Terra Nova, Sturgeon Bank, South Arm Islands are all part of an EN. In addition, an EN encompasses Green Infrastructure, the components of the natural and built environment that provide the essential ecosystem services on which the City depends. These ecosystem services include:

- | | |
|----------------------|-------------------|
| • drainage | • habitat |
| • erosion protection | • cultural values |
| • flood mitigation | • recreation |
| • water filtration | • aesthetics |

In this manner, an EN consists of all green natural and built features across the City that play a role in delivering ecosystem services.

The Strategy identifies six (6) components that form Richmond's EN:

- **Hubs:** the large natural areas in Richmond (> 10 hectares) that make up the core of the EN
- **Sites:** discrete areas of 0.25 to 10 hectares of natural ecosystems, that provide "stepping stone" connections between hubs
- **Corridors and Connectivity Zones:** linkages between hubs that facilitate the movement of species, water, nutrients, and energy
- **Shoreline and Riparian Areas:** buffers to sensitive watercourses and the edge of the Fraser River. Many also function as wildlife corridors and greenways
- **Parks and Greenways:** most developed parks lack sufficient natural vegetation to be considered hubs or sites, but they still provide ecosystem services and are recognized as high priority sites for various degrees of restoration, especially given that the majority are under City control
- **Matrix:** land lying between the other components of the EN outlined above, encompassing most of the City's land-base, many opportunities exist to restore ecological features and functions through the creation of green infrastructure on this land

Part 2: Mapping Richmond's Ecological Network

The Strategy includes mapped vegetation distribution, structure, composition and condition from 2009 air photos. A total of 6,841 ha of the City of Richmond's terrestrial land area (inside the high water mark) and another 13,861 ha of its marine and intertidal areas (outside the high water mark) were mapped. Figure 1 identifies vegetation classes and sub-classes.

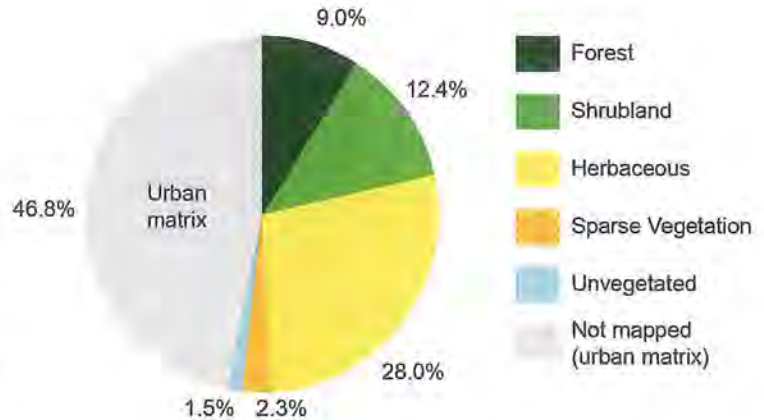


Figure 1: Vegetation classes as a percentage of total land area in the City of Richmond (2012)

Connectivity (the connections between hubs and sites) is key for a robust EN as it ensures that, as in nature, the natural systems within the City remain resilient through movement of biodiversity across the landscape. Two types of connectivity analysis were undertaken to better understand connectivity in Richmond:

1. Corridor Analysis: combined vegetation mapping with existing land use to map how the landscape fosters or impedes the movement of biodiversity, as well to identify potential corridors that could be restored or created through enhancement
2. Circuitscape Analysis: computer modeling based on electrical circuit theory to find the "path of least resistance" between different habitat areas; areas of good habitat represent less resistance to species movement, while those habitats of lower quality represented a higher resistance

These various analyses informed the strategic areas and guided mapping product described in the final part of the EN Management Strategy.

Part 3: Vision, Goals and Strategy Areas

The vision and goals, described above, informed the EN implementation framework. In order to prioritize and guide future actions, the Implementation Framework includes ten (10) EN strategy areas that were identified based upon vegetation distribution data, land-use, and current and future stewardship and development opportunities. Strategy Areas include:

1. Traditional Neighbourhoods
2. City Centre
3. Agriculture
4. Central Wetlands
5. Industrial
6. West Dike
7. Sea Island YVR
8. Iona + Sea Island Conservation Area (SICA)
9. Wildlife Management Areas (WMA) + Marine
10. Fraser River

The purpose of the Strategy Areas is four-fold:

- To provide an overview of Richmond's current ecological assets;
- To identify and group the key areas of the City in order to focus future specific actions where most appropriate;
- To provide tailored guidance on how the EN can be strengthened by different vegetation and land-use types within the City; and
- To identify the critical issues, key opportunities and stakeholder considerations that pertain to the enhancement and enrichment of the EN in specific areas.

The strategy areas are identified and included on the new map "Ecological Network Strategy Areas Map" (Figure 2).



Figure 2: Ecological Network Strategy Areas. 2014.

Focus Areas

To organize future actions and consultation, six areas of focus are identified for each strategy area. These areas of focus were selected as they represent opportunities for EN application within the City's planning, development, and operational context:

- Rainwater Management/Infrastructure
- Vegetation/Habitat
- Wildlife
- Parks, Open Space, Public Lands
- Private Development
- Stewardship

How does the proposed Strategy affect City lands, Private lands and other Public lands?

- ***City owned lands:*** The ENMS will approach ecological management on City lands through the lens of collaboration and integration. Rather than creating a series of new policy directives and projects, the Strategy will be selectively integrated with those City structures and frameworks that already exist in order to strengthen and inform them according to the Goals of the Strategy. The Strategy will provide a menu of ecological management tools for a variety of City capital and operation projects and processes such as landscape plantings, stormwater management, dike upgrades, park maintenance, ditch maintenance and community stewardship (e.g. Bath Slough Revitalization Initiative).
- ***Private lands:*** The ENMS will approach ecological management on Private lands by assessing and informing existing policies and regulations that speak to ecological management and land-use, yet could be enhanced in terms of evolving green infrastructure technologies and understandings of the natural environment. Exploring the enhancement of existing tools such as the green roof bylaw, the watercourse protection and crossing bylaw and the ecological aspects of the City's various development permit areas could yield City-wide benefits in terms of ecological connectivity, livability, ecological health and more resilient infrastructure.
- ***Other Public lands:*** Though under the jurisdiction of other agencies, collaborative opportunities exist to establish connectivity between City, Private and Public EN lands. The City currently participates as a member of several multi-jurisdictional agencies such as the YVR Environmental Advisory Committee and Metro Vancouver's Regional Planning Advisory Committee. The ENMS provides for the continuation of this type of participation under the lens of ecological connectivity across jurisdictions. Within this approach, the City can collaborate on projects of regional, provincial and federal natures that would not only enhance the ecological management of Public lands in Richmond, but further connected them with those outside of the City. One significant example of this is the City's role in Metro Vancouver's Regional Green Infrastructure Network.

How does the proposed Strategy affect Environmentally Sensitive Areas?

The Ecological Network Management Strategy does not change the current administration of the City's designated Environmentally Sensitive Areas (ESAs) as identified in the recently adopted 2041 OCP. This strategy provides opportunities to explore innovative approaches to protection, enhancement and connectivity of ESAs on public and private lands. Examples include: opportunities to establish connectivity with private ESA lands that are contiguous with the Shell Road corridor; establishment of an urban buffer using native vegetation; and invasive species removal projects on public lands, contiguous with ecologically significant City owned lands.

Public and Stakeholder Consultation

In order to develop actions that benefit from wide support, a public and stakeholder consultation program is recommended. The proposed program that provides both educational opportunities (e.g. *What is an Ecological Network?*) and seeks input regarding priority actions, initiatives and projects. The program would include the following three engagement techniques:

- **Digital Engagement:** *Let's Talk Richmond* interactive discussion forum and survey (May-August, 2014).
- **Stakeholder Engagement:** Staff will conduct multi-stakeholder focus groups for Strategy Areas, as identified in Part 3 of the Ecological Network Management Strategy – Phase 1. This engagement will include presentations to formal City Liaison and Advisory Committees as well as applicable agency and organization representatives. Suggested stakeholder questions are listed below. (May-September, 2014).
- **Public Engagement:** The public engagement will focus on building community awareness and education for the EN. The events below represent a suite of potential education opportunities. These could occur in concurrence with larger-scale themed events including:
 - Richmond Pecha Kucha Night “Secrets of the Fraser”- May 2, 2014
 - Public Works Open House – May 24, 2014
 - International Biological Diversity Day - May 22, 2014
 - Rivers to Oceans Week – June 8-14, 2014
 - Culture Days – September 26-28, 2014
 - BC Rivers Day- September 28, 2014

In addition, staff will conduct some public engagement as discrete events, or in conjunction with engagement events associated with the Bath Slough Revitalization Initiative, as appropriate. Public and stakeholder engagement is anticipated to take place between May and October 2014, with a report back to Council in the fall of 2014 on the outcomes of these engagement activities and proposed action plan.

The following questions will guide the stakeholder consultation program:

1. What aspects/features of Richmond's natural landscape/environment/wildlife do you like the most?
2. How would you improve Richmond's natural environment? Are there specific changes you would like to see in the environments where you live/work/play?
3. Have you been involved in any stewardship initiatives in the past (e.g. tree planting, river front clean-up)?
 - How can the City help facilitate increased participation in stewardship and/or education from your sector?
 - How would you like to participate?
4. Which would be the most feasible and/or desirable ecological enhancements in your sector and why? (rain gardens/ stormwater management features, green roofs and walls, natural parks, greenways/ shared streets/ trails for cyclists and pedestrians, native plantings, increase in trees, habitat for birds and pollinators, daylighting of sloughs and riparian areas, riverfront naturalization).
5. What are the greatest environmental challenges in your sector? Can natural areas and ecological enhancements serve to remedy some of these?

The following questions will guide the public consultation program:

1. What are your favourite natural places or environmental features (e.g. plants, wildlife, open spaces, etc) in your neighbourhood? In Richmond?
2. Would you be interested in participating in any stewardship projects/ initiatives (e.g. tree planting, riverfront clean-up, invasive species removal)?
 - If so, what types of projects would you be interested in?
 - If not, what would it take to get you involved?
3. What improvements to the natural areas of Richmond have you seen in the past few years? What would you like to see?
4. Is nature in the city important to you? What aspects of nature in the city do you value the most? (habitat, clean water/ air/ soil, trees, natural areas, recreation/ trails, health benefits, beauty/ aesthetics)
5. What is the biggest challenge to natural areas in your neighbourhood? In Richmond? How can the City help address these?

Financial Impact

None at this time. Potential costs to implement Ecological Network Management Strategy actions would be addressed through staff time (e.g. stewardship outreach and engagement), while other actions (e.g. acquisitions, infrastructure) would be submitted for Council consideration in future budget processes.

Conclusion

Richmond's 2041 Official Community Plan has provided strong direction to pursue an EN approach for the management of Richmond's ecological resources. While several policies and plans are currently serving to guide this ecological management, the proposed EN Management Strategy – Phase 1 seeks to provide more clarity for how the broad network can be managed for maximum community benefit. The Ecological Network Management Strategy- Phase 1 sets the stage for the development of an action plan in order to fulfill the goals outlined in the Strategy. A key piece of developing this action plan is the consultation with the stakeholders and members of the public associated with each of the 10 strategy areas. Upon review and finalization of the public and stakeholder consultation results a revised Strategy will be forwarded to Council for adoption.



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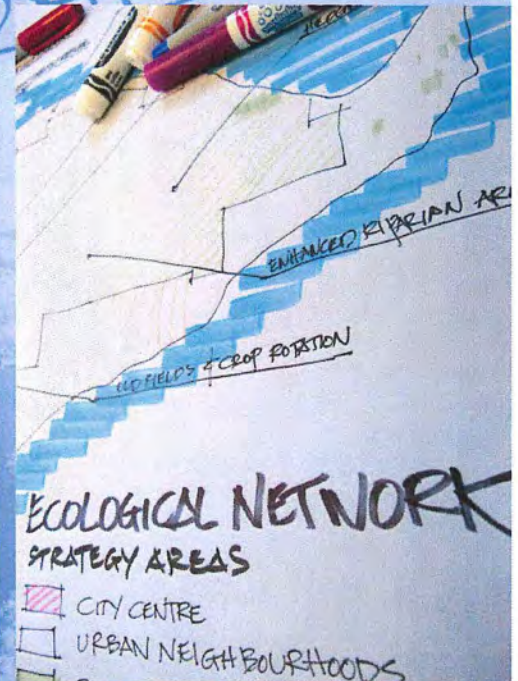


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Attachment 1 – Richmond's Ecological Network Management Strategy - Phase 1

Richmond's Ecological Network Management Strategy – Phase 1



April 2014

Acknowledgements

This document was prepared by the City of Richmond Engineering and Public Works Department - Environmental Sustainability. We would like to acknowledge the contribution of Raincoast Applied Ecology in the development of this report. We would also like to thank the many staff across the City who have provided their insight and expertise into this strategy over the past months.

Executive Summary

The Ecological Network Management Strategy – Phase 1 provides a framework for managing and guiding decisions regarding the city-wide system of natural areas and the ecosystem services they provide. The Ecological Network (EN) was incorporated into Richmond's Official Community Plan (OCP) in 2012 and is consistent with the draft Metro Vancouver Regional Green Infrastructure Network. The EN is supported by a range of regional and City policies, regulations and plans. It does not aim to create a series of new regulations and policies, but compliment and where appropriate, inform the current planning and regulatory context in order to strengthen and enhance the City's natural spaces.

The EN is the inter-connected system of natural areas across Richmond's landscape and is composed of both terrestrial and marine (shoreline and intertidal) areas. In addition, the EN encompasses green infrastructure: the components of the natural and built environment that provide the essential ecosystem services on which the City depends such as drainage, erosion protection, flood mitigation, water filtration, as well as cultural value, recreation and aesthetic beauty. All components of the EN are interconnected components of the same system, linking ecological values and services across the City while creating a unique Richmond identity that links ecology with livability, health, recreation, social and cultural values.

Vision:

The Ecological Network is the long-term ecological blueprint for the collaborative management and enhancement of the natural and built environments throughout the City, within neighbourhoods, and across land-uses and development types in order to achieve ecologically connected, livable and healthy places in which residents thrive.

The EN is composed of five main components: hubs (>10 ha), sites, corridors and connectivity zones, shorelines and riparian areas, and parks and greenways. A quarter of the City's total area, including intertidal and marine areas, is within the EN. Almost two-thirds are large hubs, over half of which are marine and intertidal areas. Most of Richmond's large natural areas (hubs) are either outside of the dike, or within Richmond's Agricultural Land Reserve (approx. 30%). This highlights the importance of collaborative actions with other levels of government to manage the EN.

Four goals were identified for improving and strengthening the EN over time:

- Goal 1: **Manage and Enhance** our Ecological Assets
- Goal 2: **Strengthen** City Infrastructure
- Goal 3: **Create, Connect and Protect** Diverse and Healthy Spaces
- Goal 4: **Engage** through Stewardship and Collaboration

This management strategy and its subsequent phases will be implemented through an opportunistic, integrated and collaborative approach that will maximize current and future land-use and development policies, guidelines, partnerships, City-wide initiatives, and area-specific projects. Plans, projects and processes which collectively implement the EN will demonstrate how this framework for on-the-ground action will be incorporated within the City's planning and development context. Phase 1 of the strategy identifies the key issues, opportunities and stakeholder considerations necessary for a robust consultation process that will ensure a collaborative approach to future implementation.

In consultation with various City departments, ten (10) EN strategy areas were identified based upon vegetation distribution data, land-use, and current and future stewardship and development opportunities:

1. Traditional neighbourhoods
2. City Centre
3. Agriculture
4. Central Wetlands
5. Industrial
6. West Dike
7. Sea Island YVR
8. Iona + Sea Island Conservation Area (SICA)
9. Wildlife Management Areas + Marine
10. Fraser River

The purpose of the strategy areas is four-fold:

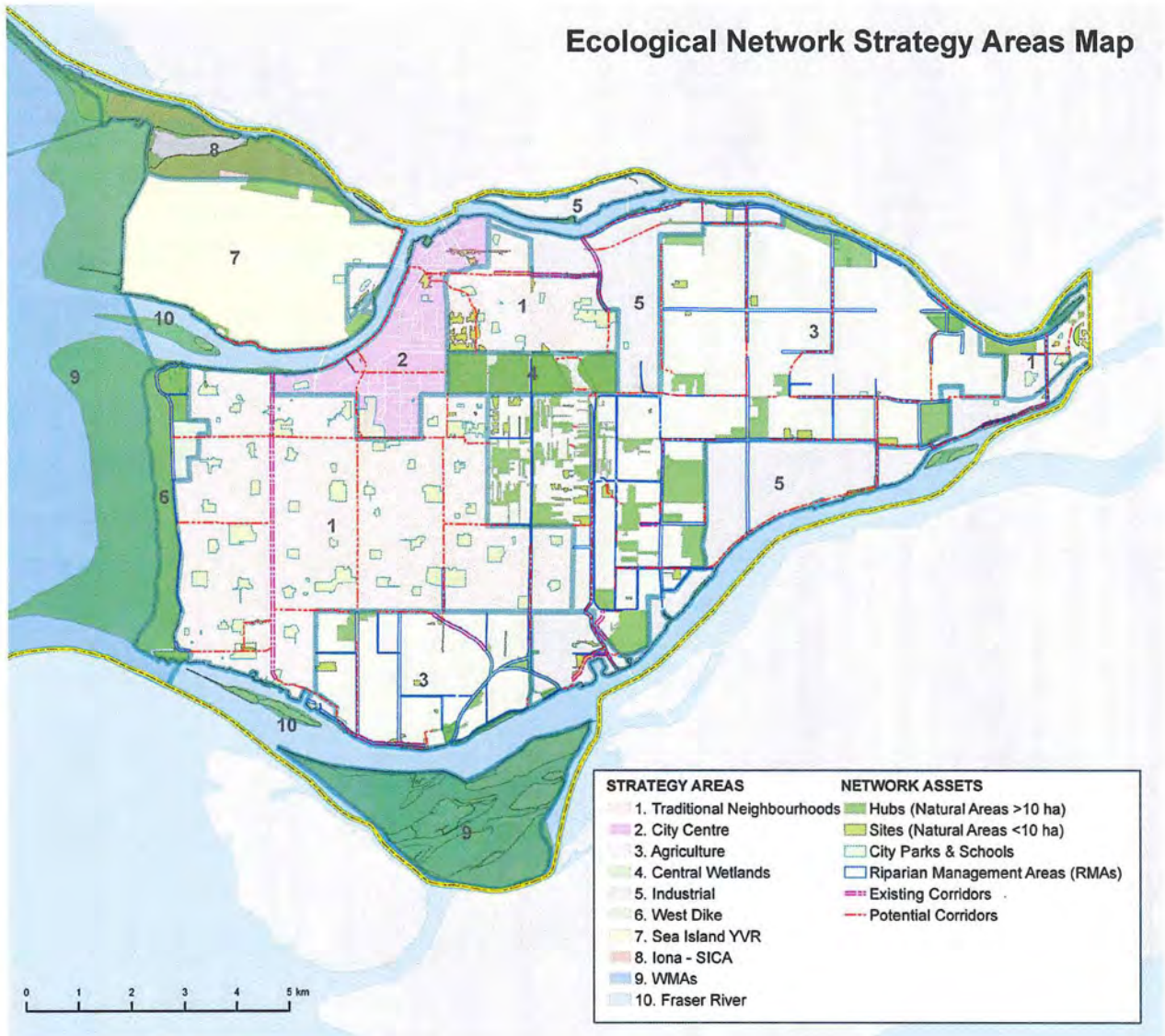
- To provide an overview of Richmond's current ecological assets;
- To identify and group the key areas of the City in order to focus future specific actions where most appropriate;
- To provide tailored guidance on how the EN can be strengthened by different vegetation/ land-use types within the City; and
- To identify the critical issues, key opportunities and stakeholder considerations that pertain to the enhancement and enrichment of the EN in specific areas.

An overview of each area's critical issues, key opportunities and specific stakeholder considerations is included in order to guide the stakeholder and public consultation process that will lead to the development of the second phase of the EN management Strategy; the action plan. To organize future actions and consultation, six areas of focus are identified for each strategy area:

- Rainwater Management/ Infrastructure
- Vegetation/Habitat
- Wildlife
- Parks, Open Space, Public Lands
- Private Development
- Stewardship

These areas of focus were selected as they represent the EN's various areas of application within the City's planning, development, and operational context. These are also the various themes under which future actions can be applied to fulfill the Goals outlined above. Under a framework of Strategy Areas and focus areas, it is clear that the EN has a role to play on public and private lands, in the natural and built environments and as a catalyst for stewardship and community action.

A new map has been developed to guide and support the development of the EN: an Ecological Network Strategies Area Map. This is an on-the-ground guide that not only reflects the current condition of the EN, but identifies priorities in the direction of its long-term evolution via delineation of the 10 strategy areas.



Ecological Network Strategy Areas Map. 2014.

Effective management of Richmond's EN involves protecting and connecting the existing natural areas whenever possible, with incorporating more green infrastructure into developing and redeveloping neighbourhoods. Actions at both the local and City-wide scales are needed to support the EN. This first phase of the Ecological Network Management Strategy provides the context for Richmond's EN, identifies key areas, issues and opportunities within the network and provides guidance on the stakeholder consultation necessary to guide future actions.

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An aerial photograph of a landscape. In the upper half, a river flows through a wooded area. In the lower half, there are large, flat, open fields, possibly agricultural, with some trees and a small body of water or pond visible. The overall tone is somewhat desaturated, with a mix of greens, browns, and greys.

PART 1

What is Richmond's
Ecological Network?

PART 1 – What is Richmond's Ecological Network?

Introduction

Richmond's neighbourhoods, parks, schools, and roads are interwoven with our natural landscape. Natural areas like Bath Slough, Terra Nova Rural Park, Iona Beach, and Richmond Nature Park are unique and essential parts of the city's landscape. Richmond's residents have a particularly strong connection to the dike trails, foreshore marshes, cottonwood forests, and sloughs which reflect the city's unique location at the mouth of the Fraser River. This system of natural areas—wetlands, forests, shorelines, and old fields - is the basis of the Ecological Network.

Purpose and Origin

This report identifies and describes Richmond's Ecological Network (EN), and recommends a vision and goals for ensuring that it is connected, protected and enhanced for the long-term. The EN is a tool for managing the system of natural areas and the ecosystem services they provide. It was incorporated into Richmond's Official Community Plan (OCP) in 2012 via Chapter 9: "Island Natural Environment (an Ecological Network approach)". The OCP directly informs and lays the groundwork for this report via a series of objectives and policies that call for the protection, enhancement and expansion of a diverse, connected and functioning EN. It calls for the identification of an EN to provide an innovative framework for the management of Richmond's ecological resources, and provides direction for the establishment of a meaningful and robust EN through: the prioritization of lands; the establishment of clear goals and objectives for EN expansion; the development of new design objectives, policies, principles and operations; the strategic acquisition of lands within the EN; the updating of Riparian Management Area policy and the continued establishment of partnerships, incentives and programs to improve the EN. Chapter 9 of the OCP also speaks to the promotion of Green Infrastructure and ecosystems services as well as the improvement of water, air and soil quality, the protection of Environmentally Sensitive Areas (ESAs) and the development of partnerships for ecological gain.

The principle underlying the use of the EN is that effective management of ecological systems must occur at the city-wide scale. Richmond's EN encompasses the whole city but emphasizes the importance of large natural areas such as provincial Wildlife Management Areas, regional parks, and private lands with significant natural areas such as large wetlands or old fields.

Effective management of Richmond's EN must also balance the goal of protecting the existing natural areas, while incorporating Green Infrastructure into developing and redeveloping neighbourhoods in order to strengthen the City's infrastructure over time.

As stated in the OCP, there are a variety of ways in which a meaningful and robust EN is established and strengthened over time. This report, a direct result of policies set out in the OCP, provides a starting point for identifying and prioritizing areas and actions to establish and expand the EN as a long-term ecological management strategy for the City of Richmond.

Report Structure

This report is divided into three parts. Part 1 provides an introduction to Richmond's ecological landscape, provides definitions, and summarizes jurisdictions of land management. It provides the context for the development of Richmond's EN. Part 2 describes and assesses the current state of the EN, providing a picture of what we've got and associated mapping and analysis. Part 3 presents a vision for the future of the EN. It provides a vision and a series of goals for the long-term development and implementation of the EN. In this section a Strategic Areas map is presented as well as the strategic areas of focus and their key issues, opportunities and stakeholder considerations. The appendix in the report provides a detailed description of analysis methods for the Circuitscape Mapping.

What is an Ecological Network?

The EN is the inter-connected system of natural areas across Richmond's landscape. It is composed of both terrestrial and marine (shoreline and intertidal) areas. It includes prominent natural areas such as Richmond Nature Park, Sturgeon Banks and the South Arm Islands WMAs, as well as larger urban parks, the Fraser River foreshore, watercourses, and riparian areas. It also includes old fields, bog forests, and wetlands found in agricultural areas and other private lands with significant natural areas.

Richmond's EN was identified using a science-based approach to mapping and assessment that recognizes the importance of a system of natural areas for protecting ecological features and functions across landscapes. Identification of the EN is a mapping exercise using Geographic Information Systems (GIS) and the principles of landscape ecology, conservation biology and ecosystem services to identify lands and features most critical to an area's long-term ecological health. The EN approach has been used successfully to identify priorities for environmental management in other jurisdictions at both large (e.g., State of Maryland) and small scales (e.g., City of Edmonton, City of Surrey).

Why an Ecological Network Management Strategy (ENMS) in Richmond?

The EN is a strategic approach to managing Richmond's natural areas. As in nature, no component of the Network exists in isolation, every piece is connected and exerts impacts and influences on surrounding environments. By managing Richmond's natural areas as components of the same Network, synergies between natural and built environments, policies, regulation, and community vision can be identified and addressed in manners that strengthen the Network and ultimately, the ecological health and livability of City. These synergies extend to reflect community values and support a vision of ecology, health, recreation and resilience thus shaping a unique opportunity for a "made in Richmond" holistic approach to land use and liveability. This approach identifies tools and common goals that are mutually supportive, and builds on and connects existing strategies with emerging priorities.

What Is The Ecological Network Management Strategy?

The ENMS (Phase 1) is a framework that will lead to the development of an action plan for establishing an inter-connected system of natural areas across the Richmond landscape. It is founded upon a suite of EN fundamentals that prioritize integration with existing City initiatives, processes, policies and projects rather than the initiation of anything new.

- Opportunistic pursuits and results. Building upon what is already happening in the City.
- Consistency, alignment and connectivity with existing City initiatives, processes, policies and projects
- Clarity of context and content. The EN builds upon City initiatives, processes, policies and projects that are already in place. Through the alignment, collaboration and integration of City action, the EN represents an opportunistic pathway forward to establish a pragmatic foundation for the preservation, enhancement and connectivity of ecological lands in Richmond.

Figure 1-1



An important part of Richmond's Ecological Network, intertidal wetlands are critical habitat for juvenile fish migrating from the Fraser River system, provide important waterfowl habitat, protect shorelines from erosion by dissipating wave energy, and capture and store carbon in accumulating sediments.

What are Ecosystem Services?

Woven into the EN is the emerging concept of ecosystem services. Simply put, ecosystem services are the benefits people obtain from ecosystems¹. In Richmond, examples of ecosystem services include the storage of rainfall in the pond in Garden City Park during storms, foraging habitat for migrating sandpipers in the intertidal mudflats outside the West Dike, the storage of carbon in thousands of years of accumulating plant material in the bog soils of Richmond Nature Park, and the North-East Bog Forest and the pollination of hundreds of hectares of blueberries by native bees and honeybees. Even the recreational value of parks and greenways is a service provided to the residents of Richmond that helps maintain healthy neighbourhoods and increases the livability and land value of the city. Ecosystem services are enhanced through green infrastructure, the physical components of the natural and built environment that provide these services. Green infrastructure is discussed below.



Building Ecosystem Services into Parks

The City is incorporating the idea of ecosystem services into the design of Richmond's new municipal parks. The large pond in Garden City Community Park is more than a beautiful part of the park landscape; it also stores and filters runoff from the adjacent neighbourhood. The new park in the Cambie West neighbourhood will also incorporate stormwater wetlands, but also hedgerows to provide habitat for songbirds and pollinators like native bees, and trees for filtering air, intercepting rain, and cooling the surrounding neighbourhood.

¹ "Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth" from Millenium Ecosystem Assessment. Ecosystems and Human Well-being: A Framework for Assessment (2003).

What is Green Infrastructure?

Like other components of the City's infrastructure such as the network of roads and sewers (often referred to as "grey" infrastructure), green infrastructure also provides essential services on which the city depends. Green infrastructure encompasses the components of the natural and built environment that provide the ecosystem services discussed above. Green infrastructure is complimentary to conventional grey infrastructure and is used to advance the resilience and sustainability of Richmond's infrastructure by employing features inherent to the natural world. Watercourses and wetlands are examples of green infrastructure because they can include both natural and constructed features, provide ecosystem services for drainage, erosion protection, flood storage, and water filtration, but also provide cultural values such as recreation and aesthetic value. Some watercourses in Richmond such as Bath Slough are also important as recreation trails and greenways. Other examples of green infrastructure are the constructed wetland at the Richmond Oval that captures and stores roof runoff, bioengineered shorelines along the Sea Island dike, the Railway Greenway which incorporates stormwater wetlands, hedgerows and trees for wildlife habitat, and the large stormwater wetland in Garden City Community Park. Figure 1-2 provides photos of different GI features in Richmond's landscape. Richmond's Green Roof Bylaw and the developing Integrated Rainwater Resource Management Strategy support the development of green infrastructure.

Figure 1-2



Large stormwater pond in Garden City Community Park stores runoff from the surrounding neighbourhood



Diverse hedgerow habitat for birds



Bath Slough Trail and riparian corridor



Community garden for pollinators



Watercourse through agricultural lands

Examples of green infrastructure in the City of Richmond

Components of the Ecological Network

The EN is composed of five main components that vary in size, condition, and ecological value. Each component is defined below.

Hubs include the largest natural areas in Richmond and are generally >10 ha. They are the core of the EN. Hubs are capable of supporting entire and diverse populations of animals and plants and associated ecological functions.

Sites are smaller (e.g., 0.25–10 ha), more discrete non-linear areas of natural ecosystems which support smaller or less diverse populations of animals and plants. These lands play an important role in increasing the structural or functional connectivity of the network by providing “stepping stones” as connections between hubs.

Corridors and Connectivity Zones provide linkages between hubs that facilitate movement of species, water, nutrients, and energy. Some may be linear corridors that are largely natural and functioning. Others may be zones of connectivity where there is not a single defined route.

Shoreline and Riparian Areas provide important buffers to sensitive watercourses and the edge of the Fraser River. These ecosystems are included as part of the EN in recognition of their important role in protecting the function of adjacent aquatic ecosystems. Many shoreline and riparian areas are linear in form and also function as wildlife corridors or greenways.

Parks and Greenways often range widely in their naturalness and ecological function. However, as most are under City control, these public lands represent some of the best opportunities for future City-led ecological restoration or enhancement projects. Most developed parks lack sufficient natural vegetation to be considered hubs or sites, but they still provide ecosystem services and are recognized as high priority sites for various degrees of restoration.

Matrix is the remainder of the land between the hubs, corridors, and other components of the EN. The Matrix is important because it encompasses most of the land base in the City. It includes many smaller ecological features (see Figure 1-3) and also provides many opportunities to restore ecological features and functions through restoration measures and the creation of green infrastructure. The matrix can contribute to the overall function and health of the EN.



Greenways for People and Wildlife: Railway Avenue Greenway

By 2016, the Railway Greenway will provide an ecological connection from the Middle Arm of the Fraser River to Steveston, through the heart of Richmond's residential neighbourhoods. Commuters, dog walkers, recreational cyclists, and visitors to Richmond will have a safe, fast, and interesting route through the city. It is anticipated that as the greenway develops, a number of Green Infrastructure components will be implemented, making this an ecologically functional link between the Middle and South Arms of the Fraser River.

Figure 1-3



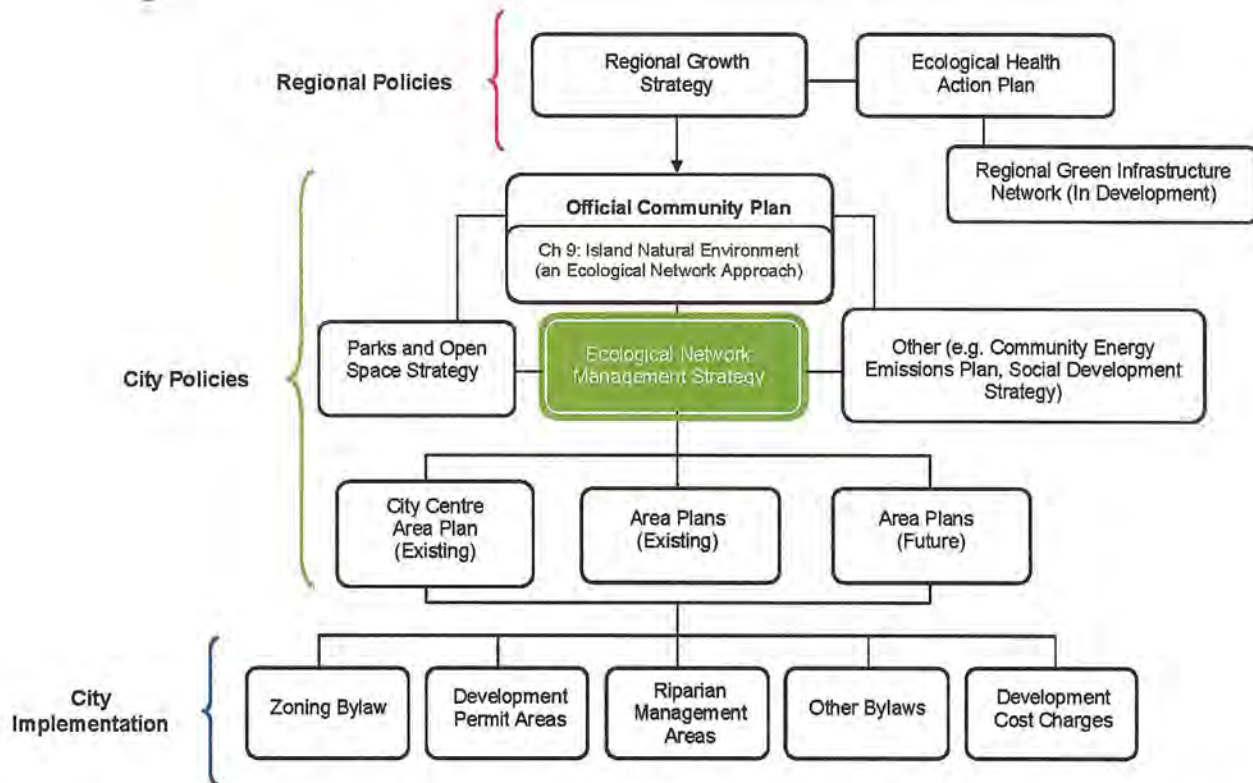
This semi-natural area in the Bridgeport area is characteristic of many remnant natural areas in the developed part of Richmond's urban Matrix. It is ecologically valuable for songbirds and other urban wildlife species, and contains a small ditched watercourse. There are a variety of opportunities for improving ecological values in the area using green infrastructure approaches: watercourse or wetland creation, tree planting, and invasive species control. Many of these opportunities could be incorporated into the development process.



Lansdowne Road Transformation Strategy: High Street Urban Ecology

A portion of Lansdowne Road was identified in the City Center Area Plan as a key location for a future linear park. The subject area, linking Lansdowne Skytrain station with the Richmond Oval and the Fraser River beyond, is rapidly re-developing from a predominantly industrial area to mixed-use residential neighbourhood with an "art walk" theme. The transformation strategy, currently being developed, has established that the street will be an ecological corridor and seeks to infuse this emerging active transportation corridor with green infrastructure, reflecting its urban context. The use of native plants, constructed wetlands, water features and the capture of rainwater from the roofs and walls of buildings will be used to create a connected urban oasis for residents, a pollinator pathway for insects, and habitat for local wildlife. The fusion of ecology and public art will also be reflected in the construction of these elements in order to broaden the public's understanding of how Green Infrastructure can be used to create community and reflect neighbourhood character.

Planning Context



The EN approach is currently supported by a range of regional and City policies, regulations and plans outlined briefly below and in more detail in Appendix 1. The EN does not aim to create a series of new regulations and policies, but compliment and where appropriate, inform the current planning and regulatory context in order to strengthen and enhance the City's natural spaces; a goal identified and endorsed by the City in a variety of contexts.

The Planning Context and Regulatory Framework

2040 Regional Growth Strategy (RGS) (Metro Vancouver)

Guiding sustainable growth in the region, the goals of the RGS must be included in each municipality's Official Community Plan. Goal 3 of the RGS ("Protect the Environment and Respond to Climate Change") contains several strategies that support the EN including the protection and enhancement of natural features and their connectivity.

Ecological Health Action Plan (Metro Vancouver)

Metro Vancouver's Ecological Health Action Plan describes how ecological health is incorporated into Metro Vancouver's plans and operations, and proposes 12 projects with associated action items that can be implemented in the next two to five years. Advancing a Regional Green Infrastructure Network in collaboration with regional stakeholders is one of the Action Plan's main projects and is currently in development (see Figure 1-4). This directly supports the EN and provides a unique opportunity for Richmond to serve a role as a key stakeholder in shaping the Regional Network.

Richmond Council Term Goals (2011-2014)

In addition to the Richmond Council Term Goals associated directly with sustainability, several other goals support component and objectives of the EN including the encouragement of volunteer programs, the creation of urban environments that support wellness and physical activity, and the continuing development of the City's parks and trails system.

Official Community Plan (OCP)

The OCP guides the City's growth and development through land use designation, policies, guidelines and targets. Chapter 9: Island Natural Environment, establishes guiding policies for the EN and the Green Infrastructure Network. In addition, policies supporting the EN or components thereof can be found in the Open Space and Public Realm section, the Sustainable Infrastructure and Resources section, the Agriculture and Food section and the Climate Change Response section.

Development Permit Areas (DPA)

Chapter 14 of the OCP contains DP guidelines for five types of environmentally sensitive areas, thus contributing to the quality of ecosystems in the EN. In addition to these, general DP guidelines and those pertaining to various forms of multi-family development often contain provisions relating to vegetation/ tree retention, rainwater collection, stormwater management and forms of green infrastructure.

Zoning

Bylaw 8500 defines watercourses, parks and landscaping. Watercourse setbacks are not included in the zoning bylaw, however, City parks are permitted in all zones.

Area Plans

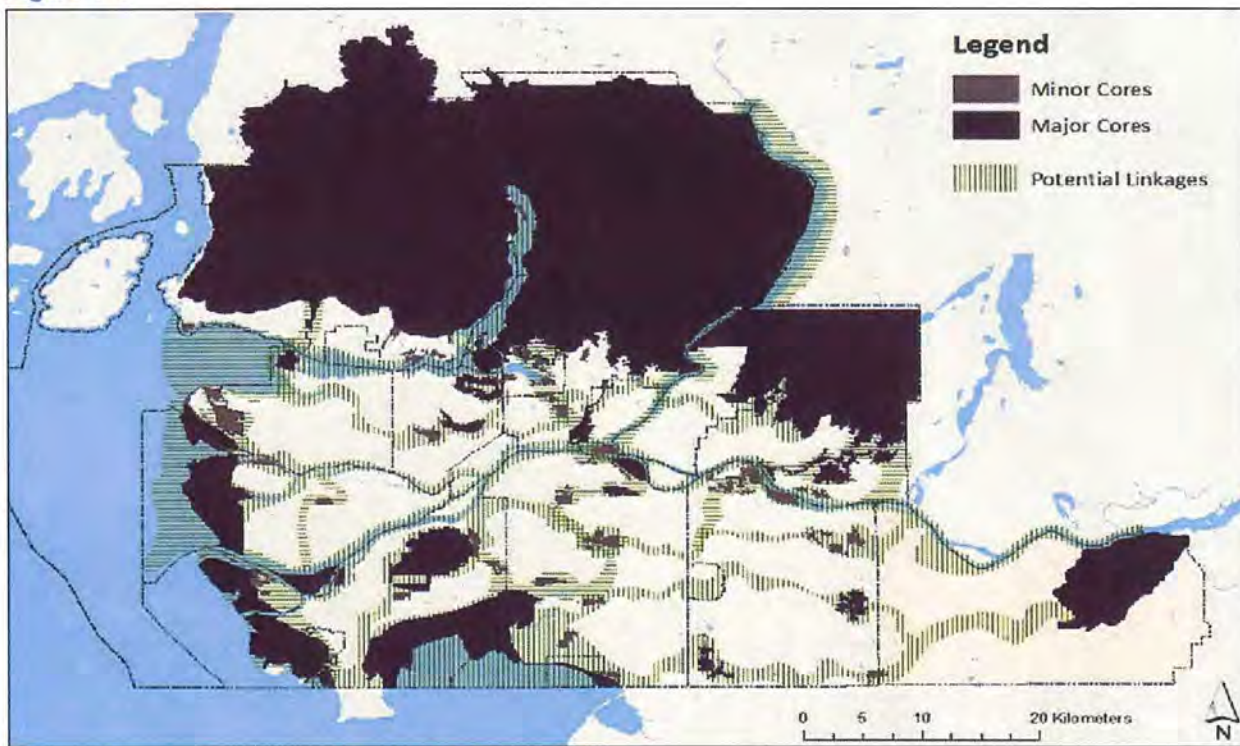
Most area plans refer to the OCP provisions regarding the natural environment. Some plans for neighbourhoods which contain major EN hubs (e.g., the East Cambie plan) contain specific policies regarding natural open space or DP guidelines that incorporate planting configurations and vegetation species that would increase biodiversity (e.g., Blundell Area East Livingston).



Hamilton Area Plan: Integrating Ecological Connections into a Neighbourhood Plan

The update of the Hamilton Area Plan was approved in February of 2014. The update provides an opportunity to improve the Queen Canal Greenway via future development. A concept strongly supported through the public consultation process, improvements to the canal would not only contribute to rainwater management and an important trail and natural amenity space, but would serve as an ecological connection between the North and South arms of the Fraser River. The Area Plan update also seeks to create a high street that will integrate creative storm water management systems with pedestrian-friendly mixed-use development. This concept proposes the use of bioswales, rain gardens and engineered wetlands; a true example of green infrastructure improvements being planned for early within a redeveloping neighbourhood.

Figure 1-4



Draft Regional Green Infrastructure Map (Source: Metro Vancouver Draft Strategy Guide for a Regional Green Infrastructure Network, 2013).

City Centre Area Plan (CCAP)

The CCAP contains a section for Ecology and Adaptability that contains policies supporting interconnected ecological services, green infrastructure opportunities and public education. The Parks and Open Space section of the CCAP speaks to the EN through policies supportive of the integration of ecological zones and greenways into the City Centre.

Bylaws

While there is no bylaw that specifically addresses the EN, there are several bylaws that support the maintenance and protection of various EN components including the Tree Protection Bylaw, the Pesticide Use Control Bylaw, the Pollution Prevention Bylaw and the Watercourse Protection and Crossing Bylaw (see Appendix for a full list).

Environmentally Sensitive Area (ESA) Management Strategy

Completed in June 2012 the ESA management strategy introduced the EN concept and served as a guiding document to update the ESA Development Permit guidelines for the recent Richmond 2041 OCP update.

Riparian Management Areas (RMAs)

In response to Provincial legislation, the City has delineated 5 or 15 metre setbacks from the top of bank of certain watercourses throughout Richmond. No buildings, structures or surface treatments are permitted within the setback, however planting of native species is encouraged. The RMA is currently not supported through Bylaws or Development Permits.

2022 Parks and Open Space Strategy (POSS) & Garden City Lands

The recently adopted 2022 Parks and Open Space Strategy is comprised of seven focus areas, each containing several outcome statements. Each focus area speaks to and supports various facets and components of the EN, with the "Green Network" focus area speaking specifically to the parks and open spaces system contributing significantly to the conservation and enhancement of the EN. This focus area contains three Outcomes, each with associated priority actions, programs and initiatives that support the EN:

1. Nature and natural areas are recognized as fundamental building blocks of a livable and healthy city.
2. The parks and open spaces system includes a range of green spaces that support recreation, social interaction and psychological and spiritual renewal.
3. The parks and open spaces system contributes significantly to the health of the EN.

This final outcome also includes an action to develop park natural areas protection and management guidelines to direct the protection and maintenance of the City's natural areas based on the recommendations of the 2012 ESA Management Strategy. This would ensure that sensitive ecological areas in parks remain protected and managed.

The status of the Garden City Lands will be governed by Council direction of the upcoming Garden City Lands Legacy Landscape Plan. This plan, once approved, will direct the intent for these lands for the future, including EN considerations for the site.

Sustainability Framework (In Development)

The Sustainability Framework is the City of Richmond's high level strategic plan to guide development into a more socially, economically and environmentally sustainable community over the coming decades. The Sustainability Framework defines the characteristics of a more sustainable Richmond; articulates how the City and other partners will pursue a sustainable community; and establishes how we will track our progress towards sustainability. The EN is a key strategy within Richmond's Sustainability Framework.

Integrated Rainwater Resources Management Strategy (IRRMS—In Development)

As a member of the Greater Vancouver Sewerage and Drainage District, Richmond has committed to the stormwater management requirements of the 2010 Metro Vancouver Integrated Liquid Waste Resource Management Plan. The IRRMS will fulfil these commitments and focuses on strategies for utilizing the resources contained in traditional waste streams such as the efficient use of energy, drinking water, nutrients in sewage and the re-use of rainwater after it falls on buildings and the ground. The strategy directly references the EN in its third objective, "Maintain the ecological health of existing habitat areas and provide enhancement opportunities to improve the City's ecological network". It provides recommendations for green infrastructure and habitat enhancements for a variety of land-use types across the City. Moreover, these recommendations focus on many of the challenges the EN seeks to address including decreasing water quality and habitat quality, increase in impervious coverage of new developments, bank erosion and slumping and strengthening infrastructure through the enhancement of green infrastructure measures that increase ecosystem services.

Social Development Strategy (2013-2022)

Richmond's Social Development Strategy was adopted by Council in 2013 and guides decisions and resource allocations on social development matters over the next 10 years. While the strategy does not directly reference the EN, it speaks to the synergies between social development, sustainability, health and creating community partnerships; many of these themes are reflected in the EN and play an important role in creating the healthy ecological communities that increased livability.

Dike Master Plan (DMP)

In response to rising sea levels, the Dike Master Plan (DMP) identifies future dike alignments and flood protection concepts for a 100 year planning horizon. Phase one of the DMP considered the Southern West Dike and the Steveston area, and its recommendations were endorsed by Council in April of 2013. Five strategic directions inform this plan:

1. Working Together
2. Amenities and Legacy
3. Thriving Ecosystems
4. Economic Vitality
5. Responding to Climate Change and Natural Hazards

The plan identifies the creation of a new primary dike alignment using Steveston Island and identifies the potential to create offshore wave mitigating barrier islands along Sturgeon Bank. Both of the concepts have the potential to create large areas of new intertidal and marsh habitat.

Partners for Beautification

The Partners for Beautification (PFB) program provides opportunities for local residents or groups to “adopt” various components of the City (street, garden, park, tree, trail, portion of the dike, or an Environmentally Sensitive Area) in order to enhance its ecological, recreational and social function as well as build a sense of stewardship and awareness within the community. The Partners for Beautification is facilitated through the Parks Department. Its framework can synergistically support increasing community stewardship, awareness and sense of ownership over the protection and management of the EN.

Roles and Responsibilities

Responsibility for managing Richmond's EN is shared by several levels of government, First Nations, private citizens, landowners, and stewardship groups. Table 1-1 on the following page summarizes the different roles government, stewardship groups, and others play in the management of the EN.

Table 1-1: Organizations and Other Groups Involved in the Management of Richmond's Ecological Network

Component	Roles and Responsibilities
City of Richmond	City of Richmond is responsible for planning and regulating land use including enacting an Official Community Plan (OCP), zoning, regulating land use and buildings, and designating parks and other amenities. Richmond uses Development Permit Areas to protect the natural environment, as well as a Tree Protection Bylaw, a Riparian Management Areas Strategy, and the Parks and Open Spaces Strategy (see Planning Context in Part 3 of this report).
Federal Government	Federal Government has a diverse role in environmental management including fish, species at risk, and migratory birds. Fisheries and Oceans Canada manages fish and fish habitat, including the foreshore of the Fraser River and some inland watercourses. Species at risk are protected by the Species at Risk Act (SARA).
Provincial Government	Provincial Government is responsible for the management of water, wildlife, contaminated sites, and other issues related to maintaining a healthy environment. The BC Ministry of Environment is responsible for the regulation of watercourses and riparian areas through the Water Act and Fish Protection Act (Riparian Areas Regulation). The Ministry of Environment manages the Sturgeon Bank and South Arm Islands Wildlife Management Areas. The Provincial Inspector of Dikes oversees dike maintenance and construction.
First Nations	First Nations have been using Richmond for over 5000 years. The Musqueam First Nation has a small undeveloped reserve on Sea Island, and is resolving land claims within an area that encompasses Richmond.

Component	Roles and Responsibilities
Metro Vancouver Regional District	MV Regional District plays a supporting role in the management of the EN. Its recent "Ecological Health Action Plan" describes a green infrastructure approach and it recently completed a Sensitive Ecosystem Inventory. The Integrated Liquid Waste and Resource Management Plan guides stormwater management. Metro Vancouver Parks manages Iona Beach Regional Park and Don and Lion islands in the Fraser River.
Port Metro Vancouver	Port Metro Vancouver, a corporation established by the Government of Canada in January 2008, owns and manages land and water-based transportation and industrial lands throughout the region, including areas south of No. 8 Road in south Richmond. It has a variety of environmental management policies and programs including the management of some of the roles associated with the now disbanded Fraser River Estuary Management Program (FREMP).
Vancouver International Airport	The Vancouver International Airport (YVR) is owned by Transport Canada. Most of its land base is developed and YVR has environmental management initiatives and policies to manage lands with ecological values.
Private Landowners	Most lands in Richmond are privately owned and include residential areas, commercial and industrial lands, and agricultural lands. Private landowners have a critical role in protecting ecological values in the EN avoiding development in sensitive areas and managing stormwater runoff and water and soil quality.
Farmers	Farmers play an essential role in the management of the EN, and given that roughly 38% of Richmond's land area is within the Agricultural Land Reserve, farming practices influence ecosystem performance and resilience.
Land Stewards	Groups and individuals involved in volunteer-based stewardship of parks and other natural areas play a critical part of the management of the EN. They support restoration and management projects, monitor ecological health, and raise the profile of natural areas conservation.



Grauer Lands: Land Acquisition and Partnerships for Stewardship

In 2012, the City of Richmond, in partnership with Ducks Unlimited Canada purchased the largest remaining privately owned land along the Sturgeon Banks. The 51 hectare area is comprised of tidal wetlands, significant for millions of migrating birds, and habitat that plays a crucial role in the life cycle of all five Pacific salmon species as well as Sturgeon, flounder and numerous estuarine species. This partnership represents an important opportunity for Richmond's Ecological Network as it not only secures privately-owned intertidal lands for ecological conservation, but also supports the connection to nearby trails, ensuring that the public will continue to experience the benefits of Richmond's foreshore natural ecology first-hand and inspire further stewardship actions and initiatives.

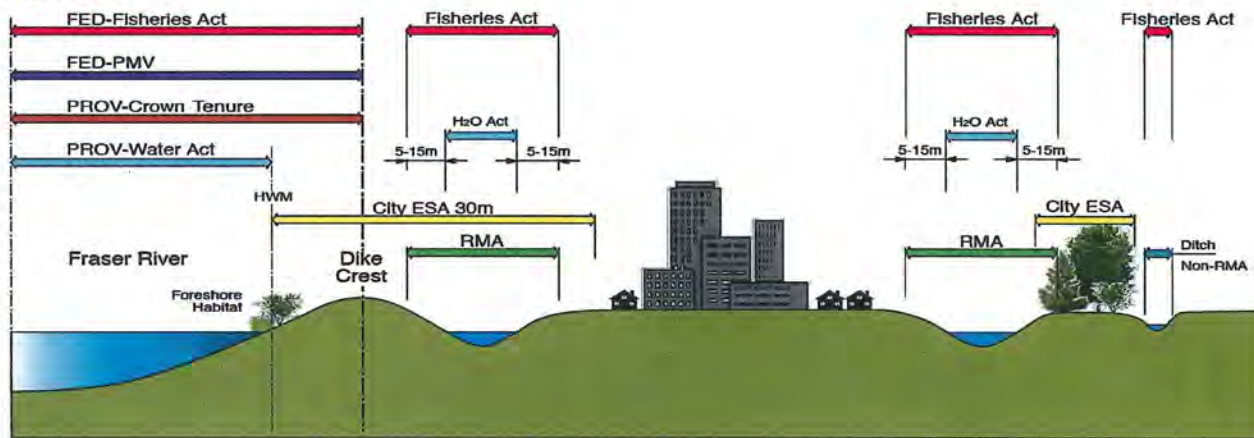
Foreshore Jurisdictions

The foreshore for the Fraser River and the West Dike is jurisdictionally complex. Key components that influence the management of the EN are summarized below:

- The foreshore and sea- or river-bed outside Richmond's perimeter dike and below the high water mark (under the Land Act referred to as "natural boundary") is owned by the Province of BC (Crown).

- The public is able to use the foreshore; however, this only includes limited rights including navigation, anchoring, mooring, and fishing.
- The Province of BC grants leases for shellfish aquaculture, log storage, moorage, and other activities. It is also responsible for dike management.
- BC's Provincial Inspector of Dikes is responsible for the general supervision of dike maintenance and construction to protect public safety. However, local dikeing authorities, such as the City of Richmond, are responsible for dike operation and maintenance activities that include inspection and emergency response.
- The federal government owns and manages the water column and is responsible for the management of fish habitat (through Fisheries and Oceans Canada) and navigation (through Transport Canada).
- Port Metro Vancouver regulates marine traffic, owns and manages industrial and port-related lands, and coordinates environmental assessments of foreshore development within its jurisdiction.

Figure 1-5



Foreshore Jurisdiction in Richmond

Importance of Agriculture Lands for the Ecological Network

Richmond's agricultural lands play a critical role in maintaining the City's environmental values and ecosystem services. Not only are they essential for food production and provide most of the City's green space, but over 30% of EN lands identified by this study are within the Agricultural Land Reserve. These areas include cultivated and natural wetlands, bog forest, remnant forest patches, and old fields. While some of these ecosystems are predominantly natural, most are the result of previous or current agricultural practices. Figure 1-6 depicts the significant role that old field sites play within a mosaic of land-uses in Richmond.



The City of Richmond recognizes the importance of farming. Farmers need to cultivate their lands to be successful, and they face many obstacles to be economically viable, often with few options to avoid farming in ecologically important areas. Examples of farming operations that protect and respect ecological areas and their beneficial services include maintaining headlands and hedgerows to protect habitat, apiculture (bee hives for honey and pollination purposes), the preservation of riparian setbacks around watercourses, and controlling runoff. Farmers often understand the ecological benefits of sound farming practices as they too benefit from clean water, unpolluted soils, and clean air. The Environmental Farm Plan Program (managed by the BC Agriculture Research & Development Corporation) is one way in which farmers can be supported in improving the ecological sustainability of their farming operations.

Delta Farmland and Wildlife Trust

The Delta Farmland and Wildlife Trust (DF&WT) is a non-profit organization that promotes the preservation of farmland and wildlife habitat through co-operative land stewardship with local farmers in the lower Fraser River delta. Each year the Trust provides local farmers with \$325,000 of cost-sharing funding through stewardship programs including the Grass-land Set-aside Program, the Winter Cover Crop Stewardship Program and the Hedgerow & Grass Margin Stewardship Programs. These programs provide farmers with tools and finances to enhance and sustain the natural areas on their properties that serve as habitat for beneficial insects, birds and wildlife, as windbreaks, as shade for livestock and for erosion control. Fostering these relationships with local farmers is key to ensuring a connected and thriving ecological network where the natural and working landscapes co-exist and support each other.

Complimenting the ecological role of agricultural lands but at a much smaller and often more urban scale, community gardens provide opportunities to integrate food growing into a variety of areas. Community gardens have a range of benefits beyond food production, including recreation and pollinator and songbird habitat. They can also be used to restore green space in brownfield sites.

Figure 1-6



Example of land use mosaic in south Richmond near Highway 1 and the Deas Island Tunnel. Industrial port development is visible along the river and two areas of agricultural old fields (shown as hubs in red) are located in the centre of the photo. Light industry is found on the western (left) flank and a small amount of single family residential occurs on the upper left.



PART 2

Mapping Richmond's Ecological Network

PART 2 – Mapping Richmond's Ecological Network

Overview

Richmond's EN was identified using a science-based approach to mapping natural and semi-natural vegetation, assessing the size, distribution, and relative value of natural habitats, and examining the potential connections between them. Vegetation was used as the primary indicator of ecological value and function because it is easily mapped from air photos, and its structure, composition, and condition can be used as a surrogate for a broad range of ecological values including biodiversity. A summary of analysis methods are provided in this section. The resultant maps for this Strategy build upon the mapping developed for the EN in the 2041 Official Community Plan (both found in Appendix 2 of this report). These include the EN Management Map (page 9-3 in OCP) and the ESA Development Permit Type Map (page 14-81 in the OCP). Note: The EN mapping undertaken for this Strategy includes the Garden City Lands. All future initiatives for the CGL will ensue in accordance with the *Garden City Lands Landscape Legacy Plan*.

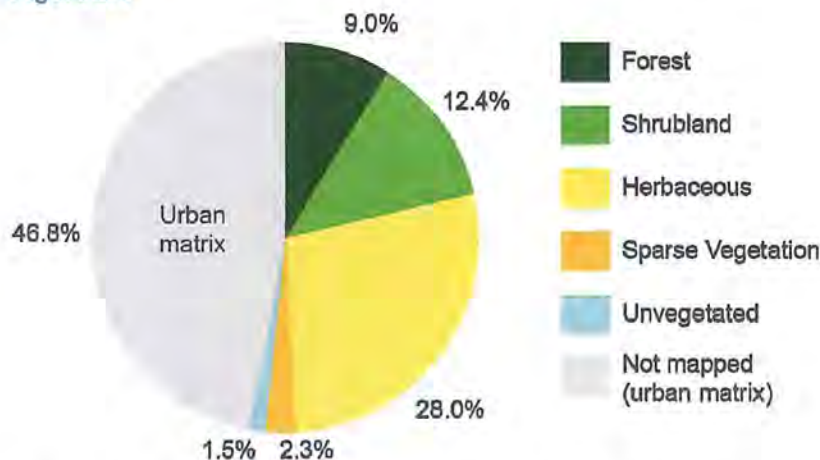
Mapping of Natural and Semi-Natural Vegetation

Natural and semi-natural vegetation in the City of Richmond was mapped using spring 2009 air photos. Vegetation was divided into five structural classes, and more detailed attributes based on vegetation structure and composition were assigned to each vegetation unit (see Table 2-1 for classification details and Figure 2-3 for examples). Larger wetlands, agricultural fields, and developed vegetation types such as lawns and gardens were also mapped. A limited field review was conducted to verify the accuracy of vegetation mapping.

Key results of the vegetation assessment are summarized in Figure 2-1 and the points below.

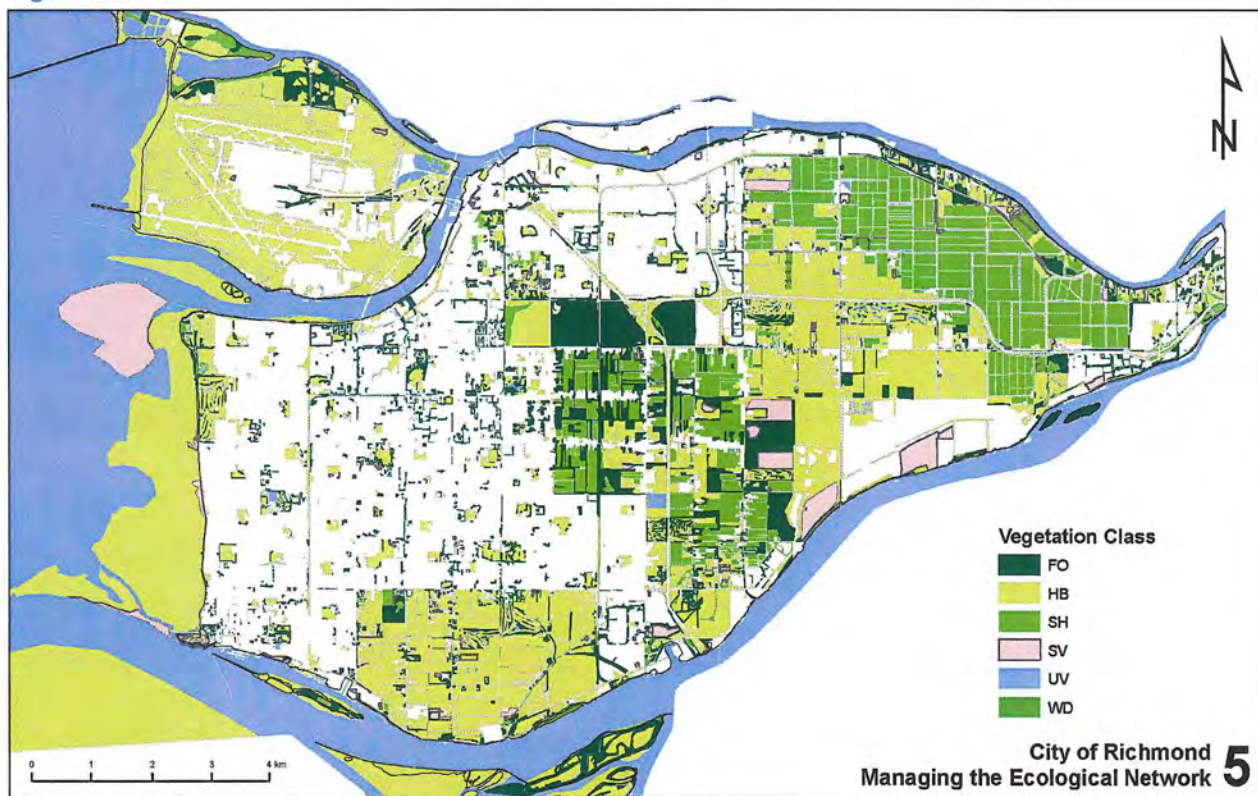
- A total of 6,841 ha of the City of Richmond's terrestrial land area (inside the high water mark) and another 13,861 ha of its marine and intertidal areas (outside the high water mark) were mapped as part of the study. Figure 2-2 summarizes the extent of different vegetation classes in Richmond.
- About 9% of Richmond is forested. Forested plant communities include bog forests composed primarily of shore pine and birch, mature black cottonwood stands along ditches and the banks of the Fraser River, and red alder stands which have regenerated in areas that were previously cleared. Some areas identified as forest are made up of planted ornamental trees and have low naturalness value.

Figure 2-1



Vegetation classes as a percentage of total land area within the City of Richmond.

Figure 2-2



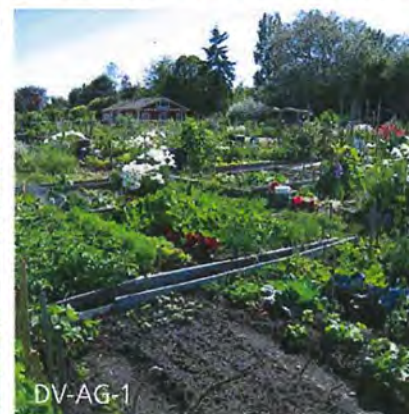
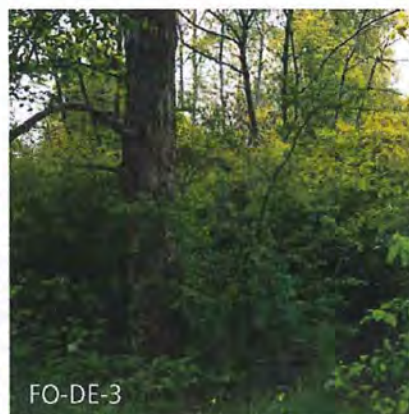
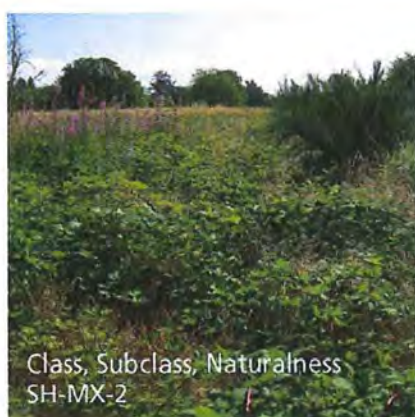
Vegetation mapping for City of Richmond showing the distribution of natural and semi-natural vegetation by class. 2012.

Table 2-1: Vegetation Classes and Subclasses

Class	Subclass
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) Hydromorphic Rooted Vegetation (HB-HY) Annual Graminoid or Forb Vegetation (HB-AN)
Sparse Vegetation (SV)	Boulder, Cobble, Gravel, Sparse Vegetation (SV-BO) Unconsolidated Material Sparse Vegetation (SV-UC)
Unvegetated (UV)	Unvegetated Unconsolidated Material (UV-UC) Unvegetated Water (UV-WA)

Table 2-2: Naturalness Values for Richmond's Vegetation

Naturalness	Definition
5. Natural	Undisturbed by direct human activity.
4. Mainly Natural	Disturbed historically (logged) by sufficient time to restore native species and structure.
3. Semi-natural	Disturbed vegetation; predominantly native species but lacking some species and structures associated with natural vegetation.
2. Altered	Heavily disturbed vegetation that is often a mix of native and non-native species; may be recovering or rapidly changing.
1. Cultural	Vegetation that is regularly maintained.



- Herbaceous vegetation is the dominant vegetation class in Richmond, covering 28% of Richmond's land area. Most of the herbaceous cover is comprised of agricultural fields, rough grass areas that are not actively cultivated, and playing fields and lawn areas in parks. Old fields (abandoned or fallow agricultural lands with a mix of grass and shrub vegetation) are also present.
- Shrub cover accounts for another 12% of Richmond's vegetation. This includes shrub communities in bogs (composed of Labrador tea, bog blueberry, and salal), agricultural fields in cranberry or blueberry production, hardhack and willow thickets in moist sites (such as along watercourses), and areas of Himalayan blackberry and other predominantly non-native shrubs along ditches, railway rights-of-way, roadsides, fence lines, and field margins.

- Only a small area of Richmond's land area (approximately 4%), is covered by sparse vegetation or is unvegetated. Sparse vegetation includes habitats like the sand dunes at Iona Beach. In contrast, 90% of intertidal and marine areas are either sparsely vegetated (e.g., mudflats) or unvegetated (mostly river channel). More natural sparsely vegetated sites include beaches and mudflats while less natural sites include dyke faces and recently cleared development sites.



Old Fields: An Important Part of Richmond's Ecological Network

The South Coast Conservation Program identified "old fields" as an important ecosystem for biodiversity in the Lower Fraser Valley. Old fields are abandoned or long-term fallow agricultural lands dominated by grasses and shrub species (often forming hedgerows and thickets). They are similar to historic natural prairie, grassland and estuarine salt marsh communities which once had a wider distribution on the South Coast. Richmond's old fields provide habitat for small mammals such as voles on which barn owls and other owls and hawks depend.

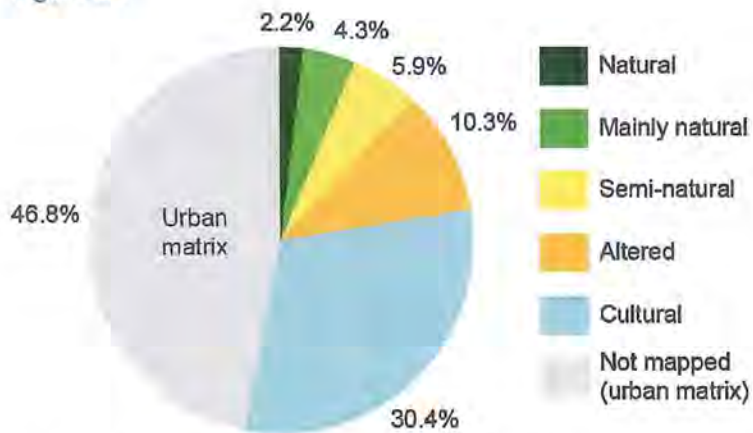
Assessing Naturalness

Vegetation naturalness is an important attribute for assessing ecological function and value, particularly for biodiversity. Naturalness describes how altered a landscape or area is from its natural state. This attribute was assessed on a scale from 1 (least natural) to 5 (most natural) for each unit (see Table 2-2 and Figure 2-3 for examples). For example, maintained non-native shrubs in a landscaped bed in an urban park generally have lower value for biodiversity than native shrub vegetation. Similarly, natural wetland vegetation is indicative of functioning hydrology and water quality relative to constructed landscape ponds without aquatic vegetation.

Key results are shown in Figure 2-4 and described in the following points.

- Of the 20,702 ha of area mapped in Richmond's boundary (land and water), 58% was classified as having some natural characteristics (Naturalness 3, 4, and 5). Only 12% of Richmond's land area has natural or mainly natural characteristics (Naturalness 4 and 5). Most is intertidal wetland, designated as ESA within the OCP.
- Within Richmond's terrestrial land area, approximately:
 - 560 ha (6%) is classified as semi-natural (Naturalness 3);
 - 558 ha (4%) of vegetation is classified as mainly natural (Naturalness 4); and
 - 283 ha (2%) was classified as natural (Naturalness 5).
- Terrestrial areas mapped as mainly natural (Naturalness 4) were predominantly remnant bog forest such as Richmond Nature Park.

Figure 2-4



Naturalness of mapped vegetation as a percentage of total land area within the City of Richmond

- The average naturalness value of Richmond's municipal parks was 1.8 which indicates a general lack of ecological features. Comparatively speaking, this is similar to the park network in the City of Vancouver but lower than City of Surrey.
- Because of Richmond's natural and cultural history (most of Richmond was originally part of the Fraser River delta, and most land was diked to allow for settlement and farming), the only vegetation classified as natural (Naturalness 5) are the foreshore marshes and mudflats on Sturgeon Banks and the western perimeter of Sea Island. Figure 2-4 shows the naturalness values as a proportion of Richmond's land area (including areas not mapped).

Identifying the Ecological Network

Several analyses using the vegetation mapping, watercourse, shoreline, and park system information were undertaken to identify the components of the EN. The main analysis focused on identifying the largest areas of natural vegetation. These were termed "hubs" because of their essential role in sustaining the EN. Hubs are essential for sustaining urban biodiversity, as well as providing other ecosystem services such as capturing, storing and infiltrating rainfall. Smaller natural areas were called "sites" and connections between EN were called either "corridors" or "connectivity zones" depending on their size and configuration. Shoreline and riparian areas, as well as parks and greenways were added to the EN because of their importance as green space for both biodiversity and people.

Hubs and Sites

Hubs are areas of vegetation comprised of semi-natural or natural vegetation (naturalness ≥ 3) and 10 ha in size or greater (see Figure 2-5 for example). Areas that were 10 ha were selected as the size threshold for hubs because they can support populations of many native wildlife species, particularly if there are other natural areas nearby. Sites are areas of semi-natural to natural vegetation (naturalness ≥ 3) between 0.25 ha and 10 ha in size (see Figure 2-4 for examples).

Shoreline and Riparian Zones

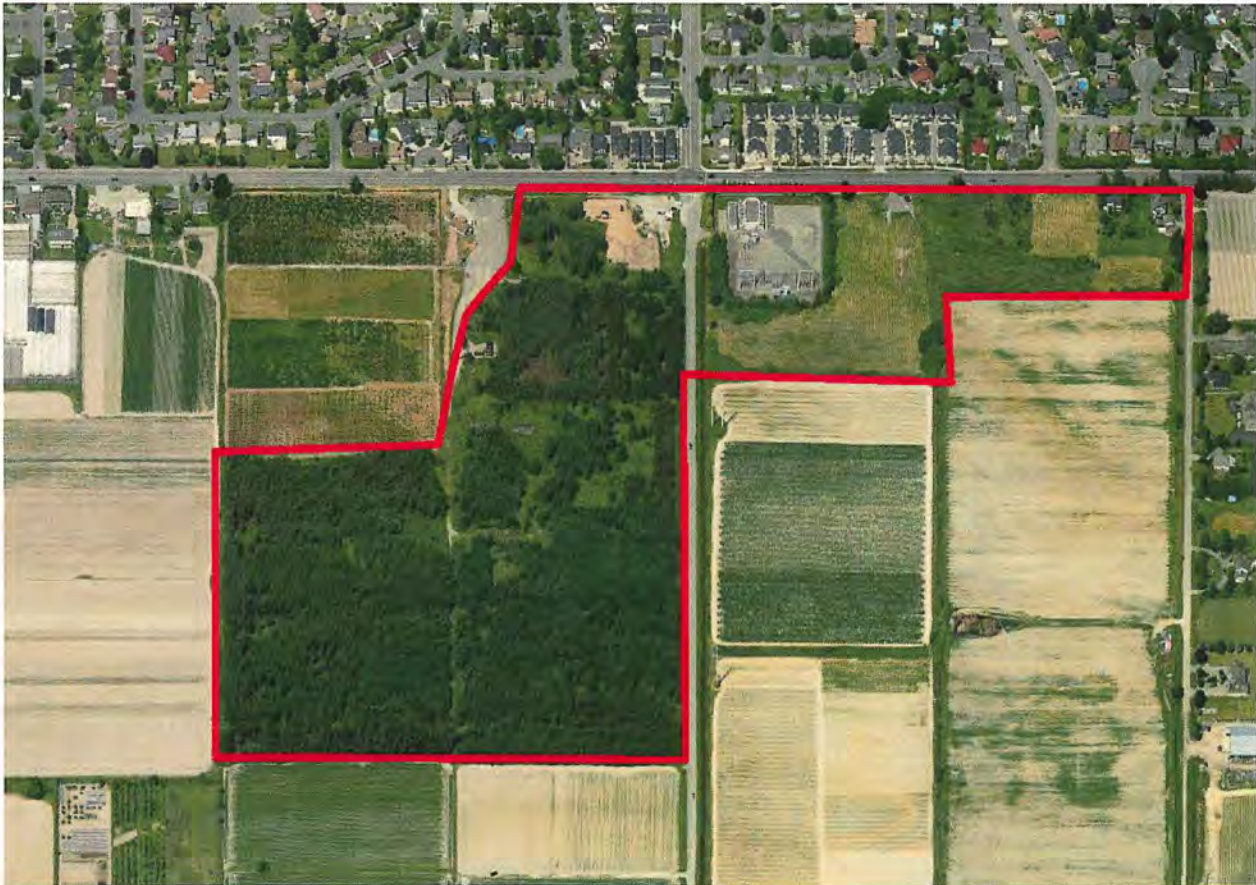
Shoreline areas (lands within 30 m (landward) of the high water mark) were added to the EN regardless of their land use, vegetation, or naturalness. These areas contribute to the health of the adjacent intertidal zone and provide important habitat for wildlife. Stable shoreline zones help maintain the ecological health of adjacent intertidal marshes and mudflats. They are also important sites to manage during development and redevelopment when ecological features such as riparian vegetation can be protected or restored.

Watercourses and their associated Riparian Management Areas (RMAs; 15 m and 5 m setbacks around selected watercourses in Richmond) are also an important part of Richmond's EN. Riparian areas are recognized as transitional areas between aquatic and terrestrial zones and have a broad range of ecological functions including shading watercourses, filtering runoff, providing nesting and feeding areas for birds and mammals, and acting as wildlife corridors in urban landscapes.

Parks and Greenways

Public parks and greenways were added to the EN for two reasons. First, they are publically-owned lands which offer opportunities for City-led restoration and enhancement focusing on green infrastructure. The stormwater pond in Garden City Community Park is an example of stormwater-related green infrastructure in an urban park. Second, most of Richmond's public parks and greenways contain only small amounts of natural ecosystems. The City can play a leadership role in EN protection and improvement by further managing some of them for ecological enhancement. Public parks and greenways cover 668 ha, just over 5% of the land area of Richmond. This represents significant opportunity for further hub and site acquisitions and ecological corridor linkages.

Figure 2-5



Large Ecological Network Hub (Gilmore-Northwest) in the agricultural area north of Steveston. The 22.9 ha unit encompasses regenerating forest, shrublands, and old fields. While the hub encompasses cultural vegetation, roads, and houses, its large size make it ecologically important.

Assessing Connectivity within the Ecological Network

Connections between different parts of the EN are essential for creating an inter-connected system. Two complimentary methods were used to assess connectivity within the terrestrial components of the EN: (1) corridor analysis using a landscape impedance model; and (2) landscape permeability using Circuitscape analysis. Both methods assess *potential* areas that allow for the movement of biodiversity through the complex ecological landscape that characterizes Richmond. The main differences are that corridor identification delineates specific routes between each hub in the EN, while the Circuitscape analysis identifies a broader range of routes or movement zones (see Figures 2-7 and 2-8). They are complimentary analyses that assist in understanding how biodiversity may move through the landscape and identifying potential corridors and connectivity zones. It should be noted that both these methods served as tools to aid in understanding the highly complex nature of species movement across a complex landscape; a difficult thing to quantify and display. These connectivity analyses represent one set of tools among several used to develop the EN Assets and Opportunities maps presented in Part 3 of this report; the maps that will serve as guides for future work and enhancements within the EN.



Ecological and recreational connections between east and west components of Richmond Nature Park are reduced by the Highway 99 Corridor (red dashed line).

What is Connectivity?

"Connectivity" is a way of understanding how wildlife and other parts of the ecosystem are able to move through the landscape. We know that many species—birds, fish, amphibians, and mammals, use different habitats for different parts of their lifecycle. We also know that urban landscapes often have poor connectivity because roads, residential areas, and developed parks create fragmented habitats. Building a functioning Ecological Network means strengthening connections using corridors like streams or greenways.

Corridor Analysis. An analysis incorporating the permeability (or, conversely, impedance) of Richmond's landscape for the movement of biodiversity was used to identify potential corridors. Vegetation mapping was combined with existing land use, roads, and other data layers to map how the landscape affects biodiversity movement. The analysis delineated paths offering the least resistance (e.g., preferred land cover types for wildlife species, lowest number of barriers) to wildlife movement between hubs. This initial corridor network was then modified and supplemented by removing corridors that were unlikely to function because of length or habitat quality, adjusting corridors to follow existing greenways and riparian corridors where they were in proximity, and adding new corridors where greenways or riparian corridors have been designated. Potential corridors were classified qualitatively according to their function where:

A **functioning corridor** is a linear area of habitat with continuous or near-continuous natural vegetation cover along its length. This type of corridor offers an existing pathway for wildlife movement between hubs.

An **impaired corridor** has some natural vegetation cover along its length but contains significant gaps that are currently compromising its function as a pathway for wildlife movement between hubs. As a result, actual use of the corridor in its current state may be limited. This type of corridor has a high potential for restoration.

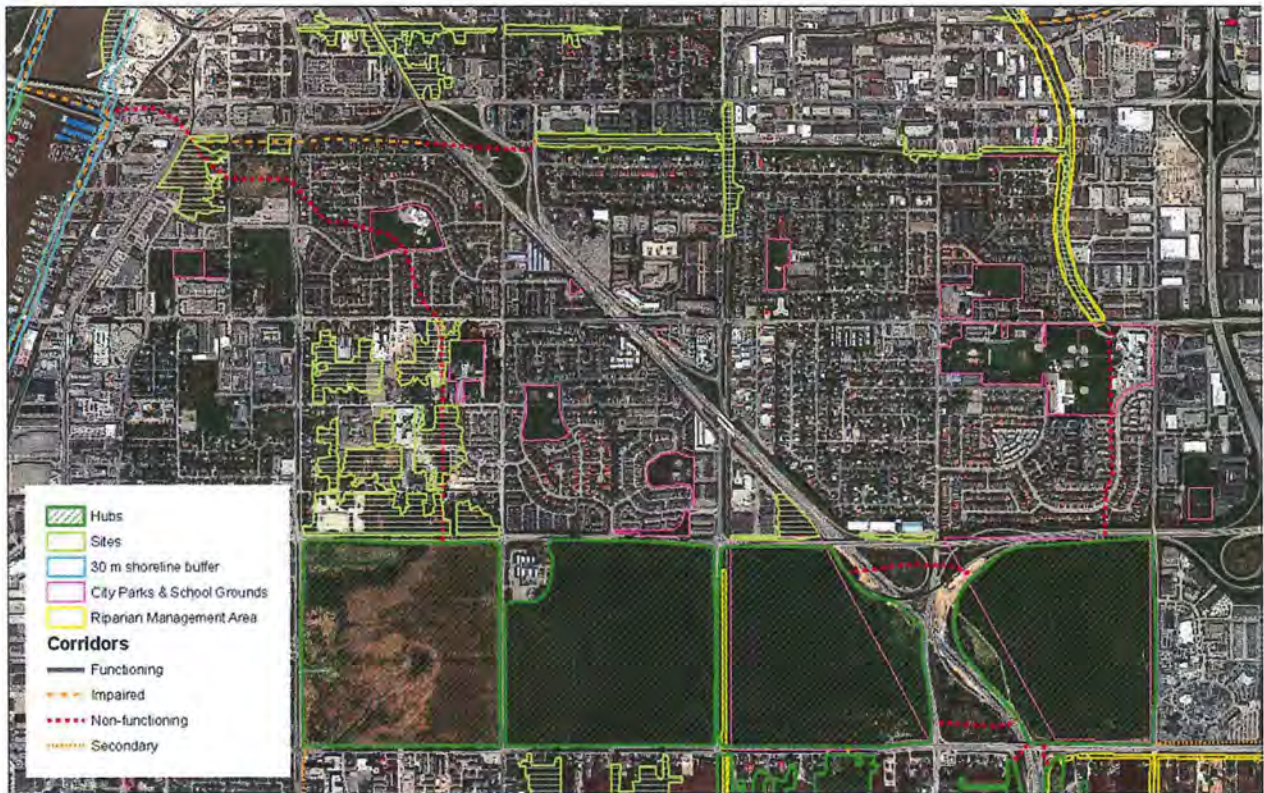
A **non-functioning corridor** has little to no natural vegetation along its length and does not function as pathway for wildlife movement between hubs in its current state. Non-functioning corridors were identified based the corridor analysis and are shown where connectivity would significantly benefit the integrity of the EN but is currently lacking. Larger-scale restoration efforts would be required to restore connectivity in these areas.

Figure 2-6



Examples of corridors and connectivity zones: Bath Slough (left) connects King George Park with the Fraser River through a linear corridor composed of watercourse, shrub and grass areas, and mixed forest. The fairways of Quilchena Golf and Country Club provide a connectivity zone (in orange) which maintains wildlife movement along the West Dike south of Terra Nova Park.

Figure 2-7

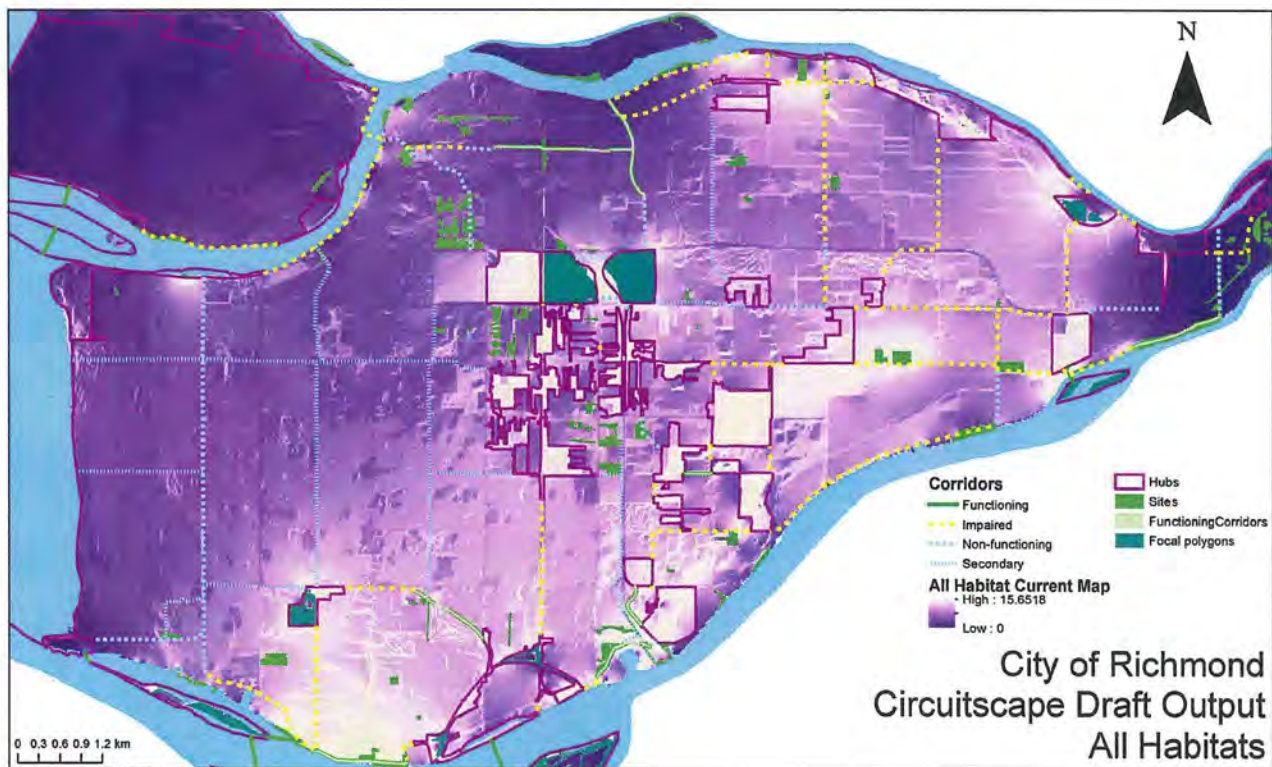


Example of Ecological Network connectivity in north central Richmond including the downtown area. Most of the identified corridors are considered "non-functioning" because of the intensity of urban land use.

Circuitscape Analysis: Circuitscape is a computer model that applies the concepts of electrical circuit theory to ecological landscapes. Simulated electrical current, representing the movement of biodiversity, finds the path of least resistance between different habitat areas. Areas of good habitat will have low resistance to the current's movement and areas of poor habitat will have higher resistance which will slow the flow of current, and in extreme cases will block the current all together. Circuitscape analysis was used to model four different habitat types (forest, wetland, shrubland, and old fields), and compared for species with high (e.g., birds) and low (e.g., amphibians) mobility.

Circuitscape has two advantages. Firstly it does not constrain connectivity to a single path or corridor. Current is free to flow anywhere and multiple pathways will often be identified as well as dead ends where a pathway meets resistance and cannot continue. This is more realistic of how biodiversity uses the landscape; mobile wildlife often use a range of possible routes or corridors rather than the single path identified (as in the corridor analysis described previously). Second, the flow of current in Circuitscape is based on the resistance a species encounters as it randomly moves across the landscape. Again, this is more realistic than corridor analysis because side routes or splits in the path are possible. An example of a Circuitscape output map is presented in Figure 2-8. Circuitscape mapping methodology is included in Appendix 3.

Figure 2-8



Example of output from of Circuitscape connectivity analysis. The lighter coloured areas indicate areas of higher connectivity, with darker purple areas indicating low connectivity.2012.

Key results of the connectivity analysis:

- The corridor analysis identified 74 km of corridors that were delineated within Richmond's EN. 29 km (39%) of these corridors are located along foreshore areas within the Agricultural Land Reserve. 17 km (23%) of these corridors are located along foreshore areas. Figure 2-8 shows the range of corridors (functioning or non-functioning) in heavily urbanized north-central Richmond.
- 12 km of corridors (17%) mapped in Richmond were identified as functioning and currently provide connectivity between adjacent hubs within the network. 45 km of corridors (60%) were classified as impaired and, while providing some connectivity currently, could be improved with minor restoration and enhancement. 17 km of corridors (23 %) were identified as non-functioning. Non-functioning corridors currently do not provide connectivity but represent opportunities to improve connectivity during large-scale City planning.
- The Circuitscape analysis provided complimentary results but was more difficult to interpret. Figure 2-9 shows an example of the city-wide results for the generalized model (all habitats + high and low dispersers).
- Circuitscape highlighted three important results. First, distance is important for connectivity. Habitat patches that are close together, such as the bog forests, old fields, and forests of central Richmond, are better connected than patches that are more isolated. Second, where there is a well-defined route like Horseshoe Slough, adjacent areas become less important for maintaining connectivity. Three, the residential areas of west and central Richmond have very little in the way of functioning ecological connections which emphasizes the value of the Railway Avenue Greenway and other constructed corridors.

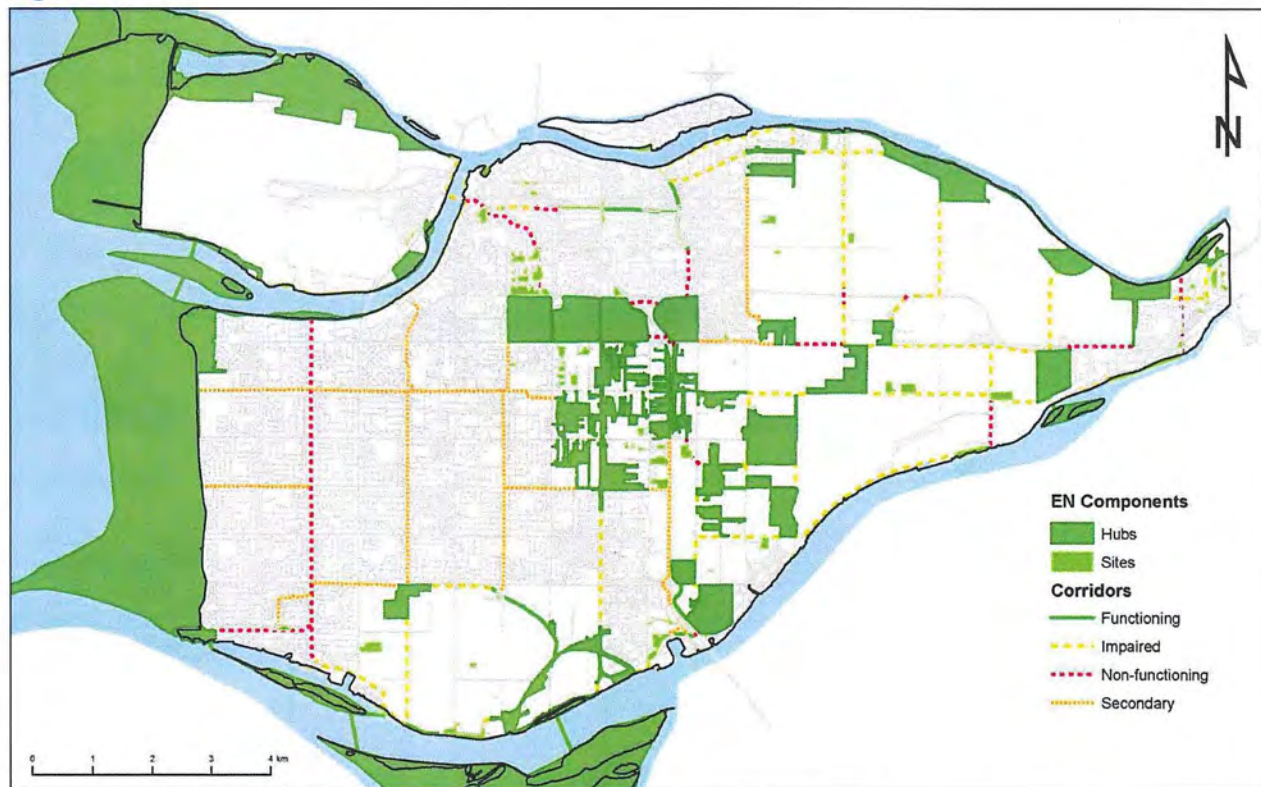
Summary of Richmond's Ecological Network

Richmond's EN is shown in Figure 2-9 and summarized in Table 2-3.

Key points:

- About 23% of the City's total area, including intertidal and marine areas, is within the EN. Almost 2/3rds of the EN is comprised of large hubs, of which over half are marine and intertidal areas. Sites account for <1% of the network, while shoreline and riparian zones make up about 5%.
- A total of 38 hubs and 103 sites were identified in Richmond's EN.
- Hubs range from well-known natural areas such as Richmond Nature Park, Sturgeon Banks and South Arm Islands Wildlife Management Areas, Terra Nova Rural Park, and the Sea Island Conservation Area (SICA), to lesser known areas such as Horseshoe Slough, Northeast Bog Forest, cottonwood forests along River Road, and bog forest areas on either side of Shell Road.
- The five largest hubs within the City of Richmond are Sturgeon Banks (1,025 ha), South Arm Islands (807 ha), Sea Island Southwest (501 ha; predominantly the mudflats west of airport and south of Iona Jetty), Iona Island (269 ha), and Sea Island North (252 ha).
- Most of Richmond's hubs are either outside of the dike (approx. 70%) or within Richmond's Agricultural Land Reserve (approx. 30%). Less than 1% of Richmond's hubs are inside the dike and not in ALR lands. This highlights the importance of Richmond's agricultural areas in contributing to ecological values, especially those which have remained uncultivated and/ or representative of native bog forest environments. It is also an indicator of how few natural areas have been protected within the urban (non-agricultural) areas of Richmond.
- The largest hubs on Lulu Island are along River Road (82 ha; River Road between Kartner Road and Nelson Road), Fraser Lands West (72 ha; west of South Shore port between No. 6 Road and No. 7 Road), Terra Nova (66 ha), and Horseshoe and Finn sloughs (63 ha). With the exception of Terra Nova, all of these hubs are located within the Agricultural Land Reserve.
- Sites are frequently located adjacent to foreshore areas, along watercourses, in agricultural areas, or along transitions between different land use types. Sites include an area in the Cambie West neighbourhood, small foreshore parks such as the off-leash Dog Park (along South Arm of the Fraser River), and Hamilton Highway Park (along Highway 91).
- Concentrations of sites also exist within the Bridgeport, West Cambie, Broadmoor, and Hamilton neighbourhoods of Richmond.
- Connectivity is generally poor because of the intensity of urban or agricultural land use throughout Richmond. Many corridors were classified as non-functioning or impaired. However, the Circuitscape analysis highlighted some areas of better than anticipated connectivity (e.g., central Richmond), as well as areas where connectivity can be improved through the creation of greenways and linear parks.

Figure 2-9



Current state of Richmond's Ecological Network including hubs, sites, parks, shoreline and riparian zones, and corridors.2012.

Table 2-3: Summary of Richmond's Ecological Network Components

Component	Hubs	Sites	Connections ¹	Shoreline and Riparian Zones	Parks and Greenways	Matrix
Definition	Large areas of natural and semi-natural vegetation	Small areas of natural, semi-natural, and semi-modified vegetation	Linear connections or zones of connectivity between hubs, variable width when finally established	Linear strips along dyke areas and watercourses to protect aquatic habitats and other values	City-owned and managed recreation lands, as well as non-City owned schools sites; opportunities for restoration and enhancement	Areas surrounding hubs, sites, and corridors including urban and other modified areas and open water
Size	> 10 ha	0.25–10 ha	30 m wide corridor	30 m buffer inside dyke; 30 m outside dyke; 15 m and 5 m Riparian Management Area buffer	various	n/a
Total Land Area ²	1,597 ha	178 ha	181 ha	755 ha	667 ha	9,353 ha

Component	Hubs	Sites	Connections ¹	Shoreline and Riparian Zones	Parks and Greenways	Matrix
% of Land Area ²	13%	1%	1%	6%	5%	74%
Total Intertidal and Marine Area ³	2,421 ha	31 ha	6 ha	470 ha	47 ha	11,158 ha
% of Intertidal and Marine Area ³	17%	0.2%	0.0%	3%	0.3%	79%
Total Area of City ⁴	4,017 ha	209 ha	187 ha	1224 ha	636 ha	20,510 ha
% of Area of City ⁴	15%	0.8%	0.7%	5%	2%	77%
Number	37 hubs	102 sites	84 corridors	-	-	-

¹ Includes functioning, impaired, and non-functioning corridors, and zones of connectivity.

² Includes all areas above the high water mark.

³ Includes all areas below the high water mark.

⁴ Includes all areas within the City boundary, including intertidal and marine areas.



PART 3

Vision, Goals and
Strategy Areas

ECOLOGICAL NETWORK
STRATEGY AREAS

☒ CITY CENTRE

☐ URBAN NEIGHBOURHOODS

PART 3 – Vision, Goals and Strategy Areas

The Official Community Plan (OCP) states that Richmond's population is expected to increase by 80,000 people by 2041. While the City is preparing to accommodate this growth through infrastructure expansion (e.g., approximately 42,000 new housing units will be needed by 2041) and the updating of Area Plans, the City will also accommodate this growth by enhancing and expanding the natural spaces and green infrastructure that currently make Richmond a healthy, livable City.

The EN has thus far been defined, spatially delineated and assessed in terms of its current components and its current quality. In order for the EN to serve as a relevant and evolving tool for managing Richmond's natural areas, the EN must be future-thinking and set the course for implementation at various scales and through a diverse and flexible set of means. Chapter 9 of the OCP supports this course of action, and the following sections provide the vision, goals and identify the key issues and opportunities that will ensure the EN's continued relevance and strategic implementation.

EN Vision

The Ecological Network is the long-term ecological blueprint for the collaborative management and enhancement of the natural and built environments throughout the City, within neighbourhoods, and across land-uses and development types in order to achieve ecologically connected, livable and healthy places in which residents thrive.

The EN is built upon four primary goals, each one contributing to the achievement of the vision, and each one lending itself to the opportunistic and collaborative approach outlined below.

Goals

1. **Manage and Enhance our Ecological Assets** – Richmond is home to a unique mix of diverse ecological places; many of which are managed through a range of municipal, provincial and federal levels of jurisdiction. The EN seeks to ensure that these protected areas remain so and are actively monitored and enhanced over time so they continue to provide the ecological services vital to community health.
2. **Strengthen City Infrastructure** – There is vast opportunity to expand the traditional approach to infrastructure in the City through the inclusion of green infrastructure. The EN seeks to not only identify priority areas where the incorporation of green infrastructure into the built environment will enhance building and street performance and efficiency, but also where it will positively contribute to the public realm in terms of ecosystem service provision, education and amenity. Green infrastructure ensures resilience of the built environment while strengthening its connection with the community.
3. **Create, Connect and Protect Diverse and Healthy Spaces** – Complimenting the management and enhancement of our current protected ecological assets (Goal #1), is the need to strategically identify unprotected ecological assets under threat and create a variety of new protected spaces that will be connected to and enrich the existing Network. The EN seeks to identify these areas in a manner that is opportunistic; working with the current and potential function of present ecology, the needs of the community, and future development processes.
4. **Engage through Stewardship and Collaboration** – Central to the continued success of the EN is the community's sense of stewardship over the Network at different scales and levels of participation. The EN seeks to ignite collaboration and stewardship through community involvement and engagement at all levels of EN delivery.

Implementation Framework

The plan will be implemented through an opportunistic and collaborative approach that will maximize current and future land-use and development policies, guidelines, partnerships, City-wide initiatives, and area-specific projects. Plans, projects and processes which collectively implement the EN demonstrate how this framework for on-the-ground action is incorporated within the City's planning and development context.

In consultation with various City departments, ten (10) EN strategy areas were identified. The strategy areas are based upon vegetation distribution data, land-use, and current and future stewardship and development opportunities. The purpose of the strategy areas is four-fold:

- To provide an overview of Richmond's current ecological assets;
- To identify and group the key areas of the City in order to focus future specific actions where most appropriate;
- To provide tailored guidance on how the EN can be strengthened by different vegetation/ land-use types within the City; and
- To identify the critical issues, key opportunities and stakeholder considerations that pertain to the enhancement and enrichment of the EN in specific areas.

The ten strategy areas are outlined in the following pages. A general description of each area and a statement about the desired outcomes for that strategy area within the context of the EN are provided. In addition, an overview of each area's critical issues, key opportunities and specific stakeholder considerations included in order to guide the stakeholder and public consultation process that will lead to the development of the second phase of the EN management Strategy; the action plan. To organize future actions and consultation, six areas of focus are identified for each strategy area:

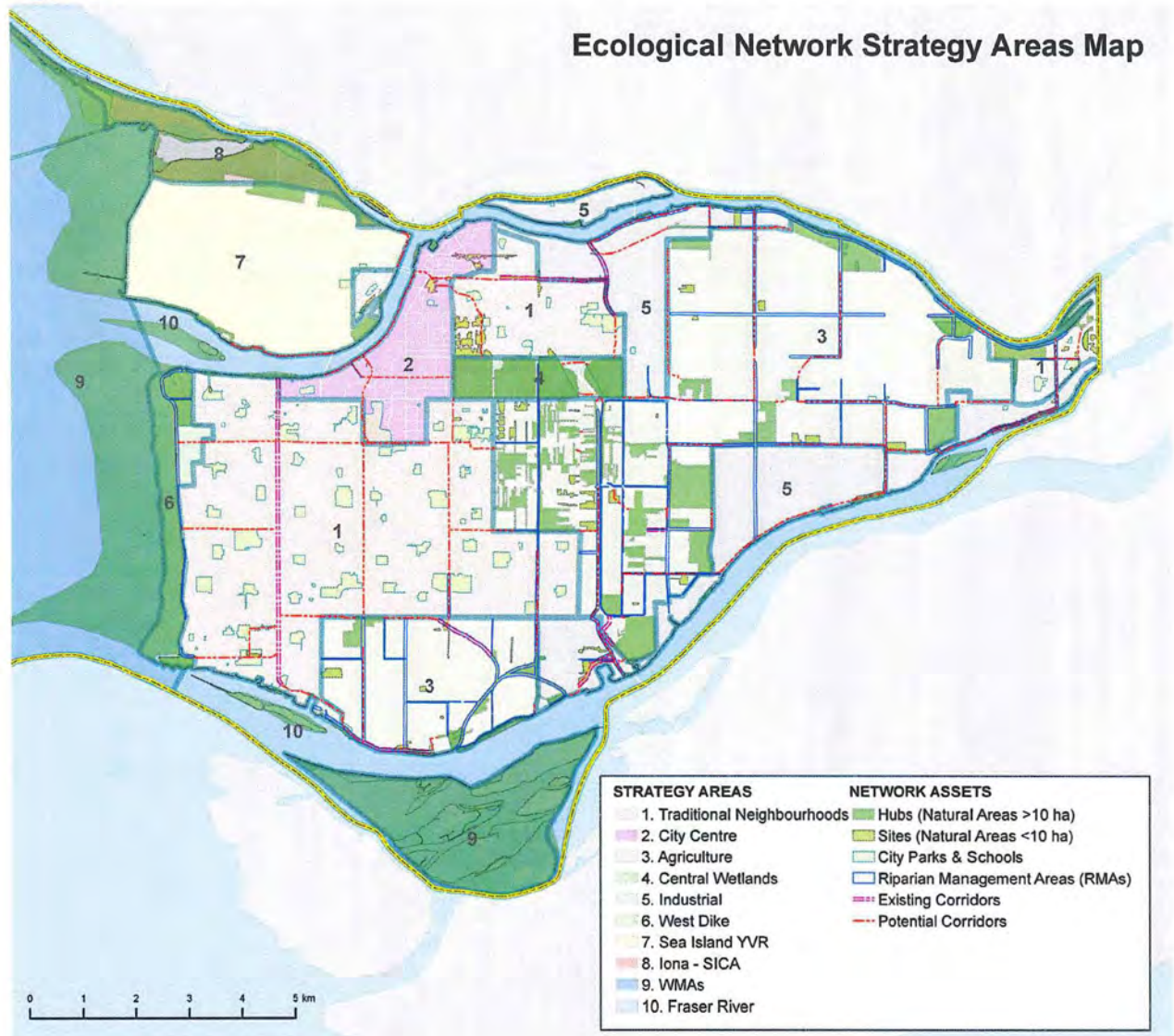
- Rainwater Management/ Infrastructure
- Vegetation/Habitat
- Wildlife
- Parks, Open Space, Public Lands
- Private Development
- Stewardship

These areas of focus were selected as they represent the EN's various areas of application within the City's planning, development, and operational context. These are also the various themes under which future actions can be applied to fulfill the Goals outlined above. While the application of these areas of focus within each strategy area will vary by land-use, vegetation, City jurisdiction and community, the key message in identifying the components of each of the strategy areas, is that the EN has a role to play on public and private lands, in the natural and built environments and as a catalyst for stewardship and community action.

Ecological Network Strategy Areas

In direct response to general desire expressed by various City departments for the future management of the EN to be supported by a visual tool, a new mapping product was developed. Figure 3-1 presents an Ecological Network Strategy Areas Map as an on-the-ground guide that not only reflects the current condition of the EN, but identifies priorities in the direction of its long-term evolution via delineation of the 10 strategy areas. The intent is that as the EN is enhanced and expanded, this will be amended to reflect that detail and identify new opportunities.

Figure 3-1



Ecological Network Strategy Areas Map.2014.

STRATEGY AREA 1: TRADITIONAL NEIGHBOURHOOD

Richmond's traditional neighbourhoods are comprised primarily of West Richmond, Burkeville, Hamilton, Steveston and portions of the East Cambie, West Cambie and Bridgeport neighbourhoods. West Richmond and Burkeville are primarily single-family residential neighbourhoods, while East and West Cambie and Steveston offer a range of housing types including single-family, townhouses and low-rise building. Over time, under the Hamilton Area Plan, this neighbourhood will become more dense, offering a range of housing types and services. **Ecologically, Richmond's traditional neighbourhoods offer the most opportunity for enhancement as they contain the majority of the City's neighbourhood parks, schools, community centres and backyards; areas ripe for stewardship activities and community engagement.** In addition to these assets, Richmond's traditional neighbourhoods contain key features such as the Railway corridor (West Richmond), the Queen Canal (Hamilton), and Alexandra Greenway (West Cambie). Finally the West Richmond neighbourhood borders on the highly diverse and ecologically valuable West Dike and Sturgeon Bank Wildlife Management Area beyond.





Desired Outcomes: Healthy traditional neighbourhoods where neighbourhood parks, school yards and community centres provide spaces for recreation, natural habitat, ecological stewardship and education. These local ecological nodes are connected via an evolving system of trails, greenways, developed urban tree canopies, and ecologically rich back-yard environments that serve as unique areas of rainwater filtration and management. Local residents are well connected to each other via a range of stewardship and education opportunities and feel empowered to be stewards of the natural environment that surrounds their homes, schools and places of work.

Critical Issues	<ul style="list-style-type: none"> • Loss of native and non-native vegetation through ongoing development • Increase in impermeable surfaces (paved lots, driveways) • Riparian Management Area process (awareness raising) • Automobile-centric neighbourhoods and patterns of development (landscape fragmentation, increased impermeable surfaces, decreased walkability) • Invasive species proliferation and loss of native vegetation/ habitat • Inadvertent Encroachment on City-owned lands • Unpermitted tree removal
Key Opportunities	<p>Naturalization and green infrastructure initiatives in:</p> <ul style="list-style-type: none"> • Backyards • School Sites • Neighbourhood parks & Community Centres • Greenways and pedestrian/ cycling infrastructure & trails • Core stewardship community located here • Large portion borders on the West Dike and Terra Nova • Watercourses • Stormwater management • Maintenance of trees
Stakeholder Considerations	<ul style="list-style-type: none"> • Residents • Residential developers/ small builders • School District (Green Ambassadors and beyond) • Terra Nova outdoor pre-school • PFB participants • Walk Richmond • Community gardeners • Community Services Advisory Committee

STRATEGY AREA 2: CITY CENTRE

Richmond's City Centre is rapidly developing into a high-density mixed-use urban environment characterized by the commercial corridor along No. 3 Road. The area is undergoing a period of rapid development, with significant opportunity for green infrastructure interventions as development takes place. Areas such as the Lansdowne corridor future linear park, and current and future park and habitat enhancement opportunities along the middle arm of the Fraser River, the Lansdowne Mall site, and potentially at Minoru present unique opportunities for green infrastructure integration into the landscape. **Progressive rainwater management strategies, the re-introduction of native vegetation, the provision of appropriate habitat, reduction of the urban heat island effect, and trail and greenway links between pedestrians, cyclists and amenities, are all examples of green infrastructure opportunities.** There is also ample opportunity to engage private developers in the incorporation of various green infrastructure features through the re-development process. The City Centre Area Plan (CCAP) provides additional detail on future parks, greenways and green links, as well as information about connectivity in an urban environment. It serves as an example of how an Area Plan successfully incorporates EN language and concepts.



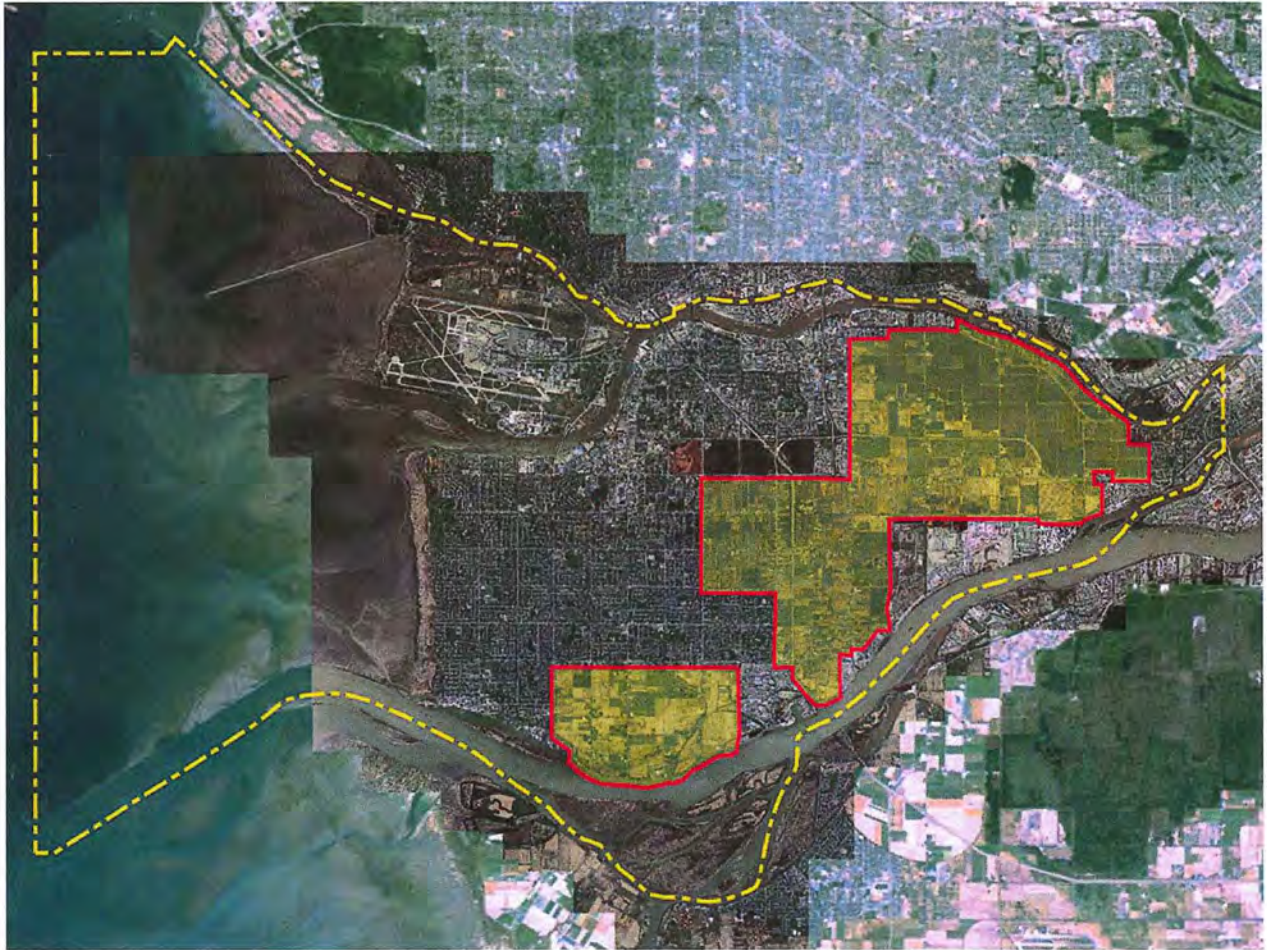


Desired Outcomes: The dynamism of a highly urban environment is heightened through the incorporation of ecological function into the urban hardscape with innovative and educational stormwater management features such as swales, rain gardens and engineered wetlands. A continuous tree canopy provides shade, respite and habitat, while continuous landscape elements are composed of native and drought tolerant species. Urban shoreline areas balance recreation with the ecological requirements needed to sustain highly sensitive habitats. Linear parks, urban parks and greenways not only connect pedestrians and cyclists with various amenities, but inherently provide ecological services such as water filtration, air purification, habitat, opportunities for education and natural beauty. Development and EN principles work in tandem to result in the creation of resilient infrastructure and healthy urban environments.

Critical Issues	<ul style="list-style-type: none"> • Loss of native and non-native vegetation through ongoing development • Increase in impermeable surfaces (paved lots, roads, driveways) • Major transit and commercial corridor • Increase in residential development, especially transit oriented development and waterfront development—20,000 new dwellings needed by 2021 (CCAP) • Pre-existing site contamination • Water quality and run-off (including sediment and erosion control for construction projects)
Key Opportunities	<ul style="list-style-type: none"> • Green infrastructure interventions included at the planning stage • Opportunities for innovative green design requirements • Stormwater Management (IRRMS) • Gradual re-development of large areas with significant civic and public park uses (e.g. Lansdowne) • Increased shoreline ecosystem protection and integration through development • City as a "Living Lab" for green infrastructure trials (e.g. stormwater management innovation) • Partnerships with planning/ architecture/ design programs
Stakeholder Considerations	<ul style="list-style-type: none"> • First Nations • Residents • Urban Development Institute/ Developers • Local business and organizations (e.g. Chamber of Commerce, Tourism Richmond, Steveston Merchants' Association) • Kwantlen & other academic institutions • Translink

STRATEGY AREA 3: AGRICULTURE

Agriculture is a significant land-use within the City of Richmond, yet it does not result in homogeneous vegetation cover or land-use patterns. The Northeastern portion of this area sits atop very moist peat soils and thus comprises of the majority of Richmond's peat-based agriculture (cranberries and blueberries), whereas the central and south western agricultural areas contain field crops, fallow areas, and permitted residential and commercial development. **Key ecological features in the Agriculture Strategy Area include the North-East Bog, a large portion of Richmond's Environmentally Sensitive Areas (ESAs), a significant portion of the City's Riparian Management Areas (RMAs), the majority of Horseshoe Slough and significant shoreline areas along the North and South arms of the Fraser River.** As the majority of the area is privately held and within the Agriculture Land Reserve (ALR), there are limited ecological requirements that the City can place upon such lands, however key initiatives such as Environmental Farm Plans (administered by the BC Agricultural Research & Development Corporation), the exploration of conservation leases, and the encouragement of hedgerow and Riparian Management Areas stewardship will ensure that the ecosystem services inherent to agricultural lands (water filtration and retention, habitat provision, healthy soils) are enhanced and connected to adjacent EN features over time.





Desired Outcomes: Agricultural lands play a significant socio-ecological role within the City of Richmond. Farming livelihoods are supported through EN initiatives and contribute to healthy environments while remaining viable. Significant natural habitats are identified and protected via a range of mechanisms including conservation leases, incentives programs and strategic land acquisitions.

Critical Issues	<ul style="list-style-type: none"> • Development that erodes useable farmland and farming livelihoods—(increase in impervious development and/or loss of productive soil) • Loss of Environmentally Sensitive Areas (ESAs) • Impacts to Riparian management Areas (RMAs) • Maintenance of ecologically beneficial habitat areas and ecosystem services that contribute to soil and water health • Inadvertent encroachment onto City land • Management of invasive species • Urban/ industrial/ agricultural interface
Key Opportunities	<ul style="list-style-type: none"> • Majority of City's ESA sites and hubs are located here and significant number of RMAs • Finding synergies between conventional farming and environmental health (hedgerows, wind throws, clean water/soil) • Several voluntary programs: setback program, hedgerow development, riparian area protection, biodiversity farm plans)
Stakeholder Considerations	<ul style="list-style-type: none"> • Farmers and farmers associations/institutes • Non-farming residents • User groups (recreational, bird watching, etc.) • Local business • Religious community • Non-profits (e.g. Richmond Food Security Society, Delta Farmland and Wildlife Trust) • Agricultural Advisory Committee • Agriculture Land Commission

STRATEGY AREA 4: CENTRAL WETLANDS

Forming the largest in-land contiguous system of EN Hubs in Richmond, the Central Wetlands are comprised of the Richmond Nature Park, the Department of National Defence (DND) lands and the Garden City Lands. These wetlands represent the remaining pieces of what was once the Greater Lulu Island Bog and are characterized by peat soils, bog forest (most prevalent in the Richmond Nature Park) and species such as blueberry, heather, birch, pine, Labrador tea, willow and hemlock as well as a rich communities of mosses, lichens and fungi. The central Wetlands also provide critical habitat to a host of wildlife including the Garter snake, the Pacific Chorus Frog, coyotes, Mule Deer, voles, shrews and a variety of birds of special interest such as Great Blue Heron, Barn Owl and Pileated Woodpecker. **The central wetlands are fragmented, and are threatened by adjacent development, road expansion and invasive species; however, they continue to play a key role in maintaining residual wildlife populations in Richmond.** In addition, the peat soils of these wetlands could serve as significant areas for carbon sequestration if managed and enhanced over time.





Desired Outcomes: The Central Wetlands continue to play a significant role in habitat provision, hydrological function and ecosystem services for the City of Richmond. Ecological enhancements, including the removal of invasive species and the management of wildlife ensure that these remnant wetlands remain ecologically productive, serve as reminders of our natural history, and provide areas for on-going education, stewardship and local identity.

Critical Issues	<ul style="list-style-type: none"> • Largest remaining area of the original Greater Lulu Island Bog • Invasive species proliferation • Lack of baseline data for hydrological regime • Fragmentation (road expansion, development, invasive species) • Future status of Department of National Defence lands • Ecological connectivity between the four Central Wetland parcels • Garden City Lands Legacy Landscape Plan
Key Opportunities	<ul style="list-style-type: none"> • High-profile and unique natural area within the City • City ownership and control of 3 out of 4 parcels • Representative of Richmond's cultural and natural heritage • Stewardship community already active • Largest in-land hubs in the City • Consultation and concept development around the Garden City Lands
Stakeholder Considerations	<ul style="list-style-type: none"> • Richmond Nature Park Society • Richmond Food Security Society • User groups (bird watchers, passive recreation) • School district • Kwantlen • Residents (target those in adjacent neighbourhoods especially in rapidly developing Cambie/Alexandra neighbourhoods) • Residents (of Richmond) • Department of National Defence

STRATEGIC AREA 5: INDUSTRIAL

Industrial areas in the City comprise of a variety of land uses including Industrial/ Office Business Park, Industrial only, and Industrial/ Office/ Limited Retail. In general, impervious paving and coverage tend to dominate these areas with very few pockets of natural or pervious space. Ecologically, Richmond's industrial strategic areas abut extensive portions of the Fraser River, thus creating significant opportunities for ecological management and restoration in addition to those outlined in the ESA DPA for Shoreline and Intertidal areas. **The Industrial strategic area presents an important opportunity for stewardship, restoration and enhancement through the Bath Slough Revitalization Initiative. The initiative builds on the upgrade of the Bath Slough pump-station in 2014 and will revitalize one of Richmond's last remaining sloughs through a series of actions and programs including; invasive species removal, native vegetation planting, and bank stabilization.** In addition, the area provides ample opportunity for the development of green infrastructure interventions such as green roofs, innovative stormwater management measures (especially in managing areas with significant impervious paving), pervious paving, rainwater collection and on-site re-use.



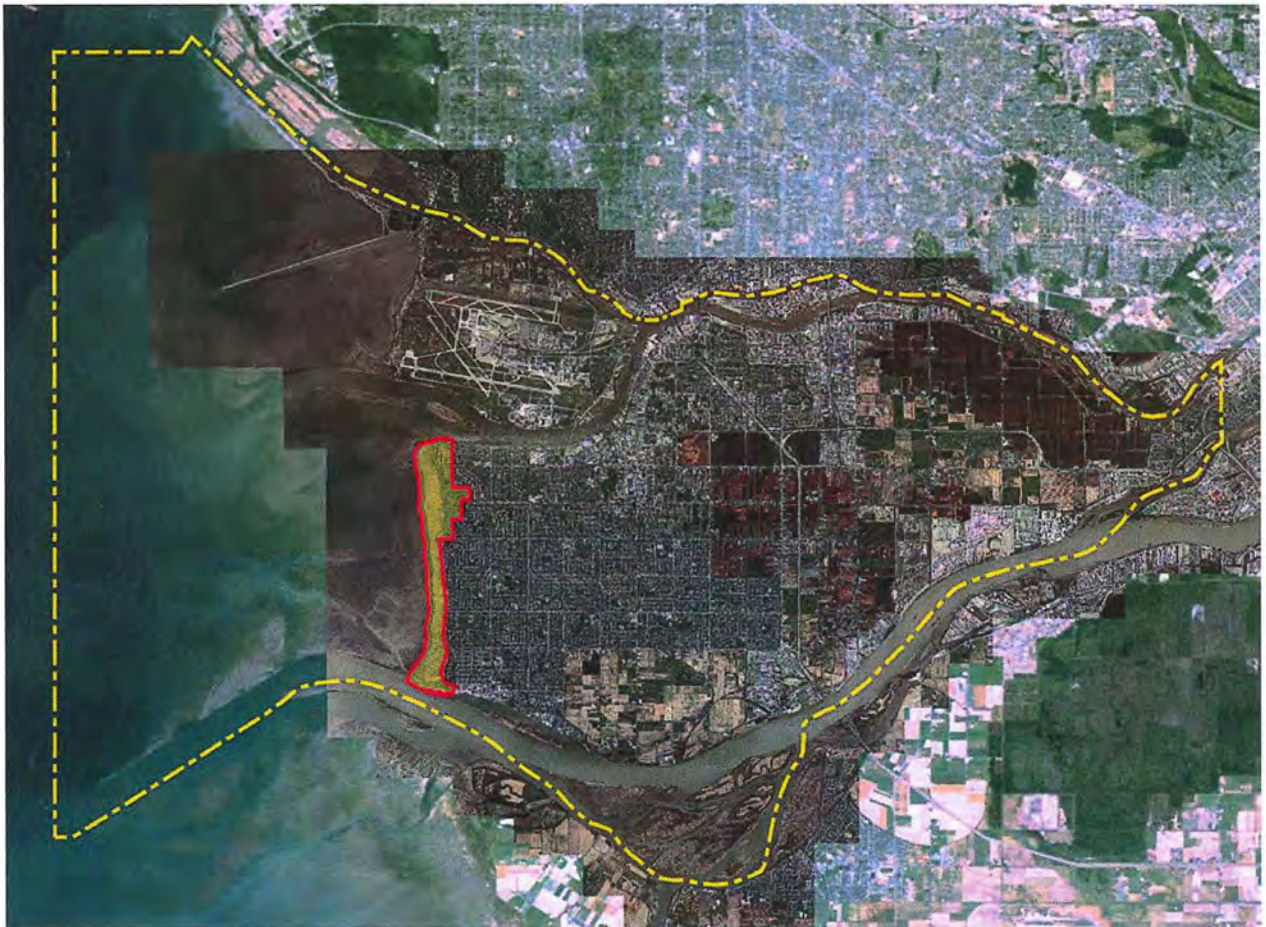


Desired Outcomes: Richmond's industrial areas serve as important sources of employment while also serving as important examples of successful and functional green infrastructure integration within industrial, highly altered environments. The shoreline areas abutting the industrial strategic area are enhanced habitat environments, and Bath Slough serves as a premier example of successful habitat and trail amenity enhancement and restoration in the heart of industrial lands. The City's industrial partners feel engaged and have a strong understanding of the role of industrial stewardship in contributing to ecological and community health.

Critical Issues	<ul style="list-style-type: none"> • Habitat loss (i.e. terrestrial and foreshore including RMA and ESA) • Increase in highly impervious areas • Encroachment of materials (storage) onto City Lands • Invasive species • Challenges with contamination, dumping, use of storm drains/storage of hazardous materials • Significant area owned by Port Metro Vancouver
Key Opportunities	<ul style="list-style-type: none"> • Bath Slough Revitalization Initiative • Extensive opportunity for restoration and green infrastructure interventions • Build upon existing industrial business outreach and engagement work to increase industrial stewardship • Eco-industrial opportunities • Build on Green Ambassadors work (storm drain "fish painting") • Explore partnerships with Port Metro Vancouver (e.g., their Land Use Plan and Sustainability Strategy)
Stakeholder Considerations	<ul style="list-style-type: none"> • Local business owners • Local residents • DFO (Fisheries and Oceans Canada) • Port Metro Vancouver • Local Economic development groups (e.g. Chamber of Commerce) • Economic Advisory Committee • School District • Railway

STRATEGY AREA 6: WEST DIKE

The West Dike is a key location for leisure activities in Richmond and is regularly identified as one of the City's most significant waterfront destinations. As the beauty and aesthetic value of the area derives from its natural values, careful management of the area is required. This unique north-south dike provides an important public amenity while providing community protection at the same time. **The West Dike acts as a transition zone between the extensive foreshore marsh habitats and adjacent inland residential neighbourhoods and park lands.** The area is defined by the adjacent Sturgeon Banks Wildlife Management Area (WMA) and the adjacent Grauer Lands that were recently purchased by the City and Ducks Unlimited. A riparian management area runs along much of the inner flank of the West Dike providing drainage and refuge for waterfowl and other fresh water aquatic species. As research on climate change and sea level rise evolve over time, the City will continue to investigate strategies and solutions that address the needs for dike upgrades and the associated tidal marsh habitats along Sturgeon Banks. Residential developments adjoin much of the west dike and have a direct role to play in its health and connection with the rest of the City.





Desired Outcomes: Maximizing the foreshore and riparian habitats and ecosystem services of Sturgeon Bank; maintaining the protection of City infrastructure through ongoing research and innovation; and continued improvement to the dike public amenity. The West Dike is a critical amenity corridor a significant recreational venue. The corridor is managed to accommodate anticipated population increases while implementing management strategies specific to the west dike. The health of the area depends not only on the habitat outside the dike but also the dike itself and the community bordering it. The ecological health of the West Dike is supported through the on-going improvement of upland watercourses and through innovative Best Management Practices such as vegetation and drainage management. On-going engagement with the adjacent community instils a sense of ownership and pride in the community's continued stewardship of the area.

Critical Issues	<ul style="list-style-type: none"> • Important transition zone between foreshore marsh habitat and adjacent residential neighbourhoods • Area of focus for Dike Master Plan • Significant ecological and recreation amenity for the City of Richmond • Climate change and sea level rise • Invasive species (e.g. Japanese Knotweed) • Critical habitat • Riparian Management Areas and Environmentally Sensitive Areas protection
Key Opportunities	<ul style="list-style-type: none"> • Significant to Richmond's "Island City" identity • High-profile/ high-usage amenity area • Grauer Lands • Large number of community groups/non-profits exist in relation to this area—core stewardship groups
Stakeholder Considerations	<ul style="list-style-type: none"> • Ducks Unlimited • Terra Nova non-profits (Sharing Farm, Richmond Food Security Society) • Terra Nova Outdoor pre-school • Recreationalists (cycling and walking community) • Partners for Beautification participants • Local residents • Provincial Diking Authority

STRATEGY AREA 7: SEA ISLAND – YVR

Situated on Sea Island, Vancouver International Airport (YVR) is the second busiest airport in Canada. **Located at the mouth of the Fraser River estuary, the airport is surrounded by large tracts of ecological lands included within the Iona/SICA and Sturgeon Banks WMA strategy area.** Vancouver International Airport is owned by Transport Canada and managed by Vancouver Airport Authority.





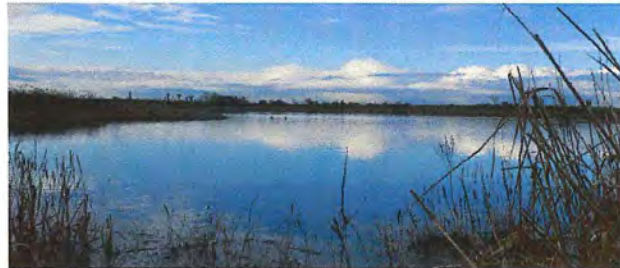
Desired Outcomes: Existing partnerships between the City, YVR and other agencies are built upon and strengthened to address burgeoning ecological challenges and opportunities.

Critical Issues	<ul style="list-style-type: none"> • YVR lands are Federally held • Significant bird habitat
Key Opportunities	<p>Joint Partnerships:</p> <ul style="list-style-type: none"> • Sea Island Slough revitalization • Collaborate with YVR regarding environmental enhancement initiatives to improve the ecological resiliency of the City's and YVR's lands • Invasive Species Management • Explore partnerships with private land owners
Stakeholder Considerations	<ul style="list-style-type: none"> • YVR • Canadian Wildlife Service • Local businesses • Vancouver International Airport (YVR) Environmental Advisory Committee

STRATEGY AREA 8: IONA – SICA (SEA ISLAND CONSERVATION AREA)

The Iona/SICA Strategy Area occupies lands within the jurisdiction of the Canadian Wildlife Service (Sea Island Conservation Area), Metro Vancouver (Greater Vancouver Sewerage & Drainage District and Metro Vancouver Park lands), YVR and the City of Richmond (Macdonald Beach Park). **Bounded by the Fraser River and Macdonald Slough and the foreshore, these estuarine lands, including the Iona Spit, provide a contiguous network of protected habitat that include remnant dune habitat, foreshore and slough marshes, remnant forest patches, upland open fields, saline marshes and open water ponds.** The Metro Vancouver Sewage Treatment Plant lands, the jetty and other leased businesses including log booming and other non conservation activities occur in this area.





Desired Outcomes: Ecological resiliency, ecosystem services and green infrastructure functions are enhanced when large, contiguous tracts of land can be assembled and managed with a common ecological goal. The Iona/SICA Strategy Area represents a unique assemblage and Hub of Fraser River riparian, dune, slough and foreshore habitats within different ownership, yet are managed for their overall ecological connectivity. These lands continue to contribute significantly to the community as a public amenity for wildlife viewing and by walkers, dog walkers, horse-back riding, cyclists, bird watchers, botanists and many others due to the unique estuary setting.

Critical Issues	<ul style="list-style-type: none"> • Multiple jurisdictions. • Invasive Species Management
Key Opportunities	<ul style="list-style-type: none"> • Collaborative environmental enhancement initiatives to establish resiliency of lands within the Ecological Network that have a diversity of tenure • Collaborative initiative to develop connectivity between sites and hubs in this Strategy Area • Collaborative approach to community stewardship and education initiatives
Stakeholder Considerations	<ul style="list-style-type: none"> • First Nations • YVR • Greater Vancouver District Sanitary Sewer facility • Metro Vancouver Parks • Canadian Wildlife Service • Port Metro Vancouver

STRATEGY AREA 9: WILDLIFE MANAGEMENT AREAS (WMAS)

As an estuarine municipality, Richmond is home to two provincially designated Wildlife Management Areas (WMAs), Sturgeon Bank and the South Arm Marshes. These large hub areas provide critical foreshore marshes and island habitat that support a diversity of ecological habitats that are integral to our estuarine island City. **These WMAs are also part of a recently expanded and renamed Ramsar site called the *Fraser River Delta*. This international designation recognizes critical migratory habitat for shorebirds, migrating and wintering waterfowl and critical feeding and rearing for anadromous salmon during their transition between river and marine stages of their life cycle.**



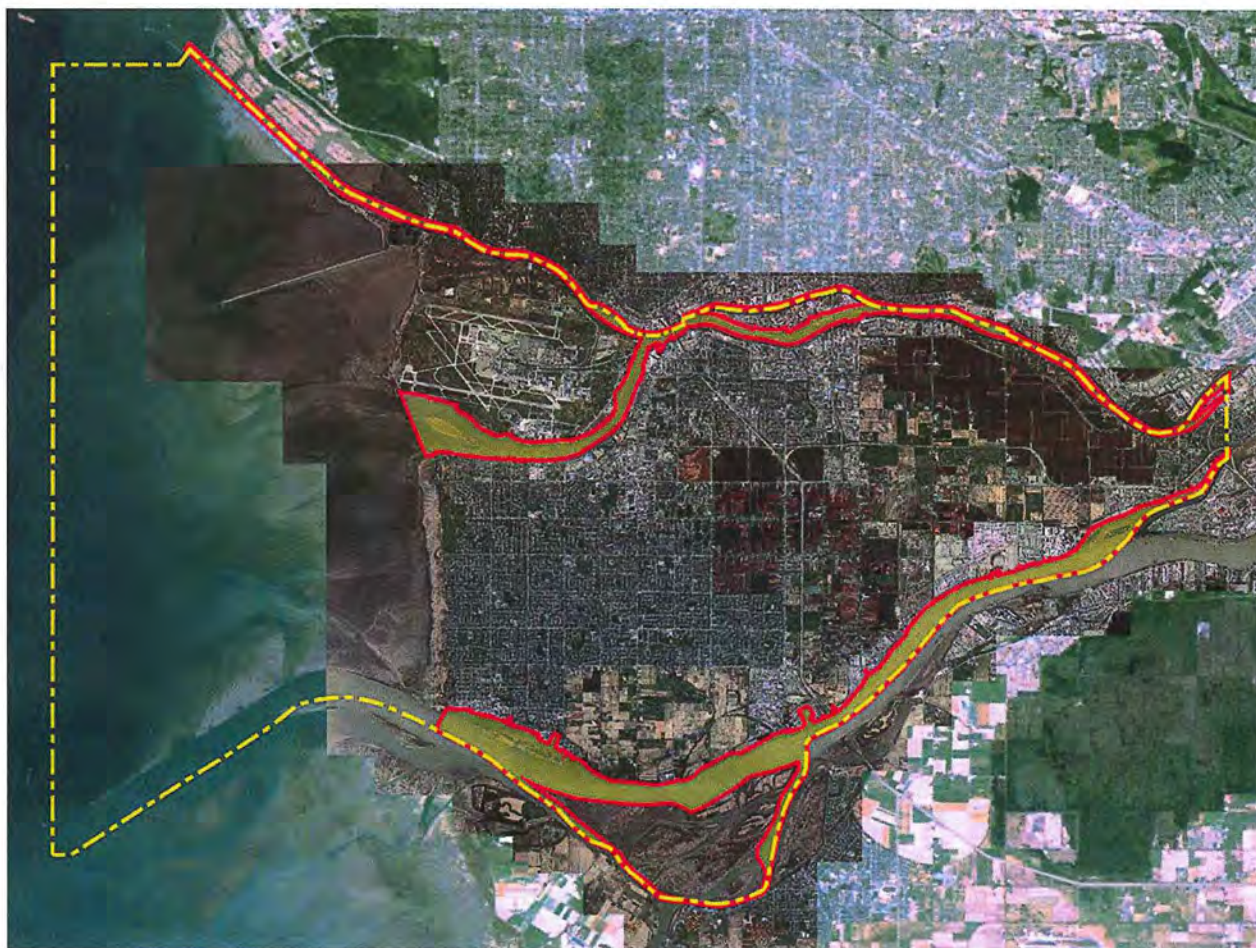


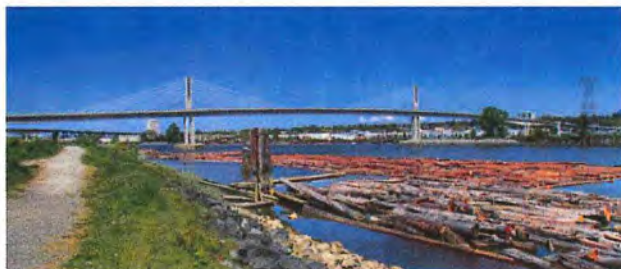
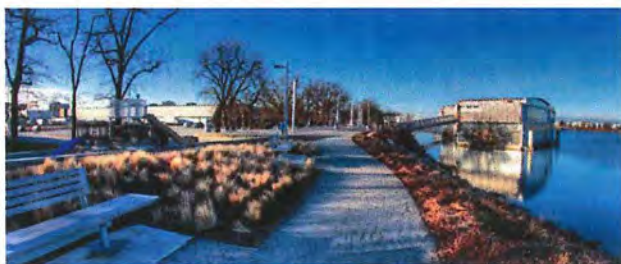
Desired Outcomes: The long term ecological resiliency of the WMAs is maintained over time. Retention of the ecological resiliency assures that the WMAs continue to provide the essential wildlife/conservation values and ecosystem services that are critical for the estuary. Expanded linkages with adjacent ecological lands (e.g., Grauer Lands), habitat restoration, enhancement projects and ongoing research within the WMAs continue to support their long term ecological resiliency.

Critical Issues	<ul style="list-style-type: none"> • Sturgeon Banks and South Arm Islands WMAs comprise the largest area of aquatic hub areas in the Ecological Network • Provide critical habitat to a diversity of waterfowl, shorebirds and salmon • Provide valuable ecosystem services for sea level rise and wave dissipation
Key Opportunities	<ul style="list-style-type: none"> • Wildlife viewing • Nature interpretation • Dike Master Planning • Habitat enhancement • Invasive Species Management • Review of original WMA Management Plans (MFLNRO) • RAMSAR designated – Fraser River Wetland Complex
Stakeholder Considerations	<ul style="list-style-type: none"> • First Nations • MFLNRO (Ministry of Forests, Lands and Natural Resource Operations) • DFO (Fisheries and Oceans Canada) • Advisory Committee on the Environment • Ducks Unlimited • Port Metro Vancouver • Canadian Wildlife Service

STRATEGY AREA 10: FRASER RIVER

The Fraser River created the islands that are now Richmond and continues to define the City and its setting. Richmond lacks conventional watersheds; instead it is located at the estuary of the largest river in western Canada. Surrounded by the Fraser and its exceptional natural values, Richmond's EN is inextricably linked to the river. **The Fraser River Strategy Area is defined by extensive wetlands critical for many species, particularly migratory birds. The Fraser River estuary serves as critical habitat for all five species of Pacific Salmon, and the Fraser River itself is one of the largest salmon-bearing rivers in the world.** The 2041 Richmond Official Community Plan (OCP) contains several policies that speak to the need to protect the Fraser River. Some of these are contained in Chapter 9 and pertain to prioritization of the protection and enhancement of the Fraser and West Dike foreshore habitat via assured compliance with established Environmentally Sensitive Area (ESA) setbacks of 30 metres seaward and 30 metres inland of the high water mark, as well as setbacks of 5 or 15 metres from all Riparian Management Areas (RMAs). In addition, Chapter 10 of the OCP, "Open Space and Public Realm", provides guidance in show-casing Richmond's waterfront by linking the river with the community through recreational opportunities as well as by protecting, enhancing and connecting ecological values and public amenities, and providing educational and interpretive programming.





Desired Outcomes: The north, south and middle arms of the Fraser are places of high-functioning ecological health, increased water quality, and are valued as Richmond's most important assets with development enhancing the environment and exerting a light-footprint upon the City's most significant ecological asset. The City will use the EN structure to be a responsible steward of the Fraser River. The EN will function to protect and enhance the foreshore and riverine environment while accommodating anticipated development. The EN directions are intended to provide tactical and site-level actions that will guide development on the foreshore.

Critical Issues	<ul style="list-style-type: none"> • The Fraser River is a "Living Working River" • Significant portion of the Ecological Network's hubs and sites within City jurisdiction occur on the Fraser River • Balancing the needs of waterfront activities (development, Port Metro Vancouver lands, industrial uses, the perimeter dike, public amenities, etc.) with high value estuarine habitat
Key Opportunities	<p>Integration of guideline documents and process related to habitat protection and development of the Fraser River foreshore:</p> <ul style="list-style-type: none"> • Dikes • Stormwater management • Pump station upgrades • ESA Development Permit • RMA process • Tree Bylaw • Perimeter trail network, • Waterfront Strategy: <i>Art on the Edge</i> program
Stakeholder Considerations	<ul style="list-style-type: none"> • First Nations • Advisory Committee on the Environment • Port Metro Vancouver • DFO (Fisheries and Oceans Canada) • MFLNRO (Ministry of Forests, Lands and Natural Resource Operations) • Fraser Basin Council • Canadian Wildlife Service • Ducks Unlimited • Harbour Commission

Next Steps

In order to ensure that the Ecological Network Management Strategy remains a pragmatic and evolving strategic document, the next phase in this work will seek input from a range of stakeholders and the public. This consultation process will inform a forthcoming action plan that will identify and provide strategies for integrating key actions, initiatives and priorities for EN enhancement into City process, and serve as a catalyst for community stewardship.

Glossary

Connectivity Zone: a non-linear area that provides connectivity for biodiversity and other ecological components between habitat patches; for example a large old field may be a connectivity zone between adjacent wetlands but the movement route does not follow a linear feature such as watercourse.

Corridor: is a linear feature such a watercourse and adjacent riparian zone that allows the movement of wildlife or other biodiversity components between habitat patches.

Ecological Network: is the inter-connected system of natural areas across Richmond's landscape. It is composed of both terrestrial and marine (shoreline and intertidal) areas.

Ecosystem Services: "Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth". From Millenium Ecosystem Assessment. Ecosystems and Human Well-being: A Framework for Assessment (2005).

Environmentally Sensitive Area: an ecologically important area identified and mapped by the City of Richmond within the Official Community Plan; most are protected as development permit areas.

Functioning Corridor: a linear area of habitat with continuous or near-continuous natural vegetation cover along its length. This type of corridor offers an existing pathway for biodiversity to move between habitat patches.

GIS (Geographic Information System): a system of organizing, analyzing, and displaying spatial (map) data; it can be thought of as digital map with many layers including features that are points, lines, or shapes.

Green Infrastructure: encompasses the components of the natural and built environment that provide ecosystem services such as drainage, water filtration, green space, and wildlife habitat; they are often smaller than components of the EN.

Green Infrastructure Network (GIN): a network of natural and built features that are introduced or enhanced across the Richmond landscape over time; the Green infrastructure Network contributes to the connectivity and resiliency of the EN.)

Greenway: is a linear corridor for improving environmental quality and outdoor recreation or transportation; the Railway Avenue Greenway is an example in Richmond.

Highwater Mark: a line defining the highest elevation of inundation from water under normal tides or floods; it is often the lowest point for rooted woody vegetation; it defines the boundary between the terrestrial and intertidal or marine realms.

Hub: a component of the EN that is >10 ha in size and naturalness >3; it may be forest, wetland, or other type of ecosystem; hubs are the most important part of the EN.

Impaired Corridor: a linear corridor with some natural vegetation cover along its length but contains significant gaps that are currently compromising its function as a pathway for wildlife movement between hubs. As a result, actual use of the corridor in its current state may be limited. This type of corridor has a high potential for restoration.

Matrix: in an EN, the matrix is the developed portion of the landscape (e.g., houses, farms, developed parks) that surrounds the main components of the EN; it also provides some ecological values and ecosystems services and influences the function of the network.

Non-functioning Corridor: a linear corridor that has little to no natural vegetation along its length and does not function as pathway for wildlife movement between hubs in its current state. Non-functioning corridors were identified based the least-cost path analysis and are shown where connectivity would significantly benefit the integrity of the EN but is currently lacking. Larger-scale restoration efforts would be required to restore connectivity in these areas.

Riparian Management Area (RMA): a 5 or 15 m wide zone (depending on watercourse size and fish habitat value) on both sides of a watercourse (measured from the highwater mark) which is used to maintain watercourse health; RMAs were implemented in response to provincial requirements under the BC Fish Protection Act.

Riparian Zone: the land area bordering watercourses or shorelines with distinctive vegetation, topography, and soils related to its proximity to watercourses; riparian zones are important for biodiversity, watercourse health, and other values (shading, bank stabilization, etc.).

Shoreline Zone: areas within 30 m of the highwater mark of the Fraser River or the Strait of Georgia; it includes developed and natural areas.

Site: a component of the EN between 0.1 and <10 ha in size and naturalness >3; it may be forest, wetland, or other type of ecosystem; sites are important for maintaining connectivity within development landscapes.

Watercourse: a water feature with a defined channel formed by the regular movement of water; in Richmond, watercourses are mainly man-made or modified features such as ditches and canals.

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Appendix 1

Ecological Network—
Regulatory Context

Ecological Network – Regulatory Context

Regional Growth Strategy (Metro Vancouver)	<p>Goals 3: Protect the Environment and Respond to Climate Change Impacts</p> <ul style="list-style-type: none"> • Strategy 3.1: Protect Conservation and Recreation lands • Strategy 3.2: Protect and enhance natural features and their connectivity • Strategy 3.3: Encourage land use and transportation infrastructure that reduce energy consumption and greenhouse gas emissions, and improve air quality • Strategy 3.4: Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks.
Ecological Health Action Plan (Metro Vancouver)	<p>Project 1: Advancing a Regional Green Infrastructure Network</p> <ul style="list-style-type: none"> • Objective: Enhance and expand a Regional Green Infrastructure Network in collaboration with regional stakeholders. <p>Project 9: Relandscaping Wastewater Treatment Plants</p> <ul style="list-style-type: none"> • Objective: Revegetate industrial sites to enhance biodiversity by focusing on flowering shrubs for pollinators and trees for rainwater detention. • Objective: Show leadership by investing in green infrastructure in industrial areas.
Council Term Goals (2011-2014)	<p>Priorities:</p> <p>2.9 Encourage the development of community volunteer programs and strategies that build a broad, knowledgeable and keen volunteer base, and that provide positive and meaningful opportunities for volunteers to utilize their talents while helping to provide important services to the community. (Community Social Services).</p> <p>3.6 Develop and integrated strategy for the Steveston Waterfront that blends business and public interest in a manner that allows for continued sustainable development in this area.</p> <p>3.8 Develop a “stay-cation” appeal for the City and region.</p> <p>8.1 Continued implementation and significant progress towards achieving the City's Sustainability Framework and associated targets. (Sustainability)</p> <p>8.2 Continue to advocate for a coordinated regional approach to enhance local food security in Richmond and the region through policy development and initiatives such as community farms. (Sustainability)</p> <p>8.3 Communicate to the public the City's Sustainability goals with detail on how the City is meeting (or exceeding) these goals and how they support Provincial goals.</p> <p>8.4 Review opportunities for increasing sustainable development requirements for all new developments, including consideration of increasing requirements for sustainable roof treatments (e.g., rooftop gardens, solar panels, etc.) and energy security (e.g., use of local renewable energy sources, use of district energy systems, etc.).</p> <p>10.3 Create urban environments that support wellness and encourage physical activity. (Community Wellness)</p> <p>10.4 Continued emphasis on the development of the City's parks and trails system. (Community Wellness)</p>
OCP	<p>Ch 2: Climate Change Response</p> <ul style="list-style-type: none"> • Section 2.3, Objective 1, policy a) protect and enhance Richmond's natural environments to support carbon retention as well as other important ecosystem services (pollution reduction, nutrient generation, habitat). • Section 2.3, Objective 1, policy b) integrate carbon retention objectives into key policies, plans and programs, including but not limited to Parks and open Spaces Strategy, Environmentally Sensitive Areas Management Strategy and land use and development policies. • Section 2.4, Objective 1, policy b) Sustainability staff to lead the integration of climate change adaptation considerations into key policies, plans, programs and services, including land-use and development decision-making, city infrastructure design and management; floodplain management, emergency preparedness, natural ecosystem health, agricultural viability, social development planning and economic development.

Ch 7: Agriculture and Food

- Ensure that land uses adjacent to, but outside of, the ALR are compatible with farming by establishing effective buffers on the non-agricultural lands.
- Designate all parcels abutting, but outside of, the ALR boundary as DPAs with Guidelines for the purpose of protecting farming.
- Minimize conflicts among agricultural, recreation, conservation and urban activities.
- Environment policies explore ways to protect the EN values of agricultural land: encourage the Environmental Farm Program, explore the leasing of lands that have important agricultural values, explore compensation to farmers for the loss of cultivation to maintain key ecological objectives.
- Urban food production policies speak to increasing the number of community gardens, edible landscapes and food bearing trees in open space, and in new and existing residential development.

Ch 9: Island Natural Environment (an Ecological Network Approach)

- Objective 1: Protect, enhance and expand a diverse, connected and functioning EN
- Objective 2: Promote green infrastructure and the Green Infrastructure Network (GIN) and their underlying ecosystem services on all lands.
- Objective 3: Proactively implement practices to protect and improve water, air and soil quality
- Objective 4: Develop partnerships for "Ecological Gain".
- Objective 5: Foster Environmental Stewardship.
- Objective 6: Achieve long-term protection for Environmentally Sensitive Areas (ESAs) through the implementation of the 2012 ESA Management Strategy.

Ch 10: Open Space and Public Realm

- Objective 5: Strategically expand the range of ecosystem services (e.g., biodiversity and habitat, rain water management, carbon sequestration) integrated within the open space and public realm to strengthen and contribute to the Ecological Network.
- Objective 6: Showcase Richmond's world-class waterfront and enhance the Blue Network (the Fraser River shoreline and estuary, and the internal waterways, the sloughs, canals, and wetlands) for their ecological value, recreational opportunities, and enjoyment.

Ch 12: Sustainable Infrastructure and Resources

Objective 1, policy e) encourage the use of collection and drainage systems that harvest rainwater for non-potable water uses, temporarily store rainwater during major storm events and reduce surface contaminants from entering drainage systems.

- Objective 1, policy h) wherever practical, retain open watercourses to provide drainage, and ensure that the watercourse permitting process is followed.
- Objective 1, policy i) integrate drainage with the Ecological Network.
- Section 12.10 Street Trees – speaks to urban forest strategy, coordinated planting, healthy diversity of trees, tree health and retention.

DPs

Ch 14 of the OCP provides Development Permit Guidelines from Environmentally Sensitive Areas:

- Intertidal
- Shoreline
- Upland Forest
- Old Fields and Shrublands
- Freshwater Wetlands

The following general guidelines speak to the retention and/or enhancement of the natural environment as part of DP requirements:

- Heritage Preservation (14.2.4, c))
- Site Landscaping (14.2.5, 14.2.5b-c)
- Green Buildings and Sustainable Infrastructure (14.2.10 d)
- Agriculture Land Reserve Landscape Buffers (14.2.14)

The following guidelines contain Sustainability Initiatives that speak directly to tree/ vegetation retention, rainwater collection/retention, naturesscaping and green technology:

- Intensive Residential Guidelines – Granny Flats and Coach Houses (14.3).

	<ul style="list-style-type: none"> • Multiple Family Guidelines (14.4: 14.4.1.F Preservation of Existing Natural Features, 14.4.5 Landscaping and Open Space Design, 14.4.8 Edge Conditions (ESAs and Public Open Space). • Commercial and Commercial/ Mixed Use Guidelines (14.4.1.H Surface Parking Landscaping, 14.5.3 Green Building and Sustainable Infrastructure, 14.5.9 Landscaping and Street Furniture) • Industrial Guidelines (14.6.1.d Adjacent Uses (edge Conditions), 14.6.4 Site Planning and Landscaping) • Marina Guidelines (14.8.1 Environment, 14.8.2 Public Access, 14.8.3 Landscaping). • Broadmoor Neighbourhood Centre Guidelines (14.9.5 Key Pedestrian Corridors, 14.9.8 Green Buildings and Sustainable Infrastructure)
Zoning	<p>Bylaw 8500 (City of Richmond Zoning Bylaw) defines watercourses but does not delineate setbacks from watercourses. It also defines Parks and Landscaping. Specific park zoning regulations pertain to the location of City parks (permitted in all zones).</p> <p>Specific Landscaping and Screening regulations are found in part 6 of the Bylaw. These speak to the provision and maintenance of vegetation during the development process as well as alternatives to landscaping. Landscaping is most commonly referred to as a screening/ fencing tool.</p>
NPs	<p>Most area plans refer to the OCP for provisions pertaining to the natural environment, while some contain their own specific policies (e.g., Bridgeport Area Plan). For plans that do contain specific policies for the natural environment, these often refer to the provision of parks and recreation. In addition, most plans also contain specific Development Permit guidelines for landscape elements, often referring to tree and ground cover plantings along boulevards, as screening elements and as enhancements in common open space. Some plans provide examples of planting configurations and vegetation species that would enhance biodiversity (e.g., Blundell Area East Livingstone). The East Cambie Plan contains more specific policies regarding natural open space as it includes the Richmond Nature Park.</p>
CCAP	<p>Section 2.5 of the City Center Area Plan provides policies for ecology and adaptability. Specifically, it contains policies to ensure the long-term supply of interconnected ecological service areas, the encouragement of ecological-based amenities, green infrastructure and opportunities for public education and out-reach.</p> <p>Section 2.6 speaks to integrating ecological zones and a system of greenways into the City Centre. It also outlines a Base Level Open Space Standard for parks acquisition and speaks to securing public access on private property for park or greenway purposes. Additional studies recommended include an Urban Forest Strategy update and an Urban Ecology Study. According to the CCAP, 160.3 hectares of open space will be acquired by the City in the City Centre in the period ending in 2031.</p>
Bylaws	<p>Bylaw 6366 – Boulevard & Roadway Protection</p> <p>Bylaw 7174 – Boulevard Maintenance</p> <p>Bylaw 7310 – Public Parks & School Grounds Regulation</p> <p>Bylaw 8057 – Tree Protection</p> <p>Bylaw 8204 – Flood Plain Designation and Protection</p> <p>Bylaw 8441 – Watercourse Protection and Crossing</p> <p>Bylaw 8475 – Pollution Prevention and Clean-up</p> <p>Bylaw 8385 – Green Roofs & Other Options Involving Industrial & Office Buildings Outside the City Centre</p> <p>Bylaw 8514 – Pesticide Use Control</p>
ESA Management Strategy	<p>Completed in June of 2012, the ESA Management Strategy introduced the Ecological Network concept, but focused primarily on the development of Development Permit guidelines for Environmentally Sensitive Areas. These served to update the ESA DP guidelines for the 2041 OCP update.</p>

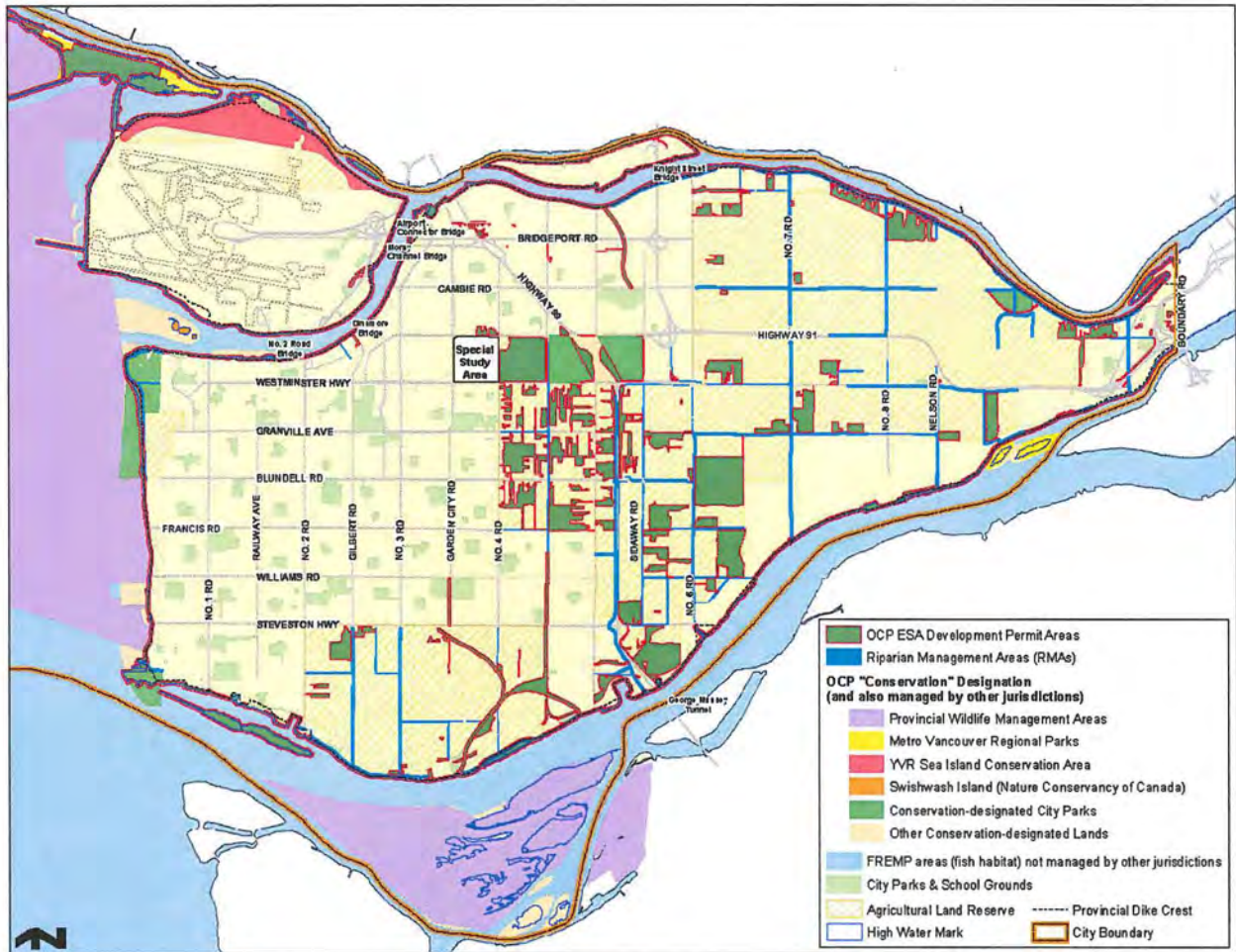
RMA	The Riparian Areas Regulation Response Strategy was developed in response to the provincial <i>Riparian Areas Regulation</i> (RAR) enacted under Section 12 of the <i>Provincial Fish Protection Act</i> . Riparian management Areas (RMAs) are setback of either 5 or 15 metres from the top of bank of inland watercourses in the City. No building, structure or surface construction is permitted in the RMA, and the RMA cannot be landscaped, however planting of native species within the RMA is encouraged. The RMA is currently not supported by a bylaw or a DP.
POSS	The recently adopted 2022 Parks and Open Spaces Strategy is comprised of seven focus areas, each containing several outcome statements. Each focus area speaks to and supports various facets and components of the Ecological Network, with the "Green Network" focus area speaking specifically to the parks and open spaces system contributing significantly to the conservation and enhancement of the EN. Other focus areas include Health and Wellness, Great Spaces and Experiences, Connectivity, Blue Network, Diversity and Multi-functionality, and Resource Management.



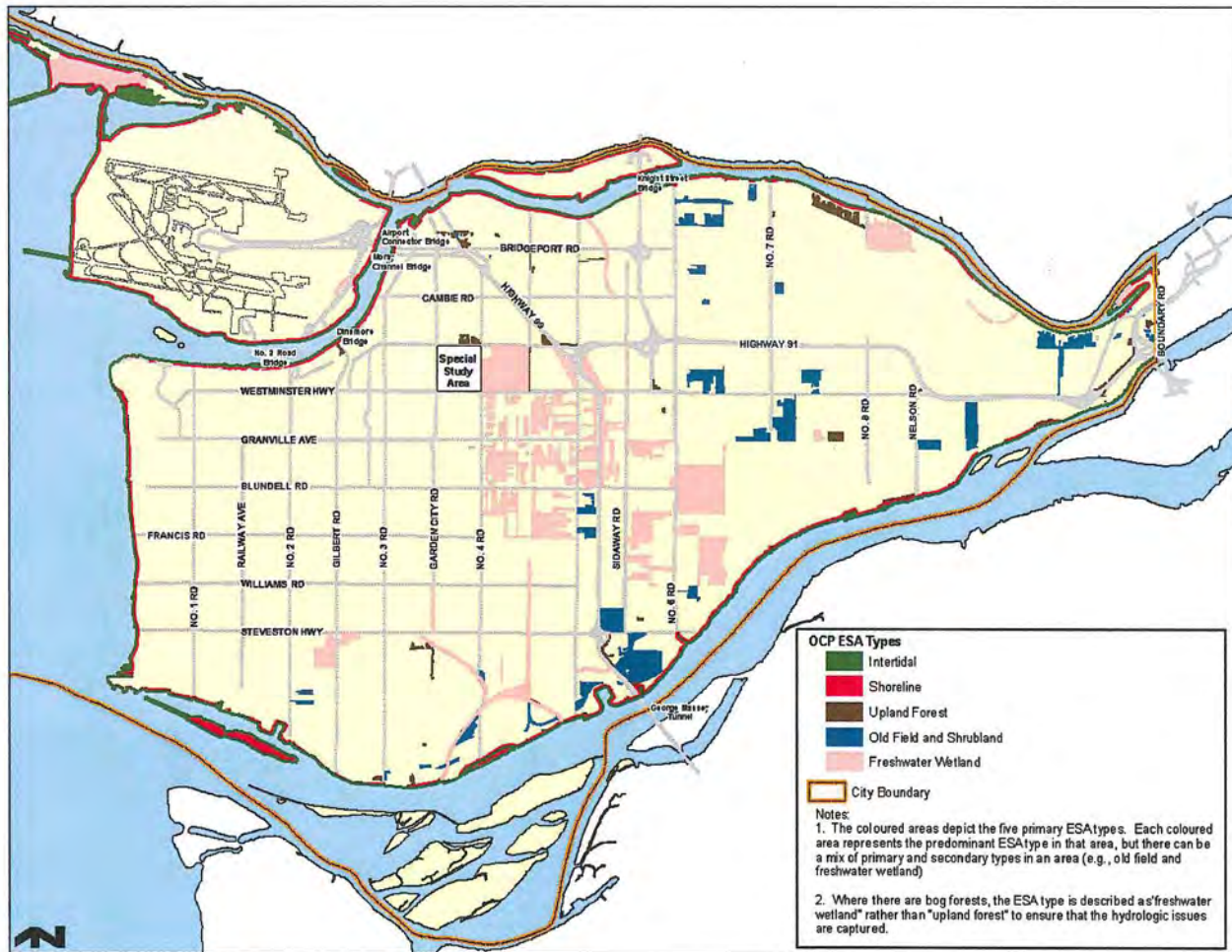
Appendix 2

Ecological Network Foundation Maps
from the 2041 Official Community Plan





The Ecological Network Management Map. 2012.



ESA Development Permit Type Map, 2012



Appendix 3

Circuitscape Mapping
Methodology



Understanding Habitat Connectivity in Richmond: Circuitscape-based Models

Draft Feb. 13, 2013

1. Introduction

This report summarises the methods used by Raincoast Applied Ecology to create habitat connectivity maps for the City of Richmond. Modelling was done in the connectivity software Circuitscape using habitat and landuse maps to identify important areas for species movement.

2. Circuitscape

Circuitscape is a connectivity model used to find pathways across a landscape (1). It can be used to model gene flow, habitat quality and for conservation planning. In this application we use it to evaluate habitat connectivity in an urban setting for a variety of habitat types.

Circuitscape is based on electrical circuit theory but applies these concepts to ecological landscapes. The model uses 'focal nodes' to introduce simulated electrical current. Focal nodes are areas identified as having high quality habitat that provides zero resistance to species movement. The rest of the landscape is assigned resistance based on the quality of habitat for the species being modelled. Current is supplied to each focal node while all other focal nodes are grounded. In this way the flow of current across the landscape is modelled between all pairs of focal nodes. The path of current is determined by the resistance it encounters at each point on the landscape. Areas of good habitat will have low resistance and will allow current to flow relatively freely. Areas of poor habitat will have higher resistance which will slow the flow of current and in extreme cases will block the current all together.

Circuitscape has two advantages over the widely use least-cost path methods. Firstly it does not constrain connectivity to a single best pathway. Current is free to flow anywhere and multiple pathways will often be identified as well as dead ends where a pathway meets resistance and cannot continue. Secondly, the flow of current in Circuitscape is based on a 'random-walk' where the species encounters resistance as it randomly moves across the landscape. This is more realistic than in least-cost methods where the species has complete knowledge of the entire landscape and can choose the best route accordingly. Detailed descriptions of the methods and theory underlying Circuitscape can be found in (2) and (3).

3. Methods

3.1 Data

Three datasets were used for the analysis:

- i) *Richmond Ecologically Sensitive Areas (ESA)*
This dataset contains information on the habitat types across much of the vegetated areas of the city. It also identifies areas of high naturalness, defined as hubs of high quality habitat. This was the primary dataset used to create habitat maps for the analysis. Examples of ESA habitat designations include forested wetlands, agricultural row crops, and old fields vegetated with shrubs and grasses.
- ii) *2006 Landuse*
Areas not included in the ESA layer were added using the 2006 Landuse data. These areas were typically un-vegetated and of low habitat quality. Examples of landuse include commercial developments, industrial areas, and housing.
- iii) *Roads*
Roads were used as barriers to species movement and were assigned resistances based on road class. Highways and connectors had the highest resistances whereas small lanes and local roads had lower resistances.

3.2 Habitat Models

Four different habitat types were modelled. The designation of habitat quality varied between the models depending on the usability of the habitat for the group of species being modelled. A forested wetland for example may provide high quality habitat for one group of species but lower quality habitat for others. By producing multiple habitat models we aimed to identify all areas of importance. Multiple models also allow identification of areas that are important for different groups of species. For each habitat type, two models were created, one for species with high dispersal potentials and one for species with low dispersal potentials. Species with high dispersal potentials are those that can travel most easily across the landscape, large birds for example. Species less able to disperse include smaller birds and small mammals. Poor dispersers would require more intact habitats and could not leapfrog as well between areas of high quality habitat.

The four habitat models were:

- i) *All species*
This model attempts to give a general representation of habitat quality across all groups of species.
- ii) *Forest*
This model targets species that rely on forested habitats. Areas of old coniferous, mixed and deciduous forest are prioritized, followed by younger forests, woody areas, and shrub habitats. Example species are cavity nesting birds such as woodpeckers and secondary cavity nesting birds and small mammals.
- iii) *Shrub*
This model targets species that utilize smaller trees and shrubs as primary habitat. It gives high priority to deciduous and evergreen shrubs, followed by forested areas and areas with graminoid/herbaceous cover. Example species include passerines and small mammals that use shrubs for feeding and nesting.
- iv) *Old Field*
This model is similar to the shrub model but places increased emphasis on the use of old field sites as productive habitat. Examples of species that could benefit from these areas are small mammals that prefer lower vegetation.
- v) *Wetland*
This model targets species that require wetland habitat such as bogs, lakes and marshland. Example species are wetland birds and small mammals.

3.3 Resistance Maps

In order to model the movement of species across the landscape, Circuitscape requires a resistance map that represents the quality of habitat in every pixel. Pixels with higher resistances represent lower quality habitat. The model will therefore seek paths between pixels with lower resistance since these are the areas that are easiest for species to move through. For each habitat model, resistances were assigned to every habitat type, landuse type, and road category in Richmond to create a single resistance map for each habitat model. The resistances assigned varied depending on the habitat type and dispersal ability being modelled.

3.4 Focal Nodes

Focal nodes are the areas of highest quality habitats that are used to start the modelling process. The modelled pathways of species movement radiate out from these nodes and if a suitable path of low resistance is found the nodes will be connected by pathways of suitable habitat. For each model a set of approximately 15 focal nodes were identified. This was done by selecting the polygons with the lowest resistances that also had ESA naturalness values of 4 or 5 (High or Very High naturalness). Geographical distribution was also considered because a spread of focal nodes across the landscape is required to identify all potential pathways. Since the

modelling is done in a pairwise fashion between all pairs of focal nodes, increasing the number of nodes greatly increases the processing time. A balance therefore had to be struck between the distribution and number of nodes. Rules for focal node inclusion were relaxed for the wetland model to include a number of lakes and to ensure geographic spread of focal nodes. All resistance maps were created in Arc GIS 10.1.

3.5 Circuitscape Modelling

All models were run in Circuitscape 3.5.8. Data inputs required for modelling are a map of focal nodes and a map of resistances, both in ASCII format. Circuitscape output was taken into ArcGis 10.1 for display.

4. References

(1) www.circuitscape.org

(2) McRae, B.H., B.G. Dickson, T.H. Keitt, and V.B. Shah. 2008. Using circuit theory to model connectivity in ecology and conservation. *Ecology* 10: 2712-2724.

(3) McRae, B.H. and P. Beier. 2007. Circuit theory predicts Gene flow in plant and animal populations. *Proceedings of the National Academy of Sciences of the USA* 104:19885-19890.



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