CITY OF PORTLAND
Invasives 2.0
A Strategic Investment in Portland's Future

Prepared for the City of Portland by

Creative Resource Strategies

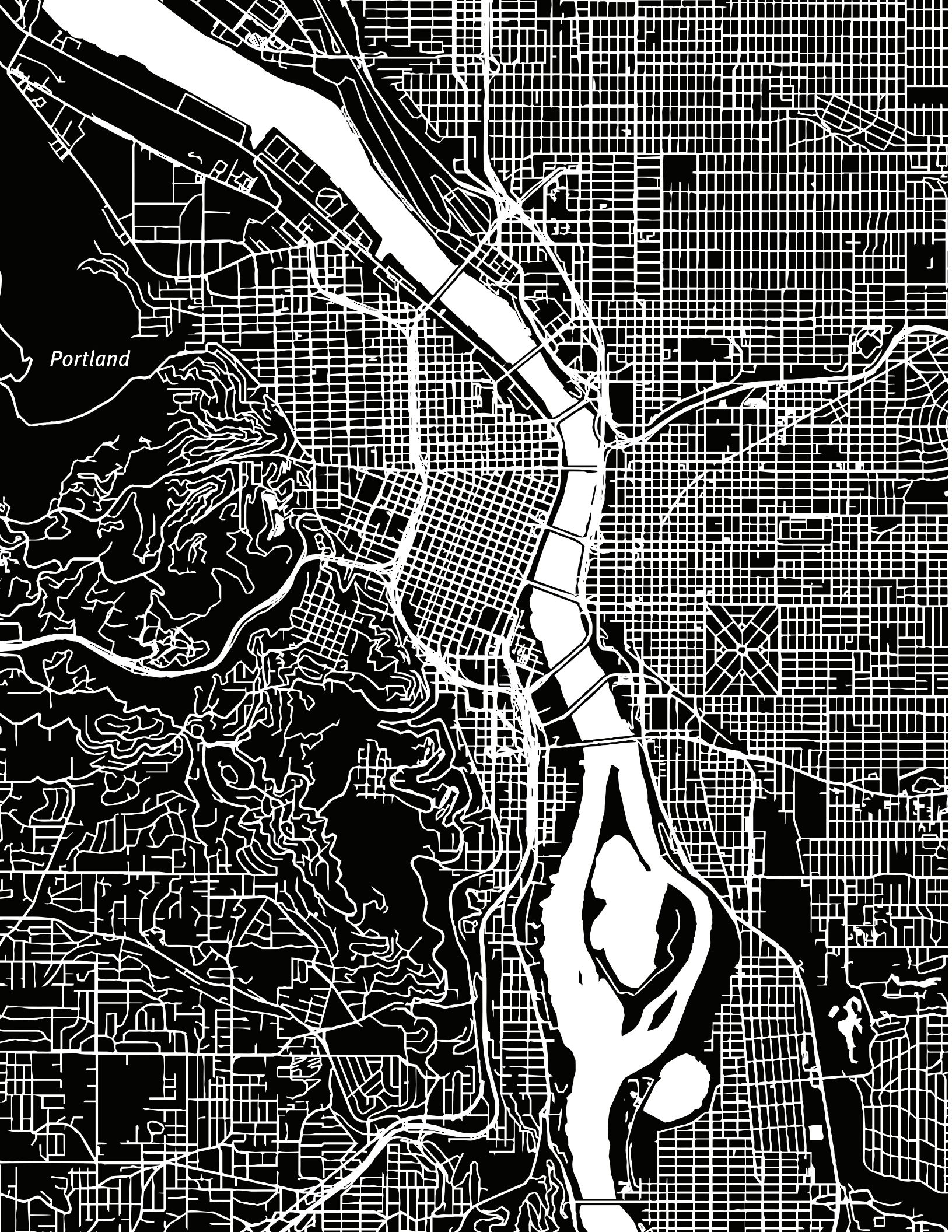
Portland

TABLE OF CONTENTS

List of Figures and Tables

FIGURES

TABLES

Glossary of Terms

Alien invasive species *(Convention on Biological Diversity)*—An alien species whose introduction and/or spread threaten biological diversity by becoming established in natural or semi-natural ecosystems or habitat; an agent of change.

Asset management *(City of Portland 2009)*—Any system that monitors and maintains things of value to an entity or group; asset management informs asset acquisition, maintenance and operations, renewal and adaption, and asset disposal.

Best management practices—Methods or techniques found to be the most effective and practical means in achieving an objective while making the optimum use of resources.

Biological control agent—*(International Plant Protection Convention)* A natural enemy, antagonist or competitor, and other self-replicating biotic entities.

City of Portland Special Status Habitat—Habitats designated in the Terrestrial Ecological Enhancement Strategy as needing protection, conservation and/or restoration: Herbaceous wetlands; Open Water-Lakes, Rivers, and Streams; Urban and Mixed Environs; Westside Upland Grasslands; Westside Lowlands Conifer-Hardwood Forest; Westside Lowlands Conifer-Hardwood Forest; Westside Oak and Dry Douglas-fir Forest and Woodlands; Westside Riparian-wetlands.

Climate resilience—The capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts (Nelson et al. 2007, Folke 2006).

Combined Sewer Overflow—An event where the volume of combined untreated stormwater and wastewater exceeds the capacity of a combined sewer system and discharges into local waterbodies.

Containment *(International Plant Protection Convention)*—Application of phytosanitary measures in and around an infested area to prevent spread of a pest.

Continuous improvement—An ongoing effort to improve products, services or processes.

Control *(Convention on Biological Diversity)*—Suppression, containment, or eradication of a pest population.

Early Detection Rapid Response *(US Geological Survey)*—A coordinated set of actions to find and eradicate potential invasive species in a specific location before they spread and cause harm.

Ecosystem *(Convention on Biological Diversity, International Plant Protection Convention)*—A dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem services—The benefits people obtain from ecosystems; includes four categories of ecosystem services, where supporting services are regarded as the basis for the services of the other three categories (provisioning, regulating, and cultural) (Millennium Ecosystem Assessment 2005).

Established species—A species with a self-sustaining, reproducing population.

Establishment *(Convention on Biological Diversity, International Plant Protection Convention)*—The process of an alien species in a new habitat successfully producing viable offspring with the likelihood of continued survival. Perpetuation, for the foreseeable future, of a pest within an area.

Exotic species *(United Nations Environment World Conservation Monitoring Centre)*—An organism that exists in the free state in an area but is not native to that area. Also refers to animals from outside the country in which they are held in captive or free-ranging populations.

Green assets—All natural, semi-natural, and artificial ecological systems within and around a city that comprise a range of habitat types, from remnant patches of native vegetation, brownfields, vacant lots, gardens, yards, bioswales and green roofs (Aronson et al. 2017). Green assets include natural assets, enhanced assets, and engineered assets.

Integrated Pest Management *(University of California Integrated Pest Management Project)*—A science-based, ecosystem function-driven approach that focuses on long-term prevention of pests or their damage through a combination of techniques, such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties, and is applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.

Introduced species *(International Council for the Exploration of the Sea)*—Any species transported intentionally, or accidentally, by a human-mediated vector into habitats outside its native range.

Invasive species—An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13312).

Monitoring *(International Plant Protection Convention, World Organization for Animal Health)*—An official ongoing process to verify phytosanitary situations. The continuous investigation of a given population, or subpopulation, and its environment, to detect changes in the prevalence of a disease, or characteristics of a pathogenic agent.

Native species *(Bern Convention)*—Species native to a given territory means a species that has been observed in the form of a naturally occurring and self-sustaining population in historical times.

Natural assets *(United Nations)*—Assets of the natural environment. These consist of biological assets (produced or wild), land and water areas with their ecosystems, subsoil assets and air. The term, "green assets," is synonymous with natural assets.

Novel ecosystem *(Hobbs 2009)*—A system of abiotic, biotic, and social components, and their interactions that, by virtue of human influence, differs from those that prevailed historically, having a tendency to self-organize and manifest novel qualities without intensive human management.

Nuisance species *(Aquatic Nuisance Species Task Force 1994)*—Aquatic and terrestrial

organisms, introduced into new habitats throughout the United States and other areas of the world, that produce harmful impacts on natural resources in these ecosystems and on the human use of these resources.

Pathway *(International Plant Protection Convention)*—Any means that allows the entry, or spread, of a pest.

Pest *(International Plant Protection Convention)*—Any species, strain, or biotype of plant, animal, or pathogenic agent injurious to plants or plant products.

Pest risk assessment *(International Plant Protection Convention)*—Evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences. Evaluation and selection of options to reduce the risk of introduction and spread of a pest.

Priority landscapes and aquatic areas—In the context of the proposed national EDRR Framework, priority landscapes and aquatic areas are generally regarded as those lands and waters (freshwater, coastal, and marine) identified by Federal, state, tribal entities, and municipalities, including the City of Portland, as areas of importance, such as for natural resource stewardship, conservation, or biodiversity purposes.

Protect the Best—A program initiated by the City of Portland in 2007 as part of the *Grey to Green* Initiative. The program has a goal of preventing small infestations of invasive plants from spreading in Portland Parks & Recreation's most ecologically healthy natural areas.

Risk *(World Organization for Animal Health)*—The likelihood of the occurrence and the likely magnitude of the consequences of an adverse event to public, aquatic animal or terrestrial animal health in the importing country during a specified time period.

Risk analysis—The set of tools or processes incorporating risk assessment, risk management, and risk communication, which are used to evaluate the potential risks associated with a species or pathway, possible mitigation measures to address that risk, and the information to be shared with decision-makers and other stakeholders (USDOI 2016).

Sanitary, or phytosanitary, measure *(World Trade Organization)*—Any measure applied: (a) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms; (b) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; (c) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or (d) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests.

Science *(The Science Council)*—The pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence.

Terrestrial Ecological Enhancement Strategy—A strategy to achieve watershed health goals and objectives in the *Portland Watershed Management Plan*. The Terrestrial Ecological Enhancement Strategy is a common body of information and agreed-upon priorities for conservation and restoration of terrestrial plant and animal species and habitats in Portland in a regional and state context.

Total Maximum Daily Load—A regulatory term in the U.S. Clean Water Act, describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Vector—Any living or non-living carrier that transports living organisms intentionally or unintentionally.

Forward

Climate change, an increasing human population, and development are a few of the many challenges and stressors urban environments and communities are facing. Cities are authorized to and play a significant role in protecting urban natural areas and maintaining these important green assets for public health and well-being. Investments in green assets are long-term commitments that ensure consistent delivery of services and values to society (City of Portland 2017a) and the economy (SEQC 2017). Poorly supported green assets contribute to reduced levels of public service and degradation and loss of these green assets through time. These reductions and losses negatively affect quality of life as well as the industries and businesses that fuel a city's economic engine.

Invasive species pose one of the most significant threats to biodiversity (Simberloff 2000, Venter et al. 2006). Invasive species reduce property values, increase risk of erosion that can cause landslides, threaten downstream ecosystems, and they exclude native plants that other native species depend upon for survival (Mattsson pers. comm). Sustainable investments in invasive species prevention and control efforts are an investment in landscape resilience that can help address climate change and other stressors on urban natural spaces (van Wassenaer et al. 2011). These investments are more cost effective than restoration of degraded ecosystems (Schoettle and Sniezko 2007).

The City of Portland Bureau of Environmental Services initiated an effort in 2018 to audit and revise its *2008 Invasive Plants Strategy*, a strategy that resulted in substantial changes to city policy code, and management practices of natural areas, developed parks, hybrid parks, and rights of way. The 2008 strategy identified regional capacity for managing invasive plants and made recommendations for implementation, including cost estimates and 10-year goals.

Creative Resource Strategies, LLC was hired to work with a city project manager to audit the *2008 Invasive Plants Strategy*, report on the findings and develop a new 10-year invasive species strategy. The audit (Appendix A) includes a literature review, internal and external stakeholder surveys, interviews and meetings with city staff and technical groups, and internal and external stakeholder reviews of the draft strategy. The audit also includes a legal review of the key pathways of introduction undertaken by the

National Sea Grant Law Center at the University of Mississippi. The findings of the audit are foundational to the development of *Invasives 2.0*.

Invasives 2.0 promotes support and expansion of strategic invasive species programs, incorporating a comprehensive all-taxa approach, and recommends adequate and sustainable funding and resources. The strategy outlined in *Invasives 2.0* strengthens our protection of built and engineered assets as well as green assets that are continually threatened by development and stressors in the urban environment. In particular, the strategy will foster biodiversity, reduce environmental hazards, mitigate the impacts of extreme weather events, and improve the overall health and well-being of Portland's 650,000+ residents (World Health Organization 2017).

The alternative to strategic, long-term sustainable investments in invasive species prevention and control efforts would be unacceptable to most Portland residents. A lack of adequate financial commitment and political support would result in the loss of forward progress achieved to date, the erosion in the confidence of regional partners and stakeholders that have worked with the city to develop and implement proactive invasive species programs, and the negation of past investments—which would ultimately result in significant future economic, environmental, and social costs.

Portland has served as a model for municipalities across the United States to take a proactive, coordinated approach to working with regional partners to address existing and emerging threats posed by invasive species. Investing in and supporting *Invasives 2.0* will ensure the city continues its wise commitment to maintain its green assets and support a high quality of life for all residents.

Executive Summary

The Bureau of Environmental Services initiated an effort in 2018 to audit and revise its *2008 Invasive Plants Strategy*, a strategy that resulted in substantial changes to city policy, code, management of natural areas, developed parks, hybrid parks, other city properties, and streets. The strategy identified regional capacity for managing invasive plants and made recommendations for implementation, including cost estimates and 10-year goals.

The city sought to review the *2008 Invasive Plants Strategy* and develop *Invasives 2.0*, a new strategy that addresses key gaps, builds on lessons learned, updates best management practices based on emerging science and technology, and articulates a cohesive, coordinated, collaborative effort across all of Portland's city bureaus. Managing Portland's green assets using an integrated multi-jurisdictional approach (both within city bureaus and with stakeholders in the region) for plants, animals, and microorganisms is a cornerstone of *Invasives 2.0*.

The audit conducted in 2018 (see Appendix A) incorporated a 10-year retrospective that documented program accomplishments as well as gaps and shortcomings identified through strategy implementation. The *2008 Invasive Plants Strategy* had 4 goals: (1) Program Development; (2) Outreach, Education, and Coordination; (3) Inventory and Assessment; and (4) Invasive Species Control. Of the 44 actions listed under these goals, 27 were completed, 13 were partially completed, and four were not completed. Those activities that remain relevant moving forward have been incorporated into *Invasives 2.0* goals and actions.

Priority shortcomings and gaps described in the *2008 Invasive Plants Strategy* that are addressed and incorporated into *Invasives 2.0* include:

- Funding and resources;
- Full integration of green assets into the Portland's asset management plans;
- Establishment of performance metrics to assess progress in achieving levels of service;
- Use of a comprehensive invasive species database or portal to document and share information;
- Long-term monitoring of green assets;

- Enhanced public engagement;
- An all-taxa approach to invasive species prevention and management efforts;
- Establishment of continual improvement processes;
- Consensus regarding the philosophy and approaches to invasive species prevention and management efforts;
- Prioritization based on risk assessments and pathways of introduction;
- Enhanced clarity of invasive species regulations;
- Development of rapid response plans and prevention strategies; and
- A watershed-based, zero-based budgeting approach.

Invasives 2.0 is the city's next 10-year invasive species strategy, which identifies a set of 30 strategies (16 high priority, 11 medium priority, three low priority) grouped into seven goals that address the key takeaways, lessons learned, and priority gaps revealed during the implementation of the *2008 Invasive Plants Strategy* as well as actions that address emerging invasive species issues and pathways.

Invasives 2.0 goals include:

Goal I: Prevent the Spread

Prevent the introduction and spread of priority species and identify existing and potential introduction pathways for known threats.

This goal is intended to strengthen the city's comprehensive watershed-based approach to managing the city's green assets based on desired levels of service, fully integrating green assets into the city's asset management plan. Five-year implementation actions are focused on watershed-based, zero-based budgeting[1], incorporation of green assets into the city's asset management plan, articulation of desired levels of service for green assets, lessening pathways of introduction, development of a biannual all-taxa risk assessment, use of a data portal to document and share information, articulation of protocols and taxa for priority surveys, and implementation of actions to address priority pathways of introduction.

Goal II: Detect New Introductions

Survey and monitor city-owned properties and high priority pathways to detect new introductions of invasive species.

This goal is intended to establish and implement an all-taxa monitoring program. The five-year implementation action focuses on identifying taxa and protocols for surveys based on the highest risk invasive species and pathways.

Goal III: Control

Control invasive species to minimize their spread and deleterious effects.

This goal is intended to manage new and established populations of invasive species to achieve desired levels of services associated with the city's green assets. Five-year implementation actions include developing teams of watershed-based city staff to budget, articulate desired levels of service, prioritize and implement treatments, implement rapid response, share information, and consistently implement best management practices.

Goal IV: Restore and Rehabilitate

Support functional urban ecosystems impacted by the introduction of invasive species by restoring and rehabilitating those systems.

This goal is intended to maintain desired levels of service of Portland's priority green assets through restoration and rehabilitation actions. Five-year implementation actions include prioritizing green assets and achieving desired levels of service through restoration and rehabilitation activities.

Goal V: Engage People

Provide equitable, diverse, and inclusive public engagement and stewardship opportunities that enhance civic capacity, improve awareness, foster natural resource-friendly attitudes and behaviors, and contribute to public health and well-being.

Five-year implementation actions are focused on

[1] *Zero-based budgeting allocates funding based on program efficiency and necessity versus budget history (Deloitte 2015).*

increasing community stewardship and participation in invasive species control and prevention efforts, evaluating how invasive species and prioritization of treatments may affect historically or currently marginalized communities, and hosting a regional summit every five years with partners and stakeholders to celebrate successes, evaluate progress, and identify gaps and emerging trends.

Goal VI: Continuously Improve

Continually assess the ability to manage invasive species to achieve desired levels of service, and implement course corrections to ensure the latest science and best management practices.

Five-year implementation actions include improving the process to update the Portland Plant List, evaluating and making needed changes to improve regulatory mechanisms, and implementing an adaptive management approach to achieve desired levels of service efficiently and effectively.

Goal VII:Fund Sustainable Efforts

Ensure *Invasives 2.0* is adequately funded to meet the ecosystem function goals and desired levels of service of the Portland's green assets.

This goal will ensure adequate funding to achieve the goals and implementation actions of *Invasives 2.0*. Five-year implementation actions include (i) using zero-based budgeting on a site-by-site basis within each watershed, (ii) hiring additional staff to address existing budget gaps, (iii) supporting an expanded all-taxa approach to invasive species, and (iv) expanding outreach and engagement with the public.

Invasives 2.0
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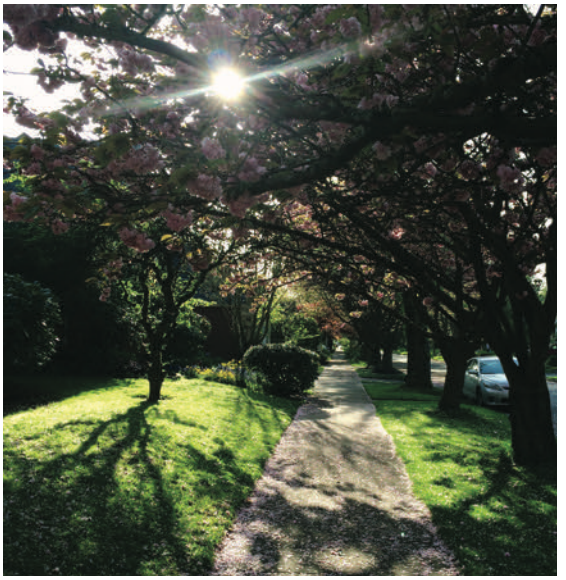
Introduction:
Ecosystem Services and Invasive Species in Urban Areas

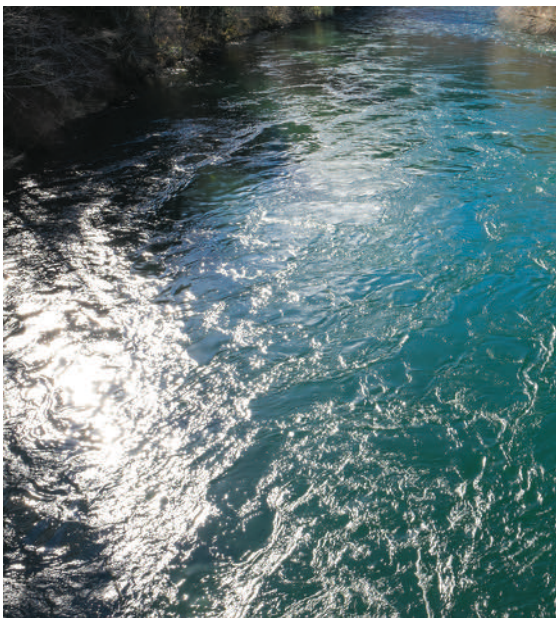
Human-dominated landscapes in urban areas influence ecosystem health and function such that cities have some of the most profoundly altered ecosystems on the planet (Collins et al. 2000). Invasive species are continually being introduced into urban environments because they are hubs for global trade of commodities (Seebens et al. 2016, Gaertner et al. 2017). Urban areas possess valuable natural resources in the form of urban tree canopies, watersheds, parks, riparian areas, wetlands, natural areas, street trees, community gardens, and bioswales, which collectively provide a suite of beneficial ecosystem services that warrant a modern approach by recognizing them as green assets that require management and protection. Invasive plant and animal species threaten to harm and degrade these green assets, directly and indirectly, by reducing a variety of ecosystem services.

Urban Canopies

Urban canopies provide ecosystem services at tree, street, watershed, and city scales (Livesley et al. 2015). Trees intercept rainfall and reflect irradiance. Trees provide shade, favorable microclimates, habitat for birds and other wildlife, uptake carbon dioxide, water, and nutrients. At the street level, trees provide thermal comfort to people and create a complex urban forest habitat for wildlife. Trees also enhance energy savings by shading buildings, reducing runoff, and enhancing water quality. At the watershed level, trees provide shade, stabilize riverbanks, prevent



erosion, and provide food and cover to fish and aquatic species. At the city level, a forest canopy is an integral component of riparian areas, and can reduce the urban heat island, particulate pollution, and runoff as well as increase filtration. Invasive species, such as wood-boring insects, climbing vines, and pathogens, can cause the loss of urban trees and forests, drastically reducing the benefits of ecosystem services as well as interrupt urban wildlife connectivity corridors.



Intact Watersheds

Intact watersheds provide clean drinking water, provide natural flood protection, reduce the need for downstream drinking water treatment and infrastructure costs[2], absorb sediments and transform pollutants (Washington State Department of Natural Resources 2012), provide habitat for native fish and wildlife (Washington State Department of Natural Resources 2012), and increase property values of nearby homes (Maine DEP 2005). Healthy and intact watersheds also provide essential services in addressing total maximum daily loads (TMDL), and combined sewer overflows (CSO) and infrastructure in natural areas (City of Portland 2017b). Watersheds impacted by invasives species experience degradations in water quality (McCormick et al. 2009) and disrupted water delivery (Hosler 2011). For example, zebra and quagga mussels clog water pipes, reducing the flow of water and altering the taste of drinking water.

Urban Natural Areas

Urban natural areas offer recreational opportunities (Baur and Tynon 2010), provide natural stormwater management, provide wildlife habitat (Larry 2013), provide access to nature and help sustain public health and well-being (Jennings and Gaither 2015, Svendsen et al. 2016), improve air quality (Nowak and Heisler 2010), assist with temperature management (Nowack and Heisler 2010), and ameliorate the effects of climate change stressors (Nowack and Heisler 2010). The existence of natural areas creates opportunities for people to connect with nature, enhancing the potential for a community to have scientifically literate residents who can contribute to informed policy decisions and conservation actions (Lepczyk et al. 2017). Degradation of natural areas by invasive species lessens habitat resilience and biodiversity (Trentanovi et al. 2013, City of Portland 2018), affects the quality and type of recreational experiences available (Marbuah et al. 2014), and increases costs for land management (Funk et al. 2014). Urban natural areas are also degraded because of development, which threatens ecological integrity, recreational experiences, aesthetic quality, public investment, and safety because of increased edge effects (Arroyo 2000) that occur adjacent to these areas. Development adjacent to urban natural areas exposes native fish and wildlife to introduced and invasive species (Arroyo 2000).

Urban areas and ecosystems are especially vulnerable to invasive species because of the significant habitat disturbance that occurs in heavily populated and developed areas as well as the numerous pathways of invasive species introduction (Hennings 2005). Globalization of commerce and the

[2] *In 2004, Clean Water Services in the Tualatin River Basin began implementing a watershed-based approach to water quality improvement through water quality credit trading. Credits are awarded to agricultural producers who partake in riparian planting and other stream enhancement activities. By 2011, this program resulted in 35 miles of restoration projects in the basin, allowing Clean Water Services to avoid investing in a multi-million dollar artificial chiller to cool effluent from the water treatment plant.*

existence of a major port and international airport in the Portland metropolitan area continually expose the city's green assets to a suite of invasive pests, such as Japanese beetle *(Popillia japonica)*. Because of the valued ecosystem services green spaces provide in urban areas, it is important to identify and manage pathways of introduction, focusing efforts on prevention of introduction and spread, which is the least expensive and most effective approach to invasive species management (National Invasive Species Council 2016).

Although most peer-reviewed science indicates that invasive species can have deleterious effects, several studies support the concept of "novel ecosystems" (Hobbs 2009). For example, in highly urbanized and fragmented systems where native species may be rare, the presence of a non-native fruiting shrub provides essential food resources to migratory birds (Gleditsch and Carlo 2010). Aronson et al. (2017) document the tension that exists relative to tolerance expressed for non-native species and a lack of science to inform management targets and goals (Murcia et al. 2014). One solution proposed is a decision tree for restoration action that integrates novel ecosystem components with modern restoration ecology perspectives (Miller and Bestelmeyer 2016) and incorporates a broader definition of restoration that:

- Allows for potentially increasingly uncertain environmental circumstances and unprecedented challenges associated with managing green assets in an urban environment;
- Focuses on restoring ecosystem function versus historical species assemblages, which may not be viable restoration targets;
- Can provide and maximize, in certain contexts, biodiversity on the landscape; and
- Requires clear statements of restoration goals and strategies as well as best practices.

Pathways of Introduction

The Era of Globalization has accelerated transportation of commodities throughout the world, contributing to the quantity of biological invasions (Hulme 2009). The major challenge associated with invasive species ecology is management of introduction vectors (Sylvester et al. 2011). Therefore, focusing on vectors, or pathways of introduction, helps to identify the potential sources of invasive species (Convention on Biological Diversity 2014). A focus on species, such as quagga and zebra mussels, should be balanced with a focus on pathways of introduction and spread, such as transporting watercraft, to prevent propagules from arriving and disbursing (McGeoch et al. 2015).

The primary pathways of introduction to Portland are: Air transportation/cargo, water transportation, land transportation, items used in shipping, travel tourism/relocation, plant pathways-plant trade, food pathways, non-food animal pathways, and ecosystem disturbances.

Table 1 illustrates the framework used to describe invasive species pathways and threats to the City of Portland, including the primary pathways of introduction as well as the techniques commonly used to manage the threats, and the priorities for protection from threats.

The 2018 audit of the *2008 Invasive Plants Strategy* (Appendix A-4) further analyzes the pathways of invasive species introduction, including pathway specifics, organisms transported, and examples of invasive species associated with pathways. The audit also describes the responsible city departments, state laws or regulations, local authorities, and recommendations for the city based on the authority it has to enhance prevention efforts to stem the introduction and spread of invasive species to the city.

A comprehensive approach is required to addressing pathways of introduction, including public outreach and engagement, best management practices (Appendix A), incentives, policies at the local, state, and federal level, and other approaches. Although some activities, such as international commerce, lie outside the jurisdiction of the City of Portland, the city can influence the outcomes of these activities through partnerships, political will, and its own policies and regulations.

Based on the 2018 audit, each of Portland's major pathways of introduction have at least one "sub-pathway" that is deemed a priority based on risk assessments completed by federal and state agencies, and emerging threats identified to the region by agencies, Canadian partners, and others.

The identified pathways are those that the city can influence, and the suggested actions are those that the city could take to enhance prevention efforts focused on pathway introduction.

Table 1. Pathways of invasive species threats to Portland's green assets.

GREEN ASSET						Note: Pathways **highlighted in orange are considered priorities** based on their risk of introduction, establishment, and spread as well as economic, environmental, and social costs once established. Medium priorities are highlighted in blue. Low priorities are highlighted in purple.	MANAGEMENT COMPONENT					
Parks	Natural Areas	Urban Forest	Street trees	Watersheds	Recreation		BMPs	City policies	Community Engagement	Incentives	State policies	Federal policies
AIR TRANSPORTATION												
X	X	X	X	X	X	Cargo	X	X		X		
WATER TRANSPORTATION												
				X		Ballast	X				X	X
	X			X	X	Hull fouling			X		X	X
X	X	X	X	X	X	Stowaways					X	X
X	X	X	X	X		Structures above water line	X				X	X
X	X	X	X	X		Dredge spoil material	X	X				
				X	X	Anglers	X		X			
LAND TRANSPORTATION												
X	X	X	X	X	X	Cars and trucks	X		X			
X				X	X	Boat trailers	X		X	X		
		X	X		X	Trains	X					
X	X	X	X		X	Equipment	X		X			
X	X	X	X	X	X	Hikers, horses, pets, recreationists	X		X			
X	X	X	X	X	X	Forest workers	X	X	X			
ITEMS USED IN SHIPPING												
X	X	X	X		X	Port containers/crates	X			X		X
X	X	X	X		X	Wood packing material	X	X		X		X
						Seaweed	X		X			

GREEN ASSET						Note: Pathways **highlighted in orange are considered priorities** based on their risk of introduction, establishment, and spread as well as economic, environmental, and social costs once established. Medium priorities are highlighted in blue. Low priorities are highlighted in purple.	MANAGEMENT COMPONENT					
Parks	Natural Areas	Urban Forest	Street trees	Watersheds	Recreation		BMPs	City policies	Community Engagement	Incentives	State policies	Federal policies
TRAVEL TOURISM/RELOCATION												
X	X	X	X	X	X	Travel/relocation		X		X		
X	X			X	X	Baggage/gear		X				
X	X	X	X	X	X	Smuggling		X				
X	X	X	X	X	X	Plant pathways - Plant trade	X	X	X	X		
FOOD PATHWAYS												
						Seafood market	X		X		X	X
X	X	X	X	X	X	Live animals					X	X
NON-FOOD ANIMAL PATHWAYS												
X	X			X	X	Bait industry	X		X	X	X	X
X	X			X	X	Pet/aquarium trade	X	X	X	X	X	X
					X	Aquaculture	X		X		X	X
OTHER PATHWAYS												
X	X	X	X	X	X	Minimally processed products (e.g., firewood)	X		X	X	X	
X	X	X	X	X	X	Natural spread of populations			X			

Air transportation/cargo
Water transportation—ballast, hull fouling, dredge spoil materials, and anglers
Land transportation—cars and trucks, all-terrain vehicles, boat trailers, equipment, and hikers, horses, and pets
Shipping—port containers/crates, wood packing material
Travel tourism/relocation—plant pathways, plant trade
Food pathways—live animals
Non-food animal pathways—bait industry, pet/aquarium trade
Other pathways—minimally processed products, such as firewood

Asset Management

The economic, environmental, and social costs of invasive species were well documented in the city's *2008 Invasive Plants Strategy* and continue to be well documented (Marbuah et al. 2014) as science and new technology help to further define the risks invasive species pose to our economy, natural resources, and human well-being.

In addition to the threat invasive species pose to natural ecosystems, invasive species pose significant threats to grey infrastructure. The infestation of zebra mussels *(Dreissena polymorpha)* in the Great Lakes has cost the power industry $3.1 billion between 1998–1999, including a total economic impact of more than $5 billion (Western Regional Panel on Aquatic Nuisance Species 2009). The power generation industry in the Great Lakes experiences costs of $1.2 million annually per power plant to monitor and control zebra mussels, and $1.7 million annually to research better zebra control methods. Water treatment plants pay $480,000–$540,000 annually, and municipal water treatment facilities pay $353,000 annually, to control zebra mussels (Colautti et al. 2006). The estimated cost to install sodium hypochlorite systems and anti-fouling paint infrastructure in hydropower facilities in the Columbia River Basin is $23,621,000 (PSMFC 2005).

When comparing grey and green assets, it is more straightforward to assign asset status, condition, and value to the city's grey infrastructure than to assign value to green assets. This is because the cost to install, replace, assign condition, and resources needed to maintain or restore an asset to a described condition is intuitively quantifiable, whereas the myriad benefits of green assets are often less direct (City of Portland 2017a).

Portland's goal of achieving a healthier human population and green assets is reflected in numerous city plans (Appendix A-7) that make distinct correlations between the well-being of its residents and the condition of the city's green assets.

Asset management is an approach that includes inventorying a community's existing assets, determining the current state and value of those assets, evaluating the risks by analyzing the likelihood and consequences of failure of those assets, and developing and implementing plans to maintain or replace those assets to ensure

sustainable service delivery to a community (Brooke et al. 2017). Generally, local governments lack policies and methods to measure green assets, which have neither been considered nor valued similar to engineered assets, and have not been included in asset management plans (Brooke et al. 2017). The town of Gibsons in British Columbia determined that failure to protect green assets, such as aquifers and forests, could result in significant risk and cost to the community (Brooke et al. 2017). Two key elements of the process Gibsons used to incorporate green assets into its management framework were to create a definition of those assets, and to develop a methodology to determine ecological function, condition, and capacity of the assets, and how they would change when challenged with stressors, such as development, or climate change. Ultimately Gibsons incorporated the costs of maintenance, monitoring, land acquisition, restoration, rehabilitation, environmental management, and other actions into their asset management framework by defining the value of services from green assets (Brooke et al. 2017).

The Municipal Natural Assets Initiative in Canada describes green infrastructure as the designed and engineered elements that are intended to mimic natural functions and processes in the service of human interests and the natural resources and ecosystems that yield a flow of benefits to people (Brooke et al. 2017).

Invasives 2.0 recommends strengthening and supporting the city's watershed-based approach to managing green assets and incorporating green assets into the city's asset management plan. Numerous city documents describe different types of green assets (Appendix A-8). For example, the Portland Watershed Management Plan describes four classes of habitats that support fish and wildlife, the Portland Plant List describes plant communities, and the Portland Natural Resource Inventory describes different types of assets and the ecosystem services they provide. None of these plans document the often-overlooked green assets—backyards, vacant lots, brownfields, and other acreages that provide green space and values. These green assets are essential in providing sustainable levels of service yet can also provide their own risks via the introduction of and spread of invasive species.

The social values of green assets are rarely described and incorporated into valuation of assets. These include, but are not limited to, recreation, existence values (i.e., the benefits people receive from knowing that an environmental resource, organism, or entity, exists), human well-being, noise abatement, and other services.

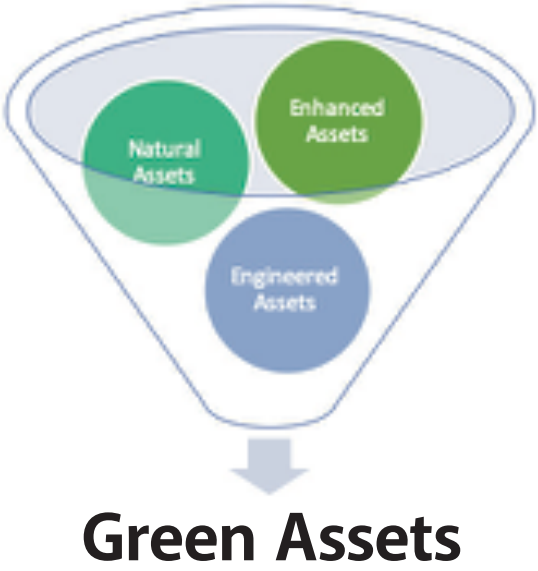


Figure 1. Green assets include natural assets, enhanced assets, and engineered assets (Municipal Natural Assets Initiative 2017).

Natural Assets
Wetlands, forests, natural areas, lakes, rivers, streams, fields, soil

Enhanced Assets
Rain gardens, urban trees, urban parks, biomimicry, stormwater ponds

Engineered Assets
Permeable pavement, green roofs, rain barrels, green walls, bioswales, cisterns

Inherent in each of the city's important plans (Appendix A-7) is the understanding that healthy green assets equate to livability and sustainability. Green assets produce a flow of goods and services that has value for people living in the city; degradation of these assets impedes the ability of a municipality to deliver cost-effective services (Natural Value Joint Venture 2010).

Despite the ability to describe grey infrastructure assets quantifiably, it is recognized that asset management is more of an art than a science (Asset Management Council 2017). This is particularly true for green assets that support community well-being and delivery of ecosystem services, which are core to sustainability and livability (SEQC 2017).

The next three pages of this report are intended to mimic an existing city brochure focused on gray assets—but using green assets in its stead. The potential exists to use this type of framework to incorporate green assets into the city's overall asset management plan.

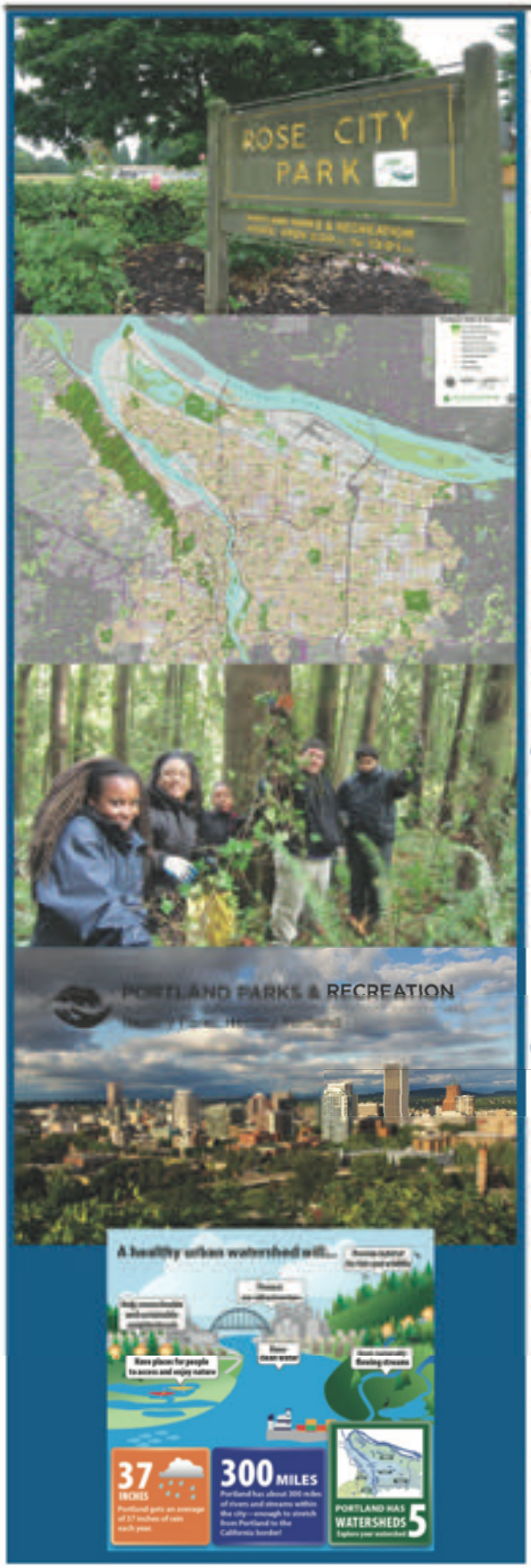
Citywide Asset Management Work Plan

APPLYING ASSET MANAGEMENT PRINCIPLES WILL:

- improve the ability to make sound decisions at all levels;
- promote effective use of resources;
- improve bureau support and accountability;
- improve and coordinate planning across bureaus; and
- support the efficient delivery of services with assets that are cost-effective, well maintained, accessible, energy efficient, and safe.

ELEMENTS FOR MANAGING ASSETS:

- good documentation of life-cycle costs, and optimum renewal strategies that ensure the lowest life-cycle cost;
- a needs assessment to evaluate current practices, asset risks, and opportunities;
- links between service outcomes, bureau programs, plans, and performance measures;
- community engagement to better define desired and affordable levels of service;
- information systems that provide data on asset inventories and their condition; and
- clear assignment of roles and responsibilities to guide efforts.



INVESTING IN PORTLAND'S GREEN ASSETS

The City of Portland invests in its natural resources to provide safe, healthy, sustainable environments for people to live and recreate. Examples of Portland's green assets include its parks, natural areas, urban forests, and watersheds. Green assets includes tangible values, such as public parks, as well as intangible assets, such as clean air. Green assets include the social, environmental, and economic values associated with Portland's landscapes, native vegetation, native fish and wildlife, and functioning ecosystems that help deliver economic and social wellbeing for residents and industries.

Invasive species are the second largest threat to biodiversity after habitat loss. Invasive species pose a greater threat to our native systems than pollution, harvest, and disease combined.

Since the city adopted its first invasive species strategy 10 years ago, it has made progress investing in its green assets to maintain and protect the highest quality natural resource sites while improving those that have degraded through time. Yet key stressors continue to be placed on Portland's green assets. A growing human population, increased competition for city staff and financial resources, and the effects of climate change are just a few examples of the challenges that make it necessary for Portland to prioritize its green asset investments while recognizing the intrinsic value of its resources.

PRESSURES ON GREEN ASSETS

ASSET MANAGEMENT

Effectively managing Portland's green assets requires examining the status and condition of the assets to determine where investments need to be made to protect, restore and enhance those assets. Asset management is used by decision makers to help select actions and investment decisions that provide the ideal mix of benefits. Asset management is an ongoing process that informs conversations among professional staff, elected officials and the public.

Bureaus must balance competing demands associated with both investments in infrastructure and green assets, recognizing that both types of investments are critical to success. For example, ensuring people have a place to safely walk to a city park must be balanced with ensuring the park that they visit is an enjoyable place where they have access to healthy habitats that reflect the native plants, fish, and wildlife of our region.

GREEN ASSET MANAGEMENT FUNDAMENTALS: LEVELS OF SERVICE, RISK AND FUNDING

Three key factors are considered when managing Portland's green assets—levels of service, risk and funding. These factors are interconnected and influence one another in both positive and negative ways.

1. Levels of Service

Green asset managers set measurable goals or targets for the services they deliver. These goals, called levels of service, describe what service is provided, how much, and how often.

Each city bureau sets levels of service based on it mission, system needs, regulatory requirements, and customer expectations. Levels of service help guide bureau operations.

PROTECT THE BEST

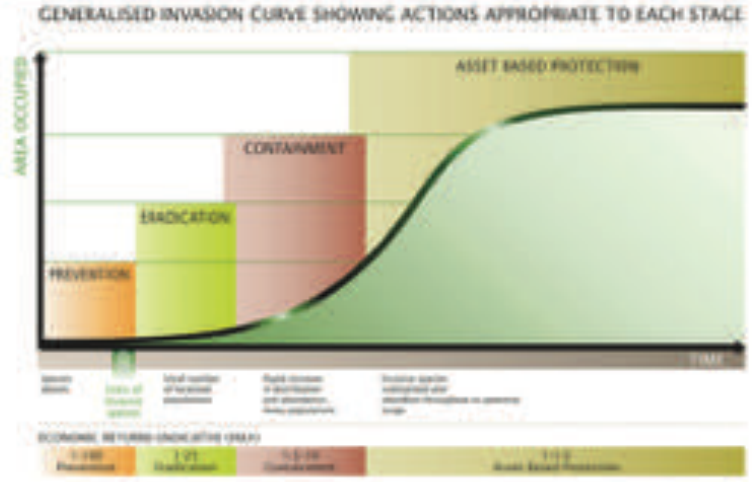
Protect the Best has the goal of preventing small patches of invasive plants from spreading in the city's most ecologically healthy natural areas by identifing and treating ecologically healthy "core habitat," then creating relatively invasive-free "buffer habitat" surrounding it, reducing the chance of reinfestation.

2. A Framework for Risk

Risk is a combination of two factors: the consequence of degradation of the asset and the likelihood that the asset cannot recover from that loss or degradation. Consequences can be relatively minor, such as a newly introduced invasive plant that is detected early and thus easily eradicated, or major, such as an introduction of quagga or zebra mussels to a water body, resulting in entire changes to the structure and function of that water body. In addition, consequences to natural assets can have corresponding consequences to infrastructure assets. For example, an introduction of quagga or zebra mussels to a city water body can increase the cost to deliver water from that system as well as increase staff time associated with preventing biofouling on a continual basis.

Part of asset management is understanding and tracking how assets degrade and taking actions to reduce the degradation and loss. By understanding trade-offs and actively managing risk, Portland's bureaus strive to minimize service interruptions and their effects on the people that benefit from healthy natural resources.

RISK ASSESSMENT HELPS GUIDE PRIORITIES



If a species is detected early, the cost to control is minimal because the size of the area infested is small. As the size of the infestation increases, the costs to control increases, and eradication is no longer possible.

Economic returns are greatest earlier in the invasion curve (i.e., prevention and eradication).

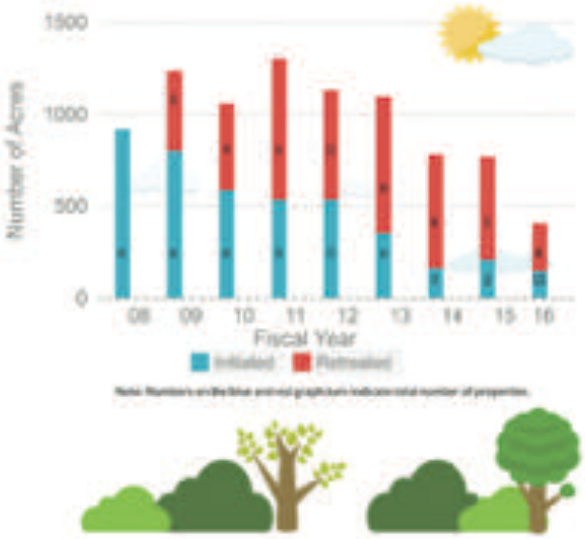
An introduction of quagga or zebra mussels to Portland's water system would significantly affect the cost to deliver water as well as the ability of the Bull Run watershed to support native fish and wildlife species and habitats.

CONDITION OF GREEN ASSETS

Three key factors are considered when managing Portland's green assets—levels of service, risk and funding. These factors are interconnected and influence one another in both positive and negative ways.

PROTECT THE BEST

Number of acres initiated and retreated, FY08-16



One way to track risk is to measure the state and condition of green assets.

Understanding current condition and trends as well as the pressures on these natural resources, will help us to develop guiding targets, high level indicators and measures to report progress in achieving target successes.

The cost to control an invasive species, such as garlic mustard, is exponentially more expensive if the infestation becomes established. Every dollar invested in invasive species yields a $34 dollar return on that investment.

3. Funding

Planned investments in invasive species outreach and education, control, early detection and rapid response, and other activities can help prevent expensive, long-term costs associated with established populations. Newly established populations of invasive species add to annual operations and maintenance costs and contribute to the ongoing degradation of Portland's green assets.

Investment levels affect the condition of the city's green assets through time. Green assets without adequate investments result in a high risk of exposure, reduced levels of public service, and degradation and loss of assets through time. This affects quality of life for people living in Portland as well as the industries and businesses that fuel the city's economic engine.

TOLEDO STREET BEFORE AND AFTER EMERALD ASH BORER

SETTING PRIORITIES

Funding, levels of service, and risk are inextricably linked. A persistent funding gap for infrastructure investment needs, as in Portland's case, results in declining levels of service and increased risks. The interplay of these factors and the trade-offs that inevitably result must be considered as policy and investment decisions are made.

Together, Portlanders and the City of Portland face challenging decisions about how to spend limited staff and financial resources. Some areas lack basic levels of service, and services may cost more in the future if inadequate efforts are made to invest in natural assets. Asset management can help to inform funding priorities and enable smart investment choices across all city green assets and infrastructure.

Photo credit: Harold Hutchinson.

River View Natural Area: A Case Study

The River View Natural Area is a 146-acre parcel in southwest Portland that is part of the westside wildlife corridor. It is home to wetlands, diverse native plant communities, and seven flowing streams, all of which provide an important forested ecosystem link with Forest Park, Tryon State Natural Area, and the Willamette River (City of Portland 2012b). The area is jointly owned by BES and PP&R, and Metro retains a conservation easement.

Level of service describes the condition land managers seek to achieve through time in a given geographic area (City of Portland 2012b). The steps to achieve level of service include 1) a description of green assets, 2) an assessment of existing conditions, 3) conditions land managers seek to achieve over time in a defined area, 4) a gap analysis that identifies the stressors, 5) project plans that describe measures of success, 6) a budget to restore and maintain the asset, 7) project implementation, and 8) monitoring.

The River View Natural Area Management Plan describes a level of service that includes a matrix of evergreen-dominated and mixed deciduous forest; pockets of seasonally-flooded deciduous forests at headwaters and depressional wetlands; protected and enhanced riparian buffers; and invasive species control to minimize impacts to forest canopy and ecosystem health. Level of service should incorporate an integrated ecosystem assessment to watershed health, including landscape condition, habitat, hydrology, geomorphology, water quality, biological condition, and vulnerability (Environmental Protection Agency 2012).

Goals for the River View Natural Area include protecting aquatic and terrestrial wildlife and their habitats; protecting water quality and hydrology in the natural area and adjacent Willamette River confluence areas; and improving forest health and structural diversity. Ecological prescriptions to achieve these goals include invasive-species related tasks to achieve ecological uplift, including treating invasive species patches, manually removing English ivy, and continued mapping and treatment of Early Detection Rapid Response (EDRR) species.

The projected cost to implement ongoing and Phase 1 (0–5 years) ecological prescriptions is $960,000.

Current measures of success for invasive species management relate to EDRR and percent cover of targeted invasive species on city-owned land as well as adjacent properties:

- Early Detection/Rapid Response Program: Control or extirpate target species within 2–5 years of identification.

- Long-term invasive species management plan: Reduce invasive species to 10–15% cover across the entire site and less than 10% within the habitat preserve; adjacent property owners are to reduce invasive species on their properties to less than 20% in the next 10 years.

The River View Natural Area serves as a case study for how a natural area is managed in an asset management context. The management plan describes levels of service, includes an assessment of current conditions, describes a set of strategies to achieve levels of service, and includes a dollar estimate to manage the land and achieve those levels of service. Monitoring the tract through time to assess if levels of service are being achieved is integral to plan success and asset management. Documenting this type of information for tracts of land the city manages in each watershed could significantly advance asset management within the city.

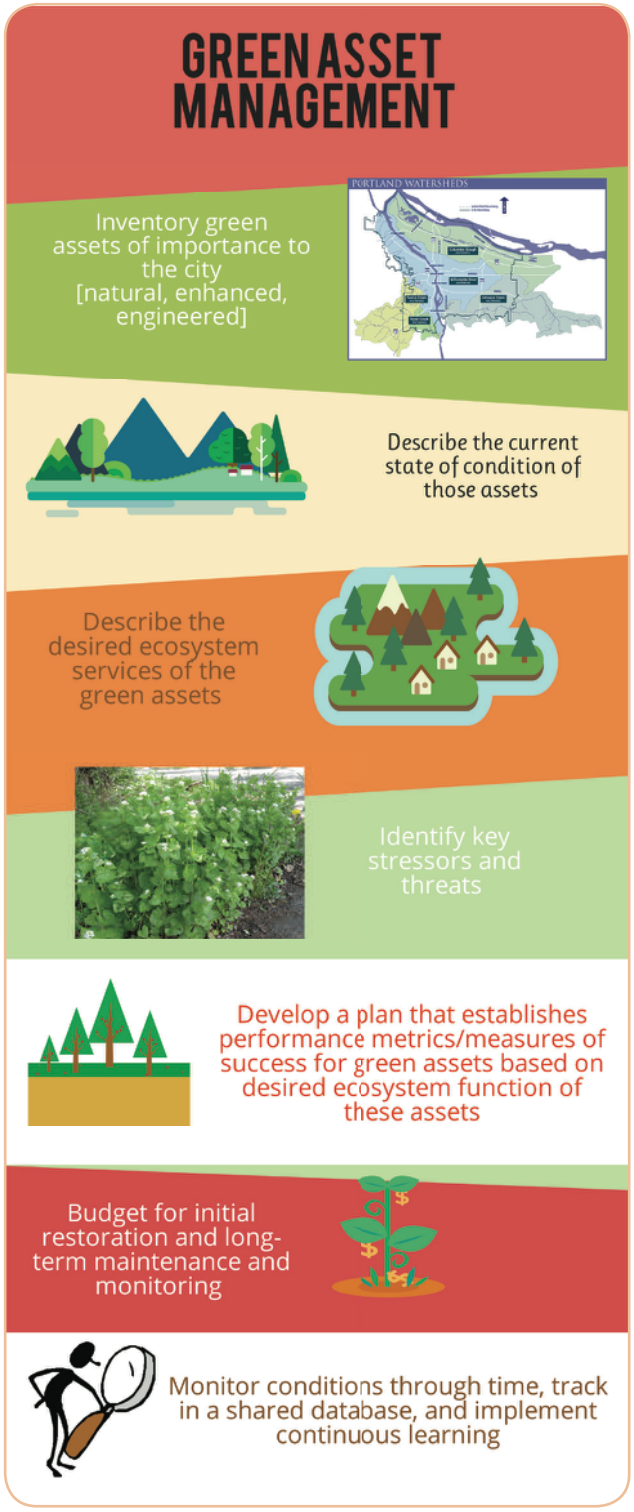
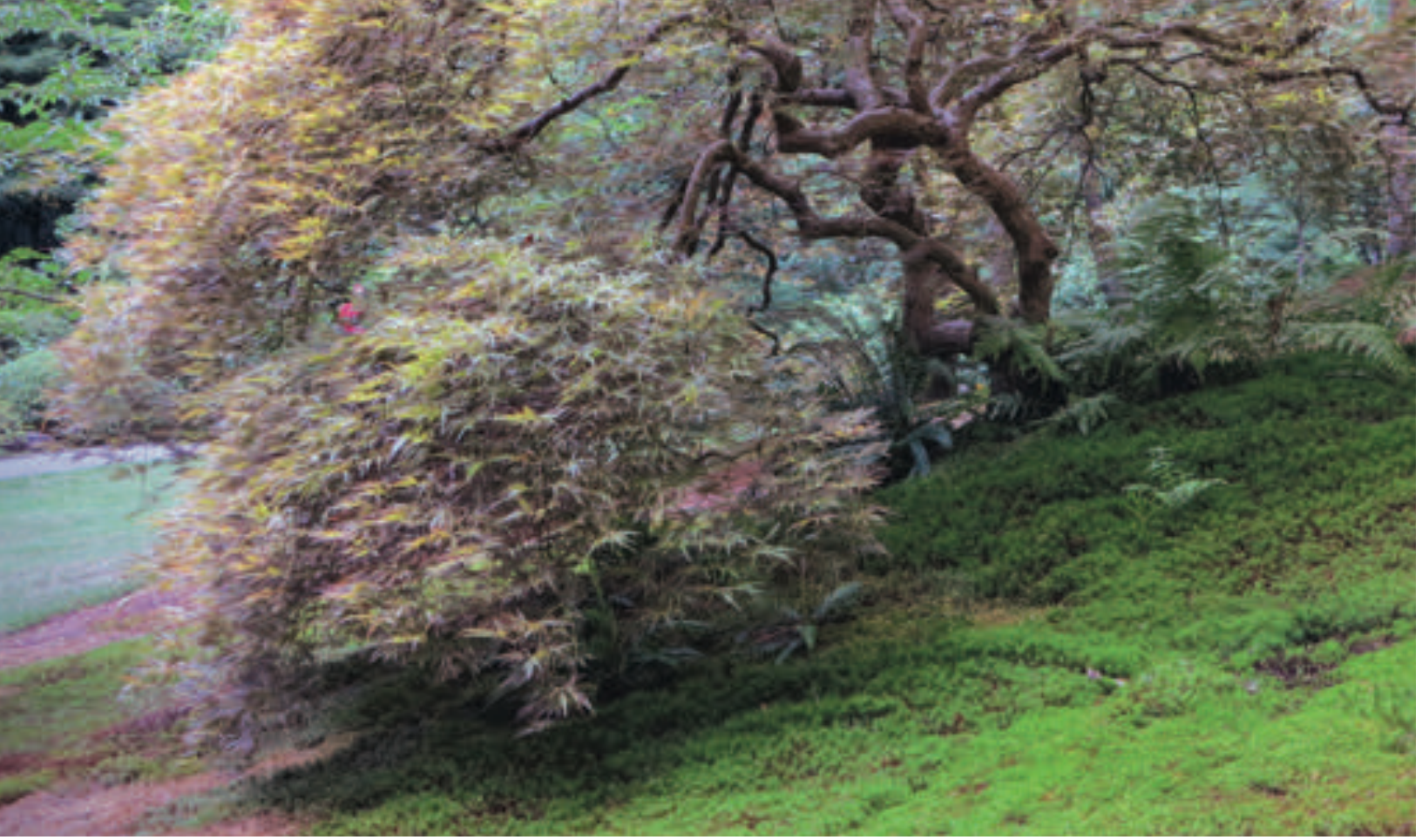


Figure 2. Key elements in a natural asset management framework.



Collaboration and Coordination Among City Bureaus

Invasive species prevention and control efforts are distributed throughout several of Portland's bureaus. In addition to the 10 bureaus and programs that directly implement invasive species prevention and control efforts because of their public land management responsibilities[3], additional bureaus play important supporting and administrative roles. The implementation actions described in *Invasives 2.0* include an expanded role for several of these supporting bureaus. For example, the Office of Equity and Human Rights can play a lead role in evaluating how the prioritization of treatments for invasive species may affect historically or currently marginalized communities. The Division of Asset Management in the Office of Management & Finance could play a helpful, supportive role implementing a city-wide, watershed-based, zero-based budgeting approach to management of green assets.

Invasives 2.0 promotes a watershed-based approach to invasive species prevention and control efforts on city properties (Figure 3). To effectively implement such an approach will require key bureau staff across all land management bureaus to convene and develop mutually desired levels of service for city-owned and city-managed green assets within each watershed. In addition, shared philosophies for management and enhanced collaborative practices, such as building budgets together and developing watershed-based performance metrics, will ensure the effective and efficient use of staff and operational resources.

Teams of watershed-based staff comprised of employees from relevant bureaus should be created to develop a framework for goal setting, budget development, implementation actions, and tracking of activities and performance metrics. Critical to this process is adopting a zero-based budgeting approach for each watershed.

[3] *Bureau of Environmental Services, Portland Parks & Recreation, Portland Development Commission, Portland Bureau of Transportation, Portland Water Bureau, Portland Fire Bureau, Portland Police Bureau, Bureau of Planning, Office of Management & Finance, and Bureau of Development Services.*

Adopting a zero-based budgeting approach would:

- Ensure that all bureaus focus on the highest priorities within each watershed, regardless of which bureau is designated responsible for management.
- Encourage bureau staff to assess existing and emerging priorities and budget accordingly, versus expending funds on legacy programs that may not achieve watershed goals/desired levels of service, or address core priorities.
- Catalyze communication and collaboration among city staff and bureaus.
- Better align strategic investments with performance metrics based on specific goals versus individual bureau or program interests.
- Improve operational efficiencies by rigorously challenging assumptions.
- Ensure that spending increases or that reductions are not simply distributed evenly across bureaus, rather strategic decisions are made to ensure the highest priorities are addressed.
- Potentially result in a reduction of costs by increasing organizational efficiencies. Note: Digital zero-based budgeting generally produces cost-savings of 10—20% (Deloitte 2015).

In 2014, the City Council adopted a Citywide Assets Management Group (CAMG) that includes the Bureau of Environmental Services, Bureau of Planning & Sustainability, Portland Bureau of Transportation, Portland Housing Bureau, Office of Management & Finance, Portland Parks & Recreation, Portland Development Commission, and Portland Water Bureau. Thus, the infrastructure exists for bureaus to convene, develop an asset management framework that incorporates green assets, and initiate zero-based budgeting to efficiently and effectively manage green assets in the city. An Interbureau Invasive Species Planning Team will advance the asset management framework and advance collaborative invasive species priorities across city bureaus.

Figure 3. Portland's watersheds include Bull Run, Lower Columbia River, Columbia Slough, Lower Willamette River, Forest Park streams, Johnson Creek, Tryon Creek, and Fanno Creek.

Invasives 2.0 Guiding Principles

The following guiding principles are philosophical cornerstones of *Invasives 2.0* and were derived from the 10-year review of the *2008 Invasive Plants Strategy*, a survey of internal and external stakeholders, and interviews with city staff (Appendix A). The guiding principles reflect important philosophies and perspectives of people responsible for implementation of city and regional invasive species programs.

- Protection of green assets requires a long-term investment by the city.
- Actions are driven by desired levels of service and enhanced ecosystem function and not simply the degree to which a target invasive species is suppressed.
- Integrated Pest Management is foundational to invasive species management.
- Sharing invasive species information via a database, or portal, enhances collaboration and will allow for a thorough evaluation of activities and outcomes.
- Prioritization of invasive species that cause profound disruptions to ecosystems and the suite of desired ecosystem services they provide is necessary.
- Science-based risk assessments help identify and prioritize emerging threats and pathways of introduction.
- Adopting a system for linking expenditures to outcomes as well as developing standardized performance metrics helps the city evaluate return on investments.
- Equitable, diverse, and inclusive public engagement and stewardship programs enhance civic capacity, improve awareness, foster natural resource-friendly attitudes and behaviors, and contribute to public health and well-being.

Invasives 2.0 Goals and Strategies

Invasives 2.0 addresses key gaps, builds on lessons learned, incorporates updated best management practices based on emerging science and technology, and articulates a cohesive, coordinated, collaborative effort across city bureaus to address all invasive species taxa. Such an approach will position the city to engage the public in community stewardship and appreciation of the suite of ecosystem services and functions that healthy green assets provide, which can foster natural resource-friendly attitudes and behaviors (Welsch and Heying 1999). There are seven goal statements in *Invasives 2.0* that address the core elements of an invasive species prevention and control program.

I. **Prevent the Spread**—Prevent the introduction and spread of priority species and identify existing and potential introduction pathways for known threats.

II. **Detect New Introductions**—Survey and monitor city-owned properties and high priority pathways to detect new introductions of invasive species.

III. **Control**—Control invasive species to minimize their spread and deleterious effects.

IV. **Restore and Rehabilitate**—Support functional urban ecosystems impacted by the introduction of invasive species by restoring and rehabilitating those systems.

V. **Engage People**—Provide equitable, diverse, and inclusive public engagement and stewardship opportunities that enhance civic capacity, improve awareness, foster natural resource-friendly attitudes and behaviors, and contribute to public health and well-being.

VI. **Continuously Improve**—Continuously assess the ability to manage invasive species to achieve levels of service, implementing course corrections to ensure the latest science, best management practices, and approaches are being used.

VII. **Fund Sustainable Efforts—**Ensure *Invasive s 2.0* is adequately funded to meet the ecosystem function goals and desired levels of service of the city's green assets.

The next section of the document includes a set of priority strategies to inform the completion of each goal. These priorities were determined based on the 2018 audit, which included surveys and interviews with city employees and regional stakeholders. These strategies detail how the City of Portland will maintain and protect the investments it has

made in reducing risks to green, enhanced and grey infrastructure and how it will address future threats.

I. Prevent the Spread

Prevent the introduction and spread of priority species and identify existing and potential introduction pathways for known threats.

10-Year Goal: Strengthen Portland's comprehensive watershed-based management approach to managing the city's green assets based on desired levels of service and reducing risks imposed by invasive species; fully integrating green assets into the Portland's asset management plan.

5-Year Implementation Actions:

Ia. Describe the funding needed within each watershed to address invasive species issues to achieve site-specific desired ecosystem services for the city's green assets and incorporate these goals into the city asset management plan.

Ib. Annually describe the condition of green assets, as well as funding gaps that exist relative to achieving desired condition.

Ic. Assess existing and emerging risks to the city's green assets by evaluating pathways of introduction, with a focus on species that are ecosystem disruptors (pathways described in Appendix A-4). Develop mechanisms and a schedule to implement options available to drastically reduce likelihood of introduction, including policy, outreach, and prevention efforts.

Id. Enhance prevention efforts for non-plant invasive species by incorporating other taxa into biannual risk assessment, and prioritizing based on species designated as ecosystem disruptors.

Ie. Identify and use a data portal that allows city and regional partners to document and share information that is scalable relative to invasive species asset management, inventory, assessment, control, monitoring, and outcomes.

If. Review the recommendations for local actions (Table 3, Appendix A), and implement actions to minimize the risk of the introduction of new invasive species via pathways.

Ig. Rewrite city construction specifications, including sanitation and materials, to address and reflect current city invasive species policy.

II. Detect New Introductions

Survey and monitor city-owned properties and high priority pathways to detect new introductions of invasive species.

10-Year Goal: Establish and implement an all-taxa monitoring program to detect threats to the Portland's green and grey assets and infrastructure.

5-Year Implementation Action:

IIa. Identify taxa and protocols for surveys based on the highest risk invasive species to the region.

IIb. Provide additional training opportunities for staff and volunteers that increases awareness and reporting of these highest risk taxa.

III. Control

Control invasive species to minimize their spread and deleterious effects.

Implementing best management practices to control and prevent further spread of invasive species is critical to long-term success in restoring and maintaining ecological function of Portland's green assets and protecting the city's grey and green infrastructure.

10-Year Goal: Manage new and established populations of invasive species to achieve desired levels of services associated with the city's green assets.

5-Year Implementation Actions:

IIIa. Prioritize and implement treatments on a watershed basis, implement rapid response for new infestations, and report outcomes into a standardized city database. Develop teams of watershed-based staff comprised of employees from relevant bureaus to develop a framework for goal setting, budget development, implementation actions, and tracking of activities and performance metrics.

IIIb. Incorporate best management practices associated with equipment sanitation and prevention standards and protocols (Appendix A) into city policies and implement cross-bureau staff training to prevent the spread of terrestrial and aquatic invasive species. Review those standards

and protocols every other year to ensure the latest and most effective techniques are being used.

IIIc. Develop rapid response plans for high priority species (based on risk assessments) that are predicted to deliver significant detrimental economic, environmental, and social effects. Ensure these plans align with any existing plans at larger scales, e.g., regional plans, statewide plans. Vet invasive species management plans with an interdisciplinary, community-based team.

IIId. Utilize the Terrestrial Ecological Enhancement Strategy, natural resource inventory updates, the Wetland Inventory Project, etc., to identify the highest value habitats and natural assets to direct targeted management.

IV. Restore and Rehabilitate

Support functional urban ecosystems impacted by the introduction of invasive species by restoring and rehabilitating those systems.

10-Year Goal: Maintain desired levels of service of Portland's priority green assets through restoration and rehabilitation actions, and inter-bureau coordination.

5-Year Implementation Actions:
IVa. Prioritize green assets based on ecosystem services that protect human and ecosystem health. Seek opportunities to protect and/or enhance connectivity between green assets.

IVb. Maintain desired levels of service in high quality, intact green assets owned and managed by the city.

IVc. Re-inventory city-owned lands to determine the ecological health of waterways and natural areas.

V. Engage People

Provide equitable, diverse, and inclusive public engagement and stewardship opportunities that enhance civic capacity, improve awareness, foster natural resource-friendly attitudes and behaviors, and contribute to public health and well-being.

10-year goal: A public that is aware of invasive species and engaged in efforts to minimize their introduction and spread.

5-Year Implementation Actions:
Va. Quantify the baseline understanding of invasive species impacts among a segment of the population (e.g. schoolchildren interacting with city environmental education programs). Increase community stewardship and participation in invasive species control and prevention efforts by creating or using a network that provides for the tracking and storing of information on invasive species as well as engagement with all people, including under-served populations and target audiences.

Vb. Evaluate how invasive species and prioritization of treatments may affect historically or currently marginalized communities.

Vc. Host a regional summit every five years with partners and stakeholders to celebrate successes, evaluate progress, and identify gaps and emerging trends.

Vd. Engage and coordinate with current environmental education programs and efforts at BES, PWB, and PP&R.

VI. Continuously Improve

Continually assess the ability to manage invasive species to achieve desired levels of service, implementing course corrections to ensure the latest science, best management practices, and approaches are being used.

Integral to the success of any green asset management framework is continuous improvement and assessment driven by the precepts of adaptive management. Engaging regional partners in continually assessing the status of the city's green assets and delivering the suite of ecosystem services expected by city residents and regional partners will result in improvements through time that create efficiencies in the ability of the city to deliver services through its green assets.

10-year goal: Implement an adaptive management approach to achieve desired levels of service efficiently and effectively.

5-year Implementation Actions:
VIa. Review *Invasives 2.0* after five years of implementation, and revise to incorporate emerging issues, changes in policy, etc.

VIb. Review the process for updating the Portland Plant List and, with stakeholders' input, recommend improvements for updating future species lists.

VIc. Review and recommend changes to regulatory mechanisms related to how invasive species are managed within the city, including Titles 11 and 33 of Portland City Code.

VId. Revisit and incorporate city strategies and plans from the recent past to ensure previous efforts and findings are recognized, utilized, and ensure consistency in city policy.

VIe. Develop an Interbureau Invasive Species Planning Team comprised of staff from PWB, BES, PPR, and PBOT. This team will identify common targets, quantify goals, and attempt to achieve coordinated context-specific management for invasive species work on city-owned lands.

VIf. Recognize the development and availability of sterile cultivars for several nuisance tree species, and their current prohibition under city code.

VII. Fund Sustainable Efforts

Ensure *Invasives 2.0* is adequately funded to meet the ecosystem function goals and desired levels of service of the city's green assets.

Several of the activities in the *2008 Invasive Plants Strategy* were never achieved, or only partially achieved because of lack of funding and resources. Some of these actions remain relevant and important, such as evaluating the city's equipment cleaning protocols, and have been incorporated into *Invasives 2.0*. Others, such as establishing 10 weed removal demonstration sites throughout the city, are no longer a priority based on existing and emerging priorities, thus they have not been incorporated into *Invasives 2.0*. Results from the 2018 internal and external stakeholder surveys expressed broad support for funding the actions described in 2008 as well as additional funding to meet demands placed on the city's green assets.

Although most internal and external stakeholders interviewed as part of this initiative were supportive of the city moving toward an all-taxa invasive species approach, reluctance was expressed by some that expansion of the program could potentially dilute existing plant-focused efforts, resulting in a poorly funded program for all taxa, versus a weakly funded program for plants. The loss of $300,000 in funding for the city's Protect the Best program since 2014 has exacerbated these sentiments.

In addition to lack of funding, the implementation of invasive species activities across numerous bureaus, each of which is funded using different fund sources, has fostered siloed approaches to invasive species efforts and has diluted efforts to achieve a unified approach to implementing the goals of the *2008 Invasive Plants Strategy*.

10-year goal: Adequate funding to achieve the goals and implementation actions of *Invasives 2.0*.

5-year Implementation Actions:

VIIa. Using zero-based budgeting, describe the funding needed, on a site-by-site basis, within each watershed, to make progress, on an annual basis, and through 10 years, toward achieving desired levels of service as well as addressing invasive species prevention, detection, control and management, restoration and rehabilitation, and communication issues.

VIIb. Hire three additional staff to achieve:

- An all-taxa approach to invasive species prevention and control efforts.
- Expanded outreach and engagement to underserved and underrepresented communities and people.
- Expanded planning needs described in *Invasives 2.0*.

VIIc. Funding to restore the budgets of Portland Parks natural area programs protecting the healthiest green assets.

VIId. Adopt *Invasives 2.0*, committing adequate city resources to create the infrastructure that will allow for an improved and unified approach to managing the city's green assets, enhanced accountability, implementation of strategies within each of the seven new goals, and development and reporting of appropriate performance metrics.

Invasives 2.0 ***Goal I:*** *Prevent the Spread*

Prevent the introduction and spread of priority species and identify existing and potential introduction pathways for known threats.

10-Year Goal: strengthen the city's comprehensive watershed-based approach to managing the city's green assets based on desired levels of service, fully integrating green assets into the city's asset management plan.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
Ia. Describe the funding needed within each watershed to address invasive species issues to achieve site-specific desired ecosystem services for the city's green assets, and incorporate these goals into the city asset management plan.	***Lead(s):*** Bureau of Environmental Services, Parks and Recreation *Participants:* All bureaus and programs that manage green assets, Office of Management & Finance (Division of Asset Management)	January 2021	Green assets are fully incorporated into the city's asset management plans and bureau budgets, and a reporting infrastructure exists to monitor progress/ identify gaps on an ongoing basis.
Ib. Annually describe the current condition of the city's green assets, and funding gaps that exist relative to achieving desired condition.	*Lead:* Bureau of Environmental Services, Parks and Recreation, Water Bureau *Participants:* Office of Management & Finance (Division of Asset Management), other bureaus that manage green assets	Annually	Current condition of green assets and trends in condition.
Ic. Assess existing and emerging risks to the city's green assets with a focus on species that are ecosystem disruptors by evaluating pathways of introduction (described in Appendix A-4), and develop a schedule to implement options available to lessen introductions, including policy, outreach, and prevention efforts.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation, Water Bureau *Participants:* City bureaus and programs listed in Appendix D; regional partners	Complete schedule by January 2021	Updated biannual invasive species risk assessment.
Id. Enhance prevention efforts for non-plant invasive species by incorporating other taxa into a biannual risk assessment, and prioritizing based on species designated as ecosystem disruptors.	*Lead:* Bureau of Environmental Services *Participants:* City bureaus and programs that manage green assets; federal and state partners, regional partners	January 2022	List of priority non-plant invasive species, funded and implemented projects addressing high-risk species.
Ie. Identify and use a data portal that allows city and regional partners to document and share information that is scalable relative to invasive species asset management, inventory, assessment, control, monitoring, and outcomes.	*Lead:* Bureau of Technology Services *Participants:* Bureau of Environmental Services, Parks & Recreation; regional partners	January 2023	Identify and begin using a data portal to share information about invasive species prevention and control efforts in the region.
If. Review the recommendations for local actions (Table 3, Appendix A) and implement actions that could be taken to lessen the introduction of new invasive species via pathways.	*Lead:* Respective bureaus and local authorities identified in Table 3 of Appendix A.	Annual review	Documented actions that have been taken to lessen the introduction of invasive species via pathways.
Ig. Rewrite city construction specifications, including sanitation and materials, to address and reflect current city invasive species policy.	*Lead:* BES, Bureau of Planning	January 2020	

Invasives 2.0 ***Goal II:*** *Detect New Introductions*

Survey and monitor city-owned properties and high priority pathways to detect new introductions of invasive species.

10-Year Goal: establish and implement an all-taxa monitoring program to detect threats to the city's green and gray assets and infrastructure

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
IIa. Identify taxa and protocols for surveys based on the highest risk invasive species to the region.	*Lead:* Bureau of Environmental Services *Participants:* Other bureaus that manage green assets, federal and state partners, regional partners	July 2020: identify species and protocols for priority species/taxa; January 2023: begin inputting data into shared data system	Conduct surveys for priority species; incorporate monitoring results into shared database/data portal
IIb. Provide additional training opportunities for staff and volunteers that increases awareness and reporting of these highest risk taxa.	*Lead:* Bureau of Environmental Services	Annually	Staff and volunteers are aware of and report high-risk taxa

Invasives 2.0 ***Goal III:*** *Control*

Control invasive species to minimize their spread and deleterious effects

10-Year Goal: manage existing populations of invasive species to achieve desired levels of service associated with the city's green assets.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
IIIa. Prioritize and implement treatments on a watershed basis, implement rapid response for new infestations, and report outcomes into a standardized city database. Develop teams of watershed-based contract staff comprised of employees from relevant bureaus to develop a framework for goal setting, budget development, implementation actions, and tracking of activities and performance metrics.	*Lead:* Bureau of Environmental Services, Parks & Recreation, Water Bureau	Annually	Eradicate new infestations, use database to share treatment information, prioritize and implement treatments on a watershed basis. Establish teams of watershed-based contractors that implement prevention and control actions.
IIIb. Incorporate best management practices associated with equipment sanitation and prevention standards and protocols (Appendix A) into city policies and implement cross-bureau staff training to prevent the spread of terrestrial and aquatic invasive species. Review those standards and protocols every other year to ensure the latest and most effective techniques are being used.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation, Water Bureau *Participants:* All city staff that manage city properties	July 2020: Incorporate BMPs into city policy. Biannually review and update standards and protocols.	Best management practices are incorporated into city policies. Staff are aware of and implement BMPs consistently. Standards and protocols are reviewed and updated every other year.

Invasives 2.0 ***Goal III:*** *Control (continued)...*

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
IIIc. Develop rapid response plans for high priority species (based on risk assessments) that are predicted to deliver significant detrimental economic, environmental, and social effects. Ensure these plans align with any existing plans at larger scales, e.g., regional plans, statewide plans. Vet invasive species management plans with an interdisciplinary, community-based team.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation, Water Bureau *Participants:* Other city bureaus that manage green assets	December 2020: produce rapid response plans for high priority species in each taxa.	Existence of rapid response plans for high priority species (all taxa).
IIId. Utilize the TEES strategy, natural resource inventory updates, the Wetland Inventory Project, etc. to identify the highest value habitats and natural assets to direct targeted management.	*Lead:* Bureau of Environmental Services, Parks and Recreation, Water Bureau	January 2021	

Invasives 2.0 ***Goal IV:*** *Restore and Rehabilitate*

Support functional urban ecosystems impacted by the introduction of invasive species by restoring and rehabilitating those systems.

10-Year Goal: Maintain desired levels of service of city' priority green assets through restoration and rehabilitation actions, inter-bureau coordination, and a re-inventory of city-owned lands to determine the ecological health of waterways and natural areas.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
IVa. Prioritize green assets based on key ecosystem services that are necessary to protect human and ecosystem health. Identify assets that are at the most risk for impact and that can provide habitat anchors. Seek opportunities to protect and or enhance connectivity between green assets.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation *Participants:* Other city bureaus that manage green assets	December 2021 to prioritize green assets and desired levels of service.	Prioritized green assets and their respective desired levels of service.
IVb. Maintain desired levels of service in high quality, intact green assets owned and managed by the city.	*Lead(s):* All city bureaus that maintain green assets	Annually	Documented maintenance of desired levels of service in priority green assets.
IVc. Re-inventory city-owned lands to determine the ecological health of waterways and natural areas.	*Lead(s):* All city bureaus that maintain waterways and natural areas	Annually	Assessment of the ecological health of the city's waterways and natural areas

Invasives 2.0 ***Goal V:*** *Engage People*

Provide equitable, diverse, and inclusive public engagement and stewardship opportunities that enhance civic capacity, improve awareness, foster natural resource-friendly attitudes

10-Year Goal: Engage people in awareness and protection of the city's green assets.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
Va. Increase community stewardship and participation in invasive species control and prevention efforts by creating or using a network that provides for the tracking and storing of information on invasive species as well as engagement with all people, including under-served populations and target audiences.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation, Office of Equity and Human Rights *Participants*: All city bureaus that maintain green assets, people living in and around Portland	December 2024	Documented increase in community stewardship and participation in invasive species prevention and control efforts, particularly among the under-served and target audiences.
Vb. Evaluate how invasive species and prioritization of treatments may affect historically or currently marginalized communities.	*Lead:* Office of Equity and Human Rights, Bureau of Environmental Services *Participants:* All city bureaus that maintain green assets	December 2024	Report that evaluates how invasive species treatments may affect marginalized communities, including recommendations to address inequities in the prioritization process.
Vc. Host a regional summit every five years with partners and stakeholders to celebrate successes, evaluate progress, and identify gaps and emerging trends.	*Lead:* Bureau of Environmental Services *Participants:* All city bureaus that maintain green assets, regional partners, state and federal partners, tribes	November 2023	Host two regional summits between 2019 and 2029.
Vd. Engage and coordinate with current environmental education programs and efforts at Bureau of Environmental Services, Water Bureau, and Parks and Recreation.	*Lead:* Bureau of Environmental Services, Water Bureau, Parks and Recreation		

Invasives 2.0 ***Goal VI:*** *Continuously Improve*

Continually assess the ability to manage invasive species to achieve desired levels of service, implementing course corrections to ensure the latest science, best management practices, and approaches are being used.

10-Year Goal: Implement an adaptive management approach to achieve desired levels of service efficiently and effectively.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
VIa. Review *Invasives 2.0* after 5 years of implementation, and revise to incorporate emerging issues, changes in policy, etc.	*Lead:* Bureau of Environmental Services *Participants:* All city bureaus that maintain green assets or provide supporting activities to natural asset management; regional partners	December 2023	*Invasives 2.0* is revised after 5 years.
VIb. Review the process for updating Portland Plant List and recommend improvements to the process for updating future species lists that are inclusive of stakeholders.	*Lead:* Bureau of Environmental Services *Participants:* All city bureaus that maintain green assets; regional partners	July 2020	Revised process for updating the city's priority invasive species list.
VIc. Review and recommend changes to regulatory mechanisms related to how invasive species are managed within the city, including Titles 11 and 33 of Portland City Code.	*Lead:* Bureaus responsible for implementing Titles 11 and 33 *Participants:* All city bureaus that maintain green assets	December 2021	Needed changes to Portland City Code are identified and implemented.
VId. Revisit and incorporate city strategies and plans from the recent past to ensure previous efforts and findings are recognized, utilized, and ensure consistency in city policy.	*Lead:* Bureau of Environmental Services Participants: Bureau of Planning		
VIe. Develop an Interbureau Invasive Species Planning Team comprised of Water Bureau, Bureau of Environmental Services, Parks and Recreation, and Portland Bureau of Transportation.	*Lead:* Bureau of Environmental Services		
VIf. Recognize the development and availability of sterile cultivars for several nuisance tree species, and their current prohibition under city code.	*Lead:* Parks and Recreation Participants: Bureau of Environmental Services , Bureau of Planning Services	January 2020	

Invasives 2.0 ***Goal VII:*** *Fund Sustainable Efforts*

Ensure Invasives 2.0 is adequately funded to meet the ecosystem function goals and desired levels of service of the city's green assets.

10-Year Goal: Adequate funding to achieve the goals and implementation actions of Invasives 2.0.

5-Year Implementation Plan Actions *Priority (high), (medium), (low)*	Responsible Bureaus/ Programs	Timeline	Performance Metric
VIIa. Using zero-based budgeting, describe the funding needed, on a site-by-site basis, within each watershed, to make progress, on an annual basis, and through 10 years, toward achieving desired levels of service as well as addressing invasive species prevention, detection, control and management, restoration and rehabilitation, and communication issues.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation *Participants:* All city bureaus that maintain green assets; city bureaus that provide support services to bureaus that maintain green assets	December 2021	Watershed-based budgets (through respective bureaus) that allow the city to achieve desired levels of service on a diversity of green assets.
VIIb. Three additional staff to achieve: • An all-taxa approach to invasive species prevention and control efforts. • Expanded outreach and engagement to underserved and underrepresented communities and people. • Expanded planning needs described in *Invasives 2.0*.	*Lead(s):* Bureau of Environmental Services, Parks and Recreation *Participants:* All city bureaus that maintain green assets	December 2021	
VIIc. Funding to restore the $300,000 reductions in natural areas management Parks program reductions since 2014.	*Lead:* Parks and Recreation	December 2021	Restored funding to Protect the Best.
VIId. Adopt *Invasives 2.0*, committing adequate city resources to create the infrastructure that will allow for an improved and unified approach to managing the city's green assets, enhanced accountability, implementation of strategies within each of the seven new goals, and development and reporting of appropriate performance metrics.	*Lead:* Bureau of Environmental Services *Participants:* Portland City Council	January 2020	

Conclusion

The *2008 Invasive Plants Strategy* contained 44 actions within four goals. At the time the strategy was developed, it was considered ground-breaking, and elements of it have been replicated in municipalities throughout North America. The 2018 audit (Appendix A) of that strategy, which included surveys and interviews with city staff and regional stakeholders, identified key strengths of the strategy, as well as gaps and emerging information that should be incorporated in a new decadal strategy.

Invasives 2.0 contains 30 actions, prioritized as high (16), medium (11), and low (3), within seven goals. The actions are focused on preventing the introduction and spread of invasive species, detecting new invasive species introductions, controlling and managing invasive species, restoring and rehabilitating the city's green assets, engaging all people, continually improving priority efforts associated with invasive species, and funding invasive species efforts sustainably.

Core elements of the strategy include:

- Implement a zero-based, watershed-based approach to managing the city's green assets based on desired levels of service, including incorporating green assets into the city asset management plan, describing the current condition of the city's green assets, describing existing and emerging risks to the city's green assets with a focus on species that are ecosystem disruptors and their primary pathways of introduction, implementing options available to lessen pathways of introduction, describing the funding needed within each watershed to achieve desired levels of service and the costs associated with achieving *Invasives 2.0*, and describing performance metrics to assess the status of these assets through time.
- Expanding the current plant-focused strategy to an all-taxa approach to invasive species management on city properties.
- Prioritizing invasive species surveys based on

the highest risks to the region, and creating rapid response plans to address priority risks.

- Prioritizing and implementing invasive species treatments.
- Hosting a regional summit every five years to assess progress in achieving goals and strategies with partners.
- Adopting as city policy a suite of best management practices associated with city equipment sanitation and prevention standards to prevent the spread of invasive species.
- Prioritizing, enhancing, and connecting green assets based on key ecosystem services that are necessary to protect human and ecosystem health.
- Protecting high quality, intact ecosystems owned and managed by the city.
- Increasing public stewardship and participation in invasive species control and prevention efforts.
- Evaluating how invasive species and prioritization of treatments may affect historically or currently marginalized communities.
- Reviewing the process for updating the Portland Plant List and recommending improvements to the process for updating future all-taxa species lists that are inclusive of stakeholders.
- Reviewing and recommending changes to regulatory mechanisms related to how invasive species are managed within the city.
- Describing the funding needed, on a site-by-site basis, within each watershed, to make progress, on an annual basis, and through 10 years, toward achieving desired levels of service.
- Committing adequate city resources to create the infrastructure that will allow for an improved and unified approach to managing the city's natural resource assets, enhanced accountability, implementation of strategies within each of the seven new goals, and development and reporting of appropriate performance metrics.
- Using a data portal that allows city and regional partners to document and share invasive species information.

Portland has served as a model for municipalities across the United States to take a proactive, coordinated approach to working with regional partners to address existing and emerging threats posed by invasive species. Investing in and supporting *Invasives 2.0* will ensure the city continues its wise commitment to expand and maintain its natural resource assets and support a high quality of life for all residents.

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