The City of Vancouver

Planting and Ecology Design Guidelines

for Green Rainwater Infrastructure

Planting and Ecology Design Guidelines

Green Infrastructure Implementation

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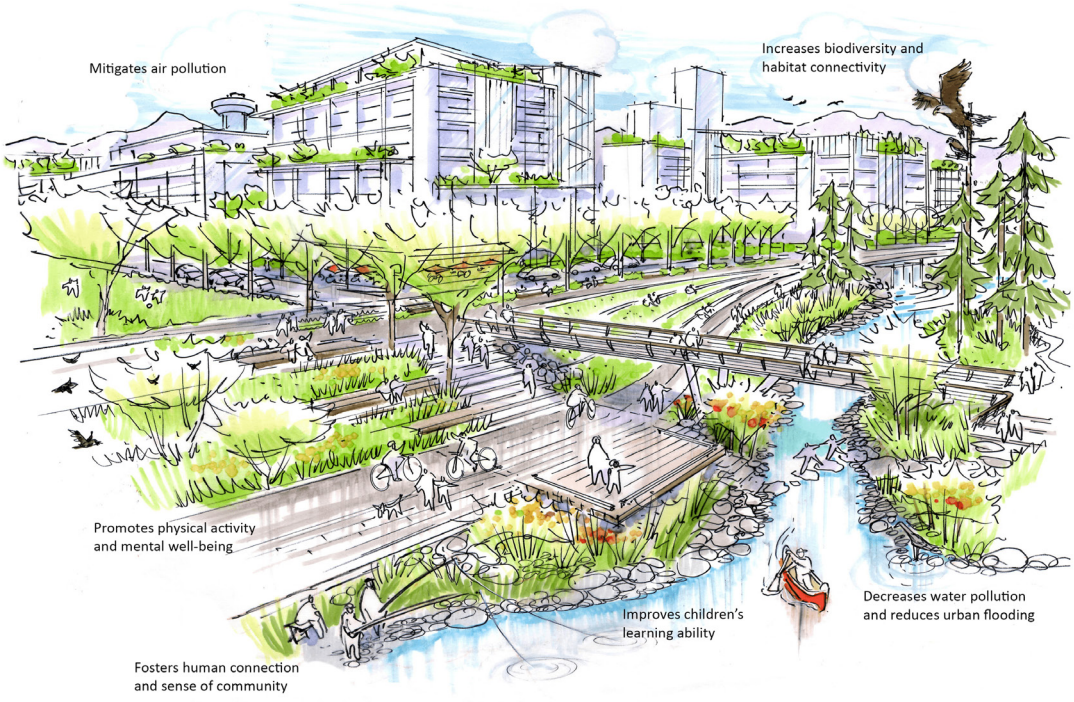
Disclaimer

This document is intended to be a resource for contractors, designers, and consultants to inform and educate on best practices for planting design in at-grade green rainwater infrastructure systems (GRI) in the road right-of-way. This document does not outline standards and requirements related to planting and is not meant to provide guidance on landscaping areas not used explicitly as green rainwater infrastructure. The guidance in this document does not replace the need for landscape consultation on GRI design.

1. Introduction

Green Rainwater Infrastructure is a suite of rainwater management tools that use both engineered and nature-based solutions to protect, restore and mimic the natural water cycle.
It is an important component of the City of Vancouver's sewer and drainage network, providing multiple service objectives:

- Improving the quality of water entering receiving waterbodies;
- Reducing quantity of water entering the pipe system;
- Increasing flood resilience;
- Contributing to the natural hydrologic cycle.



Beyond rainwater management, GRI assets also provide important climate resilience, ecological and community services, contributing to a variety of City strategies, goals and targets including:

- Urban cooling through the addition of tree canopy;
- Increased biodiversity and urban wildlife habitat through greening;
- Creation of community amenities through planting, placemaking and beautification;
- Enhancment of ecosystem services in typically underserviced communities.

2. Co-benefits of Green Rainwater Infrastructure

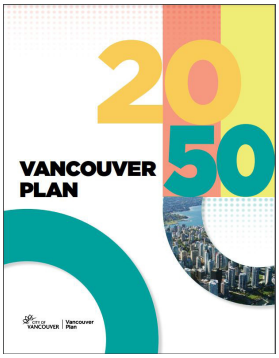
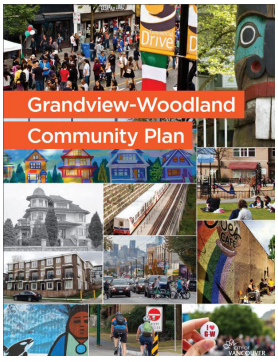
Plant selection, soil, grading, and design all play key roles in a successful GRI project. These components must be considered during the project's planning stage, not after, or separate from, the facility's engineered design. This document will provide guidance on how to consider, evaluate, plan, and design for the stressors and opportunities of GRI projects.

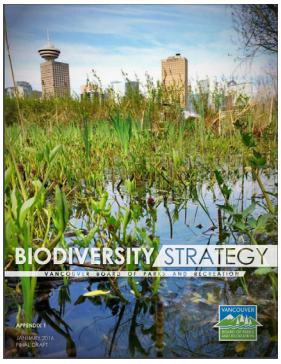
Context and Connectivity

GRI increases green space within the urban fabric, in turn increasing connectivity for water, ecology, and community. This section will explore how to understand a site within the larger context of city communities during the planning phase to optimize a project for a myriad of co-benefits. It will identify city-wide plans, as well as considerations for local conditions, that will influence your planting design.

City-Wide Planning

The City of Vancouver is guided by multiple planning and policy documents intended to shape the city. Many of these documents can help to inform GRI design.

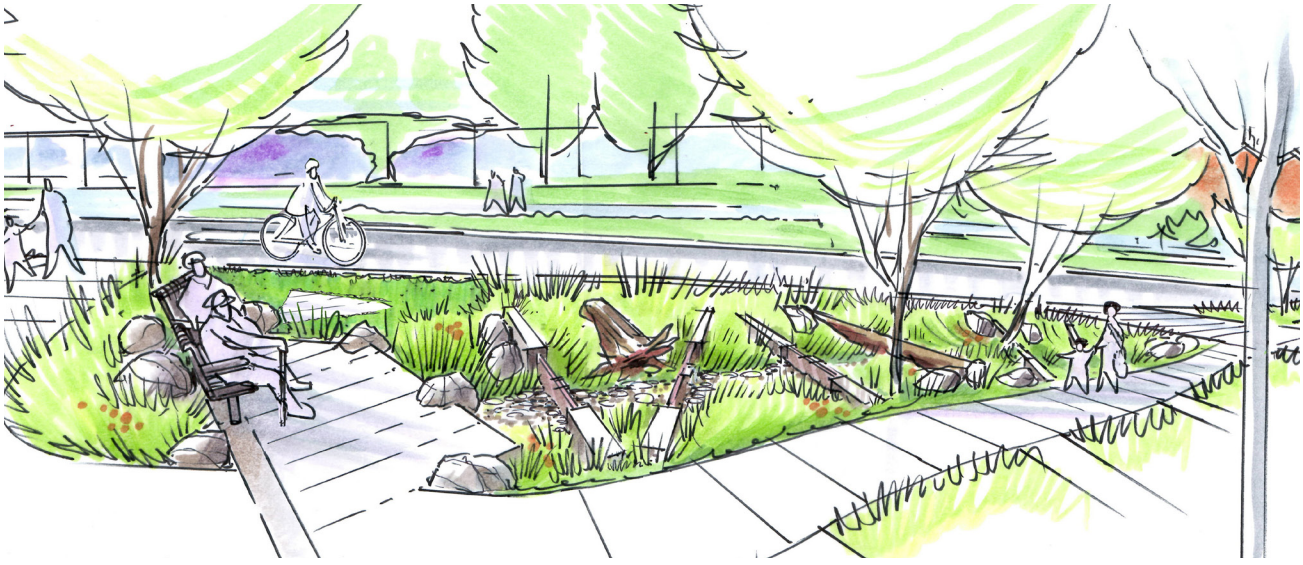
	The **Rain City Strategy** outlines how Vancouver will transform to a water sensitive city over the next 30 years using Green Rainwater Infrastructure. This document clearly outlines goals, objectives and targets for GRI, highlighting its importance as a tool for rainwater management, climate adaptation, biodiversity, equity, and reconciliation.
	The **2050 Vancouver Plan** is a long-range land use strategy to create a more livable, affordable, and sustainable city. It includes proposed alignments for blue-green systems, which are networks of connected park-like streets that manage water and land in a way that is inspired by nature and designed to replicate natural functions and provide ecosystem services. You will want to check if your GRI project is aligned with a blue-green system and see how you can match and extend the look and feel of existing green space areas in the neighborhood.
	Several communities in Vancouver have plans in place that outline how an area will develop over time. Reviewing these plans can help you understand how your design can fill gaps of missing amenities in the community. https://vancouver.ca/people-programs/neighbourhood-planning.aspx



The **Biodiversity Strategy** aims to increase the amount and quality of Vancouver's natural areas to support biodiversity and increase access to nature. The distributed nature of GRI sites offer the unique opportunity to create biodiversity corridors between Vancouver's biodiversity hotspots. By creating planting designs that match, and augment these spaces, connections between people, animals and space can be strengthened. Consider adjacent planting communities not only for their aesthetic value and connectivity, but to understand what thrives in the local conditions.

The **Urban Forest Strategy** provides a clear and balanced approach to protecting and expanding the urban forest in our city. Trees are an important component in many GRI features, and designs should support the goals of this strategy.

The City of Vancouver's **Climate Change Adaptation Strategy** identifies 5 key climate related hazards facing Vancouver: extreme heat, poor air quality, drought, extreme rainfall and sea level rise. Planting within GRI assets can provide adaptability benefits and help mitigate climate impacts for all five of these hazards. However, it's also important to consider these environmental changes and the underlying uncertainty of future conditions when selecting plants. Choosing the right plant for the right place is a fundamental best practice when developing your planting plan.



Adjacent Human Communities

Along with understanding city-wide context and drivers for GRI, a consideration of current site users is needed. How the community uses the nearby space will also impact the planting design. It's important to think through common site uses and how it may impact the design. Listed below are several things to consider about GRI in the road right-of-way:

Consideration	Potential Design Solutions
Will there be high foot traffic?	• Structural plants • Dense planting at edges to dissuade entrance to space • Consider path areas or bridges in larger systems • Add educational signage explaining what GRI is
Is your project located in a commercial area where more trash is expected?	• Educational signage about litter
Is your project taking runoff from an arterial road?	• Include plants that can tolerate high sediment and pollutant loading • Create extra buffer between planting and sidewalk to ensure maintenance crews have ample space to work
Is there potential for vehicle incursions?	• Boulders
Is it likely that pets will use the area?	• Dense planting at edges to dissuade entrance to space • Educational signage
Are you anticipating using plants that are edible?	• Ensure they are not easily accessible to members of public as plants may contain rainwater pollutants at toxic levels
Adjacent to a school, playground or family-oriented neighborhood	• Elements of informal play such as logs, boulders, stepping stones
High population of seniors in the neighborhood	• Benches
Is the site adjacent to active transportation route?	• Implement trees where possible to provide shade.

Consideration	Potential Design Solutions
Is there public safety concerns?	• Employ CPTED principles in areas known for high criminal activity
How to design detectable edges for people with a visual impairment?	• Avoid using widespread planting along travel paths. • Avoid sudden vertical drop more than 150mm in planting

Site users were considered in the design of the Sunset Park bioswale, with trees to provide shade for cyclists and benches to invite community members to spend time in the space. Boulders and gabion walls provide informal play options for students from the neighbouring school.

Local Conditions

Site specific conditions are also integral to an effective GRI planting design. It is important to conduct a thorough site condition assessment that considers soil, water, groundwater, slopes, sun, shade, existing vegetation including trees, and invasive species.

Native soils should be tested for infiltration capacity and health. See section on soil. Soil reuse should be considered wherever possible.

Both above ground and below ground water conditions should be reviewed. Ensure that you know the depth to the groundwater table. A shallow groundwater table may mean that plants have wet feet for longer periods of time. It could also indicate the need to add a liner to the GRI asset, which will impact root depth and in turn, plant selection.

The IP ratio for a GRI system refers to the ratio between the impervious contributing drainage area to the pervious vegetated area within the system. This ratio may be a helpful metric for assessing the potential saturation levels within a GRI asset. Plants within a GRI system with an IP ratio greater than 10 should be more flood resistant, while plants with an IP ratio less than 10 should be more drought resistant.

Understanding your contributing drainage area will give indicators of what kinds of pollutants and debris may end up entering your system. For instance, if there are several deciduous trees near your site, there is likely to be high leaf litter. If there are adjacent restaurants or businesses, you may see more garbage entering the system. If the road is more industrial, heavy metals and plastics may be more common.

A local condition analysis should also consider sun and shade and tailor plant selection accordingly. Keep in mind that tall buildings, commonly found in the urban environment, will impact shade ranges, as well as trees.

Finally, an inventory of invasive species within the project area or a migratable radius should also be conducted. If invasives could be found in the soil seed bank or migrate from neighbouring areas, consider what mitigation measures can be taken, including:

- Specifying larger plant pots and close plant spaces to encourage quick establishment.
- Use of strong native species known to outcompete known invasives.
- Full repacement of soils
- Adding canopy to shade out invasives.

Consider local conditions such as site use and impervious surfaces early in the project. The adjacent school yard and trees at this site will influence planting design.

3. Plant Selection and Design

Plant species selection and their placement are fundamental to the overall function of a GRI asset. All vegetated GRI assets require a planting plan to help ensure that the system can perform reliably and meet its design and longevity goals. Poor planting decisions may negatively impact GRI performance and long-term function. For instance, large plants around the inlets of a GRI system may prevent runoff from entering the GRI area.

Plant palettes may be used to ensure that complimentary plants are chosen for the proposed bioretention system and that they are placed into appropriate zones and layers. Plant palettes are helpful for planting plan design, however planting plans for specific bioretention systems should be customized to site-specific needs, community goals, and surrounding ecology.

This section will cover how to select and design a planting palette that addresses the unique stressors of a GRI asset. The goal is to maximize water quality treatment and achieve GRI co-benefits such as biodiversity, urban cooling, and climate adaptation.

Scientific Name	Common Name	Foliage	height (cm)	spread (cm)	Spacing	Moisture			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	DT	Bees	Butterflies
Perennials																							
Iris douglasiana	Douglas Iris	semi																				x	
Baptisia australis var. minor	False Indigo	perennial																					
Brodiaea hyacinthina	Fool's Onion	White -	30-60-	10	scatter	Moist, well draining	●														y	x	x
Allium acuminatum	Tapertip onion	purple	40	10	scatter	Moist, well draining	●	◑													y	x	
Echinacea purpurea	Purple coneflower	Pink	60	30-60	60	Moist, well draining	●														y		x
Lilium columbianum	Tiger Lily	perennial	20-30	10-15	scatter	Moist, well draining		◑													y		x
Camas quamash	Camas	purple																					x
Linum lewisii	Prarie flax	perennial	60-90	30-60	45-60	Moist, well draining	●	◑													y	x	
Groundcover																							
Heuchera micrantha	rounleaf alumroot	evergreen	30				●	◑													y	x	
Sedum oreganum	Oregon Stonecrop	evergreen	15																		y	x	
Stuchys bizantina	Lamb's ear	evergreen	15 -45																		y	x	
Grasses/Sedges/Rushes																							
Carex pansa	dense sedge	evergreen	40			wet dry															y	x	
Juncas acuminatus	sharp fruted rush	evergreen	30		30cm	wet dry	●	◑													y		x
Juncas effusus	Soft rush	evergreen	15-40			moist															y	x	
Shrubs																							
Spiraea betulifolia var. lucida	white spirea	White -	150	60	60		●	◑													y	x	
Symphoricarpous albus	snow berry	whie	150	80			●	◑														x	

Figure 1. Plant palette example.

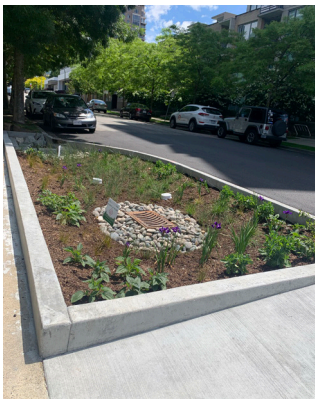
Plant Stressors in GRI Systems

GRI can be a challenging environment for plants. It is important that planting is thoughtfully laid out and chosen based on the specific locations and stressors. Often plants found in natural ephemeral conditions will function well in Green Rainwater Infrastructure. To the best extent possible, the use of native species is recommended, as they are adapted to local climate conditions. However, considering both urban and climate stressors, plant palettes should prioritize water management function and long-term sustainability, and it is expected that not all plants within GRI systems will be native. Consider plants from the Costal Pacific North-west.

The following stressors and constraints may be present within GRI assets:

Consideration	Potential Design Solutions

 Prolonged periods of seasonal ponding and soil saturation.	• Choose species tolerant of prolonged wet conditions (zone 1 plants in plant pallet)
	  • Emergent species.
	  • Evergreen – sedges, rushes and grasses.
	  • Plants naturally tolerant to ephemeral conditions.

 Prolonged periods of seasonal drought and urban heat in summer months.	• Choose drought tolerant plants. • Ensure supplemental watering until the plant is established. Avoid plant installation in the Summer. • Choose plants naturally tolerant to ephemeral conditions (zone 1,2). • Ensure by-annual mulching or living mulch. No bare soil.
 Urban pollutant loading including salt, micro-plastics and heavy metals.	• Choose plants tolerant of anticipated pollution. • Perform regular sediment and debris removal.
 Height restrictions due to sightlines in the right of way.	• Review all guidelines for height restrictions and be mindful of the users in the area. • Some flowering species have heights taller than guidelines, but are still permeable so be mindful of actual heights.

Consideration	Potential Design Solutions
 Sediment loading and water conveyance (channelized flow).	• Plant design should prevent channelization that can accelerate erosion in the GI area. - Plants should not be installed in rows. • Plant in a triangular formation. • Plant design should ensure that plants around inlets do not lead to eventual obstruction. - Do not plant large plants or shrubs directly at inlet. • Include slope interrupters to slow water flow and prevent riling. • Space out weir notches when designing sediment pads. • Channelization may occur more frequently until plants are rooted in. Increased maintenance should happen during establishment.
 Soil type and volume.	• As systems within the right of way can be narrow and linear, it is important to have adequate soil depth to counter the extreme heat in the summer. 45cm minimum. • Choose plants tolerant of the parameters of the soil. Always review soil lab analysis prior to soil installation. • Ensure the soil has enough water holding capacity for summer drought.

Planting Moisture Zones

GRI systems have up to three moisture planting zones, each with a different microclimate. Depending on the size and type of GRI system being designed, 1, 2 or all 3 zones may be relevant. No matter how many zones a system has, planting width should be a minimum of 1.2 m in systems with no side slopes, and 1.5 m in systems with side slopes. Plant selection for a GRI should consider the soil moisture and pollutant level in each planting zone. Zones within the bioretention facility are described as the following:

Zone 1 is the wettest and lowest zone, generally inundated throughout the winter.. It receives the most amount of water and supports plant species toleratant of standing water and fluctuating water levels. Ephemeral wetland or estuary species can be considered as long as they are drought tolerant.

Zone 2 is the middle zone. It is slightly drier, but also supports plant species that can tolerate fluctuating water levels

Zone 3 is the outer zone or edge of the GRI area. It contains plant species that do not anticipate standing water. Plant species in this zone should be highly tolerant of drought, heat, and urban pollution.

A list of plant species broken down by moisture zone is available here on the City of Vancouver's website.

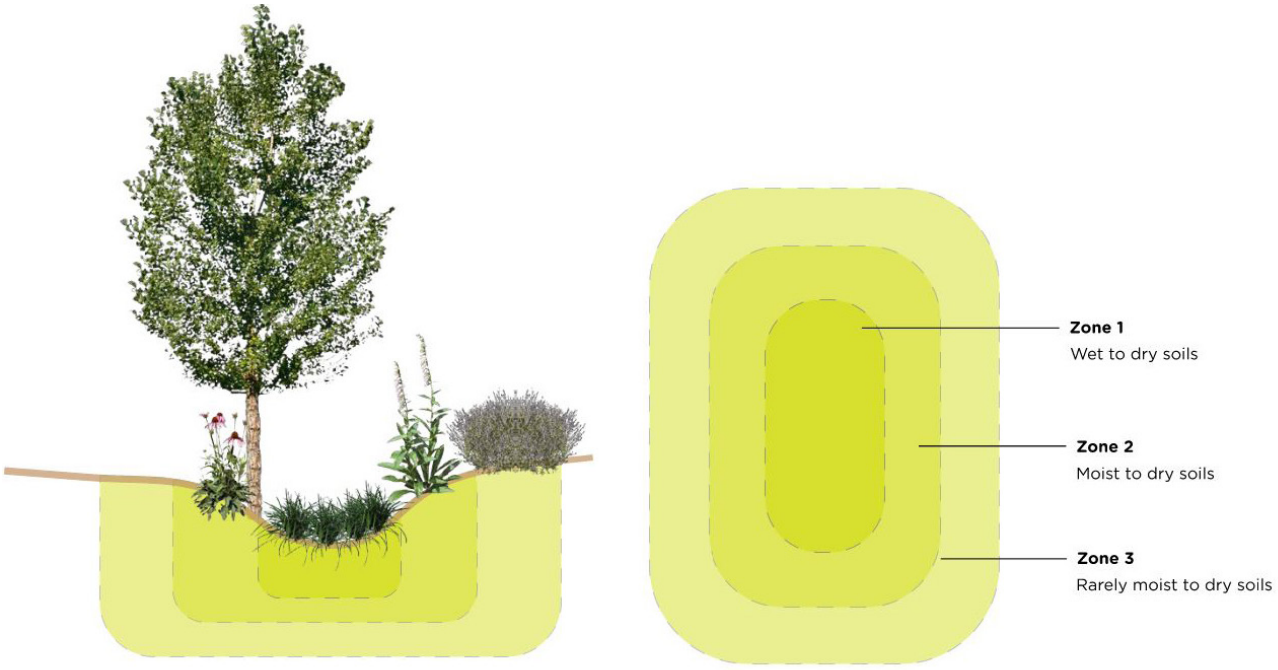


Figure 2. Planting Moisture Zones

Plant Communities

Plant communities, matrix planting, plant guilds, and companion planting are all descriptors of the same goal: compatible plant species that work together and support each other to be self-sustaining. GRI should be designed around plant communities, which allows for lower maintenance regimes, improves plant survival rates, and creates more naturalized areas that support biodiversity above and below ground. Diverse planting is strongly encouraged in GRI systems. Consider plants at different heights, bloom times and structure, as well as beneficial root systems.

The root systems of different plant species host different bacteria that perform different tasks. Nitrogen fixing bacteria for example will turn insoluble nitrogen into nitrogen that is easily absorbed by other plant root systems. Other plants communicate through mycelium that also transmit nutrients to roots stocks, and other shallow rooted groundcovers protect the soil from evaporation and provide weed suppression. Deeply rooted grasses and shrubs then offer an overarching drought tolerance and sun protection to the groundcovers.

A good plant community is made up of layers that offer protection at different times of the year and at different heights, providing shade and access to sunlight. Trees, grasses, shrubs, perennials and groundcovers all have a place in matrix planting to support each other. The goal of a matrix planting is a community of self-sustaining plants once established. There should be very little bare soil through tight planting and groundcovers. A diverse plant matrix will not only support the plants themselves, but also the pollinators that rely on a steady food supply, where in turn the plants rely on as well.

Figure 3. Graphical representation of Community planting Elements

Scanlon, K. Greenest City Scholar 2020. Exploring Regenerative Planting Strategies for Green Rainwater Infrastructure. P.16. https://sustain.ubc.ca/sites/default/files/2020-51_Regenerative%20Planting%20GRI_Scanlon.pdf

A good way to determine a plant community is seeking what grows together naturally, and seek out local knowledge holders to gain input. It's also important to ensure the community of plants chosen can thrive in the same soil type (further discussed in Section 5. Soil).

Designing around plant communities creates a more natural and 'wild' aesthetic compared to traditional horticulture planting in blocks and rows. While the layered and non-uniform arrangement might seem messy, embracing natural planting can enhance the urban environment and ultimately lead to a lower-maintenance, self-sustaining landscape

Examples of naturalized 'wild' aesthetic of native plants thriving together in a community

In the natural environment, plant communities change over time, and the same can be expected within GRI systems. As micro-climates may dictate, certain plant species may out-preform others in hotter or cooler locations. Providing diversity will support adaptability withing the plant community so that all species will thrive. Planting plans should not be designed to be static, but to work with natural processes to change, adapt and evolve.

Examples of matrix layout and growth one season later

4. Trees in GRI

Incorporating trees can provide several benefits to the performance and durability of GRI systems. Trees provide shade for other plants, their roots can help aerate the soil and improve permeability, they absorb and evapotranspirate significant quantities of water and prevent it from entering the sewer system.

This section, in conjunction with the City of Vancouver Construction Specifications, the City of Vancouver Standard Detail Drawings, and the Development Permit process, outlines the criteria for tree plantings within GRI systems and how to help ensure that proposed GI systems do not negatively impact existing trees within the City of Vancouver.

The City of Vancouver Street Tree By-law No. 5985 stipulates that the Vancouver Board of Parks and Recreation has care and custody of all trees growing on Vancouver street rights-of-way. Vancouver Board of Parks and Recreation staff are responsible for overseeing or conducting tree planting including species selection, risk assessments, and general maintenance of trees on streets. Trees planted within GRI assets (bioretention areas or rainwater tree trenches) are still the responsibility of the Vancouver Board of Parks and Recreation, however some special considerations should be taken to ensure that these trees thrive in the GRI environment.

The City of Vancouver Engineer Design Manual, Section 9.3 Urban Forest provides the following guidance around trees planting in the right-of way:

To ensure a healthy urban forest and the safety of residents the following are requirements for trees planted in Vancouver's right-of-way:

- tolerant of local growing conditions
- maintain sightlines for vehicular and cyclist traffic
- have adequate soil space to reach its natural form at maturity
- not prone to branch failure or windthrow
- not susceptible to pests
- not possessing significant nuisance problems (large nuts, allergenic properties)
- not requiring excessive maintenance
- meet required utility offsets

Richards Street Rainwater Tree Trench

Existing Trees Around GRI

Trees are an essential component of public infrastructure with benefits improving as the tree ages and grows. GRI systems may be placed near existing trees, but steps should be taken to ensure that construction never negatively impacts existing street trees. This includes the protection measures outlined in the City of Vancouver Engineering Design Manual.

The protection and preservation of older existing trees should be prioritized over the planting of new trees. Whenever possible, GRI planting design should strive to incorporate existing street trees into the planting areas. An important consideration is the ability of existing trees to withstand the additional saturation from adjacent GRI systems. If the tree may be negatively impacted by the soil saturation, replacement may be considered.

The excavation of new GRI systems should never negatively impact existing healthy street trees. The root protection zone of existing healthy trees should always be maintained. Careful grading design around the existing trees to ensure root systems are protected during excavation is key to preserving existing trees in GI. Limited hydrovacing around tree roots may be permitted by the Vancouver Board of Parks and Recreation under limited circumstances.

Existing street tree next to bioretention bulge

Tree Selection

Tree maintenance and species selection in the City of Vancouver is the responsibility of the Vancouver Board of Parks and Recreation. All new trees should be reviewed and approved by Parks Board staff. Refer to the City of Vancouver Engineer Design Manual, Section 9.3 Urban Forest for further information on Street Tree selection.

Soil Volumes for Street Trees

Trees in urban environments are often given inadequate soil volume, which can slow their growth rate and/or lead to poor tree health. Street trees without adequate soil volume can also cause sidewalk buckling and create a tripping hazard. GRI systems can support a healthy tree canopy and reduce street maintenance needs by providing additional sub-surface soil volume for trees. When selecting tree species for GRI areas, it is essential to ensure that they will be given adequate soil volume to reach their maturity.

Engineering soil and soil cells may be used to support root growth underneath adjacent hardscapes such as bike lanes and/or sidewalks. The void space of a particular soil cell product should be used when calculating the soil contributions of these products. Engineered soil is a combination of stone aggregate and soil, and consequently it must be calculated as 50% soil volume when accounting for the contributions to total tree soil volume.

The soil that contributes to a given trees soil volume requirement must be directly adjacent to the tree and not interrupted by any utility conflicts.

Native soils/fill in highly urbanized environments with overlying hardscapes are often heavily compacted and nutrient poor. In these areas, native soil underneath the hardscape surrounding the GI system should generally not be considered as contributing to the required soil volume for the tree.

Additional information on recommendations for tree spacing and soil volume may be found in the City of Vancouver Engineer Design Manual, Section 9.3 Urban Forest. Native fill may be considered acceptable soil volume for trees if tests are conducted that demonstrate that the soil has acceptable properties as outlined this manual and is not excessively compacted.

5. Soil

Soil composition, biology and health and are an integral part of plant health and pollutant removal. Ensuring a healthy soil that will sustain the life of the plants is integral for plant installation. Poor soil quality at the onset of the project will set it up for struggle and the need for renewal in the future.

Most bioretention projects in the City of Vancouver will require engineered, imported soils to be installed. However, reviewing the feasibility of reusing existing soils onsite should be done. Taking advantage of existing soil biology and structure and reducing the carbon footprint of trucking in new soil is the preferred approach. To determine viability of soil reuse, you will need to complete the following:

- Test the soil and determine potential amendments to meet the specification;
- Send to environmental lab to ensure no contamination;
- Ensure soil is free of invasive weeds and seed bank;
- Determine stockpile location and ensure protection from erosion.

As GRI systems are required to infiltrate quickly, replacement with a higher infiltrating bioretention medium is often specified. Amendments, and additives such as biochar may be considered in high pollutant loading areas to increase urban pollutant removal. The type of soils you are planting in will have a large impact on species selection. Many of the plants specified in GRI are more tolerant of acidic soil conditions. If there is only one soil blend installed, ensure all of the plants specifies can grow in the same soil conditions.

Soil in GI systems should comply with the parameters listed in City of Vancouver's Engineering Design Manual Section 32 91 23S Bioretention Soil, which is available upon request to raincity@vancouver.ca.

New Planting in Bioretention Soil

6. Designing for Biodiversity

Vancouver is an urban landscape consisting of habitat patches fragmented by urban development, roads, utilities and other land uses. Habitat fragmentation can negatively impact ecosystem services and reduce the dispersal ability of plants and animals. With thoughtful design, planted GRI can help to connect habitat patches that support birds, pollinators, insects and mammals.

Even small additions of native plants can support biodiversity in the urban environment. However, the location and size of GRI planting will impact what biodiversity solutions are implemented into your project. In the design planning stage, consider the following questions:

- What kind of natural habitat can you realistically create on your project site? I.e. coniferous forest, deciduous/mixed forest, shrubland, meadow, riparian.
- What kinds of species can access your site? What does it make the most sense to design for?
- Who else uses the space? Are there areas that could be designated for wildlife refuge that can be kept away from human interaction?

City of Vancouver's Biodiversity Strategy can be a resource to help identify appropriate biodiversity to target in your projects. iNaturalist is another resource which can provide you with open-source citizen science data, to help identify what species are commonly found in your project area and could be targeted through design. Given the opportunities and constraints of GRI in the urban environment, the likely species to be target include native birds, pollinators, native bee species, bats, small mammals, and beneficial insects.

All plants and animals need three key ingredients to sustain themselves: food, water and shelter. Beyond plants themselves, GRI systems can support habitat creation through natural features such as small ponding areas, nurse logs, bird and bee houses, boulder, and terrain complexity. Habitat features should be incorporated into the GRI design in a way that complements the hydraulic requirements of the system. This may be achieved by using nurse logs and boulders as weirs and/or erosion control, or ponding areas when high infiltration rates are required.

Consideration / Guideline	Native Birds	Pollinators	Small Mammels	Beneficial Insects	Bats
Plant Selection and Placement					
Each pollinator species is attracted to a mix of plants based on the size, shape, and colour of their flowers. Variety is key to supporting pollinators.	x	x		x	
Plant placement is equally important as plant selection when designing for biodiversity. Early blooms and food sources can be strategically located near nurse logs, decaying wood, designating nesting and hibernation areas.	x	x		x	
Include plants that provide seeds and berries, particularly in winter months when food is harder to find.	x		x		x
To maximize biodiversity, no single plant species should be more than 10% of total seed/plant mix.	x	x	x	x	x
Habitat Creation					
In larger systems, create micro-habitat throughout to support a wide variety of biodiversity including: • Mud Puddles • Decaying wood (piles of snags, nurse logs) • Water dishes • Hotel structures • Perches	 x x x	 x x x x 	 x 	 x x x 	 x x x
In larger systems, designate nesting areas for insects where stems can be left over winter.		x		x	
In larger (blue-green) systems, consider including a mix of habitat: coniferous forest, deciduous/mixed forest, shrubland, meadow and riparian.	x	x	x	x	x

Consideration / Guideline	Native Birds	Pollinators	Small Mammels	Beneficial Insects	Bats
Plant shade-tolerant native ground cover and shrub plants to increase foraging and nesting opportunities.	x		x	x	
Conserve and replant large trees and shrubs where possible. Consider leaving trunks of cut/dead trees or repurposing them as nurse logs and perching posts.	x			x	
Species Protection					
Encourage the presence of predator species and beneficial insects as they will support healthy growth of native species (flora and fauna) and provide natural pest management.	x		x		x
Keep human and dog access limited in some areas to allow species to have refuge. Use sidewalks, boardwalks, dense vegetation, fencing and other indicators.	x	x	x	x	x
Use signage to help nurture and develop respect for wildlife and biodiveristy.	x	x	x	x	x

Nurse logs at St. George Rainway

7. Establishment and Maintenance

The success of GRI planting is dependent not only on design, but also how it is cared for in the long-term. A GRI landscape can be set up for success by properly considering how the site will be established and maintained.

Designing for Ease of Maintenance

When designing a GRI system, it is important to consider how the landscape will be maintained. Consider access points for maintenance crews, maintenance frequency and skill. GRI systems should be designed for low-maintenance regimes, including:

1. Provide vertical layering and consider dense vegetation as living green mulch for soil stabilization, weed suppression, moisture retention, and increased infiltration rates.
2. Create a defined edge (timber, steel, concrete) where planting and sod meet to avoid intrusion of grass and other weed species.
3. Rethink the use of excessive stone riprap. Pollutant remediation often occurs in the soil layer and plant rhizosphere. Erosion control can also be achieved with dense vegetation and proper planting schedules.
4. Ensure parking and maintenance vehicle access is available.
5. Balance having a variety of species that supports biodiversity with a recognizable plant palette.

Planting at Sunset Park

Establishment

The planting establishment period refers to the early stages of growth when plants begin to establish themselves in their new environment. During this period, plants are particularly vulnerable to stressors such as drought, prolonged soil saturation, physical disturbance, and disease. The City of Vancouver requires that all Green Infrastructure systems have a minimum 2-year establishment warranty period to ensure that appropriate maintenance activities are undertaken and that the plants in green infrastructure systems have a higher likelihood of long-term survival. GI will not meet its full performance goals until plant roots have fully established.

GI perform at its best with a combination of healthy soils and densely rooted vegetation. Plant replacement should take place routinely during the warranty period to ensure vegetation coverage of 75% of the planting bed or more. Replacement should take place throughout the establishment period, and not exclusively at the end of the two-year warranty. Plant die off may have occurred for a number of reasons such as lack of maintenance, drought, or overwhelming sedimentation. Understanding the root cause can help when selecting species replacement options.

Monthly maintenance visits are recommended during the establishment period. Care should be taken to empty pre-treatment/sediment pads routinely, as sediment entering the planting bed can be particularly harmful to small, establishing plants.

Sunset Park bioswale after planting, at plant replacement 1 year into the establishment period, and the site once fully established.

8. References and Resources

City of Vancouver Green Rainwater Infrastructure Resources

- Green Rainwater Infrastructure Planting List: https://vancouver.ca/files/cov/green-infrastructure-approved-plant-list.xlsx
- Green Rainwater Infrastructure Design Resources: https://vancouver.ca/home-property-development/green-rainwater-infrastructure-design-resources.aspx
- Green Rainwater Infrastructure Projects: https://vancouver.ca/home-property-development/green-rainwater-infrastructure-projects.aspx
- Rain City Strategy: https: //vancouver.ca/files/cov/rain-city-strategy.pdf

City of Vancouver Resources

- St. George Rainway Bioblitz Report back: https://syc.vancouver.ca/projects/st-george-rainway/st-george-rainawy-2022-bioblitz-report-back.pdf
- Vancouver Plan: https://vancouver.ca/home-property-development/vancouver-plan.aspx
- City of Vancouver Community Plans: https://vancouver.ca/home-property-development/neighbourhood-planning-projects.aspx
- City of Vancouver Urban Forestry Strategy: https://vancouver.ca/parks-recreation-culture/urban-forest-strategy.aspx
- City of Vancouver Biodiversity Strategy: https://vancouver.ca/parks-recreation-culture/biodiversity.aspx
- City of Vancouver Bird Friendly Guidelines: https://vancouver.ca/files/cov/bird-friendly-strategy-design-guidelines-draft-2014-09-01.pdf
- City of Vancouver Boulevard Gardening Guidelines: https://vancouver.ca/files/cov/boulevard-gardening-guidelines.pdf
- City of Vancouver Street Tree Bylaw: https://vancouver.ca/your-government/street-tree-bylaw.aspx

External Resources

- Bat-Friendly Communities Guide: https://bcbats.ca/attachments/BC-Bat-friendly-Communities-Guide-2018.pdf
- Surrey Biodiversity Guidelines: https://www.surrey.ca/renovating-building-development/land-planning-development/environmental-protection/biodiversity/design-guidelines
- Planting in a Post Wild World: https://www.thomasrainer.com/book
- Metro Vancouver Grow Green Guide: https://growgreenguide.ca/Pages/default.aspx
- Grow Me Instead: https://bcinvasives.ca/play-your-part/plantwise/grow-me-instead/
- Native Bee Society of BC: https://www.bcnativebees.org/

The City of Vancouver

Planting and Ecology Design Guidelines

for Green Rainwater Infrastructure