3

The Environmental Framework

ENERGY, WATER, WASTE, AND GREEN INFRASTRUCTURE

Over the last two decades, both the public and private sectors achieved measurable results reducing greenhouse gas emissions and natural resource consumption by integrating sustainability early into the building design process and throughout building operations. While this approach is now standard and widely used, these efforts can only achieve so much. Today, each person or building may use less water and energy than in the past, but the world's overall development footprint continues to grow and impacts the ecosystem. Depleting scarce natural resources also limits the nation's success at being internationally competitive. As a result, people must be even smarter about how they develop their neighborhoods and cities.

The financial and sustainability benefits that can be achieved with district-scale systems that operate beyond the individual building and site scale are increasingly acknowledged. These systems yield greater results by taking advantage of economies of scale while still being small enough to adapt to new technologies.

The federal government's footprint within the SW Ecodistrict presents the opportunity for it to be a leader in supporting district-scale strategies. These strategies also support efforts to achieve Executive Order 13514: *Federal Leadership in Environmental, Energy, and Economic Performance* (E.O. 13514), signed by President Obama in 2009.

E.O. 13514 requires all federal agencies to reduce greenhouse gas emissions, manage stormwater, and reduce water use and waste. Each presents challenges for buildings in urban areas. Through district-scale planning the Ecodistrict has the opportunity to transform a resource-intensive environment into one that is able to capture, manage, and reuse a majority of its resources. Through district, block, and building strategies, the Ecodistrict can create energy from renewable sources, capture and use rainwater for its non-potable water needs and divert a majority of its waste from landfills. It can also support connected, living corridors of green infrastructure, with green roofs and walls, streetscape and tree plantings, and public open spaces contributing to improved human health and urban biodiversity. These strategies can provide cost savings over the long run, and enable federal agencies to exceed the goals and requirements of E.O. 13514.

E.O. 13514 also requires agencies to prepare for the effects of climate change—a process known as climate adaptation. The U.S. Climate Change Science Program examined the potential effects of climate change in the National Capital Region in 2009. Washington, DC is particularly vulnerable to threats associated with sea-level rise. Because its topography is substantially elevated from the Washington Channel near-term impacts with regard to sea-level rise and intermittent flooding are not an immediate concern for the study area.

This chapter first describes the overall modeling process. Then, strategies for energy, water, and waste at the building-scale are proposed. These strategies are often integrated and focus on ways to reduce a building's overall use of resources. Following the building-scale discussion, are sections on energy, water, waste and green infrastructure at the block and district-scale.

Conceptual Modeling of the Development Scenario

The development scenario (which is described in greater detail in Chapter 4) was created through the conceptual modeling of potential development alternatives, urban design, and sustainability strategies. The conceptual modeling measured the resource use of energy, water, and waste on an annualized basis within the study area. The modeling of improvements was done at the building, block, and district scale.

Through an iterative process, the conceptual designs were refined as modeling results were identified. The modeling results were compared against national baselines for energy, water, and waste use. The modeling also included the potential cost of proposed improvements based on a conservative estimate of near term construction costs.

Resource use was measured on a square foot basis. For example, gallons per square foot for water and energy use were used to illustrate building system outcomes. As the design for the study area was developed, the value of an improvement at each scale of the study area was assessed. For example, as the population in the study area increases through redevelopment, the relative use of resources is reduced. The cost trade-off for these potential outcomes informed refinement of the development scenario.

The baseline for the SW Ecodistrict included an assessment of existing conditions for water, waste, and energy at the building scale. This was the starting point to measure compliance with the Executive Order as new building strategies were employed. Year over year reductions in energy and water use will be required from the existing condition to meet the executive order. In the future, reductions in resource use will be achieved by exceeding the baseline indices as building occupancy changed. The baseline establishes the point beyond which the likely cost and benefits of higher levels of resource use efficiency are reasonable. For example, energy use for new buildings in the study area can be measured against other buildings nationally in the Commercial Buildings Energy Consumption Survey (CBECS) of 2003. This is a national index of energy use in commercial buildings. In early phases, it is feasible to achieve a 30 percent reduction overall in the Ecodistrict below the CBECS survey indices. In later phases, an 80 percent reduction below the CBECS can be achieved. For perspective, Leadership in Energy and Environmental Design (LEED) Platinum certified buildings in DC have achieved a 30 to 40 percent reduction in energy use from the CBECS survey. Modeling of water and waste will similarly measure success against the baseline.

At the block-scale, the model quantified how streets, open space, and buildings will share resources. A key strategy in reducing stormwater runoff is to collect it for reuse. Here, a collection of buildings on a block, or group of blocks, share a single stormwater system to clean and then convey stormwater to a storage tank for reuse. The measurement of this block strategy included the likely loss of stormwater to evaporation as well as the loss of water through the transpiration of water through plants. Roof, streets, and open space areas were quantified. In the block scale modeling, the amount of pervious or impervious area was measured to quantify the amount of potential rainwater harvesting.

At the district scale, the resource use and cost of all building, street, and open spaces improvements were quantified for different development alternatives. Where blocks were redeveloped the model accounted for changes in land use and the intensity of activity. Across the study area, modeled building systems included rehabilitated and redeveloped buildings, and buildings with new uses.

It was assumed that the existing central utility plant will supply buildings across the district with power, cooling, and heat. In the near term, natural gas will be used to create power, heating, and cooling in the central plant. The carbon emissions from gas fuel use can be offset with carbon credits. In the future, the fuel source for the central utility plant can be changed from natural gas to another fuel that does not release as much carbon into the atmosphere.

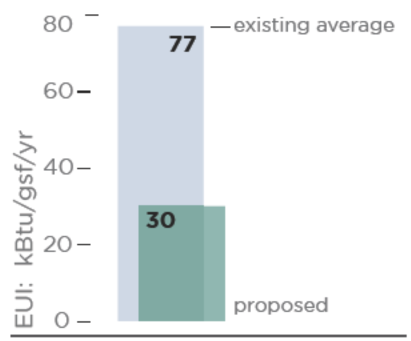
By separating potable and non-potable water systems in the Ecodistrict, non-potable water can replace potable water for specific uses. For example, potable water will no longer used for toilets. It will be limited to potable uses such as showering or drinking. To accomplish this, the greywater and stormwater will be treated onsite to extract water for non-potable uses. As a result, DC's wastewater system will be used less.

The following strategies were informed by the conceptual modeling to define the development scenario and to help achieve standards in accordance with E.O. 13514.

CONCEPTUAL MODELING

TOTAL ENERGY USE

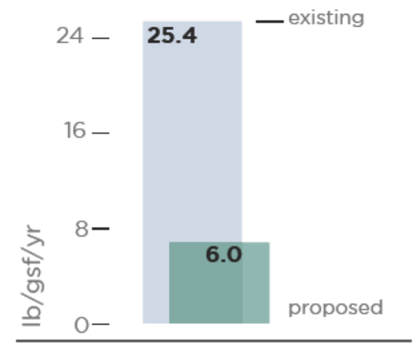
Modeling of improvements to existing buildings identifies significant reductions in energy use.



EUI, or energy use intensity, is a unit of measurement that describes a building's energy use. A building's EUI is calculated by taking the total energy consumed in one year (measured in kBtu) and dividing it by the total floorspace of the building. Generally, a low EUI signifies good energy performance

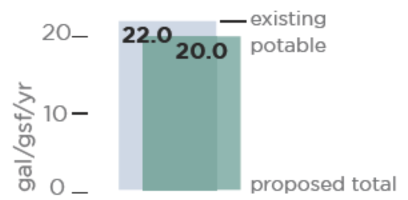
SCOPE 1 & 2 CARBON

Improvements to existing buildings' energy use will lead to a reduction of carbon prior to decarbonization at the central utility plant.



TOTAL WATER USE

Currently, all water used in the study area is potable. The modeling identified a reduction in total water use, with a significant reduction in potable water use and the potential for using non-potable water. where appropriate

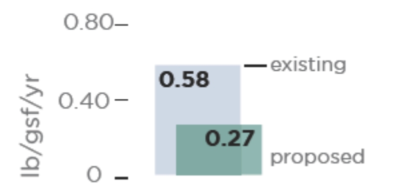


potable use will be reduced to 11 gal/gsf/yr

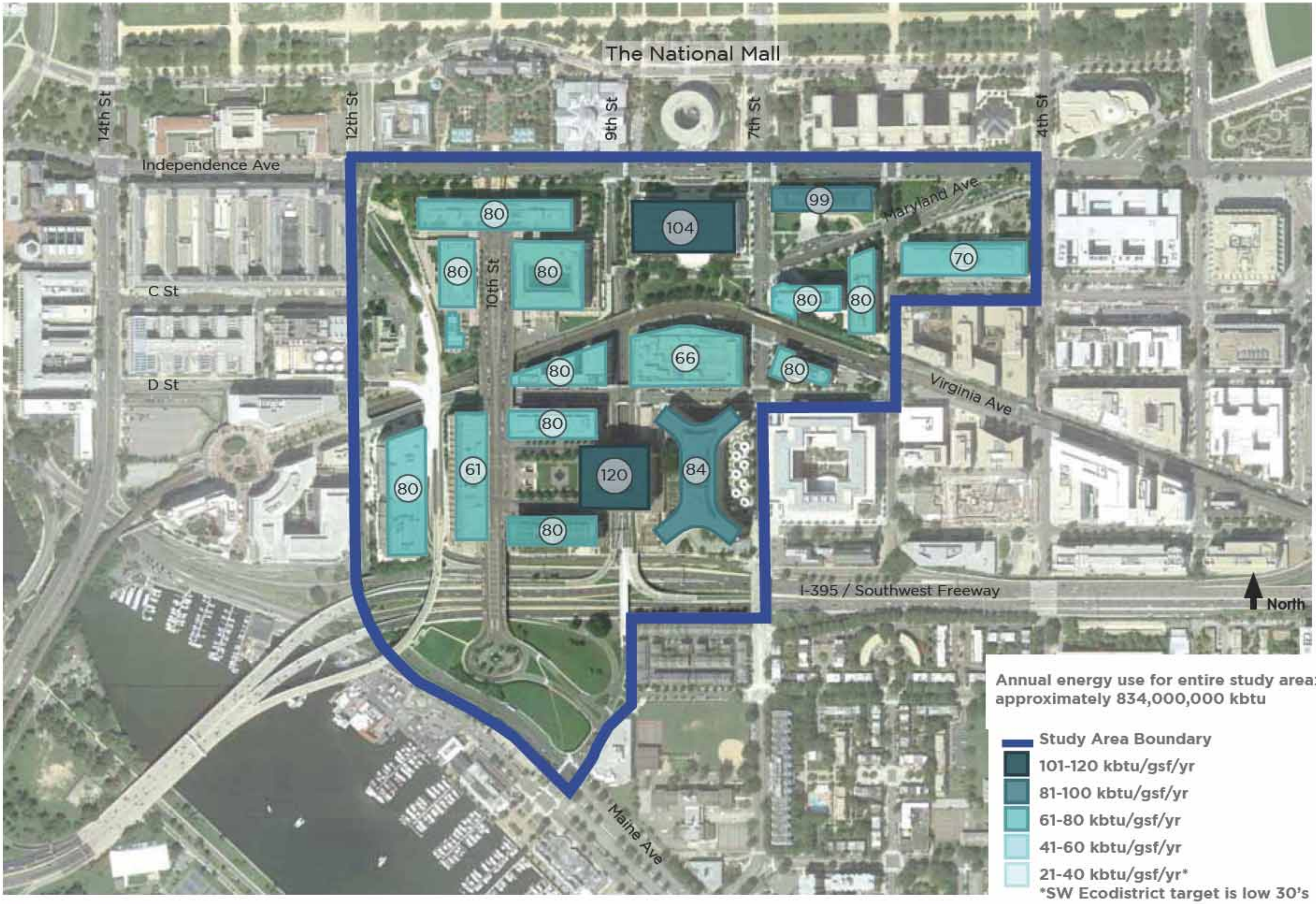
non-potable will provide 9 gal/gsf/yr

TOTAL WASTE IMPACT

Improvements to the recycling program will lead to a reduction in waste going to the landfill.



Existing Energy Use



Energy, Water, and Waste at the Building Scale

CONCEPTUAL STRATEGIES

While energy, water, and waste strategies at the district-scale often result in greater sustainability improvement, building-scale strategies can be considered “low-hanging fruit.” Often simple improvements to buildings can vastly improve energy, water, and waste performance without substantial cost. Other, more costly improvements can also be made, yielding even better performance.

Due to their design and antiquated infrastructure systems, existing federal buildings in the study area are not energy or water efficient. When possible, the federal government is making improvements such as installing low-flow fixtures and energy efficient lighting. These measures save money and resources; however, to meet the energy, water, and waste objectives (described in the following sections) greater improvements will need to be done in the future.

An important component of formulating the development scenario was modeling individual buildings and sites. The conceptual modeling for the individual buildings identified a potential 47 percent reduction in energy use with a light rehabilitation (upgrading controls and lighting) of existing buildings. By fully rehabbing or constructing new buildings, the Ecodistrict can expect a 72 percent reduction in energy use compared to how the existing buildings perform today.

The modeling considered the amount of water, waste, and energy that will used at each building, street, or open space. The modeling also identified sources of power, heating, and cooling to be supplied across the study area. This analysis provided the content for initial cost estimates to determine the value of individual improvements in meeting E.O. 13514. The matrix on this page provides the guidelines for building improvements.

BUILDING SCALE DESIGN STRATEGIES

	Building Strategy				
	Light Rehab	Full Rehab	Repurpose	Infill	Redevelop
Energy					
Tenant Improvement					
Lighting system upgrade	X	X	X	X	X
Plug load reduction	X	X	X	X	X
Sustainable and certif ed materials	X	X	X	X	X
Radiant heating and cooling		X	X	X	X
Low volume air distribut on		X	X	X	X
Core and Shell					
Upgrades to building systems during natural cycle of obsolescence.	X				
New mechan cal and electr cal system - hydron c thermal energy distribution.		X	X	X	X
High performance building envelope.		X	X	X	X
Maximize the use of renewable energy resources (PV) and shared energy technology.		X	X	X	X
Maximize building energy use eff c ency.		X	X	X	X
Capitalize on ground source heat below building site.				X	X
Capitalize on ground source heat below open space and streets.					X
Water					
Replace existing plumbing fixtures w th high efficiency fixtures.	X	X	X		
Install high eff ciency plumbing fixtures.		X	X	X	X
Collect rainwater.		X	X	X	X
Install non-potable water system.		X	X	X	X
Waste					
Provide waste sorting stations at point of use locat ons.	X	X	X	X	X
Reclaim, recycle, and compost the majority of waste (sol d and organ c) generated within the area.		X	X	X	X
Minimize construction waste		X	X	X	X

Energy

THE IMPORTANCE OF ENERGY

The majority of global energy consumption comes from non-renewable fossil fuels such as coal, oil, and natural gas which produce greenhouse gas emissions, known to cause global warming. As a result of greenhouse gas emissions, our planet is experiencing climate change and extreme weather events, which are permanently damaging the ecosystem. There are various types of greenhouse gas emissions, with carbon considered the primary cause of global warming. To curb climate change and its detrimental effects, it is necessary to reduce energy consumption and switch to renewable "carbon-free" sources of energy that do not produce greenhouse gas emissions.

THE AREA TODAY

ENERGY USE

In terms of energy use, the federal buildings within the study area are inefficient. These buildings have thin walls and windows; are oriented north/south which maximizes heat gain; have little natural light because of large interior hallways and extremely large footprints; and have antiquated mechanical systems. When possible, the U.S. General Services Administration (GSA) has made energy efficient improvements, but the overall design and layout of the buildings continue to prevent significant improvements in energy efficiency. An existing federally-owned central utility plant provides heating and cooling to the federal buildings within the area, but is not authorized to provide service to non-federal users. The private buildings are more energy-efficient because property owners made investments. However, none can benefit from use of the central utility plant because it is not available to private property owners.

ENERGY SOURCE

Today, the majority of the energy used in the study area comes from coal-fired electricity plants. Coal is highly inefficient and one of the most polluting energy sources. Burning coal is a significant contributor to global warming and releases toxic pollution into the air and water. Approximately 74 percent of the energy used within the Ecodistrict is provided by Pepco and comes from burning coal.

Natural gas, a cleaner and more efficient form of energy, produces 26 percent of the Ecodistrict's energy supply and is provided by Washington Gas. While natural gas is a cleaner alternative to coal-fired electricity, it is also a non-renewable source of energy and produces carbon dioxide and other emissions that contribute to global warming. Less than one percent of the Ecodistrict's energy use is currently generated from renewable resources within the study area.

THE OBJECTIVES

The SW Ecodistrict objective for the study area is to create a zero net energy district, as measured in carbon. This means that in addition to producing all of the energy it consumes on site, the Ecodistrict must not produce any carbon emissions or must pay for offsetting carbon credits. This objective is derived from E.O. 13514, which requires all new federal buildings entering the design phase in 2020 or later, be designed to achieve zero net energy by 2030.

Buildings in warm climates on large sites have the opportunity to harness a significant amount of renewable energy from the sun. If the buildings are also energy efficient, it is possible that they will be able to operate on the solar energy that the site generates (thus becoming a zero net energy building). Achieving this objective on a site-by-site basis within a dense urban environment, where solar exposure is usually limited to small rooftops, is more difficult. Dense urban areas such as the SW Ecodistrict can, however, move closer to achieving this objective by taking advantage of energy planning at the block and district-scale.

ZERO NET CARBON BY THE YEAR 2030

Solar panels on the roof of the U.S. Department of Energy Building.

BLOCK SCALE STRATEGIES

BLOCK-SCALE ENERGY SYSTEMS

There are several strategies that will allow both public and private buildings within any block to produce and share energy.

SOLAR THERMAL - Solar thermal equipment heats water using solar energy.

› Use solar thermal on both new and rehabilitated buildings. Office buildings that do not need a lot of hot water can share excess hot water with adjacent residential/hotel buildings that may need more than they can produce individually.

SOLAR PHOTOVOLTAICS (PV) – Solar PV equipment may be placed on building rooftops or integrated with a building's skin to harness solar energy for building use.

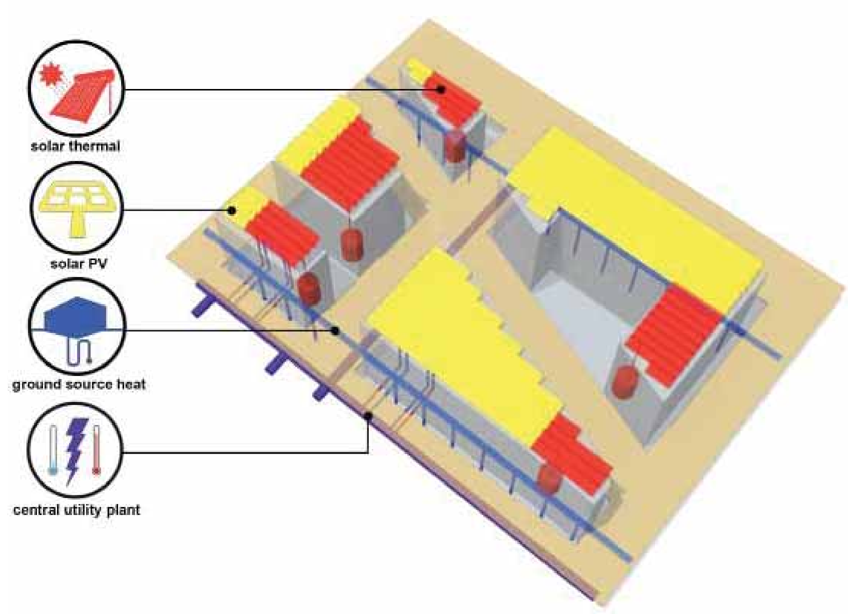
› Install solar PV on all building roofs and over the Southwest Freeway between 7th and 9th Streets. The energy from the freeway installation can support energy use in the adjacent block and district.

GROUND SOURCE HEAT – The earth's relatively constant temperature under ground is used to provide heating and cooling for buildings.

› Use ground source heat technology for new buildings north of C Street on land where large blocks will allow subsurface wells that do not conflict with existing elevated structures.

CENTRAL UTILITY PLANT (CUP) – At the block-scale, the central utility plant (also see district-scale strategies) allows the sharing of heating and cooling between buildings. For example: excess heat from an office building can be used in an adjacent residential or hotel building.

› All new and rehabilitated buildings (both public and private) should connect to the existing central utility plant.



BLOCK-SCALE ENERGY SYSTEMS

DISTRICT SCALE STRATEGIES

There are three district-scale strategies that will significantly curb energy consumption and generate and share renewable energy.

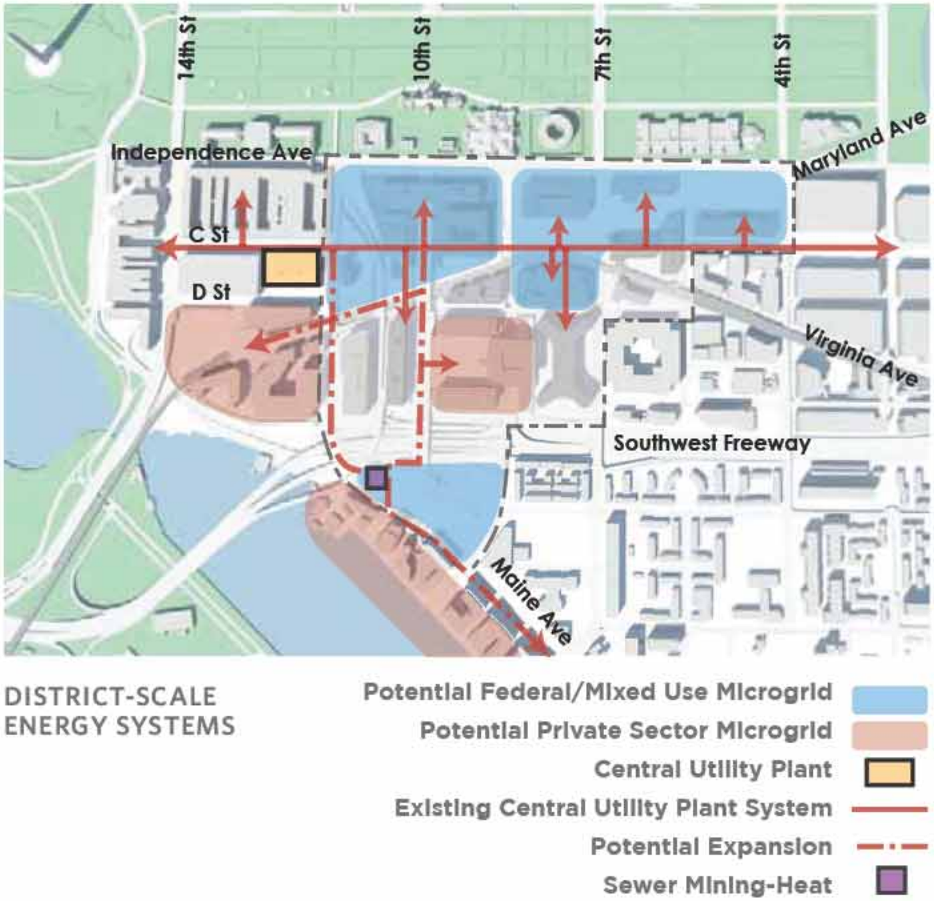
CENTRAL UTILITY PLANT

In 1933 the federal government built a central utility plant at 12th and C Streets, SW to provide heat to federal buildings in downtown Washington, DC. Today the plant predominantly provides heating through steam and also a small amount of cooling to a majority of the federal office buildings within the study area and other parts of downtown, in addition to several buildings of the Smithsonian Institution. GSA owns and operates the facility. By law, they can only provide service to federal users. Nearing 80 years old, the plant is in need of modernization and as a result is not very efficient compared to today's standards.

Central utility plants, sometimes called combined heat and power or cogeneration, are integrated systems that provide both electricity and heat. These plants have an advantage over conventional single-source electricity plants because they capture waste heat as electricity is produced (from natural gas in this case) and recycle it to provide heat to buildings. Conventional systems simply exhaust heat into the environment, requiring additional fuel to heat the buildings.

Key strategies to maximize efficiency of the central utility plant include:

- Invest in the existing central utility plant for heating and cooling. Modernize the plant's equipment.
- Increase efficiency by adding new residential and commercial uses throughout the study area and upgrading equipment to support new users. Adding residential uses to the central utility plant will balance loads between day and evening use.
- Change the central utility plant to a less carbonized energy source when the technology is available. While natural gas is significantly better than coal as an energy source, it still produces carbon emissions. Anhydrous ammonia (that is generated through a renewable power source) is an emerging technology under study by the U.S. Department of Energy, which shows promise as a future renewable, decarbonized energy source.



DISTRICT-SCALE ENERGY SYSTEMS

MICRO-GRIDS

Micro-grids are small-scale power grids that allow electricity to be produced and used locally within a small area. The advantages are numerous: micro-grids optimize heat energy. Between 60 and 80 percent of a typical power plant's energy consumption never becomes usable electricity, but is instead lost through production and transmission. Energy produced and distributed locally through a micro-grid has a variety of uses including heating of water. Renewable energy produced within the study area can be distributed through a micro-grid to other nearby buildings. This creates opportunities for property owners to sell excess power to the regional grid. Adding additional energy sources increases electrical reliability within the area and reduces dependence on the regional power grid. As new areas are redeveloped in locations remote from the central utility plant, they may develop a micro-grid district to balance loads among day and evening users.

› Establish micro-grids, grouped by development areas of both private and federal buildings, within the Ecodistrict. These micro-grids can be connected together with other buildings that might share power and energy.

SEWER-MINING

Sewer heat-mining uses the constant temperature of sewage from buildings to create even warmer heat for nearby buildings. It is a below ground, completely enclosed process that requires no combustion and works well in densely built areas with high heat consumption, such as residential buildings.

› Build a sewer-mining facility in the southern area of the Ecodistrict to provide heating to new residential and cultural buildings immediately north and south of Banneker Park.

ENERGY - PROJECT RECOMMENDATIONS

	Summary Description	Phasing	Potential Partners Federal – F District – D Private Sector –P Public Utility - PU
1. Solar Thermal	Use solar thermal on both new and rehabilitated buildings.	As buildings develop/redevelop or on existing buildings	F,P
2. Solar Photovoltaics	Install solar PV on all building roofs and over the freeway between 7th and 9th Streets (this will need further study)	Freeway solar array must be coordinated w th the m crogrid.	F,D,P,PU
3. Ground Source Heat	Use ground source heat technology for new buildings north of C Street on land where large blocks will allow subsurface well f elds that do not conflict with existing elevated structures.	As buildings develop/redevelop	F,P
4. Central Utility Plant (CUP)	Connect new and rehabilitated buildings to the CUP to allow for the sharing of heating and cooling between buildings. Modernize the CUP's equipment. Add res dential and commercial uses to increase effic ency. Sw tch the CUP to a less carbonized energy source when technology is available.	Make improvements to CUP pr or to major redevelopment in the Study Area. Connect buildings as they develop/redevelop.	F,P
5. Microgrids	Establish micro-grids grouped by development areas for both private and federal buildings.	Pr or to solar arrays and in coordination with CUP improvements	F,P,PU
6. Sewer Heat Mining	Build a sewer heat-mining facility in the southern area of the Ecodistrict to prov de heating to new residential and cu tural buildings immediately north and south of Banneker Park. This needs further study.	In coordination with new residential development	P,PU

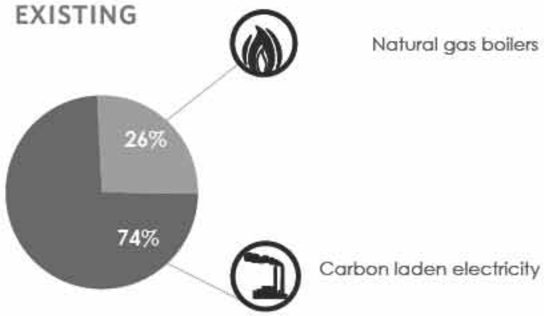
RESULTS

Strategies identified for the development scenario will lead to an increase in use of alternative energies and a reduction in greenhouse gas emissions and operating costs.

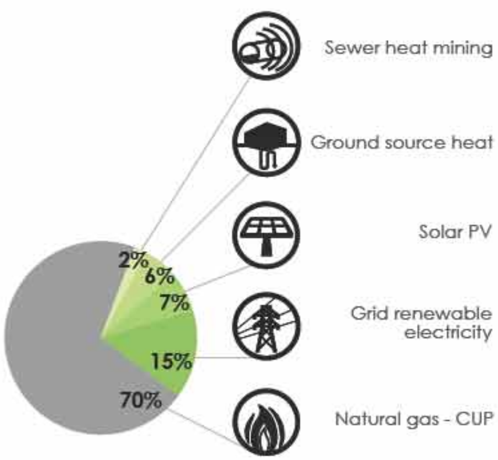
Greenhouse gases will be reduced 51 percent. The SW Ecodistrict will eliminate its greenhouse gas emissions when the central utility plant switches to a non-fossil fuel source.

ENERGY SOURCE

EXISTING



DEVELOPMENT SCENARIO



THE CASE FOR DISTRICT ENERGY

ENERGY District-scale energy systems help communities reduce their operating costs and keep more energy dollars local by reducing the need to import fuel for heating and cooling. The environmental impacts of heating and cooling systems are significantly reduced because these district-wide systems improve efficiency. Developing district energy/central heating plant systems can ease the transition of the power sector as older, polluting coal plants are closed and removed from the grid. District cooling can cut peak electrical demand that typically occurs in the late afternoon, thus reducing strain on the grid and avoiding peak costs.

BEST PRACTICES

CENTRAL BUSINESS DISTRICT – ST. PAUL, MN District Energy St. Paul provides heating to more than 80 percent of St. Paul's central business district and cooling to more than 60 percent. District Energy St. Paul meets 70 percent of its customers' annual heating from a biomass central heating plant which reduces greenhouse gas emissions by over 200,000 tons annually.

DOWNTOWN CLEVELAND Cleveland Thermal's district energy network provides 30 percent of the heating and cooling needs of the city's business district. The pipeline spans more than 30 million square feet, bringing steam and chilled water to commercial, institutional, and municipal buildings in downtown Cleveland. Customers reduced their peak power demand, thereby reducing their cost per kilowatt hour.

SW WATERFRONT, WASHINGTON, DC The Wharf, a new waterfront mixed-use development project by Hoffman-Madison Marquette, will have a three-story central utility plant designed to serve the energy needs for the project. The new plant will significantly reduce the neighborhood's greenhouse gas emissions compared to traditional systems contained within each individual building.

THE CASE FOR GROUND SOURCE HEAT GSA recently installed ground source heat in the Mary E. Switzer Building, two blocks from the SW Ecodistrict. Heating and cooling loads are expected to be 30 percent more efficient with this technology.

Water

THE IMPORTANCE OF WATER

People, plants, and urban wildlife depend on water for their existence. People also depend on water to heat and cool buildings. There are five types of water that are important to the sustainability of the Ecodistrict:

Potable Water – water that has been processed and treated so that it is clean enough to drink. It is pumped to buildings within the district from the municipal water system.

Stormwater – rainwater that falls onto the Study Area. It eventually runs into the municipal storm system where it is pumped to the water treatment plant for treatment and discharge.

Greywater – water that is generated from domestic activities such as laundry, dishwashing, and bathing.

Recycled Stormwater/Greywater – combined stormwater and greywater that is captured and reused for irrigation and/or toilet use.

Blackwater – water that is discharged from toilets.

Traditionally, these five types of water function independently. Potable water is currently used for all water needs in the study area. Stormwater, greywater, and blackwater are all pumped to a wastewater treatment plant. While this has worked in the past, it is becoming increasingly clear that it is cheaper and more sustainable to integrate systems. Highly treated and energy intensive potable water is unnecessary for all of the area's water needs, especially when the stormwater and potable water rates (paid by property owners) are scheduled to increase substantially by 2032. The monetary savings will increase as the study area captures stormwater, reuses it for non-potable uses, and decreases its dependence on potable water.

THE AREA TODAY

While this area is not part of the District of Columbia's combined sewer system, where stormwater and sewage use the same pipes and frequently overflow into the rivers during heavy rains, it is still important to capture and treat stormwater.

Approximately 92.4 million gallons of rainwater falls on the study area each year. With 82 percent of the land area comprised of hard surfaces, a majority of rainwater flows directly off the area's buildings and streets into the municipal combined stormwater/sewage discharge system. On its way, it picks up pollutants such as oil, gasoline, and pesticides. Once in the system, it must be pumped eight miles south to the Blue Plains Treatment Plant where significant amounts of energy are used to clean the water before it is released. None of it is reused. The Blue Plains Treatment Plant is owned and operated by DC Water, the water and sewer authority that provides water and wastewater treatment services to the District of Columbia and parts of region.

Today, all of the water that is used in the study area is potable - meaning it has been processed and treated so that it is clean enough to drink. Potable water is unnecessary for many uses, including irrigation, building mechanical systems, and toilet flushing since rainwater and greywater can be used instead.

THE OBJECTIVES

The targets for stormwater and potable water come from E.O. 13514.

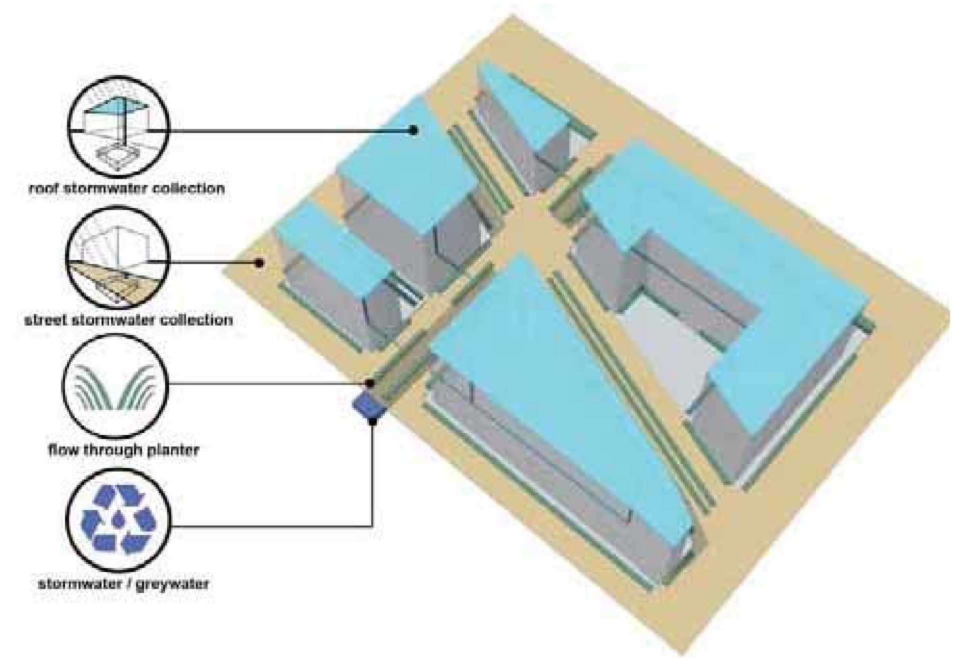
STORMWATER - RETAIN 95TH PERCENTILE RAIN EVENT

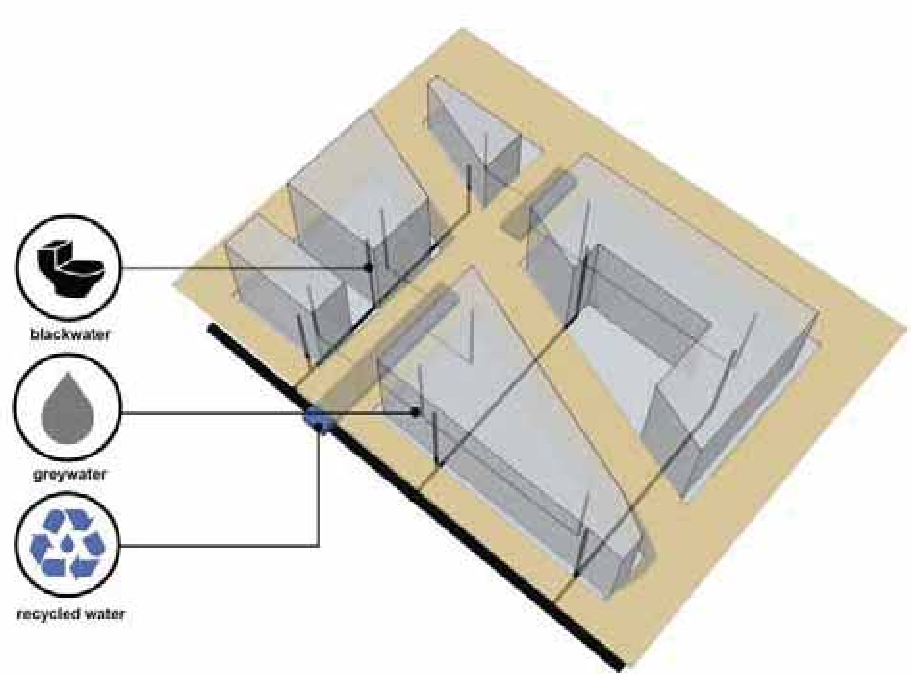
POTABLE WATER USE - REDUCE BY 50 PERCENT

The stormwater objective is to retain a 95th percentile rain event. In Washington, DC this means all rain events that produce up to 1.7 inches of rain in 24 hours. Few rain events in Washington, DC actually produce more than this amount so the objective is to essentially retain and reuse all of the rain that falls in the area throughout the year. This is very challenging in a dense urban area with little pervious surface.

The potable water objective is to reduce potable water use by 50 percent (as measured per square foot). Today, the area uses potable water for all of its water needs. This amounts to approximately 22 gallons of water/sq. ft./year. The objective is to reduce potable water use to 11 gallons/sq. ft./year.

BLOCK SCALE STRATEGIES





BLOCK-SCALE WATER COLLECTION SYSTEMS

A key strategy in reducing stormwater run-off is to collect it for reuse. Here, a single block or group of blocks share a stormwater system to clean and then convey stormwater to a storage tank for reuse. Our modeling at the block-scale indicates that the project can maximize the capture and reuse of naturally occurring rain and the treatment of wastewater leaving the Ecodistrict.

› **ROOF STORMWATER** - Collect rain water from building rooftops and send to the district-scale water system.

› **STREET STORMWATER** - Collect stormwater runoff from streets/ plazas and send to the district-scale water system.

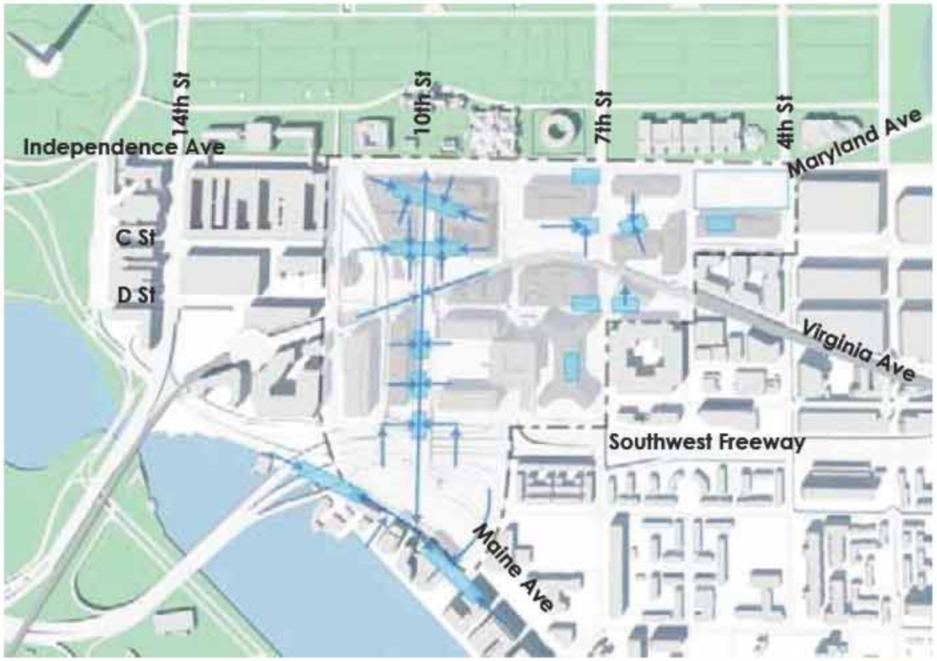
› **FLOW THROUGH PLANTERS** - When possible, pretreat as much stormwater in vegetated flow-through planters prior to sending to the district-scale water system.

› **RECYCLED STORMWATER/GREYWATER** - Reuse collected stormwater/greywater for all non-potable water needs and landscaping.

BLOCK-SCALE WASTE WATER SYSTEMS

› **WASTE WATER** - Solids captured from wastewater can ultimately reduce the Ecodistrict's greenhouse gas emissions while providing an alternative energy source through anaerobic digestion. It is not technically or financially feasible to do this in the near future in the Ecodistrict. The solids in wastewater will continue to be pumped to the DC Water Blue Plains Treatment Plant. The anaerobic digestion facility that DC Water is building will offer a regionally scaled process that is effective in capturing its latent energy, resulting in usable fertilizer and a low carbon energy source.

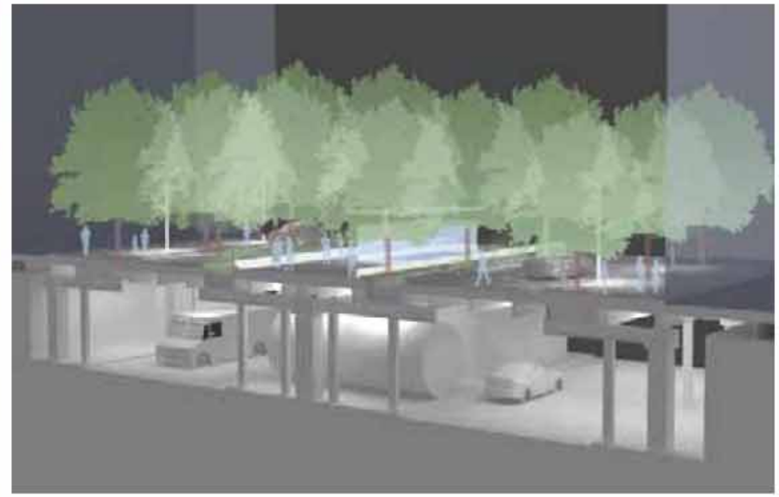
DISTRICT SCALE STRATEGIES



DISTRICT-SCALE WATER SYSTEMS

Water Storage

Water Collection



Potential stormwater storage (tank or cistern) under 10th Street

DISTRICT-SCALE STRATEGIES

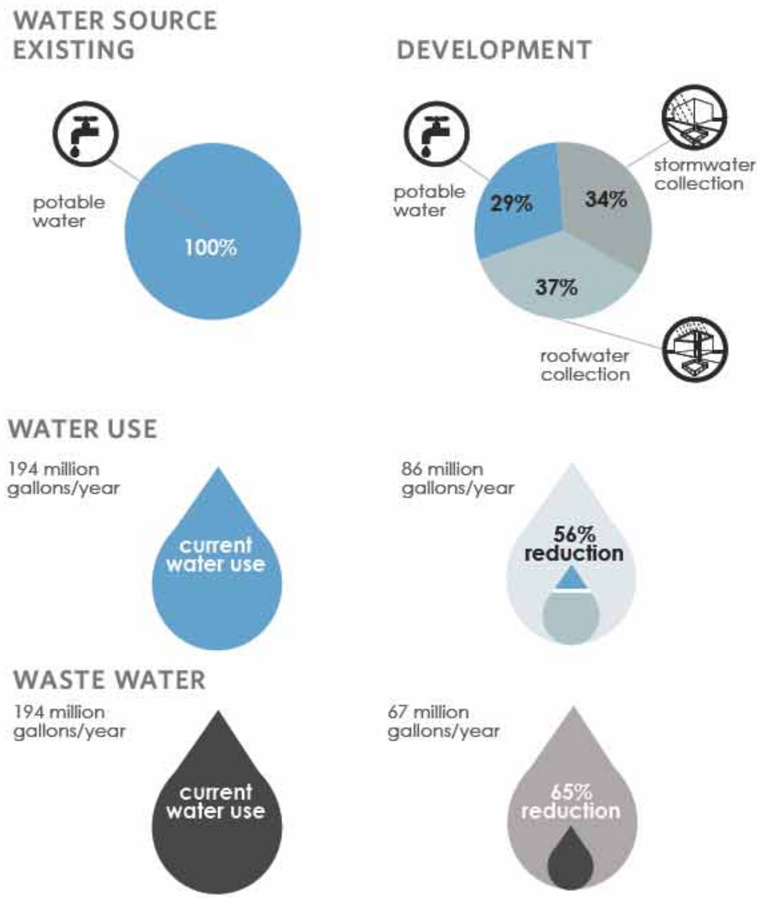
- All stormwater and greywater will be sent to cisterns under 10th Street. Reuse of this water in buildings and landscapes can provide 71 percent of the total water used in the Ecodistrict. It can also provide a free water source to the central utility plant (described in the Energy Section), which uses significant amounts of potable water annually.
- Recycled stormwater and greywater strategies are important for meeting the area's potable water reduction goals. Potable water use can be reduced by 63 percent and stormwater runoff can be eliminated.

WATER - PROJECT RECOMMENDATIONS

	Summary Description	Phasing	Potential Partners Federal – F Distr ct – D Private Sector –P Public Utility - PU
1. Roof Stormwater	Capture all rainwater from building rooftops in the study area and send to the district system under 10th Street.	As buildings develop/redevelop	P,D,F
2. Street Stormwater	Send stormwater on streets in the study area through flow through planters to the district system under 10th Street.	Existing streets as district system is built New streets in coordination with construction	P,D,F
3. Ground Source Heat	Send greywater from buildings to distr ct system under 10th Street.	As buildings develop/redev	P,D,F
4. Waste Water	Send all waste water to DC Water in Blue Plains for treatment.	As new buildings develop (existing buildings already do this)	P,PU
5. Distr ct Water System	Construct cisterns underneath 10th Street to hold and treat stormwater and greywater for reuse.	Construct prior to any parcel development and in coordination w th permanent improvements to 10th Street.	F,D,P
6. Greywater/ Stormwater Reuse	Plumb all new buildings and fully rehabilitated buildings with pipes for greywater reuse.	As buildings develop/redevelop	F,D,P

RESULTS

Strategies identified for the development scenario will lead to a 63 percent reduction of potable water use.



THE CASE FOR DISTRICT WATER

While the exact value proposition for a district-wide water system requires detailed research, it is clear that stormwater-related fees for property owners will become increasingly more expensive. DC Water's Clean Rivers Impervious Area Charges (IAC) and the District Department of the Environment's (DDOE) stormwater fees are projected to grow significantly between 2012 and 2018. The IAC helps fund DC Water's investment to reduce pollution in the Anacostia and Potomac Rivers and Rock Creek. It applies to all lots, parcels, properties, and private streets within the District of Columbia. DDOE assesses a stormwater fee to control pollution from stormwater runoff. This fee is based on the average amount of impervious surface on properties.

In 2012, federal property within the area paid approximately \$6,800/month in combined fees. This is projected to increase to approximately \$32,000/month or \$384,000/year by 2018. Together, federal and private development in the area will pay approximately \$48,000/month or \$576,000/year by 2018.

Both programs are looking at ways to provide credits and rebates for property owners who manage their stormwater. DDOE is currently developing a stormwater fee discount program that will provide the opportunity to receive up to a 55 percent discount off the stormwater fee to rate-paying property owners who implement measures to manage and reduce stormwater runoff. While rebates alone may not cover the initial cost of infrastructure for a district-water system in the near term, the savings from reduced potable water use and associated reduction in energy use could make this project economically feasible over the long-term.

BEST PRACTICE

The Wharf will have an elaborate 675,000 gallon cistern system that will be constructed to capture more than 25 million gallons of stormwater each year that currently drains into the Washington Channel due to the lack of permeable surfaces. The captured runoff will be recycled to the greatest extent possible, including the provision of chilled water for the development's cogeneration plant.

Waste

THE IMPORTANCE OF WASTE

Reducing overall waste is critical to the success of the Ecodistrict because processing waste uses a lot of energy and if it cannot be reused, the waste is trucked to a landfill where it consumes large amounts of land, making it unusable for anything else. This section discusses two kinds of waste:

› **Building waste** – the waste that is produced in buildings every day such as waste from food and paper.

› **Construction waste** – the waste that results from building materials that can't be reused when an existing building is demolished or when a new building is constructed.

THE AREA TODAY

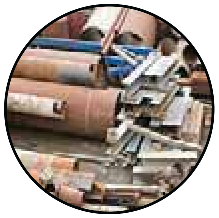
Today, it is estimated that 60 to 70 percent of the study area's overall waste is sent to the landfill outside of Washington, DC. This means that approximately 30 to 40 percent of its current building waste—predominately paper, plastics, and glass — is recycled. There are limited composting opportunities for food and landscape residuals. For comparison, the City of San Francisco in 2012 diverted 77 percent of all waste from the landfill. This means that it is recycling and/or reusing 77 percent of its waste and that only 23 percent is sent to the landfill.

THE OBJECTIVES

There are two waste-related targets that are achievable in this plan.

SOLID WASTE TO LANDFILL - REDUCE BY 80 PERCENT

(No waste should be incinerated in the study area)



CONSTRUCTION WASTE - RECYCLE 75 PERCENT AS BUILDINGS ARE REHABILITATED OR REDEVELOPED

WASTE STRATEGIES

DISTRICT SCALE

The Ecodistrict can effectively reduce waste generation through collective community action. In this regard, sorting waste at the point of use or altering procurement protocols is best orchestrated at a district scale.

USE REGIONAL WASTE AND RECYCLING SYSTEMS FULLY

The study area strategies utilize the regional waste and recycling system because currently it is not financially or technically feasible to process and reuse waste within the area itself.

Operational improvements such as designated composting and recycling stations at all of the buildings will go a long way towards meeting the 80 percent diversion rate from the landfill.

IMPROVED RECYCLING PROGRAM

› Engage federal and private building occupants in robust recycling programs. Provide recycling bins throughout buildings, in parks, and on the streets. Measure and inform residents and employees of annual progress.

PILOT COMPOSTING PROGRAM

› In addition to continue bolstering recycling programs in federal and private buildings, the federal agencies and private buildings will significantly benefit from a pilot composting program for food and landscape residuals.

CONSTRUCTION WASTE MANAGEMENT STRATEGIES

Operational improvements during the demolition and construction of buildings are the key to meeting the Ecodistrict's construction waste goals. Construction waste management strategies include:

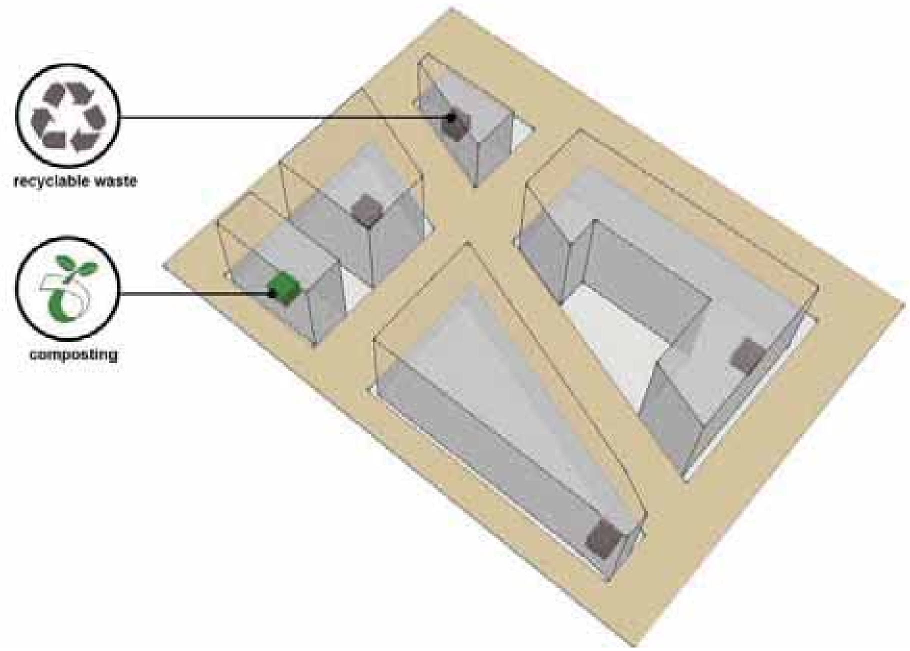
› Early planning to set targets and adopt waste prevention plans.

› Requiring that reusable wood and other materials are used before new ones.

› Purchasing reused, recycled, or recycle-content materials and equipment.

› Finding creative ways to reuse items already existing within the project site.

BUILDING & BLOCK-SCALE STRATEGIES



WASTE - PROJECT RECOMMENDATIONS

	Summary Description	Phasing	Potential Partners Federal - F District - D Private Sector -P Publ c Utility - PU
1. Recycling	Improve recycling programs and facilities throughout the study area.	Immediately	F, D, P
2. Composting	Implement a pilot composting program.	Immediately	D (part of the DC Sustainabil ty Plan effort)
3. Construct on Waste Management	Use construction waste management strategies during demolition and construction of new buildings.	As buildings develop/redevelop	P

RESULTS

The development scenario strategies will lead to recycling of 80 percent of solid waste and 75 percent of construction waste.

EXISTING SOLID WASTE

DEVELOPMENT SCENARIO

CONSTRUCTION WASTE RECYCLING

251 thousand tons/year

BEST PRACTICES - WASTE

In 2010 San Francisco exceeded its goal to divert 75 percent of materials away from the landfill. Residents and businesses can utilize the green/blue/black bin system that is picked up at each property and allows people to recycle and compost easily. The city's goal is to be zero waste by 2020. Zero waste means products are designed and used according to the waste reduction hierarchy (prevent waste, reduce and reuse first, then recycle and compost) and principle of highest and best use, so no material goes to landfill or high-temperature destruction. Reaching this goal means sending zero discards to the landfill, instead all discards generated in San Francisco are either reused, recycled, or composted.

Green Infrastructure

THE IMPORTANCE OF GREEN INFRASTRUCTURE

Green infrastructure is defined as a connected system of landscaped elements such as parks, living walls, green roofs, streetscape plantings, bioretention such as rain gardens, and mature tree canopies. When linked together, green infrastructure can provide a unified, resilient urban ecosystem that improves both ecological and human health. Green infrastructure, particularly in the form of parks, can also increase property values and contribute to the overall economic health of a community. The most successful systems seamlessly blend these elements into energy, water and waste infrastructure, and enhance the built environment for improved human connections with nature.

Integrating a green infrastructure system into the buildings, sites, and utility infrastructure will result in cost-effective improvements through a living system that:

- **Cleans** the air and stormwater to enhance urban ecology and improve human health.
- **Cools** the overall temperature of the area, reducing the heat island effect, decreasing energy costs, and improving habitat and pedestrian comfort.
- **Connects** contiguous green spaces along the ground, up living walls, and over green roofs, creating diverse habitat opportunities and connecting people to nature.

There are three green infrastructure elements that work together to improve the urban ecology of the SW Ecodistrict.

- **Permeable surfaces** – areas on the ground and on roofs that are able to absorb water and oxygen. Permeable surfaces increase the health and vitality of vegetation.
- **Tree canopy** – the overall area covered by trees. Extensive tree canopy coverage helps reduce the heat island effect, offers greater habitat opportunities, and provides a more comfortable pedestrian experience.
- **Parks and plazas** – publicly accessible spaces that provide vegetation, increase habitat opportunities, and improve human health. They also contribute to the cultural character of a neighborhood.

THE AREA TODAY

Typical of many urban areas, the study area is a low-functioning ecosystem. This is caused by a number of factors:

- Approximately 80 percent of the surface is impervious, a state where the ground is unable to absorb water and oxygen.
- About 50 percent of the study area is built above the ground. Due to weight restrictions, older elevated structures often limit the ability to retrofit streetscapes with a large tree canopy and vegetation.
- The few areas that are vegetated, including the 10 acres of parks and plazas, are mostly small spaces between a building and the sidewalk that are unsuitable for habitat. They suffer from severely compacted soil, are not properly maintained, and contain non-native invasive species.
- Only about 8.6 percent of the study area is covered by tree canopy, and the surviving trees have limited growth potential. As a comparison, about 37 percent of Washington is covered by tree canopy.

As of November 2012, there were no green roofs, living walls, or bioretention areas that collect and treat stormwater, or other green infrastructure elements in the study area. However, the District of Columbia's 2012 update to the Zoning Regulations requires parcels to calculate and maintain a Green Area Ratio (GAR), a calculation that compares the permeable surfaces, tree canopy and landscaped areas to the overall site area. Based on the District's underlying land use for the study area, the GAR is 0.30.

THE OBJECTIVES

The target for green infrastructure in the study area is to achieve a minimum Green Area Ratio of 0.45, well above the District of Columbia's minimum GAR of 0.30. This will be accomplished by using green roofs and living walls; bioretention in parks, plazas, sidewalks and medians; edible gardens and improved parks; and permeable pavements and sidewalks that allow for greater tree canopy and vegetation.

Green roofs significantly contribute towards increasing the Ecodistrict's GAR, and provide a variety of benefits to urban ecology and human health. They reduce energy use by providing superior insulation qualities, increase permeable surfaces, and establish vegetated areas that provide habitat opportunities for pollinators and rooftop gardens for occupants. However, the SW Ecodistrict must balance the benefits of green roofs with the need to increase renewable energy use and capture and reuse as much stormwater as possible. Because there is a limited amount of area available to successfully achieve all three goals, the use of green roofs should be strategically located in places where they are visible to building occupants, maximizing both ecological and human benefits. Establishment of green roofs, renewable energy systems and recycled stormwater/greywater systems should be planned holistically to yield maximum results.

As a part of the GAR, credit is also given to reducing the amount of impervious surface in the area, increasing the overall tree canopy, and establishing urban parks. By establishing a minimum pervious surface area objective of 35 percent, the SW Ecodistrict will contribute to the improved health of the Chesapeake Bay watershed. By establishing a minimum tree canopy area objective of 40 percent and concentrating new plantings along streets and in the 14.3 acres of new or improved parks and plazas, the SW Ecodistrict can help Washington move towards its city-wide goal.

ACHIEVE A MINIMUM GREEN AREA RATIO OF 0.45

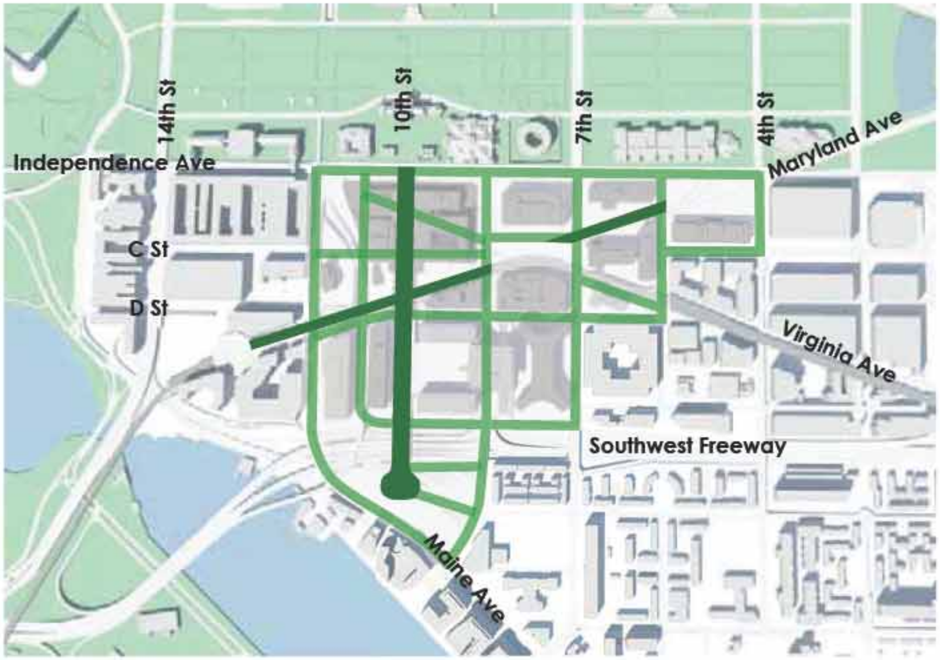
STRATEGIES

BUILDING-SCALE STRATEGIES

The following strategies are able to make the biggest impact through implementation on a building-by-building basis.

- **Green Roofs** Locate and design green roofs to maximize their ecological function and their visibility to on-site and nearby building occupants and/or from the street level.
- **Edible Rooftop Gardens** Designate selective rooftop areas for edible gardens, and use compost and mulch from the area to amend planting beds and improve soil quality.
- **Green Walls** Incorporate green walls into exterior building features to cool structures, decrease energy costs, reduce heat island effect, and enhance streets and plazas.
- **Rain Gardens** Incorporate rain gardens into landscaping to manage and treat stormwater.

(Images, clockwise from upper left) - Solar/green roof, edible rooftop garden, edible green wall, green wall, rain garden



GREEN STREET INFRASTRUCTURE

Green Corridor

Enhanced Tree Canopy

Green streets manage stormwater and improve urban ecology.

BLOCK-SCALE STRATEGIES

While many strategies at the block-scale are implemented in the public realm, adjacent landowners and government agencies with jurisdiction over the public realm can work together to achieve even greater results.

› **Stormwater Management** Capture and treat stormwater across property lines using integrated green infrastructure elements in parks, plazas, building yards, and along streets. Elements include low impact development features like rain gardens, cisterns, and grassed swales.

› **Pervious Area** Maximize ground infiltration by increasing open space and using permeable pavement and structural pavement systems that allow for water and oxygen absorption to improve vegetative root growth.

› **Native Vegetation** Integrate native vegetation into parks, plazas, streetscapes and bio-retention features such as rain gardens to improve water quality and visual aesthetics, lower energy/water consumption, and promote mid-Atlantic ecology.

› **Parks and Plazas** Design parks and plazas for people to socialize and reconnect with nature, treat stormwater, control flooding, and provide habitat opportunities.

› **Urban Soils** Establish healthier urban soils by using compost and mulch from the Ecodistrict, structural soils that resist compaction, and more permeable pavers that allow for vegetative root growth.

› **Urban Heat Island Effect** Use shade from trees and structures, as well as surface materials with a high solar reflectance index (SRI), to reduce the heat island effect.

DISTRICT SCALE STRATEGIES

In order to meet green infrastructure targets, some strategies must be implemented at a district-scale.

› **Green Corridor** Transform 10th Street into a "green spine" of vegetation to connect the National Mall and the southwest waterfront. Use street trees, water features and other green infrastructure elements such as rain gardens to connect parks and plazas.

› **Tree Canopy** Use tree-friendly construction details that increase soil permeability and root growth, in streetscapes. Concentrate new tree canopy into parks and plazas, redeveloped parcels, and along streets.

› **Awareness Campaign** Integrate exhibits and way finding elements into the green infrastructure system to connect people to nature. Provide interpretive/educational information about regional ecology, history, and culture.

› **Indicator Species** Identify a bird or insect to serve as the "indicator species" to monitor the ecological health of the SW Ecodistrict.

GREEN INFRASTRUCTURE - PROJECT RECOMMENDATIONS

	Summary Description	Phasing	Potential Partners Federal – F District – D Private Sector –P Public Util ty - PU
1. Green Roofs	Locate and design green roofs to maximize their ecolog cal function and their visibil ty to on-site and nearby building occupants and from the street level.	As buildings develop/redevelop	P, F
2. Edible Rooftop Gardens	Designate selective rooftop areas for edible gardens, and use compost and mulch from the area to amend planting beds and improve soil qual ty.	As buildings develop/redevelop	P, F
3. Green Walls	Incorporate green walls into exter or building features to cool structures, decrease energy costs, reduce heat island effect, and enhance streets and plazas.	As buildings develop/redevelop	P, F
4. Rain Gardens	Incorporate rain gardens into landscaping to prov de stormwater management.	As buildings develop/redevelop	P, F, D
5. Stormwater Management	Capture and treat stormwater across property lines using integrated green infrastructure elements in parks, plazas, building yards, and along streets. Elements include low impact development features like rain gardens, cisterns, and grassed swales.	Coordinate with design of cistern infrastructure under 10th Street	PU, F, D, P
6. Pervious Area	Maximize ground infi tration by increasing open space and using permeable pavement and structural pavement systems that allow for water and oxygen absorption to improve vegetative root growth.	As buildings develop/redevelop; coordinate in public spaces with streetscape design	PU, F, D, P
7. Native Vegetat on	Integrate native vegetation into parks, plazas, streetscapes and bio-retention features such as rain gardens to improve water qual ty and visual aesthet cs, lower energy/water consumption, and promote mid-Atlantic ecology.	As buildings develop/redevelop; coordinate in public spaces with streetscape design	P, F, D
8. Parks and Plazas	Design parks and plazas for people to socialize and reconnect w th nature, treat stormwater, control flooding, and provide habitat opportunities.	Coordinate with design of cistern infrastructure under 10th Street and green corridor design	F, D
9. Urban Soils	Establish healthier urban soils by using compost and mulch from the Ecodistrict, structural soils that resist compact on, and more permeable pavers that allow for vegetative root growth.	As buildings develop/redevelop; coordinate in public spaces with streetscape design	P, F, D
10. Urban Heat Island Effect	Use shade from trees and structures, as well as surface materials w th a high solar reflectance index (SRI), to reduce the heat island effect.	As buildings develop/redevelop; coordinate in public spaces with streetscape design	P, F, D
11. Green Corridor	Transform 10th Street into a “green spine” of vegetation to connect the Nat onal Mall and the SW Waterfront. Use street trees, water features and other green infrastructure elements such as rain gardens to connect parks and plazas.	Coordinate with design of cistern infrastructure under 10th Street, parks, and plazas	P, F, D
12. Tree Canopy	Use tree-friendly construction details that increase soil permeability and root growth. Concentrate new tree canopy into parks and plazas, redeveloped parcels, and along streets.	As buildings develop/redevelop; coordinate in public spaces with streetscape design	P, F, D
13. Awareness Campaign	Integrate exhibits and way finding elements into the green infrastructure system to connect people to nature. Provide interpretive/educational informat on about regional ecology, history, and culture.	Coordinate with Ecodistrict marketing strateg es	F, P
14. Indicator Spec es	Identify a bird or insect to serve as the “indicator species” to mon tor the ecological hea th of the SW Ecodistr ct.	Coordinate with Ecodistrict marketing strateg es	F, P

RESULTS

The development scenario strategies will lead to a resilient green infrastructure system that significantly improves ecological health; treats stormwater and prevents flooding; reduces energy use in buildings; reuses compost created in the SW Ecodistrict to improve soil quality and connect green spaces for contiguous habitat for critters. The green infrastructure system will also filter air pollutants; reduce urban heat island impacts; absorb carbon dioxide in the soil and tree canopy; and improve human health with views and access to roof gardens, parks, and recreational areas for rest and social interactions.

GREEN INFRASTRUCTURE

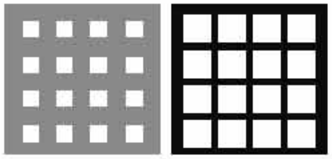
- Achieve a Green Area Ratio of 0.45 and 14.3 acres of improved parkland for ecological and human health.

TREE CANOPY

- Increase tree canopy coverage from the existing 8.6 percent to 40 percent.

PERMEABLE SURFACES

- Increase permeable surface from the existing 20 percent to at least 35 percent.



BEST PRACTICES - GREEN INFRASTRUCTURE

Philadelphia Municipal Green Infrastructure Plan (Philadelphia, PA)

The Philadelphia Water Department captures, treats, and reuses stormwater through an integrated green infrastructure system. When compared to traditional underground stormwater conveyance systems, green infrastructure provides a cheaper and more flexible solution that delivers additional ecological and personal health benefits. Linking smaller elements such as green roofs, rain gardens, and tree boxes creates a resilient and growing system that not only treats stormwater, but increases awareness of city residents and employees about the health of the ecosystem.

Greenwich Millennium Village (London, England)

Initiated in 2006, this brownfield development in southeast London is a mixed-use community that fully integrates a contiguous system of green infrastructure into the neighborhood. The green infrastructure treats stormwater runoff, provides habitat for a variety of species, and teaches residents and visitors about their ecosystem. It contributes towards an overall 30 percent reduction in water use, 80 percent reduction in energy use, and provides opportunities to interact with nature throughout the development, both in a streetscape/public realm setting as well as in restored wetland areas.

The Environmental Framework

Recommended Development Scenario
Study Model (2030).

CONCLUSION

ENERGY, WATER, WASTE AND GREEN INFRASTRUCTURE

The outcomes of the Environmental Framework recommendations include:

ENERGY

- **Reduces the energy use of all buildings,** including lightly rehabbed buildings by 47 percent and fully rehabbed buildings and new development by 72 percent.
- **Results in a 30 percent increase in the Ecodistrict's total energy use supplied by renewable energy.** This assumes 15 percent will be produced within the area and 15 percent will be purchased from credits. This energy will not create any greenhouse gas emissions and will reduce costs over the long-term.
- **Results in a 51 percent reduction in greenhouse gas emissions for the Ecodistrict.** This significantly exceeds the federal government's goal to reduce greenhouse gas emissions 28 percent by 2030. If the central utility plant could adapt to using a renewable fuel source in the future, the area could be zero net energy with no greenhouse gas emissions.
- **Demonstrates that the central utility plant is extremely valuable in reducing the ecodistrict's greenhouse gas emissions.** The proposed development scenario assumes that the plant will provide heating and cooling to all buildings in the Ecodistrict resulting in 70 percent of the area's total energy use being supplied by natural gas instead of coal.

WATER

- **Reduces the overall potable water use by 67 percent per square foot per year.** This will be accomplished through high efficiency buildings and the capture and reuse of stormwater for non-potable water uses.
- **Allows for the capture and reuse of all the rainwater in the SW Ecodistrict throughout the year.** Not only will this provide a free water source for non-potable water uses but it will decrease the Ecodistrict's greenhouse gas emissions by eliminating the need to pump and treat water miles outside of the study area.

WASTE

- **Increases the amount of waste diverted from the landfill from 35 to 80 percent.** This will be achieved through executing programs to reduce product consumption and encourage recycling and composting.

GREEN INFRASTRUCTURE

- **Improves human health with views and access to roof gardens, parks, and recreational areas for rest and social interactions.**
- **Increases the tree canopy from 8.6 to 40 percent.** This will improve air and water quality, reduce heat island effect, and provide a more comfortable pedestrian experience.
- **Increases the permeable surface from 20 to 35 percent.** This improves water quality and allows more stormwater to be captured and reused within the Ecodistrict.

THE SW ECODISTRICT WILL BE A HIGH PERFORMANCE ENVIRONMENTAL SHOWCASE