



ADMINISTRATIVE REPORT

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TO: Standing Committee on Policy and Strategic Priorities

FROM: General Manager of Engineering Services in consultation with the General Managers of Planning, Urban Design and Sustainability, Development, Buildings and Licensing, Parks and Recreation Board, Finance, Risk and Supply Chain Management, and Real Estate and Facilities Management

SUBJECT: Rain City Strategy - A Green Infrastructure and Urban Rainwater Management Initiative

RECOMMENDATION

THAT Council amend the vision and goals of Vancouver's Integrated Rainwater Management Plan and Green Infrastructure Strategy, as described in this report.

REPORT SUMMARY

In April 2016, the Vancouver Citywide Integrated Rainwater Management Plan (IRMP) and Green Infrastructure Strategy was presented to Council. Council directed staff to establish a team to develop a long-term green infrastructure implementation plan. The purpose of this report is to provide an update on the progress and emerging direction of the work and to seek Council approval for the vision and goals that will guide future implementation work plan.

This report presents a re-articulation of the vision and goals for the initiative to further emphasize the notion of being more resourceful with rainwater and to expand the goals of the initiative beyond water quality, to also include long-term resilience and liveability through healthy urban ecosystems. It is anticipated that a report back to Council with a high level implementation plan, including targets, will be in early summer 2018.

COUNCIL AUTHORITY/PREVIOUS DECISIONS

Green infrastructure (GI) intersects with a wide range of City initiatives and previous Council and Park Board directions:

- Rezoning for Sustainable Large Developments (2010)
- Green Buildings Policy for Rezonings (2010)
- Greenest City 2020 Action Plan (GCAP) (2011)
- Climate Change Adaptation Strategy (2012)
- Transportation 2040 (2012)
- Coastal Flood Risk Assessment Program - Phase I (2012)
- Vancouver Food Strategy (2013)
- Urban Forest Strategy (2014)
- Healthy City Strategy (2014)
- Vancouver Citywide Integrated Rainwater Management Plan (2016)
- Biodiversity Strategy (2016)
- Coastal Flood Risk Assessment Program - Phase II (2016)
- Green Building Policy for Rezonings (2016)
- Complete Streets Policy Framework and Related By-law Changes (2017)
- Coastal Flood Risk Assessment Program - Phase III (2017)

For more information on previous Council directions and related City initiatives, see Appendix A: Relevant policy decisions and related City initiatives.

CITY MANAGER'S/GENERAL MANAGER'S COMMENTS

The City Manager supports adoption of the recommendation. The Rain City Strategy is seeking to embed a holistic, integrated, resourceful and more resource-efficient approach to sustainable urban rainwater management on both public and private property that will take many years, even decades to deliver.

For many cities, urban stormwater and combined sewer overflows are two of the most significant sources of water pollution in their urban environments, impacting local waters, ecosystems and aquatic species such as salmon. In consideration of projected changes to our climate in the coming decades, including both greater abundance and scarcity of rain and water resources and warming temperatures, actions towards a more rain, water and heat resilient city are vital.

Thoughtful planning and actions now through the Rain City Strategy will be critical to our social, economic and environmental health, resilience and livability for the future.

REPORT

Background/Context

Green infrastructure implementation plan scope and horizon

The IRMP presented to Council in April 2016 provided a high level framework and valuable information base about precipitation, physical, and geological conditions and a generalized toolkit of options to support rainwater management in the city.

The intention of the Green Infrastructure Implementation Plan work underway is to develop a long-term, high level implementation plan, with an outlook to 2050, to guide the application of sustainable urban rainwater management in future community and infrastructure planning, policy development, capital planning, design standards, operations and maintenance procedures, and asset management programs.

Staff are researching best practices in implementation planning in leading peer jurisdictions and are seeking to develop a rationale and framework to identify and prioritize: (1) Which green infrastructure strategies and tools are most applicable in a respective watershed; (2) To what extent the green infrastructure strategies and tools meet the goals and objectives; (3) Considerations for the timing of deployment in the next 30 years; and (4) Short-term strategies that could be readily implemented.

City staff are taking an integrated and holistic approach, aiming for actions that can be sustained over the long-term. The potential for transformative change in how we manage rainwater as a city is significant.

Defining green infrastructure

Green infrastructure is an emerging field and term for sustainable water management that uses both engineered and ecosystem-based practices to protect, restore or mimic natural processes in water systems and cycles in a way that supports healthier, more resilient urban environments. The focus of the Rain City Strategy is application of green infrastructure approaches to rainwater management.

Historically, rainwater management focused on conventional stormwater systems with the goal of efficiently moving water away from private lands and public spaces, typically through underground pipe systems. The primary goals were drainage, flood protection and sediment management. Other water quality or resilience objectives were not integral to the system. For many cities, including Vancouver, protecting receiving waters and aquatic ecosystems as well as long-term climate resilience have grown in importance, prompting new approaches to managing urban rainwater.

Cities across the world are embracing green infrastructure systems to help meet water quality objectives and as part of planning for cost-effective, multi-purpose infrastructure investments for the future. Green infrastructure investments have become a vehicle for aligning water management with a multitude of other city building priorities and co-benefits, including greater water security, enhanced public realms, increased habitat and bio-diversity, mitigation of urban heat island effects, mitigating future risks and costs of climate change, and creating new economic development opportunities.

Green infrastructure systems can take many forms and use vegetation, soils, and engineered elements to mimic natural ecosystem processes to slow, clean, evaporate and absorb rainwater. Examples of green infrastructure practices include raingardens, green roofs, absorbent landscaping, trees, soil cells, bio-retention swales, permeable pavements, underground infiltration trenches or drywells and water collection and re-use systems.

At a city scale, green infrastructure is a distributed network of natural areas and engineered practices that contribute to cleaner water and air, habitat, flood protection, and cooler urban environments. From a citywide perspective, a core principle is a decentralized approach; small, widely applied green infrastructure practices across a city collectively will have significant impacts.

At a local scale, green infrastructure practices are designed to reduce pollutant loads at the source and create alternate pathways for rainwater. The piped system, also known as grey infrastructure, serves rainwater flows that cannot be readily accommodated through infiltration, evapotranspiration, and harvest and reuse.

Grey infrastructure is a complementary asset that plays a role in helping to integrate our water, drainage and sewer systems. Green infrastructure practices do not eliminate the need for grey infrastructure. Pipes will still be needed to handle the more extreme rainstorm flows that would exceed the capacity of most green infrastructure systems.

Vancouver's regulatory obligation

The City has regulatory obligations around: (1) Eliminating combined sewer overflows by 2050; (2) Monitoring and mitigating water quality impacts from urban stormwater; and (3) Implementing stormwater management through the Integrated Rainwater Management Plan, which is a condition imposed by the Provincial Ministry of Environment on all municipalities in Metro Vancouver that are subject to the regional Integrated Liquid Waste and Resource Management Plan. Investments in green infrastructure will aid the City's efforts to respond to these regulatory obligations in a cost-effective way.

Strategic Analysis

Imperatives for a new approach to urban rainwater management

Vancouver has had a long-term interest in reducing the impacts of our sewer and drainage system on local receiving waters. Since the 1980s, the City has been pursuing a plan to separate our combined sewer and drainage pipes in order to meet our obligation for no combined sewer overflows by 2050. Over the past two decades, a range of green infrastructure innovations have been applied in the public right-of-way, in large developments such as Olympic Village, on private developments, and throughout our park system. These green infrastructure installations, however, have tended to be pilot projects or one-offs and have yet to become standard practice citywide. As the city continues to grow and densify the need to take further action increases.

Currently, in the absence of a new approach, expanded development means declining absorbent green spaces. At the same time, our climate is changing, leading to very different precipitation and temperature patterns for our growing city in the future. Without purposeful interventions around sustainable urban rainwater management, increased development will create more impermeable surfaces in the built environment and reduce the presence of mature trees and other plants, leading to increased rainwater run-off to our drainage pipes. By linking sustainable urban rainwater management and adaptation planning with land use and infrastructure planning, Vancouver can evolve the way we build the city to restore hydrological pathways, protect our sensitive aquatic ecosystems and valued local waters while helping our city become more resilient to climate change.

The three imperatives for action on sustainable urban rainwater management include water quality, resilience planning, and liveability in our city:

1. Protecting water quality through green infrastructure

Reducing the impacts of urban activities on the waters and aquatic ecosystems around Vancouver are fundamental to the Rain City Plan. Water quality concerns in Vancouver are twofold:

Combined sewer overflows

As with many older cities, Vancouver historically buried natural creek channels and used sewers that combine both sanitary sewage and storm water drainage. During lower precipitation periods, the combined waste water goes directly to the regional wastewater treatment plant. During higher precipitation periods, the combined volume of rainfall mixed with sewage can overwhelm the capacity of the pipe. This results in a combined sewer overflow (CSO), a mix of sewage diluted with rainwater that flows directly in to our local receiving waters, such as Burrard Inlet, False Creek, English Bay or the Fraser River.

To date, the primary tool to eliminate combined sewer overflows has been the sewer separation program. We now also look to green infrastructure strategies to be part of the solution by removing the volume of rainwater from combined sewer and drainage pipes, thereby reducing CSOs.

Urban rainwater pollution

Even if we had a fully separated system, urban rainwater runoff continues to be a major cause of water pollution in urban areas. When rain falls on our roofs, streets, and parking lots in the city, the rainwater cannot soak into the ground as it would have in an undeveloped watershed. Instead, rainwater flows overland and picks up pollutants before entering a street catch basin or drain on private property that ultimately discharges the untreated rainwater directly in to our surrounding waters.

Common pollutants found in urban rainwater run-off include litter, bacteria, heavy metals, hydrocarbons, sediment, and other pollutants from the urban landscape. With green infrastructure systems, the intention is to capture and clean rainwater using sediment traps, soil, microbes and plant ecosystems that filter, metabolize, and absorb pollutants. Today, Vancouver has few interventions in place to manage the negative impacts of urban rainwater pollutants on the environment and in aquatic ecosystems in particular.

As part of Vancouver's IRMP, the City is required to develop a water quality monitoring strategy. The obligation is to show 'continuous improvement' towards a set of specified pollutant targets within Metro Vancouver's Adaptive Management Framework (AMF). Water quality regulations may become more stringent in future and developing a response within a short time horizon would prove both challenging and very costly. Acting now to reduce our water quality impacts, in a more strategic, holistic and methodical way, will help improve conditions and mitigate future risks, costs and penalties.

2. Adapting to climate change and fostering resilience

Green infrastructure represents a multi-functional infrastructure investment and has gained popularity in recent years across the USA, Europe and Australia because it is recognized as being a strategic and cost-effective way to meet stormwater-related regulatory requirements and enhance climate change resilience while also delivering on many other civic objectives.

In 2016, the Pacific Climate Impacts Consortium, in partnership with the University of Victoria and the City of Vancouver, updated its climate projections for Vancouver and the results have significant implications for Vancouver by 2050. Their models are projecting:

- More extreme rainfall events in winter (an increase of 33% very wet days and 63% extremely wet days, '1 in 20 year storm events' are expected to increase by 36% indicating an increase potential for flooding);
- Prolonged dry periods in summer (increase of 23% in consecutive dry days, from 23 to 29 consecutive dry days per year);
- A greater number of summer heat days (increase of 139% from 18 to 43 days greater than 25°C per year) and more hot summer days above 30°C (average occurrence today is once per year, projected increase to 12 times per year, with the very hot day temperatures intensifying from 32°C today to 37°C in 2050);
- Declining snowpack in our drinking watershed (a decline of 58%); and
- Rising sea levels (sea level increase of 0.5 m by 2050 and 1 m by 2100) in areas that also receive rainwater from all over the city via our network city-serving drainage outfalls.

The resilience benefits of this initiative also extend to water security considerations. Currently, Metro Vancouver is undertaking significant investments to expand its water supply to meet 2030 needs. In response to population growth and climate change, beyond 2030, additional long-term drinking water storage expansion projects are also being considered, which will have significant cost implications for the region. Reducing drinking water consumption and identifying new sources of non-potable water for non-potable uses will be important to align with supply planning and investments.

The pressures on the water supply system, combined with climate change projections for more heat and drought, highlights the need for Vancouver to demonstrate leadership and new thinking related to wise water use, changing how we view rainwater as a resource and allowing rainwater to return to its natural pathways to support our urban ecosystems.

3. Supporting liveability through healthy urban and natural ecosystems

Redirecting rainwater to its natural pathways rather than a pipe network is essential for plants and trees to flourish, particularly in light of changing climate patterns that put the health of natural assets at risk. Furthermore, plants and trees play a critical role in surface water management by improving infiltration, capturing pollutants and sediment, absorbing and releasing water to the atmosphere, and providing shade, habitat, food, and shelter for urban wildlife. Even small patches of vegetation like green roofs can provide habitat for a variety of insects and birds. Green infrastructure designs link water quality, resilience, and liveability benefits.

In addition, access to nature in the urban environment contributes to the liveability, enjoyment and health of our community. Multiple studies cite access to nature as directly correlated to improved health outcomes. Green infrastructure investments for rainwater management can therefore contribute to our community's health and wellness.

Attractive streets and greenways support our sustainable transportation goals around walking and cycling. Lush green public spaces and parks attract people to enjoy the public realm and have a sense of connection. Seeing and experiencing nature in the dense urban environments is also known to contribute to mental health and well-being, helping to reduce feelings of stress and anxiety.

These three imperatives for a new approach to rainwater management are closely connected and in many ways reinforce one another. Projected changes to Vancouver's climate pose significant risks to the City, our infrastructure and our communities, and will take many years to prepare for and adapt to. Green infrastructure has a significant potential to help mitigate a variety of long-term risks related to increasingly intense rain events and flood damage, stormwater quality impacts on habitat and aquatic ecosystem health, increasingly hot and dry summer weather patterns and availability of water for people, natural assets and urban food systems.

The climate adaptation benefits of green infrastructure will also help protect and prolong the lifespan of our asset investments in, for example, sewer, drainage, park, public space and natural assets such as trees, gardens and other horticulture elements. There is a financial risk to having to alter or replace assets before the end of their design life based on changing climatic conditions. Many natural assets perceived as amenities in our community, such as street trees and gardens, may also be at risk and very costly to replace if they cannot remain healthy with changing conditions.

Progress towards the implementation plan development

An interdisciplinary GI Team was established that brings together engineers, planners, landscape architects, an urban ecologist, financial analyst, communications specialist and technicians. The team involves staff from Engineering, Planning, Urban Design and Sustainability, Finance, and Corporate Communications.

The role of the GI Team is to develop a long-term implementation plan in collaboration with departments from across the organization. The team is leading and providing coordination in the identification and prioritization of citywide strategies, researching best practices, developing relationships with subject matter experts including peer jurisdictions, academia and private sector, data gathering, developing material for communications and leading internal and external engagement. The team is also supporting other departments who are taking the lead on specific parts of the work program related to the public and private realms and parks.

Action while planning for the future

Staff are currently pursuing about a dozen 'quickstarts' and pilot projects, including integration of GI in capital projects, large planning projects and rezonings. We are developing prototype concepts for rainwater management at Yukon and 63rd (refer to Appendix B) in 2017 and intend to explore options for the St. George Rainway corridor and surrounding area in Mt. Pleasant in 2018. For more information on the St. George Rainway initiative, see Appendix C: Bringing rainwater management to the St. George Rainway and surrounding area in Mt. Pleasant.

A summary of actions taken since the adoption of the Vancouver Citywide Integrated Rainwater Management Plan are summarized in Appendix D: Summary of actions while planning & quickstarts.

Discussion

Amending the implementation plan vision, goals, and objectives

The Integrated Rainwater Management Plan presented to Council in April 2016 included the following:

- Current Vision: Vancouver's abundant rainwater is celebrated as a resource
- Current Goal: Vancouver is surrounded by clean water
- Current Target: Capture and clean 90% of Vancouver's average annual rainfall through the implementation of green infrastructure on public and private property

There was broad engagement within the organization to explore the needs, opportunities, and potential synergies of green infrastructure implementation with a wide range of priorities being pursued by a number of departments. Refer to Appendix G for more on internal and external engagement. Based on this engagement, there was a sense that the vision and goals should be re-articulated to focus more strongly on being resourceful with rainwater and to further align the Green Infrastructure Implementation Plan with other City priorities, the emerging work around long-term resilience planning and the 30 year Strategic Outlook for City Building. In particular, there was an interest in reinforcing integration of our drinking water conservation goals with rainwater management planning.

The Greenest City 2020 Action Plan includes a goal to reduce water consumption by 33% by 2020. A great deal of effort around water conservation has been underway for a number of years, yet a significant gap persists and more transformative measures are needed to make significant progress. Research completed by the water conservation team indicates that water is perceived to be plentiful in our region. This perception of 'abundance' is a

barrier to public understanding of the need for action to reduce potable water consumption. It also misrepresents the action needed to address future water resilience in light of projected changes to our climate and regional water supply constraints. Based on these considerations, Staff recommends the following re-articulated vision and goals and recommends the current IRMP target be maintained:

Proposed Vision: Vancouver's rainwater is embraced as a valued resource for our communities and natural ecosystems

Proposed Goals:

1. Improve and protect Vancouver's water quality
2. Increase Vancouver's resilience through sustainable water management
3. Enhance Vancouver's liveability by improving natural and urban ecosystems

Maintain Target: Capture and clean 90% of Vancouver's average annual rainfall through the implementation of green infrastructure on public and private property

The goals intersect and are intended to reinforce one another. In order to measure our progress towards these goals, the following six objectives have been identified to guide the implementation planning, provide a means of measuring progress towards the goals and for establishing additional targets in future. Proposed objectives:

Proposed Objectives:

1. Remove pollutants (water and air)
2. Reduce volume of rainwater entering pipes
3. Increase total green area
4. Increase managed impermeable area (to capture, treat and then infiltrate, evaporate or convey runoff)
5. Mitigate urban heat island effects
6. Harvest and reuse water

The implementation plan development is organized around seven strategic priorities and programs, which are detailed in Appendix E: Work program.

Understanding Vancouver's baseline

Determining metrics and a baseline of where the City is at today is a critical step in developing an implementation plan for the future. A suite of quantitative and qualitative metrics are being developed for each objective and will help guide strategic priorities and quantify the impact of green infrastructure options. Given that a more comprehensive approach to sustainable urban rainwater management is a new undertaking for the City, the availability of base data is limited. As part of the final implementation plan, a program for monitoring metrics will be developed. Data collection efforts are being planned for 2018 to provide a clear baseline of the City today.

Emerging themes for citywide green infrastructure

In an effort to identify and prioritize green infrastructure implementation strategies, inter-departmental mapping workshops were held to identify citywide patterns, synergies, barriers, and strategic opportunities for the implementation of green infrastructure. The qualitative screening exercise involved overlaying data layers to narrow down opportunities, considerations, and areas for further quantitative analysis and engagement. This process yielded a number of emerging themes relevant to implementation planning:

- Emerging themes:
1. High pollutant load areas
 2. Highly impervious areas
 3. Combined sewer overflow severity areas
 4. Green deficient and urban heat areas
 5. Harvest and reuse opportunity areas

For more details, see Appendix F: Emerging themes.

Developing the business case

Based on the mapping, spatial analysis and community engagement work, a business case will be developed to support the decision-making process for green infrastructure investments. In particular, the Business Case will assess the green infrastructure approach in terms of costs, benefits, risks and feasibility, and bring greater clarity to the implications of inaction or continuing with a primarily grey infrastructure-based approach.

Implications/Related Issues/Risk

Financial

The original IRMP report received by Council in April 2016 approved start-up funding of \$1.5 million for the creation of the project team to support best practices research, capacity building and development of baseline metrics, monitoring and assessment programs.

It is anticipated that staff will report back to Council with a high level implementation plan in summer 2018, at which time longer-term funding requirements associated with the plan will be identified for Council consideration as part of the 2019-2022 Capital Plan.

Environmental

The current citywide IRMP for Vancouver has a single goal around water quality. By embracing two additional goals related to resilience and livability in the IRMP, the implementation planning work will encourage decisions that protect and enhance a wide range of long-term environmental values for our communities and natural ecosystems.

Legal

Vancouver has regulatory obligations it must meet around the elimination of combined sewer overflows, acting on integrated rainwater management through its IRMP and reducing the water quality impacts of our drainage system on local receiving waters. The City's efforts to meet its obligation to have no combined sewer overflows by 2050 require an accelerated and diversified approach, and green infrastructure investments have a strategic role to play to meet this obligation.

Social

Adapting to climate change and the impacts of more intense precipitation, extended hot and dry periods will have significant social implications. Vulnerable populations would particularly benefit from increasing nature in the city and mitigating urban heat island impacts and increased flood risks through green infrastructure investments and increased resilience.

In addition, some aspects of the care for green infrastructure systems represent new opportunities for community stewardship and the development of new industries and employment opportunities to support implementation on both public and private property. Other North American jurisdictions have leveraged green infrastructure implementation as economic development opportunities that can also provide training, capacity-building and job opportunities for youth and underemployed populations. Opportunities to support partnerships, stewardship and industry readiness will be explored as part of the development of the Green Infrastructure Implementation Plan.

Other

As part of the process for identifying and prioritizing actions, staff will be exploring the risks and considerations related to prospective implementation plan policy directions. It is expected that some of the more complex directions being explored for the implementation plan will require more in-depth research, analysis, engagement, risk analysis and policy development beyond the scope of this plan. The current high level, strategic implementation planning work with a planning horizon to 2050, however, does have significant long-term risk implications, including:

1. Complexity of work

Water quality and rainwater management impact the entire City and all its residents and businesses. Effectively addressing water quality, while continuing to strive for resilience given climate change, is a difficult challenge. Success will be predicated on our ability to work collaboratively as staff across departments and with our partners in the Metro Vancouver area. There is risk that action taken without careful thought or action taken

in isolation will be inadequate and unsustainable. An effective and cost-conscious approach will require departments to work in concert to evaluate options and integrate green infrastructure best practices early, consistently and wherever practical into their ongoing work and future planning.

In addition, since green infrastructure systems typically bridge the planning, design, maintenance, operations and budget responsibilities of many departments, deliberate planning and decision-making around asset ownership and management will be required. Where possible, City staff will be basing recommendations on global best practice and/or from lessons learned through past projects, pilots and 'quickstart' initiatives.

2. Green infrastructure life cycle implications

Like existing piped sewer systems, green infrastructure systems need to be maintained through their lifecycle on both public and private property. The kind of care they require, however, will differ from many of our current practices. For example:

- Permeable pavements and paver systems will require regular cleaning for performance. Appropriate, preventative maintenance and street sweeping with purpose-designed equipment may be needed. Current programs may need to expand deployment to reflect the important role of sediment management in preventing pollutants from entering the drainage system and our local waters.
- In bio-retention systems or green roofs, the soil, plants and trees provide rainwater and pollution management and so keeping the system healthy and functional is vital to supporting their ability to perform.

Operations and maintenance is a critical component of green infrastructure systems and will require dedicated, ongoing program budget that reflect their function as critical infrastructure in the drainage system, not just as aesthetic elements. Inadequate maintenance poses risks to performance and public acceptability if systems are not cared for appropriately. Identifying long-term, sustainable funding mechanisms will be a critical part of the work ahead.

While operations costs may go up in some areas, other costs, including capital expenditures, may be reduced or avoided. Studies in other jurisdictions indicate that when considering life-cycle capital and maintenance costs, green infrastructure is often less expensive than equivalent traditional or grey sewer infrastructure while also providing the added benefit of beautification, biodiversity and healthy city outcomes.

CONCLUSION

Green infrastructure provides an opportunity to reimagine the role of rainwater in the city, as a resource that both serves and shapes our communities and natural systems. The implementation plan development work has prompted efforts to take a more integrated, 'one water' approach to water, wastewater and rainwater management planning and to contemplate greater integration of land use and infrastructure planning. The work thus far has been mainly focused on bringing clarity to the vision and goals of the plan, on raising awareness across many internal departments and building capacity and alignment around the work ahead. The next steps will focus on external engagement with the community, private sector, and academia along with further research and analysis to develop a high level implementation plan that will improve and protect our water quality, help the city become more resilient, and contribute to liveability through healthy urban ecosystems over the long-term.

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APPENDIX A: RELEVANT POLICY DECISIONS AND RELATED CITY INITIATIVES

Green infrastructure intersects with a wide range of City initiatives and previous Council directions:

In 2010, Council adopted the Rezoning Policy for Sustainable Large Developments, which requires large developments to have a Rainwater Management Plan that will address how the project will limit interference with natural hydrology by minimizing impervious cover, increasing on-site infiltration opportunities, limiting rainwater run-off and managing rainwater runoff quality.

In 2010, the Green Buildings Policy for Rezonings was adopted by Council and updated in 2016 to include requirements to explore and describe measures for the management of rainfall on-site through integrated rainwater management and green infrastructure.

In 2011, Council endorsed Metro Vancouver's Regional Integrated Liquid Waste and Resource Management Plan that, in accordance with Ministry of Environment regulatory requirements, began requiring municipalities to create Integrated Stormwater Management Plans to enhance the overall health of watersheds by reducing pollutant loads in urban rainwater runoff. In addition, this plan requires the City to monitor stormwater, and assess and report out on the implementation and effectiveness of the Vancouver Citywide Integrated Rainwater Management Plan (IRMP).

In 2011, the Greenest City 2020 Action Plan (GCAP) set goals toward a healthy, prosperous and resilient future for the City. GCAP Goal 6 - Clean Water- strives to have the best water in the world, which applies to both drinking water and overall environmental water quality.

In 2012, Council adopted the Climate Change Adaptation Strategy to ensure that Vancouver remains livable and resilient in the face of climate change, including the increasing frequency and intensity of rain storms.

In 2012, work commenced on Phase I of the Coastal Flood Risk Assessment program, which identified current and future flood risk hazards, the impacts of future flooding impacts in 2100 and 2200 in 11 flood prone neighbourhoods in Vancouver and identified flood plain areas and potential flood plain construction levels.

In 2012, Transportation 2040 was adopted by Council setting a long-term strategic vision to guide transportation and land use decisions, including the exploration of opportunities to improve local ecology when designing and (re)building streets and other rights-of-way by improving wildlife habitat and stormwater management, restoring native flora, increasing the number, size, and health of street trees, and daylighting lost streams. The Plan also aims to improve pedestrian safety and accessibility and create more interesting streets and public spaces to support a vibrant public life.

In 2013, Council approved the Vancouver Food Strategy to support a just and sustainable food system by taking a systems approach to food policy and planning including preparing for climate change.

In 2014, Council adopted raising the flood construction level from 3.5 to 4.6 m within the flood plain area to improve flood resistance for new buildings and infrastructure to the year 2100.

In 2014, the Vancouver Board of Parks and Recreation and Council adopted the Urban Forest Strategy, which reinforces the important environmental and social roles the urban forest plays including cleaning the air, absorbing rainwater, providing habitat, and improving health and well-being.

In 2014, Council adopted the Healthy City Strategy providing a comprehensive and integrated plan for social sustainability that complements the environmental sustainability focus of the Greenest City Action Plan.

In 2016, Council adopted the Vancouver Citywide Integrated Rainwater Management Plan which calls for a Green Infrastructure Strategy to improve Vancouver's water quality and enhance our resilience to rain and heat events, while supporting biodiversity. In addition, Council adopted the long-term target to capture and treat 90% of Vancouver's average annual rainfall through the implementation of green infrastructure on public and private property.

In 2016, the Vancouver Board of Parks and Recreation and Council approved the Biodiversity Strategy to guide the ongoing work to protect, enhance and restore biodiversity throughout the park system, including the aquatic environment.

In 2016, the City of Vancouver was selected to join the 100 Resilient Cities global network providing tools, funding, technical expertise, and other resources to build resilience to the social, economic, and environmental challenges of the 21st century including climate change.

In 2016, Council was presented the outcomes of Phase II of the Coastal Flood Risk Assessment Program, which identified specific adaptation solutions and a tool to assess the timing of flooding risks for the 11 flood prone neighbourhoods.

In 2017, Council approved the Complete Streets Policy Framework and Related By-law Changes, directing the City to deliver more Complete Streets including the exploration of opportunities to improve rainwater management in street design.

In 2017, work commenced on Phase III of the Coastal Flood Risk Assessment Program, which will outline when and how decisions should be made to initiate flood management measures in each of the city's 11 flood zones, identify tools support adaptation interventions and develop a sea level monitoring plan. Work on a citywide education campaign about sea level rise and targeted engagement for Phase I of the Fraser River Flood Management Plan was also initiated.

APPENDIX B: ACTION WHILE PLANNING FOR THE FUTURE

Departments across the organization are pursuing a number of projects and initiatives to explore and apply design and policy in support of the Integrated Rainwater Management Plan:

- The City is actively integrating modest green infrastructure strategies in a range of transportation and street redesign projects, sewer projects, parks, and private site developments to test their performance. Implementing and monitoring these installed green infrastructure practices is key to foster a 'learning by doing' approach that facilitates 'proof of concept' and helps create understanding and increased acceptance for these functional landscapes throughout the city. It will also inform the Green Infrastructure Implementation Plan.



Sketch of Yukon and 63rd green infrastructure boulevard improvements

- One of the larger joint pilot initiatives between Planning, Engineering and Park Board is the enhanced boulevard and public space treatment for 63rd Avenue and Yukon Street. The boulevard on 63rd Avenue and Yukon Street was identified in the Marpole Community Plan as an opportunity to increase access to green space, enhance rainwater management, and improve neighbourhood amenities. The project is capturing, cleaning and infiltrating rainwater water from the surrounding streets, showcasing new trees, rain gardens, new sidewalks, seating plazas, bike racks, and a drinking water fountain. As part of this project, staff are developing new design standards for rainwater inlets, bio-retention planting palettes and internal, inter-departmental processes for the design process. The project will construct engineered rain gardens that will receive water from a large area of the adjacent street and allow it to recharge the local groundwater.

- Other initiatives include the integration of green infrastructure objectives in recently approved policy (Green Buildings Policy for Rezoning (Nov 2016), Character House Guidelines (Jul 2017)), community plans (Cambie Corridor, False Creek Flats, and North East False Creek) and large scale rezonings (Pearson Dogwood, Heather Lands, and East Fraser Lands).
- Through Vancouver's Greenest City Scholar Partnership with the University of British Columbia, a graduate student in water resources conducted an assessment of the many innovative rainwater management strategies used in the Olympic Village project. The purpose is to identify successes, challenges and lessons learned through implementation that could be applied more broadly in the city.

APPENDIX C: BRINGING RAINWATER MANAGEMENT TO THE ST. GEORGE RAINWAY PROJECT AND SURROUNDING MT. PLEASANT AREA

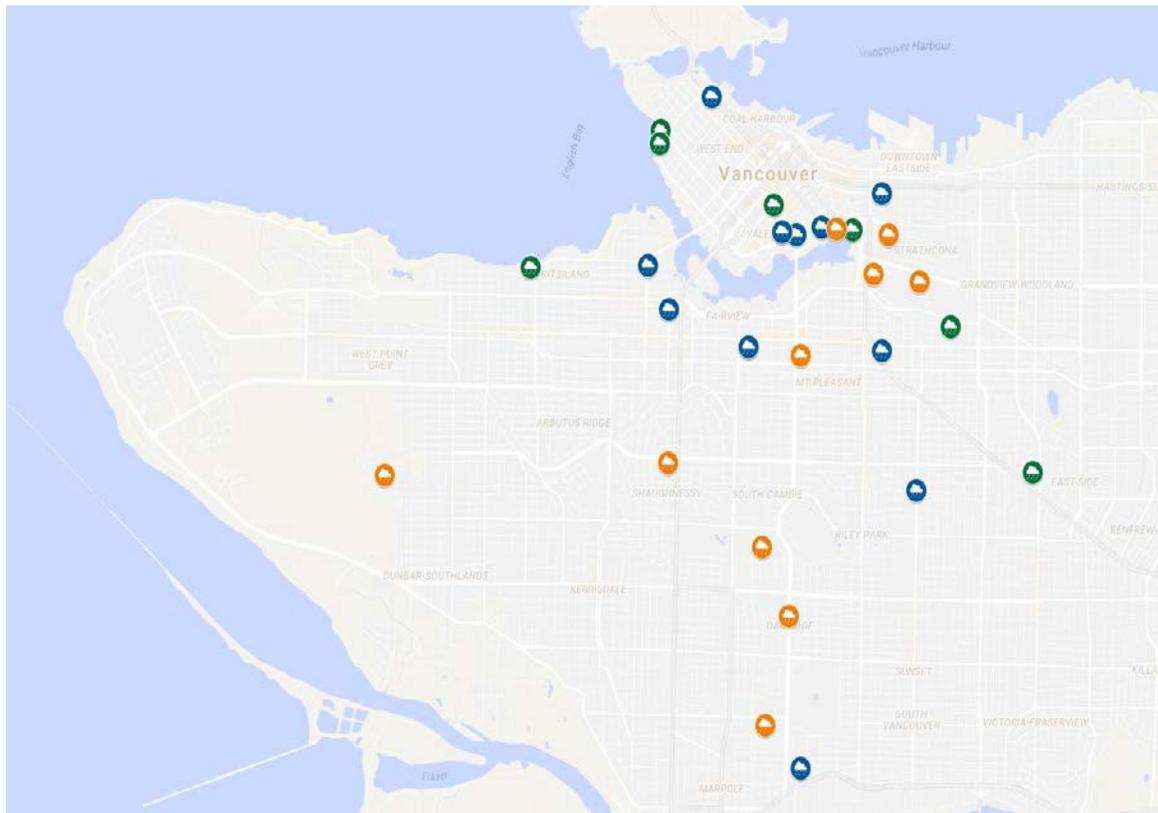
The St. George Rainway Project has been a community driven initiative that seeks to recall a historic waterway in Mt. Pleasant. Over the past decade, this active community collaborative has been working together to craft a vision for sustainable urban rainwater management along the St. George Street corridor from Great Northern Way to Kingsway. They aspire a street and boulevard that uses rainwater runoff from adjacent properties, the street, and connecting laneways to recreate a symbolic version of the lost stream well below the street, one that can still be heard from the surface today.

To date, the St. George Rainway Project has been focused on community-building, place-making, raising awareness about Vancouver's lost streams and rainwater management, and expressions through art in the right-of-way. This community group continues to show strong interest in moving the St. George Rainway Project forward as an example of functional integrated rainwater management. Given the implications for desired changes to the right-of-way, further work will require a commitment of resources and actions by the City.

The Transportation Division is currently considering Safe Routes to School planning for the schools on the corridor and there is a street closure pending on the southern part of the corridor, near Kingsway, as part of an adjacent redevelopment. These two other initiatives could form part of a coordinated effort along the corridor. In addition, there are two schools along the route, which present opportunities for education and community stewardship partnerships.

Noting the strong alignment between the St. George Rainway project and the City's integrated rainwater management implementation planning, staff will begin engagement with the community in 2018 to develop a feasibility plan and potential design concepts for green infrastructure installations along the corridor and in adjacent areas of Mt. Pleasant. The feasibility study will be pursued using existing resources.

APPENDIX D: SUMMARY OF ACTIONS WHILE PLANNING & QUICKSTARTS



-  Public Realm Initiatives
-  Private Realm Initiatives
-  Park Initiatives

 Public Realm Initiatives	 Private Realm Initiatives	 Park Initiatives
<ul style="list-style-type: none"> • 10th Ave Bikeway • 53rd & Prince Edward St • 63rd & Yukon St • Arbutus Corridor • Burrard & Cornwall • Expo & Cambie • Fraser St • Gore & Pender Bike Share Station • NEFC Pacific Boulevard • Nelson & Cambie Bus stop • Quebec St Reconstruction • Georgia Gateway 	<ul style="list-style-type: none"> • Pearson Dogwood • Heather Lands • St. Paul's Hospital • Innovation x hub • NEFC rezonings • York House School • St. George's Sr. School • City Hall Campus • False Creek Flats • Cambie Corridor Plan 	<ul style="list-style-type: none"> • Beach Ave & Morton Ave • Tatlow Creek & Volunteer Park restoration • English Bay Beach • China Creek North Park • Brewer's Park • Smithe & Richards • NEFC park

APPENDIX E: WORK PROGRAM

The work program for the Green Infrastructure Implementation Plan will take approximately 15 months over 2017 and 2018. The work is organized around seven strategic priorities and programs, as described in Table 1.

Work Program Focus Areas 2017-18 (15 months)	
1. Metrics & Tracking	<ul style="list-style-type: none"> • Develop baseline metrics and indicators • Assess current state • Develop plan to monitor progress towards objectives and targets • Identify timelines and milestones
2. Actions Public Realm	<ul style="list-style-type: none"> • Identify and prioritize strategies & tools • Develop prototypes, proof of concept plans & design standards • Develop asset management & performance monitoring strategy • Develop maintenance & monitoring plans
3. Actions Private Realm	<ul style="list-style-type: none"> • Identify and prioritize strategies & tools • Explore tools at building, site, district and citywide scale • Align with City processes & regulations
4. Current Projects Planning & Quickstarts	<ul style="list-style-type: none"> • Integrate in to City-led planning initiatives • Integrate in to rezoning & development reviews • Initiate demonstration projects & pilot projects
5. Engagement & Capacity Building	<ul style="list-style-type: none"> • Raise awareness and build capacity in the City, private sector and community • Consult and engage on high level proposals for implementation plan
6. Strategic Communications	<ul style="list-style-type: none"> • Frame Green Infrastructure messages • Educate and inform
7. Funding Mechanism & Tools	<ul style="list-style-type: none"> • Develop business case analysis • Assess Implementation costs • Explore funding and delivery models • Explore potential partnerships and grants • Integrate green infrastructure in to existing capital planning, DCL & Public benefit strategies

Table 1: Work Program Focus Areas 2017-18

APPENDIX F: EMERGING THEMES

In an effort to identify and prioritize green infrastructure implementation strategies, a series of five inter-departmental mapping workshops involving 30 branches from Engineering, Planning, Urban, Design and Sustainability, Development, Buildings and Licensing, Parks, Finance, Real Estate and Facilities Management, BPPS, and Communications were held to help identify citywide patterns, synergies, barriers and strategic opportunities for the implementation of green infrastructure. The qualitative screening exercise involved overlaying data layers to spark dialogue across departments and disciplines and to narrow down opportunities, considerations and areas for further analysis. This process yielded a number of emerging themes relevant to implementation planning:

1. High pollutant load areas

High pollutant load areas, such as industrial lands and local streets serving industrial lands, truck routes, arterial streets, diesel bus routes, and local streets adjacent to construction sites are prone to urban stormwater pollution. These higher pollutant corridors may present unique opportunities to target pollutant reduction at the source. Further research is needed to prioritize particular areas.

2. Highly impervious areas

More and more hardscaped surfaces will be part of the city as it grows and densifies. Green infrastructure can play a significant role in how the city is managing its impermeable surfaces by directing rainwater into green infrastructure practices or by implementing permeable pavement solutions. Key observations from the mapping workshop are that parking lots, plazas, large roof areas, working yards, shopping areas and ICI zones are highly impervious and therefore present opportunities for mitigation strategies.

3. Combined sewer overflow severity areas

Combined sewer overflows and urban stormwater pollution are detrimental to water quality and aquatic ecosystems in our receiving waterbodies. The mapping exercise identifies watersheds with the highest volumes and frequency of combined sewer overflows. It also identifies receiving waters that have increased sensitivity in terms of their use as community recreation areas. All receiving waters and aquatic ecosystems have ecological sensitivity.

4. Sea-level rise vulnerable areas

Many of Vancouver's low lying coastal areas are vulnerable to sea level rise and pressures on the drainage outfalls arising from high tide and storm surge, which can lead to localized flooding. As these issues become more prevalent with climate change, restoring rainwater to the ground near where it falls rather than transporting it to drain in these already vulnerable areas is an important opportunity and risk mitigation strategy.

5. Green deficient areas and urban heat areas

The city is vulnerable to extreme heat and drought, especially in green deficient areas and areas with a lot of hardscape that absorbs and radiates heat. Extreme heat in the city can cause public health risks, stress due to poor sleep when temperatures are high, energy use spikes, high water demand, deteriorated water quality, less productivity in employment, damage to vegetation and biodiversity, and social nuisance. Key observations from the mapping workshop are that areas in the eastern and south-eastern parts of the city are green deficient along with industrial zones and school yards.

In addition, high growth areas are at risk of losing tree canopy, green space and permeable area due to redevelopment. Further exploration is needed to identify how green infrastructure practices can help mitigate urban heat island effects and increase greenery whilst the city is developing.

6. Harvest and reuse

Metro Vancouver's water is collected in the Capilano, Seymour, and Coquitlam reservoirs. On an average day, the water system delivers 360-million litres of high-quality water throughout the city. Maintaining the water system to continually provide high quality water remains a high priority in the City. The mapping workshop has identified opportunities for district scale harvest and water reuse systems, matching high rainwater generation land uses with high non-potable water consumption land uses, and large scale site redevelopments. Further exploration is needed to study the feasibility of a district scale or building scale harvest and reuse system.

APPENDIX G: INTERNAL AND EXTERNAL ENGAGEMENT

Green infrastructure encourages a more sustainable and resource-efficient way of managing rainwater in the city. Green infrastructure implementation will bring new ideas, new players, new roles, and potential for new partnerships between First Nations, communities, the public sector, the private sector, and academia. Collaboration between governments, industry, scientists, and the public will be vital to foster innovative ideas and solutions to achieve the proposed goals and objectives.

Staff will prepare an inclusive engagement strategy, both internally and externally, that reflects the local needs and issues related to sustainable urban rainwater management.

Internal engagement

As part of implementation planning, the City wanted to better understand the potential of this Green Infrastructure initiative by engaging and collaborating with various City departments to learn from their experience, best practices and find alignment with other City initiatives. A number of actions and events were organized to engage with the City departments and groups:

Interviews

At the start of the Green Infrastructure Implementation Branch a series of 26 interviews with internal departments and groups were held to understand:

1. Existing and potential intersections between various departments of the City and the Green Infrastructure mandate;
2. Relevant initiatives underway or pending;
3. Perceived opportunities (strategic, systematic and one-offs);
4. Perceived barriers;
5. Needs or support the group has identified as it relates to implementation planning; and
6. Relevant data sources to help with analysis and decision-making.

Mapping workshop and staff engagement

Five inter-departmental workshops were held with various departments to help identify and prioritize citywide patterns, synergies, barriers and strategic opportunities for implementing green infrastructure. This workshop yielded emerging directions for implementing green infrastructure and needs further research to inform the implementation planning (see Appendix D for emerging themes). Currently, the team is reaching out to other departments and teams to give a 'roadshow' presentation to introduce staff at large to the Green Infrastructure mandate, emerging directions, and next steps in implementation planning.

Governance structure

A governance structure is in place to help guide the implementation work and to build alignment between the different departments and City initiatives involved.

Given the scope, complexity and co-benefits of implementing green infrastructure an interdepartmental Green Infrastructure Steering Committee has been established, which provides strategic oversight. The Green Infrastructure Steering Committee is comprised of the City Manager and the General Managers of Engineering, Planning, Urban Design and Sustainability, Development, Buildings and Licensing, Real Estate and Facilities Management, and Park Board. In addition to its strategic oversight role, the Green Infrastructure Steering Committee fosters efficient communication, ensures that senior staff is informed on key project elements and provides a clear path to elevate material issues for timely resolution.

Alongside the Green Infrastructure Steering Committee, a Green Infrastructure Directors Working Group has been established to ensure successful delivery of the Green Infrastructure Implementation Plan and integration of the discrete work being completed by the City's departments. The Green Infrastructure Directors Working Group is comprised of the relevant Directors of the City (Engineering, Planning, Urban Design and Sustainability, Development, Building and Licensing, Real Estate and Facilities Management, and Finance, Risk and Supply Chain Management)

External engagement

While Vancouver has many excellent examples of innovative green infrastructure practices, these practices are not yet universal or standard within our organization and in the community. A more holistic, integrated, adaptive, and strategic approach to urban rainwater management will require culture change and a new way of thinking about rainwater as a resource. It also requires a great deal of inter-sectoral and inter-disciplinary thinking and action. Green infrastructure implementation will bring new ideas, new players, new roles, and potential for new partnerships between First Nations, communities, the public sector, the private sector, and academia. Collaboration between governments, industry, scientists, and the public will be vital to foster innovative ideas and solutions to achieve the proposed goals and objectives.

There will be a variety of ways that the public, First Nations, community organizations, the public sector, the private sector, and academia can engage in the preparation of the implementation plan. Both education and raising awareness are important early steps, followed by engagement events to provide opportunities for input and capacity building to support industry, community, and department readiness for new approaches to rainwater management. A series of engagement events will be organized reflecting the diversity of communities and will include workshops, walking tours, information on the City's website, and public talks sponsored by external organizations.

An objective of engagement conversations will be to develop a new water narrative that contributes to greater understanding and ideas for how water can be regarded as a valuable resource rather than a nuisance. The engagement will also help generate discussion and directions for how our actions around rainwater management can open up new opportunities to make the city more attractive, liveable and resilient.

In addition, staff will be creating an external expert panel with members of the public sector, private sector, academia, not-for-profit societies, among others, to help guide the implementation work ahead.

Staff will prepare an inclusive engagement strategy that reflects the local needs and interests related to sustainable urban rainwater management.