SUSTAINABLE INFRASTRUCTURE INITIATIVE:
INTERDEPARTMENTAL PLANNING FOR BETTER CAPITAL PROJECTS

City of Seattle Department of Planning and Development

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Abbreviations

CIP – capital improvements project

CSO – combined sewer overflow

DOE – Washington Department of Ecology

DOF – Seattle Department of Finance

DPD – Seattle Department of Planning and Development

FFD – Seattle Fleets and Facilities Department

GHG – greenhouse gas

GIS – geographical information system

IDT – Interdepartmental team

MLK – Martin Luther King Avenue

O&M – operations and maintenance

PAH – Polycyclic Aromatic Hydrocarbons

PSCAA – Puget Sound Clean Air Agency

SCL – Seattle City Light

SDOT – Seattle Department of Transportation

SHA – Seattle Housing Authority

SPR – Seattle Parks and Recreation Department

SPU – Seattle Public Utilities

TBL – Triple Bottom Line

UW –University of Washington

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1 INTRODUCTION

In the City of Seattle, every major department involved in the City's capital budget is beginning to address the need for long-term infrastructure planning by implementing "asset management" strategies. These approaches include "full cost accounting" as well as better identification of asset ownership and asset conditions.

However, as asset management is adopted by each department, the city runs of the risk of precluding integrated solutions that may cross lines of business. When projects are conceived, it is almost always within the context of a particular line of business, and disincentives discourage a broader scope: you don't control other departments' budgets, collaboration complicates project management and timelines, or it never occurs to you. Consequently, transportation projects miss opportunities to provide open space or take advantage of private investment in new buildings, and utility projects move on their own timeline without coordination across utilities. Opportunities for city-wide benefits are missed because departmental priorities supplant broader priorities.

The concept of "sustainable infrastructure" has emerged in this environment, to connect a general commitment to sound asset management with environmental and inter-departmental concerns. The Sustainable Infrastructure Initiative was inspired by the diversity of capital projects needed to deliver the City's various services, the presence of significant environmental and social impacts for many of them, and the opportunities to improve coordination among potentially complementary projects from multiple departments.

The City of Seattle's Sustainable Infrastructure Initiative, supported in part by a grant from the Washington State Department of Commerce, Trade and Economic Development, established a planning process and implementation plan for Sustainable Infrastructure projects. The Department of Planning and Development has the primary responsibility to implement the City of Seattle Comprehensive Plan which delineates city-wide policies for land use and sustainability. The Department of Planning and Development is also ultimately responsible for the permitting of private sector development projects, which largely drive the need for new infrastructure improvements. This responsibility is consistent with the Sustainable Infrastructure Initiative as it seeks to balance green building efforts with a broader city-wide approach to overall urban sustainability.

The Sustainable Infrastructure project team, led by staff from the Department of Planning and Development and their consultant, convened an interdepartmental team (IDT) to help develop the

Sustainable Infrastructure planning approach and select an initial set of pilot projects to illustrate and test the capital planning concepts included in the Initiative. This IDT considered a wide range of potential pilot projects – discarding some and refining others – and helped the Team narrow the number of candidates to those that could most effectively demonstrate the concepts involved.

Despite the inherent diversity of projects, the Sustainable Infrastructure IDT and support team sought to define a consistent approach that would produce efficient, environmentally sound, and wisely timed project selection and design outcomes. This involved identifying guidelines to help find a wider range of alternatives, testing them against a multi-departmental range of illustrative projects, listing project circumstances likely to benefit from a Sustainable Infrastructure approach, and addressing the range of analytical tools and presentation standards that would support that approach.

This process and report are not intended to draw conclusions about how specific capital projects should proceed; rather, they are intended to provide strategic recommendations for a set of potential pilot projects and thereby establish a more holistic lens through which to evaluate future asset management decisions throughout City government.

1.1 Problem Statement

The City owns over 30 % of the land base in Seattle, but has no integrated plan to manage this resource for multiple outcomes including sustainability. Land is managed in silos by different departments with different priorities and different methods. This means that departmental interests regularly supplant city-wide ones.

Because project managers are focused on their particular line of business, opportunities to maximize the benefits of city capital spending are regularly missed. When a solution to an identified problem is selected, the majority of the project costs are fixed. To be most efficient with public resources, it is important to look at robust alternatives before a solution is selected. Too often we fail to do this either because we don't have the systems in place that require a robust evaluation, or because decision-makers tend to pre-select solutions based on habit or tradition. While these solutions may pencil out in many cases, we have no way of knowing if they are truly the best solution because alternatives are not analyzed based on their full cost to build, own and operate.

As an example, transportation projects may miss opportunities to provide open space or take advantage of private investment from new buildings; utility projects move on their own timeline, missing opportunities to coordinate across utilities.

Additionally, City departments have idiosyncratic methods for prioritizing, evaluating, and implementing projects leading to wide variation in quality of decision-making. This creates significant financial burden to implement integrated strategies. Further, it limits the ability of the City financial experts to track spending. It also means that many quantifiable benefits are not captured each year. For example, the City's reinvestment in Seattle Center could play a significant role in cleaning up the water quality of critical watersheds if SPU and Seattle Center can collaborate. If not for our Sustainable Infrastructure

Initiative, neither would have necessarily recognized this opportunity and its potential for optimizing city investments.

Each department has different ways of thinking about their needs for capital spending in "out" years. Some are very rigorous and some are not. This makes it very difficult for one City department to coordinate with another in a meaningful way. This means lost opportunities to leverage resources and minimize repeat visits to the same site.

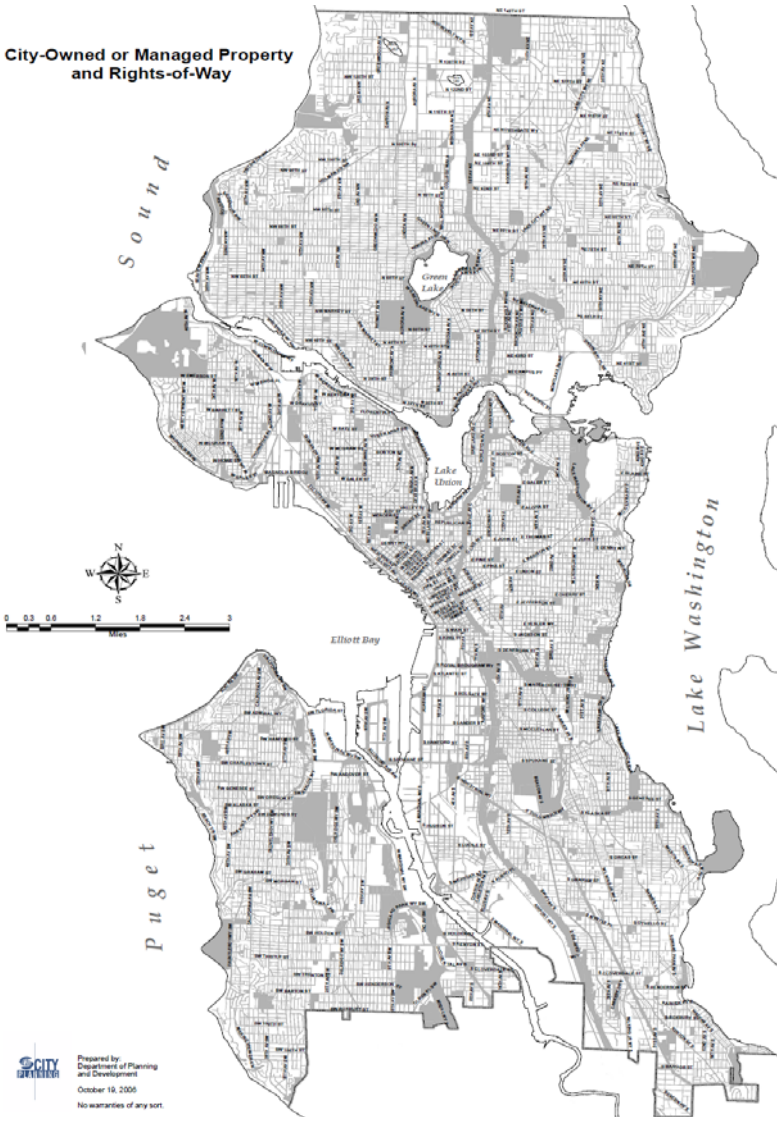

Figure 1 - Property Owned and Managed by the City of Seattle

Too often departments make capital planning decisions based on past practice rather than on a review of alternative approaches. Dollar savings or valuable benefits to the community can be missed. SPU alone has identified well over $100 million in savings by adopting asset management approaches that evaluate alternative approaches to meeting levels of service. How much could we save if we applied the same rigor to the city's $650 million annual capital budget?

Many capital departments in the city are recognizing the benefits of asset management, but prefer to develop their own system that may or may not mesh with citywide needs for information, collaboration, or value optimization in a holistic sense. Thus we add unnecessary costs and complexity in our tasks to monitor and track city spending. Also, different prioritization methods make it difficult for city leaders to prioritize between competing proposals, especially when competition for general fund dollars is fierce. As asset management principles are adopted by different City departments it will be important to make sure that these systems are compatible with a city-wide approach.

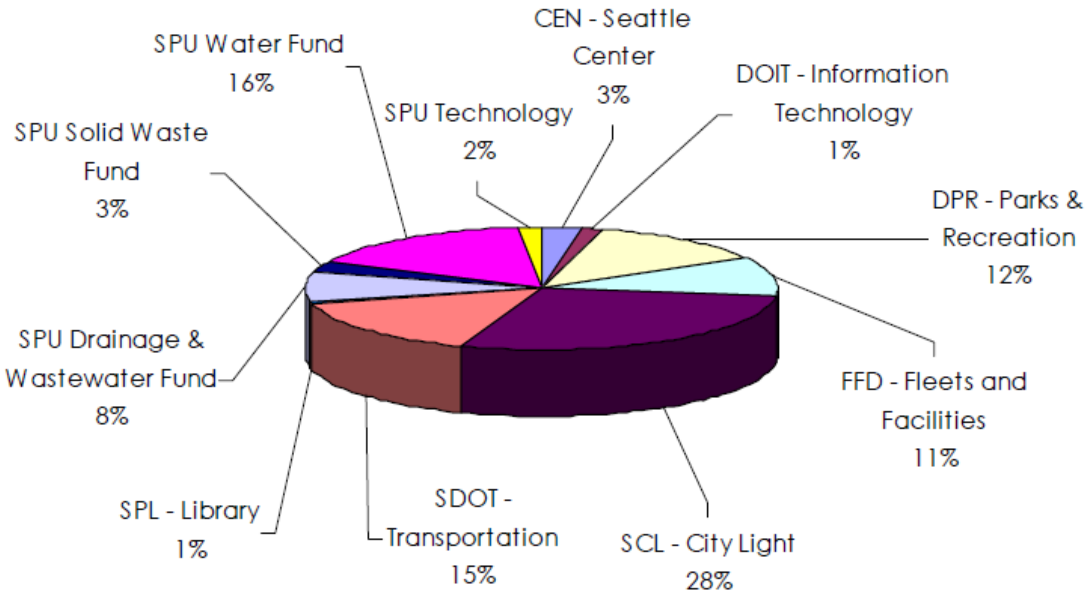

Figure 2 - 2007 Proposed Capital Improvement Budget, by Department

What are the barriers to a sustainable infrastructure approach?

There are numerous and reasonable barriers to collaboration and cooperation within the City family.

- Often times funding is constrained to very specific purposes, such as our enterprise funds that are limited to fairly narrow definitions of purposes.
- Sometimes there are grants that have very specific and limited uses.
- Other times, capital spending may be programmatic in nature such as “spot drainage” where it is difficult to predict more than a few days in advance of where the next project will be.
- And there are institutional issues where it is simply much easier to complete a project within the confines of one’s own department, given that departments may differ in their methods, priorities, and urgency to accomplish certain tasks.

To achieve a more coordinated, more environmentally-oriented approach to capital planning, we must face squarely the normal institutional frictions that confound collaboration between departments. Some departments seek to avoid thresholds for their projects that might require them to spend money on infrastructure improvements outside of their line of business. Other departments might “gold plate” requirements for repair or restoration of infrastructure disturbed during project construction. Such

issues drive up the cost of infrastructure work to a level that may have nothing to do with customer promises about level of service.

1.2 Definition of "Sustainable Infrastructure"

"Sustainable infrastructure is a decision-making framework for capital spending that links **asset management** to an interest in **green outcomes** and an understanding that the most effective capital investments may require us to **explore some non-traditional alternatives** and **integrate efforts across department silos and lines of business**."

Based on this definition, sustainability means many things – all involving the ability to sustain efficient delivery of city services over time

Financial Sustainability. Optimizing the value of capital dollars spent compounds the benefit year after year. The city gets more robust investments that provide multiple services. Money that might otherwise been spent in less optimal ways instead builds value upon value, creating a system that can better withstand economic downturn or a sudden shock due to natural or manmade disaster. This makes it more financially sustainable.

Natural Resource Sustainability. Sustainability also means investigating alternatives for capital spending that explicitly consider environmental and community impacts of that spending. This broadens traditional searches to identify and select alternatives that achieve an equal level of service but may also achieve better environmental and community outcomes.

What are important dimensions of the definition of Sustainable Infrastructure?

- Multi-media (integrated across resource types or lines of business)
- Full life cycle costs
- Whole city
- Systems thinking
- Public/public – public/private solutions
- Use existing flows of capital (follow the money)
- Use triple bottom line tools
- A conscious effort to consider solutions that are not limited by departmental silos and traditional approaches

The Sustainable Infrastructure Initiative being developed for the City of Seattle will be supported by new Department of Finance processes that are intended to:

- Promote cross-departmental cooperation on project development and implementation, and
- Ensure that asset management tools being developed by City departments remain compatible with the City's sustainable infrastructure approach to capital spending.

1.3 GOALS

City wide asset management is an approach that should be adopted with sustainability as an underpinning.

The intent of the Sustainable Infrastructure Initiative is to provide needed services in a more integrated, sustainable and cost effective manner. Asset management is a key aspect of a sustainable infrastructure approach and it can be used very effectively to lower costs of services. However, the overall intent of the initiative is to build on the creativity and experience of existing city staff, using their insights to identify where systems can be improved. To improve levels of service and better match the expectations and needs of our citizens, the Sustainable Infrastructure Initiative is seeking to engage knowledgeable staff to collaborate in overcoming barriers and improving sustainable outcomes to our work.

All capital departments should evaluate the benefit/costs of capital projects using appropriate methods including alternatives that achieve the same level of service.

The capital planning benefits from this more "sustainable" approach are both significant and varied. When pursued effectively, the targeted benefits of sustainable infrastructure planning include the following:

- It pays for itself over time (the aggregate value of services provided exceeds the cost). Sustainable infrastructure approaches do not eliminate any options, so it will only change current planning outcomes when it helps us identify a superior opportunity.
- It will help to restore environmental functions through greater reliance on natural systems/ecologies. Again, by more explicitly highlighting and accounting for environmental values – and costs – a sustainable approach will tend to lead to choices that capture these benefits (or avoid these costs) in ways that may not have occurred otherwise.
- It directly benefits the community by providing services, cultural diversity, open space, etc. These are other outcomes linked to some City infrastructure projects, whose values can also be incorporated in selection of appropriate projects or project alternatives.
- It benefits the economy by creating jobs, increasing opportunity, etc. A likely result of sustainable infrastructure will be a more diverse set of City projects. This may help emerging, green, decentralized, and local businesses of the future establish themselves.

Sustainability can also build community support

Our citizens want a more integrated and sustainable approach to how the City manages public lands in the City. This desire is demonstrated in many ways, from Seattle Open Space 2100 to Sustainable Seattle, from neighborhood councils and groups demanding open space, housing and transportation options to business interests identifying sustainability as a key regional core competency, from green infrastructure investments by City departments to City utilities implementing sustainable strategies for their line of business.

Many times community resistance to City capital projects is based upon the idea that greener or lower impact alternatives were not adopted or considered. Citizens may argue against auto parking in a park because of global warming, or wonder why we don't build sidewalks when we lower parking requirements in business districts. While spirited debate is an essential feature of city living, capital departments may be able to temper community angst if we do robust analysis of alternatives, attempt to accommodate community interests and concerns, and seek to maximize environmental benefit and increase community opportunities. Using asset management tools, the City will routinely evaluate full life cost of facilities as well as environmental and community costs.

Sustainability makes a healthier and more beautiful city

As we move aggressively to curb emissions for green house gasses and to improve water quality, we will also be building a healthier city. By controlling green house gasses we can also be diminishing smog-forming gasses that exacerbate health in the city.

What is the general capital planning approach that will help achieve these aims?

Adopt a "sustainable infrastructure" capital planning approach. Sustainable infrastructure is a decision-making framework for capital spending that links **asset management** to an interest in **green outcomes** and an understanding that the most effective capital investments may require us **to integrate efforts across department "silos" and lines of business**.

Sustainable Infrastructure:

- Links sustainability principles with asset management to bring the rigor of asset management to our green ambitions.
- Helps the City identify innovative solutions that transcend lines of business and departmental silos.
- Provides a decision-making framework for capital spending that maximizes the City's values of service levels and policy goals relative to life cycle-costs.

The Sustainable Infrastructure decision-making framework for capital spending includes:

- Consideration of economic, environmental and social concerns in assessments of project costs and benefits (the "Triple Bottom Line" approach),
- A thorough analysis of alternatives, and
- A conscious effort to consider solutions that are not limited by departmental silos and traditional approaches.

The Sustainable Infrastructure Initiative will:

- Promote cross-departmental cooperation on project development and implementation, and
- Ensure that asset management tools being developed by City departments remain compatible with the City's sustainable infrastructure approach to capital spending.

Even with existing constraints, the city regularly does coordinate and collaborate between departments. Some projects, like the viaduct replacement project, are so large that they demand collaboration. For these kinds of projects tools have been developed to assist in project delivery; Memoranda of Agreement are signed between department directors, interdepartmental teams are convened to monitor and coordinate response, and joint problem solving is typically arranged to minimize conflicts between different departments and their different timelines.

These large "mega-projects" give us a challenge. Can we make it an expectation that cross-departmental collaboration is a given? Can we create tools and processes that facilitate this coordinated approach? Can we lower the transaction costs to departmental coordination such that it is not a burden, but best practice to collaborate?

2 PLANNING PROCESS

In order to achieve the goals described above, the City should adopt a Sustainable Infrastructure capital planning approach. The Sustainable Infrastructure Initiative will:

- Promote cross-departmental cooperation on project development and implementation.
- Ensure that asset management tools being developed by City departments remain compatible with the City's sustainable infrastructure approach to capital spending.
- Promote consideration of economic, environmental and social concerns in assessments of project costs and benefits (the "Triple Bottom Line" approach).
- Link sustainability principles with asset management to bring the rigor of asset management to our green ambitions.
- Help the City thoroughly identify and evaluate alternatives, including innovative solutions that transcend lines of business and traditional approaches.
- Provide a decision-making framework for capital spending that maximizes the City's values of service levels and policy goals relative to life cycle-costs.

This report is intended to provide a conceptual model of how an ongoing Sustainable Infrastructure Planning Process could work to incorporate this approach.

2.1 TWO DIMENSIONAL APPROACH TO SUSTAINABLE INFRASTRUCTURE PLANNING

Since 2008 the City has been developing a Sustainable Infrastructure planning process which embraces both vertical and horizontal dimensions, diving more deeply into the true business needs of individual departments to identify innovative but previously unrecognized possibilities, while simultaneously developing a broader perspective that encompasses multiple lines of business.

2.1.1 DEEP PROGRAMMATIC REVIEW

Review business practices or programs for optimization, integration, and/or greener outcomes. This entails a thorough review of a particular task that requires city coordination and collaboration, such as

sidewalks or street trees. As we conduct this review we will identify areas where processes, communications, or funding categorization constrains achieving our best possible outcomes. Candidates might include street trees or ecological restoration projects. Deep Programmatic Review provides the vertical vision needed to look at all levels within a single line of business, and ensure that the permitting and investment decisions are in alignment with strategic goals.

2.1.2 Coordinated Capital Planning

Coordinate management of selected current projects to promote on time and budget delivery. For projects in out years, develop a strategic cross-departmental working group to identify opportunities for interdepartmental coordination and collaboration before solutions and timelines have been decided. Additionally, the Department of Finance will begin mapping capital spending projects to facilitate opportunities for collaboration and coordination between departments. Coordinated Capital Planning provides the horizontal vision needed to look across multiple lines of business and across time (3 to 5 year planning horizon).

2.2 Key Elements of Sustainable Infrastructure Planning Approach

The following key organizational elements will be needed in order to support this planning process:

2.2.1 Sustainable Infrastructure IDT

The Sustainable Infrastructure IDT will meet regularly to: review business practices or programs for optimization, integration, and/or greener outcomes; catalogue assumptions guiding current practice; brainstorm opportunities for coordination, integration and optimization; apply asset management evaluation methodologies with a city-wide perspective; and recommend program changes, if any.

2.2.2 Expert Teams

Expert teams will consist of a small group of experts who are very knowledgeable of departmental processes and priorities, but also have the ability to consider a city-wide perspective on projects. The teams would provide assistance to departments seeking integrated solutions within the sustainable infrastructure framework. For best results, the teams would be composed of “T-shaped” individuals – people who have expertise in a particular capital department’s line of business, combined with broad familiarity with issues across multiple lines of business. The teams could be composed of city staff or consultants selected by departments to represent their interests.

2.2.3 Asset Management Liaison

The liaison ensures that every asset management system has the capacity to coordinate consistent with sustainable infrastructure approach.

2.2.4 Budget Policy Guidelines and Training

Policy guidelines, to be included in Budget Instructions, will establish the expectation for cross departmental coordination and a robust assessment of sustainable/green alternatives.

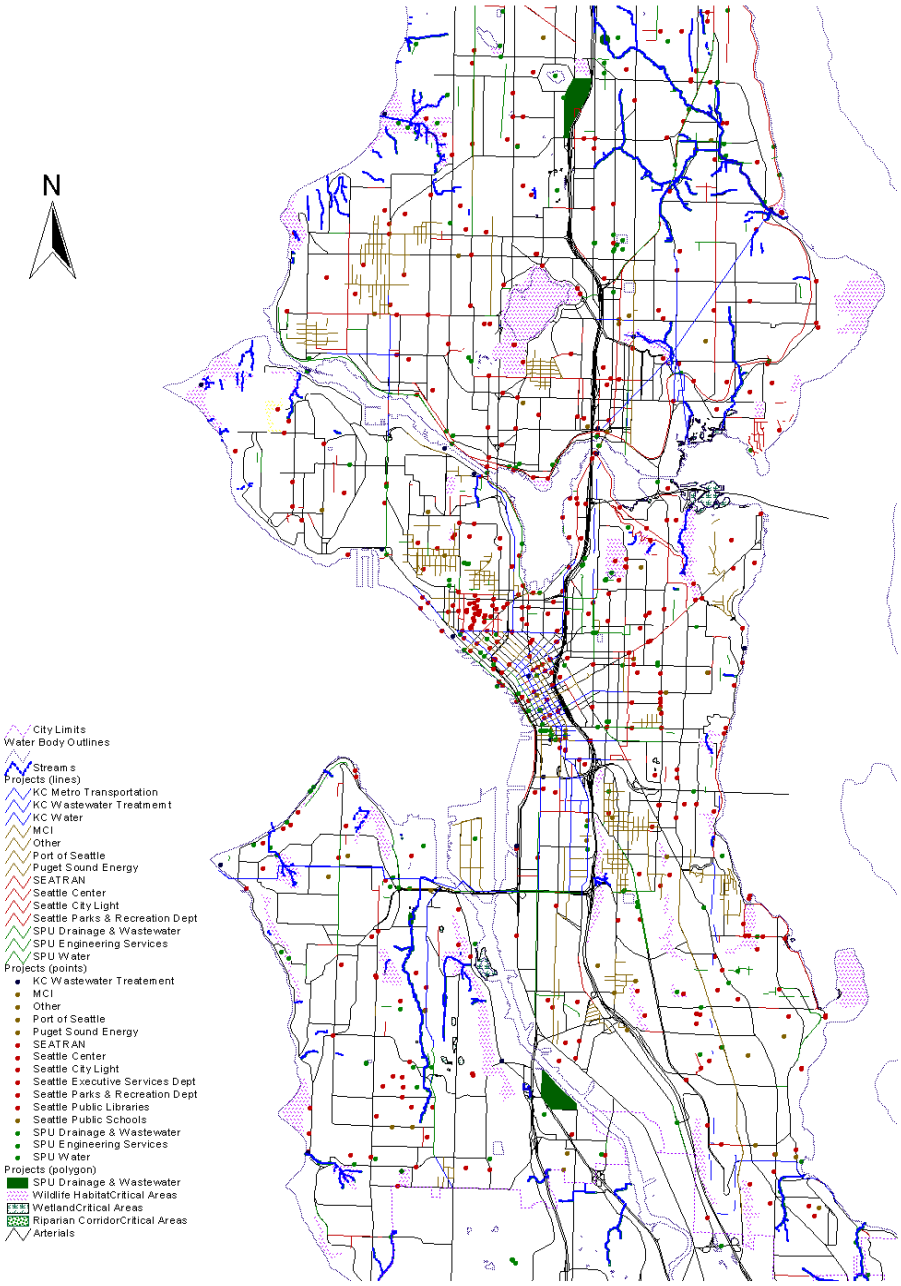

Figure 3 - Map of Projected Capital Improvement Projects

2.3 Sustainable Infrastructure Implementation Plan

Transitioning to a process that fully embraces a Sustainable Infrastructure Planning perspective will entail major cultural, institutional and procedural changes. This requires a significant shift in thinking, and is not a process that can happen overnight. It is more likely that this will take several budget cycles to actualize, and would occur over a four to six year period.

The Sustainable Infrastructure Planning model is currently being developed and considered for adoption by the City of Seattle. Using Seattle as a case study, we envision that early implementation of Sustainable Infrastructure Planning will follow the roadmap outlined below. The City of Seattle has completed the initial steps in this process, and will continue to refine this roadmap as implementation progresses.

2.3.1 Executive Briefings

Numerous briefings will be needed to inform key decision makers and garner early but-in of this process. Briefings should be occurring in parallel at two different levels:

Capital Cabinet: These briefings are for management and staff within Capital Cabinet, who may be taking on new roles in guiding sustainable infrastructure and asset management approaches. Briefings will review principles of sustainable infrastructure and essentials of asset management.

Each quarter expand one Capital Cabinet to two hours for a Coordinated Capital Strategy session.

- Q1 and Q3 will focus on SDOT, SCL and DPD
- Q2 and Q4 will focus on all other capital departments

Senior Staff: These briefings are for leadership within the Executive and Capital departments, who need to be knowledgeable of this emerging initiative. Briefings will outline major elements of larger briefings presented to Capital Cabinet on principles of sustainable infrastructure and essentials of asset management.

2.3.2 Data Gathering

GIS mapping tools can play a critical role in helping to identify where multiple departments are anticipating constructing capital projects in the same location over different time periods. Sustainable Infrastructure data gathering will work with the existing capital projects reporting systems to define processes for adding spatial and time-oriented information, as well as examining where standards may need to be developed to allow consistent sharing of GIS data across departments.

2.3.3 Training

Training is required at several levels for a sustainable infrastructure approach. In Year 1, members of the Sustainable Infrastructure Inter-departmental Team will work with SPU's successful training program and a consultant to develop a training program. This training must be cognizant of the fact that each capital department will have their own unique training for asset management. However, Executive department briefings will be held in Year 1 to bring leadership up to date on Sustainable Infrastructure Initiative elements and emerging issues.

Elements of Training for Analysts

- Analytical tool training – training analysts in development of alternatives
    - Recognition of direct and indirect costs
    - Use of total Life Cycle Analysis approach for cost-benefit accounting

- Use of Triple Bottom Line accounting practices

- Use elegant models that have the least complications necessary to solve problems consistently
- How and when to use which elements of what model
- Systemize to get consistently better answers than we do now
- Do not over-define problems
- Create consistent approaches to similar problems and use consistent values when analyzing them
- Locate analysts in-house

    - One in Finance (centralized experience)
    - One or more in each capital department

2.3.4 Preparation of Staff Materials

- Basic Sustainable Infrastructure materials – to be used in Year 1, to put departments on notice that in the next budget cycle projects will be evaluated based on Sustainable Infrastructure principles. This will alert departments that they should now begin thinking that way while planning.
- Policy Guidelines and Training – ready for roll-out to City capital planners in Q3 of Year 1 for use in budget decisions in Q3 of Year 2.
- Training for DOF Capital Analysts – this will inform DOF Capital Analysts so that by Q2 of Year 2 they are able to evaluate projects from a Sustainable Infrastructure perspective.

2.3.5 Silo Busting

Convene "silo buster" working groups, consisting of staff representing each capital department, to help design coordinated capital strategies for presentation to Capital Cabinet. Members will be strategic thinkers, identified by Department Directors. Hold working group meetings prior to each Coordinated Capital Strategy session.

Meeting 1: Focus on potential coordinated strategies

- What are the big issues in this area?
- What are we thinking we might do about it?
- Are there neighborhood strategies that have already been identified in the Bands of Green, or Seattle Open Space 2100, or Neighborhood plans that might be starting points for our discussion?
- What are some options that reflect our best integrated thinking that might be considered?

    - Multi-media (integrated across resources/lines of business/departments)
    - Capital-intensive versus O&M-intensive approaches
    - Centralized versus decentralized approaches
    - Dept-alone versus collaborative approaches
    - Traditional versus natural or green approaches
    - Supply enhancement versus demand

- City staff versus contracted performance of project development

Meeting 2: Focus on selecting and developing strong candidates

- Consider existing flows of capital (follow the money)
- Use triple bottom line tools
- Off-ramp: elimination of inferior alternative types and alternatives

2.3.6 Implement Pilot Projects

The focus of pilot projects must be on future problems, still within planning and scoping stages, where solutions are still adaptable. Previous efforts have worked with project manager, which means solutions and timelines had largely already been decided.

- Identify potential pilot projects that demonstrate benefits of Sustainable Infrastructure planning approach
- Develop business cases
- Assist in innovations
- Identify policy/regulatory barriers

Illustrative examples of real-world pilot projects for the City of Seattle, and alternative solutions to consider, are presented in Section 3.

2.3.7 Asset Management Involvement

Participate on asset management teams for all departments that are developing these systems. The goal is not to create uniform asset management systems throughout City, but instead to ensure that every asset management system in the City provides the basic information needed for Sustainable Infrastructure capital planning.

2.4 Analytical Tools and Methodology

2.4.1 Sustainable Infrastructure Analytical Hallmarks

To make a difference, the Sustainable Infrastructure design, review and analysis of capital projects must be sound and accessible, and its advances over previous practices must be clear. A few "hallmarks" help define in brief terms how it will work and what it will look like.

Simple Checklists – Project managers and Capital Improvement Project (CIP) staff will be better able to spot sustainable aspects of a project, and even sustainable projects and alternatives if they have one or more checklists that guide them through key characteristics to look for, such as inter-department synergies, environmental benefits and costs, and life-cycle cost implications.

Consistency – Systematize the capital planning approach to get consistently better answers than we do now. Create consistent approaches to similar problems and use consistent values when analyzing them, by sharing simple guides and a library of researched values for environmental impacts in particular.

Elegance – The framework presented for analysis and the steps used should be as simply structured as possible, while providing enough depth to address the issues that define "sustainable infrastructure" planning. There can be a tendency to apply complicated tools to too many projects and to over-define analysis. The Sustainable Infrastructure process should emphasize the use of the least complicated approach necessary to solve problems consistently, always including a basic minimum and adding special tools only when useful to support good decisions.

Analysis "Off-Ramps" – An important principle of sustainable infrastructure analysis will be the design and use of "off-ramps," that help staff identify unpromising alternatives and unnecessary analytical tools as early as possible, to avoid costly and wasteful work and time.

Support for Analysts – Provide both written "guidebook" and staff expert reference support, to help analysts answer: Here is how and when to use which elements of what model.

In-House City Capability – Analysts should be in-house staff, not contractors. Finance (centralized experience) should be the lead and central "clearinghouse" of both record-keeping and methodological support, and each capital department should have some level of dedicated staff assigned this responsibility.

2.4.2 Sustainable Infrastructure Analytical Guidelines

These hallmarks were broadened into a set of general "analytical procedure guidelines," which were discussed and accepted by an Interdisciplinary Team convened by the City to review Sustainable Infrastructure analysis:

1. Establish a standard checklist of project impacts or design features most likely to spawn synergistic opportunities. An inclusive list might include the following:

    - Building construction projects in an urban area
    - Any street surface disruption
    - Projects that are near streams or wetlands
    - Projects that use substantial amounts of water
    - Projects that generate heat as a by-product
    - Projects that produce ongoing vehicle emission impacts
    - Projects that are part of a transmission, collection or distribution system

2. Broaden the range of project alternative types that are consistently sought, to include a range of solutions to defined problems:

    - Both centralized and decentralized solutions
    - Both "green" or alternative, and traditional solutions
    - Both supply enhancement and demand management solutions
    - Both direct and indirect project design solutions
    - Both interdepartmental or public/private and department-only solutions

3. Subject innovative approaches to analysis; do not reject them unless they are shown to be inferior to other approaches. Avoid bias.

4. Identify and plan early for interdepartmental project alternatives. Assign staff responsibility for working on interdepartmental projects.

5. Focus the City's GIS capabilities on spotting co-location of different capital needs.

6. Establish a set of "early detection" capital planning procedures that consistently identify and produce sustainable solutions throughout the City.

7. Develop-checklists of environmental and social impacts common for municipal capital projects, together with shared information on tools, multipliers, etc. for quantifying those impacts.

8. Universalize the consistent use of environmental and social considerations in evaluation of capital alternatives ("Triple Bottom Line," or TBL).

9. Account for the impact of changing future conditions, such as those potentially accompanying continued global warming.

10. Broaden risk evaluation to identify capital alternatives that are most suitable for a wide variety of potential futures, including major natural and financial disasters.

11. Consistently apply Sustainable Infrastructure analysis tools to identify the best overall solution, independent of financial constraints. Then address the need for innovative financing, cost-sharing arrangements, etc., to translate the solution to a "win-win" outcome for City and private interests and for various involved City departments.

Several crucial guidelines are described further below.

2.4.3 Guidelines for Alternatives Definition

The IDT discussed general types of projects for which Sustainable Infrastructure planning was most likely to produce new alternatives or more efficient outcomes. These included the following general project types, which are listed along with some key sources of potential Sustainable Infrastructure planning benefits associated with each:

1. Urban Building Construction Projects: Major City capital programs have recently recognized the importance of coordinating City projects for stormwater control, transportation mobility, and environmental enhancement with the development of new construction projects. The Green Factor, the currently evolving CSO Plan, and Complete Streets are all examples of the benefits that may be available from coordinating City capital plans with private development.

2. Any Street Surface Disruption: Potential exists for multiple utilities' access and upgrades; there is also potential for stormwater-managing repaving.

3. Projects That Are Near Streams or Wetlands: These projects have the potential to reduce environmental impacts through project design and construction timing.

4. Projects That Use Substantial Amounts of Water: Potentially economical reuse of water is most likely to occur for these projects.

5. Projects That Generate Heat as a By-Product: These have the potential for capture and use for heating needs in the immediate area.

6. Projects That Produce Ongoing Vehicle Emission Impacts: Such projects have the potential to limit environmental greenhouse gas emission and health impact costs by limiting vehicle use; potential to select clean-fuel vehicles.

7. Projects That Are Part of a Utility Transmission, Collection or Distribution System: For these, the City might economize on pipe system costs and reduce water quality impacts, by selecting a mixed strategy including on-site contributions or conservation efforts.

Focusing on these project types may also be useful as part of a "filtering process" to more efficiently identify the most likely Sustainable Infrastructure planning candidates from within each department's full CIP listing. The departmental CIPs are very large for some departments, and quick filtering guidelines may allow planners and analysts to pursue the best Sustainable Infrastructure candidates without an undue search and analysis effort on each and every project.

An important component of Sustainable Infrastructure planning is expanding the search for alternative means of achieving a project's basic purpose. As described below, this can include both non-traditional techniques for addressing the basic project purpose and exploring multi-faceted alternatives that can address the original project purpose as well as other complementary purposes, either within the same department or from other departments or agencies. Some general rules that can help uncover new, more efficient alternatives are the following:

Seek both centralized and decentralized solutions. In recent years, utilities have looked harder at decentralized solutions to stormwater, CSO control, and energy generation requirements. Information regarding these alternatives is still relatively new, and identifying suitable decentralized alternatives for some services will require that project planners do more research than is required for traditional centralized alternatives' planning.

Seek both "green" alternatives and traditional solutions. Some so-called "green" alternatives emerge from considering ways to avoid environmental impacts of traditional solutions that range from paving with impervious materials to relying on fossil fuels rather than cleaner energy sources.

Consider both supply enhancement and demand management solutions. Energy conservation, water conservation and waste recycling are by now well-established alternatives for City capital planners. These types of alternatives should remain, while planners expand their demand-management alternatives search. Emerging or growing demand management approaches include such things as on-

site solutions for stormwater runoff, financial incentives to overcome obstacles to increased private initiatives, and street planning options that encourages shifts from SOV to other travel modes.

Try to define interdepartmental, public/private, and department-only solutions. The IDT discussed the "silo" approach, in which individual departments tend to focus on service requirements and solutions that can be managed within their respective departments. More efficient opportunities may be available if that constraint is loosened and departments actively seek solutions that involve coordinating schedules or uses of space, or even making choices of alternatives in one department that improves the performance or lowers the cost of alternatives within another department.

These perspectives were discussed by the IDT, with promising project examples identified for each. The group also included checking for capital-intensive versus O&M-intensive, and City-planned and managed versus privately planned, managed or constructed approaches as areas to consider in any alternatives screening process.

2.4.4 Triple Bottom Line Evaluation

The Sustainable Infrastructure capital planning approach expands on the asset management technique adopted by SPU in 2005. This is the "triple bottom line" approach, which folds environmental and social impacts into project review along with the normal financial considerations. As described in the SPU "Quick Start Guide to Project Development Plans:"

> *"The triple bottom line analysis differs from the typical financial analysis. A triple bottom line analysis considers all the benefits and costs accruing to the community as a whole. This means that values are assigned to benefits and costs that arise from non-market-priced sources. The triple bottom line considers all benefits and costs to be relevant, no matter to whom, or how, they accrue."*

This approach is different from the narrower financial impact approach, which focuses on the direct budget impacts to the City and its individual departments. It was recognized as particularly well-suited to the environmental and shared-impact issues that motivate much of the Sustainable Infrastructure approach.

Environmental Impacts Incorporated in Three-Phase Approach

Environmental and social impacts are important to project evaluation, but frequently they are difficult to describe in terms of dollars – which are the natural units for financial impacts. While the triple bottom line approach seeks dollar translations of these impacts whenever that is feasible and reasonable, the Sustainable Infrastructure approach recognizes that the impacts remain important even when they cannot be converted to equivalent dollars. The recommended approach is to address these impacts in three steps:

- List and describe the impacts at a minimum,
- Quantify them in some consistent physical units that work for all alternatives when that is possible, and

- Monetize them when that is possible, preferably using standard valuation units that have been developed by a pioneering department such as SPU or that may become a City-wide standard in the future.

It was recognized that environmental impacts are much more important for some project evaluations than for others; therefore environmental costs will be included with varying degrees of quantification, as determined by the specific impact. The important planning guideline is to consider them for every project, using impact checklists, etc., and to include them in alternatives comparisons and decisions to the extent that they are significant.

An important note: The research and evaluation costs of refining environmental cost estimates can be quite high. It is important to rely on secondary research and standardized multiplier values whenever possible. Some have been developed by departments (such as SPU) that encounter environmental impacts in project planning on a regular basis. Others may be developed as part of an established Sustainable Infrastructure planning effort. Planners should consider a significance threshold for quantitative analysis – that is, do an implicit Benefit:Cost evaluation of potential supporting analyses.

2.4.5 Life Cycle Cost

In conjunction with a triple bottom line evaluation, which includes multiple impacts and perspectives, Sustainable Infrastructure planning also aims to include a long-run focus through the use of life cycle cost analysis, in order to consider and anticipate impacts associated with project alternatives over their entire lives. This long-run focus also encourages consideration of the relative flexibility of various alternatives to adapt and perform their intended purpose in the changing environments that may emerge as a result of climate change, market transformation and other forces. Thus, a life cycle cost focus can improve both long-run economic efficiency and performance risk management.

A life cycle costs analysis is designed to encompass all associated costs, both direct and indirect, and all costs anticipated to be associated with a project alternative over its useful life. There are several major features of life cycle cost analysis that support that inclusive perspective.

Inclusion of All Project Phases and Costs. The broader range of alternatives that characterizes Sustainable Infrastructure planning heightens the importance of including the projected costs of all stages of a project's life. Competing alternatives may include some that are capital-intensive and some that are O&M-intensive, or some that are department-only and some that rely on public/private coordination or decentralized, privately owned facilities. Fair and thorough comparisons of such alternatives requires full inclusion of all costs, including initial capital cost, operating cost, routine maintenance and major maintenance costs, and periodic replacement costs. Risk costs for uncertain future events such as performance failure or private abandonment should also be included.

Use of "Full Cost Accounting." Another key feature of life cycle costs analysis is the use of "full-cost" accounting. This means inclusion of both the City's direct and indirect project costs, and specifically the inclusion in projects' initial year cost of the various allied overhead and administrative costs that are inevitably associated with project development. These include project planning, design, property acquisition, environmental review, permitting, contingency allowance, project management, and

closeout activities. These costs comprise a large portion of first-costs for many projects, and can vary among alternatives as a proportion of direct construction cost, so their full and consistent inclusion in the life cycle cost analysis is important.

Coverage of End-of-Life Costs. Many projects require specific handling at the end of their useful lives, with associated costs. These can range from decommissioning to demolition to disposal. End-of-life adjustments may also include revenues from salvage value for certain project assets. All of these should be part of the comparative analysis among alternatives.

Another part of the end-of-life focus is to ensure that comparisons among alternatives with different projected useful life cycles include credits for remaining life or costs for reinvestment in replacement assets, as appropriate. There are several techniques for making these adjustments, which are necessary to produce fair cost comparisons that support economically efficient decisions.

Net Present Value, with Benefit: Cost or Comparative Cost Analysis. Life cycle cost analyses include costs over a long planning period. It is important to combine these costs in the normal present value units already used by City departments. There are policy rationales for assuming a range of discount rates to make the present value calculations, and those choices – along with calculations using one or more discount rates – will be part of the overall City Sustainable Infrastructure process.

In addition to using discounted dollars and net present value, individual project evaluations may rely on either Benefit:Cost analysis or Comparative Cost analysis. If the benefits provided by each alternative are essentially the same, they can be evaluated based on their comparative costs. However, for many Sustainable Infrastructure candidate projects, there will be differing benefits among alternatives. In these cases, the evaluations will either use Benefit:Cost analysis, or "net out" the benefits of each alternative in expanded Comparative Cost analysis.

2.4.6 Guidelines for Sustainable Infrastructure Presentation "Packaging"

The information included in Sustainable Infrastructure presentations will be more diverse than the relatively straightforward information in a narrower financial analysis of capital projects. The subsections below describe briefly some of the key presentation requirements.

Global Benefit:Cost or Comparative Analysis

The linchpin of Sustainable Infrastructure evaluation presentations will be the all-inclusive triple bottom line results, including the life cycle cost analysis and all relevant environmental and social descriptive information. The tools listed in the preceding section indicate the nature and level of detail involved in producing those evaluations.

Sensitivity Analysis

In general, Sustainable Infrastructure projects and alternatives will be more complex than standard projects, and will involve more factors and assumptions. It will be important to recognize which assumptions are critical to the ranking of alternatives, whether because of their wide band of uncertainty or their significance as a proportion of composite project costs.

While there are some assumptions – such as real discount rate – that are standard candidates for sensitivity analysis, many will be project-specific. Results should include information on which variables assumed values may alter conclusions and which don't.

Perspectives/Departmental Impacts

The global impact should also be disaggregated to show the portions of the overall impact that will be borne or accrue to various agencies or groups. Some of the important perspectives to consider are these:

- Implementing Department
- Entire City government
- Other public agencies or private entities
- Seattle citizens
- Region
- Global

Projected Budget Impacts

From the City's perspective there are several important impacts. While the City seeks sound capital investment choices, it also considers separate capital and operating budget impacts, recognizing its debt position and borrowing constraints, as well as its revenue projections. As a result, project information on both is important to provide complete presentations.

> **Capital Budget Impact.** Both the six-year CIP period and longer term projected capital budget impacts are important. Sustainable Infrastructure planning specifically encompasses long-range impacts and opportunities, and produces information that will help the City anticipate long-range budget consequences.
>
> **Projected Operating Budget Impact.** Sustainable Infrastructure presentations should also provide information to anticipate ongoing budget commitments associated with each alternative. For example, if an alternative appears to have the lowest triple bottom line life cycle cost, but requires significant new maintenance and regular replacement activities to maintain the same level of service as other alternatives, that information and the future budget commitment inherent in that choice would be important features of the project presentation.

Financing Requirements and Potential Solutions

If the global life cycle cost analysis of a project alternative shows a positive net benefit relative to other alternatives, it would generally be the preferred choice. There may, however, be market conditions that produce both "winners" and "losers" from such a choice.

In those instances, it is important to describe the conditions that produce that outcome, and address and evaluate possible tools the City might use to modify the distribution of impacts. These might include negotiated inter-agency agreements, private incentive programs or City utility rate structures, as

well as other options. At this stage of the presentation, there may also be significant legal issues to explain, financial policy choices to point out that would be necessary components of an alternative's choice, or administrative burdens to describe (with costs) that would be involved in modifying the City's financial system or billing procedures to implement some potential tools.

3 Illustrative Sustainable Infrastructure Projects

Without detailed examples illustrating Sustainable Infrastructure planning concepts and their benefits, these concepts will not find traction with project planners. The first step in identifying a set of Sustainable Infrastructure pilot projects in Seattle involved a series of focused workshop discussions of specific projects that illustrate Sustainable Infrastructure opportunities and methods.

An initial list of illustrative projects was prepared to focus discussions of the Sustainable Infrastructure Interdepartmental Team (IDT). The list was designed to include projects from each of the City's major capital departments, with the intent being that they would also illustrate Sustainable Infrastructure themes, the foremost being:

- projects that would benefit from cross-departmental collaboration,
- projects for which promising non-traditional alternatives could be defined, and
- projects for which social or environmental impacts present a clear case for "triple bottom line" analysis.

Brief synopses of these projects were developed for and discussed with the IDT. These summaries were the starting point for the IDT discussions. Following a series of IDT workshops, the illustrative project list was modified – with some projects dropped and others added – resulting in a more refined list of consensus pilot project candidates, which were subsequently examined and discussed in more detail.

In most cases, these candidate projects reflected existing City initiatives for which some amount of work had been done, since that extra definition made it more practical to use these projects to examine and illustrate the Sustainable Infrastructure opportunities that might be available. This approach, however, also meant that some projects were already proceeding with limited or no regard for the opportunity to consider alternatives through the Sustainable Infrastructure lens. The IDT recognized that there is an inherent timing challenge when identifying appropriate illustrative pilot projects. An ideal pilot project should be far enough along in its deployment to demonstrate how this approach works in detail, but that goes against the fundamental requirement of early involvement necessary to allow sufficient opportunity to freely explore both traditional and less obvious alternatives. As a result, the more specific projects discussed in this report are not necessarily likely to ultimately adopt Sustainable Infrastructure solutions.

Based on a combination of factors, including Sustainable Infrastructure features, available information, and the stage of project development, the candidate list of potential illustrative projects was sorted into three categories:

Recommended projects

These projects are the ones that appeared to be the most viable in terms of funding, stakeholder interest, and potential to demonstrate Sustainable Infrastructure concepts, and were subject to more detailed examination and structured development along the lines defined for Sustainable Infrastructure projects.

Projects recommended for further consideration

This section outlines future projects that could benefit from a Sustainable Infrastructure approach. These projects are promising, but they either have a longer planning horizon or have not yet been vetted with all of the interested stakeholders. Some are large capital projects already in planning, while others are examples of small projects that may come up with shorter notice.

Projects dropped as Sustainable Infrastructure demonstrations

Though these project concepts are useful for illustrating the potential of Sustainable Infrastructure analytics, they were dropped for a variety of reasons prior to detailed examination. In some cases early analysis suggested that they were technically infeasible, and in others it became clear that the opportunities for interdepartmental collaboration were limited.

Of these three categories, the recommended projects have been analyzed in greater detail, and their documentation is accordingly more detailed. In this report, dropped and recommended projects are treated with varying degrees of detail, since some were eliminated early and others went through several levels of discussion.

3.1 Recommended Projects

Three projects were recommended for more detailed development as Sustainable Infrastructure Pilot Projects. These are: a) the Linden Avenue Redevelopment, b) the Seattle Center/Lake Union Stormwater Swap, and c) the South Waterfront Shore Power Conversion.

In the sections below, each of these has been outlined in detail, along with short narrative descriptions of selected steps, to highlight the problem statements, the conditions that produce sustainable infrastructure planning opportunities, the nature and range of the benefits and costs that are pertinent to a sustainable infrastructure project review, and the types of issues and analytical tools that come into play for specific projects. Together, these comprise the key elements of Sustainable Infrastructure project reviews of the three projects.

3.1.1 Linden Avenue Redevelopment

a) Problem Statement

Linden Avenue North is a 3,500-foot stretch of street in north Seattle that runs parallel to Aurora Avenue and has termini at 128th and 145th. Linden Avenue currently has below standard street infrastructure with a degraded road surface, sidewalks that are incomplete or difficult to

navigate, and an overloaded sewer and drainage system. Significant residential and commercial growth is anticipated along the corridor and in the Bitter Lake Village. Capital improvements on the street have become a priority for residents, the Mayor and City Council, and will require coordinated investments from SDOT, SPU and SCL.

The project purpose is to define and implement a comprehensive roadway and sidewalk mobility upgrade solution for Linden Avenue, considering life cycle costs and benefits of roadway, parking and sidewalk design and timing alternatives, near-term and long-term utility requirements in the corridor, and recognizing the unique plans for and non-motorized uses of Linden Avenue.

b) Project Opportunity, History and Stage as a Sustainable Infrastructure Project

Members of the Broadview Bitter Lake neighborhood area have been organized for over ten years to improve the Linden Avenue corridor. The 1999 neighborhood plan adopted by the City Council called for sidewalks, repaving, bicycle lanes and vegetated swales for storm water control. SDOT prepared a plan for a traditional arterial with concrete sidewalks, two travel lanes, parking lanes, piped drainage and a two way left turn lane. Grant funding was sought but never received to build the project. Ten years later the community is faced with significant recent and anticipated growth and the same list of infrastructure needs.

In 2007, Linden was identified as a potential Sustainable Infrastructure project. Up until this time, the City had only offered two alternatives - build Linden the standard way or don't build it at all. Sustainable infrastructure made sense for Linden, as it looks at multiple alternatives including non-standard approaches to meet defined levels of service. In particular, Sustainable Infrastructure seeks to optimize city processes through i) better integration across lines of business; ii) enhanced collaboration between departments; iii) additional rigor to alternatives' generation and analysis; and iv) recognition of the role of public property including rights-of-ways, parks, and other city lands to provide an array of sustainability and livability benefits. A successful Linden project would involve significant collaboration and coordination between SDOT, SPU, SCL, Parks, and City Design.

c) Alternatives/Components

The Linden Avenue corridor includes public facilities ranging from streets and sidewalks to a full range of utilities. All will need upgrading in the future, with the design, timing, level of service, and coordination among these city services all being variables in the upgrade scenario. The main alternatives explored for this pilot project were defined in terms of the transportation elements, but the efficiencies available through coordination with utility service expansion investments were an important dimension of each alternative. Alternatives defined during the City team review, along with potential "add-on" urban design features, included the following:

- Do nothing
- City-standard complete streets project, including concrete sidewalks

- Full corridor planned development, including City Light and SPU service upgrades and long-term service installations/reservations
- Infill sidewalk construction only (no street replacement elements)
- Full corridor sidewalks only
    - Maximum City standard
    - Cheaper sidewalk construction (self mitigating at a minimum)
    - Walking pathways
        - Asphalt
        - Gravel
- Add-on elements
    - Bike-only sharrows on existing street surface
    - Recreational trails
    - Trails with pedestrian/bike separation
    - Trails without pedestrian/bike separation
    - Local shuttle service for elderly residents
    - Landscape plantings
    - Local nursery project
    - Incremental landscaping
    - Programmed events (with design to support them)

d) Key Benefits

A comprehensive street corridor reconstruction produces significant benefits, particularly in automobile traffic flow, mobility, parking and safety. Those benefits would be realized from any alternative, although they would be deferred in the "do-nothing" alternative. Other benefits would be associated more closely with the integrated alternatives designed according to Sustainable Infrastructure principles. These include avoided future costs, earlier pedestrian mobility and safety improvements, and water quality and amenity values. The benefits that would be most enhanced by Sustainable Planning are highlighted in bold and italics below.

- Improved auto mobility
- ***Improved pedestrian mobility***
- ***Improved pedestrian safety***
- Improved bicycle corridor connectivity/use/safety
- ***Avoidance of future electric transmission line relocation***
- ***Avoidance of damage to new street surfaces from future SPU utility upgrades***
- Provision of street amenities
- ***Improved water quality from naturally filtered runoff***
- ***Amenity value of boulevards, planting strips and natural drainage systems***
- Environmental value of view improvements through electric wire undergrounding

e) Key Costs

As with benefits, there would be major costs associated with any comprehensive street corridor reconstruction alternative on Linden Avenue. Other costs would be associated with the integrated alternatives designed according to Sustainable Infrastructure principles. These include accelerated future costs for earlier pedestrian mobility facilities and utility facility installation, possibly an incremental cost for the stormwater facilities that deliver water quality improvements, and costs of streetscape amenities. The costs that would be most affected by Sustainable Planning are highlighted in bold and italics below.

- Complete Street reconstruction
- Power line undergrounding
- ***Increased lineal feet of sidewalk installation***
- ***Accelerated sidewalk installation***
- ***Accelerated utility installation***
- ***Accelerated electricity transmission line relocation***
- ***Possible cost increment for natural drainage system installation***

f) Interdepartmental Elements and Potential Efficiencies

The Linden Avenue project involves investments from several City departments, and its Sustainable Infrastructure benefits are linked in large measure to the opportunities available from coordinating their design and timing.

- **SDOT** – Building street surfaces, creating parking spaces, traffic control & turn lanes, bike lanes, and installing power pole bulbs and sidewalks
- **SCL** – Moving 1st transmission line from west to east side, designing a route for a 2nd transmission line, installing distribution poles, and potentially under-grounding wires
- **SPU** water – replacing and upgrading potable water line in street right-of-way
- **SPU** sewer – replacing and upgrading sewer line in street right-of-way
- **SPU** drainage – installing drainage flow control facilities, either though new pipes or with natural drainage
- **DPD** – applying zoning requirements, and coordinating growth and development information with other City departments
- **Project element sequencing** – some needs have less flexible siting requirements and need to be defined first; others can be developed more cheaply if scheduled around activities of another department

g) Inter-Agency Coordination and Financing Complexities

N/A

h) Key Parameters and Information Needs for Sustainability and Triple Bottom Line Analyses

This project involves both extensive opportunities for coordinating multiple city service investments, and alternative approaches or timing for individual project elements. Consequently, the key information needs to include details on both.

For coordination of the various services involved, the most important information concerns the spatial needs of the various transportation system elements and of the electricity transmission lines (including set-back requirements). Also important for service investment coordination is the timing sequence of the various service components and their impacts on the choices for the remaining components.

For evaluation of alternative approaches to individual project elements, in addition to their space needs implications, it is important to define level of service options (e.g., sidewalk materials/design), the cost of constructing now versus waiting as long as possible (e.g., water and sewer line upgrades), and the cost of feasible alternatives for meeting the same service needs (e.g., stormwater pipes versus natural drainage systems). A partial listing of key parameters and information needs follows.

- Complete feasible transportation layout alternatives within corridor area
- Projected need and timing of SPU sewer collection system upgrades
- Projected need and timing of SPU water distribution system upgrades
- Comparative costs of sewer and water system installations as part of street upgrades and as retrofit projects
- Cost, runoff management potential, and space requirements of SPU bio-installations in the Linden corridor
- Projected need and timing of SCL transmission corridor upgrades
- Space and set-back requirements of projected SCL transmission and distribution system upgrades
- Comparative costs of overhead and underground SCL power lines
- Comparative costs and timing of development-provided sidewalk installations versus SDOT infill sidewalks with alternative pavement (e.g., concrete, asphalt, permeable paving)
- Projected population and associated pedestrian mobility requirements for the Linden corridor

i) Analytical Techniques

This project requires a mix of basic economic calculation methods. Some improvements will be made over time in the area even in the base case, possibly on a piecemeal basis. That suggests that some components of alternatives can be evaluated with a comparative cost approach rather than a benefit cost approach, since level of service standards exist for both transportation/mobility and utility facility elements. Other discretionary elements such as amenity improvements can best be evaluated with a triple bottom line benefit cost analysis, recognizing that quantification of some benefits may require judgmental assessments.

Other significant elements of the analysis of this project include the following:

- **Life Cycle Cost Analysis, with a long-run perspective** – Comparisons of sidewalk surfacing options, drainage options and transmission line siting options all require life-cycle cost analysis. The life cycle cost analysis period should be sufficiently long to reflect SCL distant

future transmission needs that may require planning now to prevent costly relocation later; also, several options include different capital-versus-operating cost schedules whose evaluation requires a long-run perspective.

- **Level of service reconsideration** – The city sidewalk design requirements may ensure that no continuous sidewalks will be completed for decades in the Linden corridor. Consideration of possible lower-cost options that could accelerate this completion can be done with separate benefit-cost analysis.
- **Constrained optimization** – The project's space utilization and service locations will require staff coordination among departments. Specifically, space limitations in the right-of-way will require the design of alternative roadway width allocations relaxing various level-of-service constraints.
- **Service sequencing for alternative development** – As alternatives are developed, they will require that the designs recognize certain sequencing constraints. Specifically, SCL transmission line corridor requirements, including set-backs, should be considered first. Then, SPU natural drainage system alternatives' locations should be defined, given minimum roadway space requirements. Then the range of feasible locations for alternative sets of traffic and pedestrian components can be defined.
- **Sensitivity analysis** – For this project, several variables should be examined with sensitivity analysis to determine the effect of alternative assumptions on the overall triple bottom line economics of the alternatives. These include the timing of future second transmission line needs, the timing of SPU water and sewer line upgrades, and the cost of transmission lines. Other standard sensitivity analysis such as those involving alternative discount rates should also be performed.

j) Sources of Input Values

City departments:

- SDOT
- SPU
- SCL
- DPD

k) Major Sustainable Infrastructure issues

This project would benefit from evaluation according to the sustainable infrastructure principles for several reasons. Project features that make it an attractive candidate for this approach include the following:

- The need for creative alternatives – tailoring transportation layouts to space constraints, including corridor width variations and need to choose among alternative exceptions to various transportation components such as parking, planting strips, two-way left-turn lanes, bicycle lanes, etc.
- The need for inter-departmental service design coordination
- Dependence on interdepartmental capital construction sequencing

- Consideration of deviating from current level of service standards, in particular complete streets and sidewalk construction standards
- The presence of environmental and amenity benefit opportunities

l) Decision

The City dropped the omnibus Linden Avenue project from consideration in April. It cited the high cost compared to financial constraints, as well as problems in assembling land to support the most favored layout for multi-service corridor development and the need for more detailed analytical support for a project of this financial magnitude.

m) Retrospective on "Lessons Learned"

Key lessons learned include:

- The value of early coordination among departments,
- The need to maintain communication among divisions within each department,
- The need to establish a process and assign staff early enough to support full development of information on complex projects,
- The importance of considering service constraints imposed by level-of-service standards,
- The importance of a process that maintains a voice for projects independent of any single department's position.

3.1.2 Seattle Center Water Swap

a) Problem Statement

Develop a stormwater management strategy for the Seattle Center acreage as part of the comprehensive Center capital plan, considering the potential efficiencies of coordinating on-site strategy elements with optimal use of CSO facilities in the area and needs to manage stormwater flows from other major pollution-generating streets and highways draining into the same basin.

b) Project Opportunity, History and Stage as a Sustainable Infrastructure Project

Stormwater runoff in the South Lake Union area drains to the lake, carrying toxic contaminants such as polyaromatic hydrocarbons and heavy metals. Direct alternatives include discharging flows into the lake and treating them in a facility prior to their release. In the same general area, King County has a line around Lake Union that carries combined flows to the West Point treatment facility. A significant portion of the flow in that line is relatively clean runoff from Seattle Center.

There may be an opportunity to substitute some of the more contaminated stormwater flows for equivalent Seattle Center flows, reducing the amount treated and discharged to Lake Union, and possibly directing some Seattle Center flows to attractive or ecological water features in the area. By removing a large volume of the relatively clean Seattle Center water that enters the CSO downstream and introducing a smaller amount of contaminated surface water upstream,

we would a) keep much of the PAHs and metals from road runoff out of the lake, b) decrease the volume of water discharged through the CSOs, and c) reduce the volume of water to be treated by King County.

The project's history began in 2007-08 as a "brainstorming" idea, and has evolved into its current status as a promising feature of the current Seattle Center planning effort.

c) Alternatives

In a larger context, this project focuses on one of the overall options for Seattle Center redevelopment. Several of these do not involve a stormwater management/water feature emphasis. This project in effect constitutes consideration of alternatives one or which could then become an alternative within the larger Seattle Center redevelopment plan selection process.

Seven on-site stormwater capture or reduction measures have been identified and discussed with Seattle Center. A composite on-site strategy could combine any of a wide variety of combinations of these measures. Whatever composite on-site strategy is selected could then be coupled with a stormwater swap with flows from city surface streets.

On-Site Measures

- No action, with respect to stormwater issues
- Targeted percentage reduction in Seattle Center runoff (up to 100%), through one or more of:

    - On-site wastewater treatment
    - Water features, such as "Enviro-Lakes"
    - Evaporation-promoting water features
    - Green roofs
    - Toilet flushing recirculation
    - Building cooling use
    - Infiltration features

and

Off-Site Swap Components. Replace Seattle Center flows into the Dexter Avenue CSO Interceptor with stormwater from north downtown.

Some refinement and possibly reduction in number of these on-site alternatives would be a valuable next step in what otherwise may be too amorphous a project.

d) Key Benefits

The Seattle Center comprehensive Plan alternatives will all address wastewater and stormwater flow management requirements. These will produce significant benefits. Some Plan alternatives also include water feature amenities. Other benefits would be associated more closely with the

integrated alternatives designed according to Sustainable Infrastructure principles. These could include deferred future costs of wastewater and stormwater conveyance, reduced CSO volumes, improvements to Lake Union water quality, and Seattle Center on-site amenity values. The benefits that would be most enhanced by Sustainable Planning are highlighted in bold and italics below.

- ***Environmental values –improved Lake Union water quality, in excess of that resulting from simply meeting minimum regulatory standards***
- Amenity values – Some of the Seattle Center water flow control measures could have significant amenity value as a side benefit
- ***Reduced potable water use at Seattle Center***
- Reduction in CSO volume and frequency
- ***Recaptured carrying capacity in King County's Dexter Avenue CSO***

e) Key Costs

The costs of on-site water capture projects depends on the nature and condition of the existing facilities, since that determines what repairs, improvements and additions would be needed to collect, hold or apply stormwater under the various potential measures.

- New drainage connections
- New combined system conveyance connections
- New on-site plumbing installations at Seattle Center
- New water features at Seattle Center

f) Interdepartmental Elements and Potential Efficiencies

The Seattle Center redevelopment alternatives that include special consideration of drainage, water recirculation and the installation of water features involve benefits and costs that are dependent on the impacts on the utilities serving the Center. Determining the magnitude of potential benefits available from such features and the flow impacts required to generate different levels of benefit involves detailed cooperation between departments.

- **Seattle Center** – Comprehensive Plan water feature, stormwater management and water recirculation facilities
- **King County/SPU Drainage** – Existing system capacity planning, drainage system work associated with the Seattle Center redevelopment and the King County CSO reduction program

g) Inter-Agency Coordination and Financing Complexities

The project's benefits would require coordinating design and flow direction with other involved agencies.

- King County Wastewater Treatment Division – The County must agree to terms that would control or neutralize the impact of any flow changes on the County's treatment and

conveyance system needs. There may also be economic benefits to the County that could be part of an overall agreement.

- Washington DOE – Revisions to the flow direction may require interaction with and approval from the state regulatory authority.

h) Key Parameters and Information Needs for Sustainability and Triple Bottom Line Analyses

This project would require coordination among multiple city departments and King County to realize the sustainable alternative. It would also rely on alternative approaches for some stormwater flow management and Seattle Center design project elements. Consequently, the key information needs include details on both.

For coordination of the various departments and agencies, the most important information concerns the impact of the "swap" on King County's system flows and the timing of Seattle Center improvements.

For evaluation of alternative approaches to stormwater flow management, it is important to define the cost of feasible alternatives for meeting the same service needs (e.g., stormwater pipes versus re-programmed on-site facilities, natural drainage systems, and dual-purpose water features), and the amenity values of alternative design options that could accompany these alternative approaches. A partial listing of key parameters and information needs follows.

- Runoff distribution from Seattle Center and its sub-areas
- Detailed definition of various Seattle Center flow management, detention and reuse options
- Flow reduction impacts of each measure being evaluated for inclusion in a composite strategy
- Cost of the various candidate elements of a potential mix of existing Seattle Center facility modifications and new facility construction required
- Design features that could be either pursued or improved through use of on-site flow management options
- On-site irrigation needs projection
- Runoff distribution for blocks whose runoff flows could be redirected to replace Seattle Center flows in the combined system
- Timing of Seattle Center improvements
- Chemical content of Seattle Center peak and off-peak runoff

i) Analytical Techniques

The basic economic analysis of the swap will require triple bottom line benefit cost analysis. The "Do Nothing" alternative is viable, so other alternatives can be measured according to their net benefits relative to that case.

Other significant elements of the analysis of this project include the following:

- **Life Cycle Cost Analysis with a long-run perspective** – This project will require life cycle cost analysis over a sufficiently long period to capture anticipated saturation flows to existing CSO system and treatment system facilities.
- **Specialized cost estimation** – There are several possible non-standard components of an on-site stormwater management system that will require special cost estimation. These include unique options such as the reprogramming of existing storage tanks.
- **Developing "win-win" planning and financial arrangements** – Independent action by Seattle and King County is not likely to accomplish some potential beneficial outcomes. If both agencies were involved from the outset, the range of solutions that would at least hold each agency harmless may be more limited than the global solution set. The global optimum may require some compensation flow between the agencies. The analysis can identify the overall optimum, determine the financial impacts on each agency under current decision-making roles, and then determine the parameters for cost-sharing or flow redirection limits that are necessary to ensure net beneficial outcomes to both parties.
- **Sensitivity analysis** – There are several key areas of uncertainty for this project, the impacts of which can be estimated with sensitivity analysis. These include: i) levels of flows generated on the Seattle Center site and its sub-areas, ii) flow reduction impacts of each measure being evaluated for inclusion in a composite strategy, iii) costs of the ad hoc mix of existing facility modifications and new facility construction required, and iv) pollutant loadings of each separate source of stormwater that may be involved in the swap. When the basic project analysis has been completed, it will be possible to plug in alternative assumptions for these sensitivity analysis variables.

j) Sources of Input Values

City departments:

- Seattle Center
- SDOT
- SPU

- A substantial number of input requirements have been defined for this project. They include general descriptions of flow quantities, area-specific flow capture options, and pollutant information for source flows that could potentially be swapped. Cost information would also need to be developed for project elements managed by Seattle Center, SPU and SDOT.
- Other needed information includes Seattle Center drainage and wastewater bills and water usage. The reduction in any of these depends on the flow capture available from the various on-site measures. Physical descriptions of the existing facilities, can allow for modeling the flow impacts of measures.
- Generic pollutant loading information may be available from SPU.

k) Major Sustainable Infrastructure issues

This project would benefit from evaluation according to the sustainable infrastructure principles for several reasons. Project features that make it an attractive candidate for this approach include the following:

- The need for creative alternatives definition – No agency's service planning requires action for which this alternative might emerge. Adequate, but sub-optimal solutions are in place to deal with area surface runoff flows and Seattle Center flows.
- The need for inter-agency service design coordination
- The need for inter-agency cost sharing agreement
- Recognizing the opportunity inherent in Seattle Center water features that can double as campus visual amenities and stormwater management facilities.
- The potential for net benefits from exceeding water quality minimum requirements in Lake Union or achieving overflow reduction targets earlier than required in an efficient way while pursuing Seattle Center comprehensive redesign and construction.

l) Next Steps

- Evaluation. This step has not been begun. It depends on assembling the information described above. However, it is possible to design the analytical model, into which we can then insert data and assumptions as they are developed.

3.1.3 South Waterfront Shore Power

a) Problem Statement

Address anticipated and potential additions in demand for electricity for "Cold Iron" shore power service needs from ships docked at the Port's facilities on the South Seattle Waterfront. Determine the "Triple Bottom Line" least-cost strategy, considering life cycle costs of alternatively scheduled shore power capacity additions and the positive environmental and health impacts of the service. Identify a coordinated multi-agency, and possibly multi-city strategy that could increase aggregate net benefits and improve the likelihood of a cooperative effort among involved parties.

b) Project Opportunity, History and Stage as a Sustainable Infrastructure Project

Container ships run diesel engines to provide power while docked at Port of Seattle facilities on the south waterfront. The emissions cause significant levels of air pollution, which the Puget Sound Clean Air Agency has suggested could be reduced or eliminated by connecting the docked vessels to the SCL grid. If SCL chooses to respond to this suggestion, it has a range of possible strategies to consider.

Transferring ship demands onto the electrical grid introduces opportunities for a set of alternatives to the current practice. For example, a traditional response may be to acquire additional power supply and substation capacity to serve the added demand. A more imaginative response could be to coordinate City efforts within the area served by the current

SCL south waterfront substation, so that development guidelines within the substation service area include sufficient energy efficiency features to offset some or all of the added ship demands, possibly including energy allowance swaps within new developments in the area.

The project's sustainable infrastructure history began in 2007-08 as a "brainstorming" idea, followed by initial conversations involving Seattle City Light staff. Research indicated that at least some aspects of the project had been included in a Port of Seattle 2005 study, and other aspects in a more general demand management investigation by Seattle City Light staff.

c) Alternatives

Four alternatives have been defined, all addressing ship power requirements, and ranging from "do nothing" to full expansion of on-shore power supply capacity provided by SCL through the Port of Seattle (see attachment).

Among these, the two incremental alternatives will require refinement as analysis progresses.

- No "Cold Iron" service from SCL; continued reliance on on-board diesel power.
- Incremental Cold Iron service over time; adopt a passive strategy, in which SCL responds to Port demands, based in turn on shippers' conversion plans and consequent shore power demands.
- Accelerated incremental Cold Iron service, with the City, the Port and SCL collaborating with other West Coast cities, Ports and electric utilities to expand availability of on-shore electrical service and fleet capacity to substitute electricity for on-board diesel-fueled power supply.
- Full Cold Iron service capacity and maximum hookup in the near term.

d) Key Benefits

This project has a perfectly viable "do-nothing" alternative. Thus, <u>all</u> project benefits associated with the other alternatives designed according to Sustainable Infrastructure principles are incremental. These include avoided diesel fuel costs, and improvements to air quality, water quality and the health of the area population. The benefit listing, including potentially accelerated timing of most, includes the following:

- Avoided diesel fuel costs
- Reduced health costs through pollution reduction
- Water quality improvements in Puget Sound through reduced diesel emission deposition
- Greenhouse gas environmental cost savings through reduced air pollution
- Their timing is an important variable, and more importantly, they must be quantified.
- A crucial element of this project, from a Sustainable Infrastructure perspective, is the potential efficiencies to be gained by expanding the numbers of ships with on-board hookups and the number of ports with on-shore hookups. This is where the economies of scale would occur.

e) Key Costs

Since this project has a perfectly viable "do-nothing" alternative, all project costs associated with the other alternatives designed according to Sustainable Infrastructure principles are also incremental. These include electricity supply costs, and the cost of electrical connections on both the ships and the shore facilities. The cost listing, including potentially accelerated timing of most, includes the following:

- On-shore electrical hookup installations
- On-board electrical conversions
- Seattle City Light may be required to add substation capacity

f) Interdepartmental Elements and Potential Efficiencies

Most of the inter-agency complexities of this project are between the City and other governmental or private entities. However, for certain potential elements of the project, coordination between the regulatory role of DPD and the power planning activities of City Light would be important.

- **SCL** – Installation of power supply facilities for ships, possible expansion or acceleration of substation capacity, and special contractual service arrangements with major area customers
- **DPD** – Regulatory agency capacity to adopt neighborhood development energy budget regulations involved in a broad area energy demand management strategy

g) Inter-Agency Coordination and Financing Complexities

The "parties potentially involved" have been identified. The general nature of their involvement has also been defined.

- City of Seattle – Electrical service provider, offering alternative to diesel power
- Port – service provider, partially controlling demand and any financial mitigation terms required
- Steamship Lines – point-of-service customer, whose agreement to terms will be required
- PSCAA – possible coordinator, officially representing air quality interests
- State – technical support agency, involved in 3rd party health benefit verification
- Seahawks/Qwest Field – major, complementary electricity customer, whose game day demands or exceptions may be involved
- Mariners/Safeco Field – major, complementary electricity customer, whose game day demands or exceptions may be involved

A key feature of this project from a Sustainable Infrastructure perspective is how the roles of these various parties can be defined and coordinated to produce a successful outcome. That needs attention in the near term.

h) Key Parameters and Information Needs for Sustainability and Triple Bottom Line Analyses

The capital installation impact of this project is clear – the addition of on-shore electrical hookups suitable for container ships on the south waterfront. However, defining and achieving the sustainable benefit and cost outcomes of the project would require coordination among the city, other agencies, and private entities.

The scale of the impacts depends on the traffic of ships docking in the area, the proportion of those ships that has electrical hookup capabilities, and the number of on-shore slips that have been equipped with electrical hookups. Those parameters in turn depend on the degree of success in coordinating the efforts of multiple ports and multiple shipping companies.

The benefits and costs of such a sustainable strategy over time depend on the installation costs, the cost of fuel saved, the cost of additional electricity produced, and the environmental impacts of switching the sources of energy/fuel and relocating them from the densely-populated central Seattle area to more remote energy generation locations. The following list contains some of the most important pieces of information needed to define a range of potential outcomes and complete the triple bottom line analysis.

- Projected numbers and durations of stay of vessels requiring power at South Waterfront moorage
- Projected power demand profile of South Waterfront shippers over time
- Projected shipping fleet capacity to hook up to shore power
- Health costs of air pollution components
- Environmental costs of air pollution components
- Projected amounts of air pollution components emitted per energy use unit from docked diesel-powered vessels
- Amounts and location of air pollution components emitted from incremental electrical power generation facilities needed to provide shore power
- Discounted SCL costs of long-run alternatives' comparisons
- Discounted shipper costs of L-R alt comparisons
- Timing of health improvements
- Distribution among parties of benefit shares versus cost shares
- Similar information concerning other West Coast ports that provide moorage and that could potentially provide shore power to improve shippers' overall ability to realize a return on investment in on-board capability to hook up to shore power
- Future cost (and avoided cost) of diesel fuel and electric power
- Future trends in Port visits by ships with on-board electrical hookup capability
- Potential changes in legal limits for allowable sulfur content of marine diesel fuel

i) Analytical Techniques

The basic economic analysis of the Shore Power project will require triple bottom line benefit cost analysis. The "Do Nothing" alternative is again viable, so other alternatives can be measured according to their net benefits relative to that case.

Other significant elements of the analysis of this project include the following:

- **Triple Bottom Line analysis** – Environmental and health benefits are a significant feature of this sustainable project. It is crucial that they be quantified to the maximum extent possible and included in the evaluation.
- **Life cycle cost analysis with a long-run perspective** –The analysis period should be sufficiently long to capture anticipated evolution of shipping industry practices. In addition, some major costs will be incurred at the front end, while the benefits will continue to accrue over a very long period.
- **Developing "win-win" planning and financial arrangements** – This project involves a complex mix of direct participants and indirect beneficiaries. An important element of the analysis will be to determine the overall best outcome, determine the distribution of benefits in that scenario, and then design the necessary cost-sharing or financing arrangements that would align the costs with the benefits, to ensure willing participation and equitable outcomes.
- **Sensitivity analysis** – There are several significant areas of uncertainty in this project. They include: i) the future cost (and avoided cost) of diesel fuel and electric power, ii) the future trends in Port visits by ships with on-board electrical hookup capability, and iii) the future trends in baseline pollutant loadings of both diesel and electrical power production fuel. When the basic project analysis has been completed, it will be possible to plug in alternative assumptions for these sensitivity analysis variables.

j) Sources of Input Values

Public Agencies:

- Seattle City Light
- Port of Seattle
- Puget Sound Clean Air Agency

- A substantial number of input requirements are needed for this project. They include various relevant dimensions of power demand, alternative power supply costs, avoided costs, and air pollution damage costs, in particular.
- Some data and impact estimates have been developed in the Port's Shore Power Study.
- Private shipper data is also necessary, including on-board investment requirements, fleet electrical capabilities and Seattle stops and duration of stay projections.

k) Major Sustainable Infrastructure issues

This project would benefit from evaluation according to the sustainable infrastructure principles for several reasons. Project features that make it an attractive candidate for this approach include the following:

- The need for creative alternatives definition – No agency's service planning requires action for which this alternative might emerge. Non-electric service currently provides needed

power. A potentially superior solution would require both coordination of multiple parties and probably creative financing to ensure shared incentives are consistent with that solution.

- The presence of significant "un-internalized" environmental values – The health and greenhouse gas benefits that could be provided with an electrical solution are not adequately reflected in current market conditions, but can be addressed in a sustainable analysis.
- The need for an inter-agency compact – This project will proceed only in conjunction with a formal agreement among the agencies that must be involved to achieve and encompass all potential benefits.
- The probable need for a public/private partnership – There is a "Prisoner's Dilemma" situation with respect to the investments in on-shore and on-board electrical hookups and retrofits. Neither party has an incentive to invest unless they know the other party will. The shippers may actually require multiple jurisdictions to commit to shore power investments before it is in their financial interest to do so.

l) Next Steps

- Evaluation. This step has not been begun. It depends on assembling the information described above. However, it is possible to design the analytical model, into which we can then insert data and assumptions as they are developed.

3.2 Projects Deferred for Future Sustainable Infrastructure Evaluation

3.2.1 SPU Reservoir Re-Programming: Maple Leaf & Roosevelt Reservoirs

Concept description: SPU is in the process of putting lids on all drinking water reservoirs. In some cases, these capped reservoirs are becoming parks. In some cases parks are less feasible – on these sites, the lidded area could be used for alternate uses. The Maple Leaf and Roosevelt reservoirs offer opportunities for a variety of uses, which should be aligned with planned uses on adjoining parcels.

Partner agencies: SPU, SPR, SCL

Alternatives:

- Lid the existing Maple Leaf reservoir per SPU standards
- Lid the reservoir per the Open Space 2100 design concept
- Retire and remove the reservoir, and select a (mixed) combination of:
    - SPU alternative utility purpose site use
    - Camp Fire site private development
    - Maple Leaf Playground expansion opportunities
    - "Maple Leaf Grove" quiet space
    - Solar, wind, or heat pump energy collection
- Ownership arrangements may include:

- Stand-alone SPU site retention and reuse
- SPU/DPR land sharing and potential surplus of a portion
- SPU/Camp Fire land swap, with Maple Leaf Grove land transfer to DPR

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Water distribution system storage requirements and projections
- Costs for alternative lidding designs
- Costs of reservoir removal
- Projected alternative SPU real estate uses in the area
- Projected real estate value for private sector options

3.2.2 Central Waterfront Promenade: Amenities and Stormwater Demand Management

Concept description: During large rain events, the Elliott Bay Interceptor combined sewer conveyance system often fills to capacity. Runoff from downtown Seattle either flows untreated into Elliott Bay or causes combined sewer overflows. The removal of the Alaskan Way Viaduct and Seawall present an opportunity to incorporate green stormwater infrastructure facilities as part of the planned promenade and adjacent street improvements. Demand management provided by bioretention planting areas can help reduce CSO events to Elliott Bay, while contributing a pedestrian amenity through landscaping.

Partner agencies: SPU, SDOT, WSDOT

Alternatives:

- Mitigation only for Alaskan Way surface road and sidewalk improvements (required for Alaskan Way improvements)
- Detention/treatment of downtown runoff through underground facilities (required for Clean Water Act compliance)
- Integrated green stormwater infrastructure management of downtown runoff, through one or more of:
  - Swales, lined and unlined bioretention cells, plantings, water features
  - Treatment of Alaskan Way runoff
  - Treatment of runoff from downtown
- Build detention capacity through re-use of Battery Street Tunnel (~2.2 million cubic feet)

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Constraints and overflow rates for each waterfront CSO outfall
- On-site detention/treatment facility options (gray and green)
- Per unit costs of detention/treatment facility options
- Opportunities to fit green infrastructure into planned public open space improvements
- Potential capacity to treat downtown runoff
- Chemical content and volume of downtown peak runoff

- Chemical content and volume of downtown off-peak runoff
- Chemical content and volume of waterfront peak runoff
- Chemical content and volume of waterfront off-peak runoff
- Flow reduction impacts of each measure being evaluated for inclusion in a composite strategy
- Cost of the ad hoc mix of existing facility modifications and new facility construction required

Benefits of Sustainable Infrastructure Approach:

- Investment in stormwater treatment and detention doubles as investment in public amenities along the Central Waterfront (trees and other plantings)
- Repurposing of the Battery Street Tunnel for stormwater detention "recycles"
- Reduce the frequency of CSO events, improving water quality in Puget Sound

3.2.3 Reservoir Capping: Generating Neighborhood Energy

Problem Statement: To improve the security of Seattle's water supply, Seattle Public Utilities is capping reservoirs throughout the city. In many cases, the newly capped reservoirs are being converted to park space, but some remain closed to the public given site-specific concerns. When adjacent to new development, these reservoirs may provide an opportunity to generate local energy through geothermal or solar collectors.

Alternatives:

- Current model: cap reservoir with turf, maintain fence around perimeter
- Install geothermal heat pump system and/or photovoltaic panels to supply energy to an adjacent development

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Additional capital and maintenance costs for energy infrastructure
- Potential energy production
- Economic impact (savings for a public development, rate fees for private development)
- Potential reduction of GHG emissions

Benefits of Sustainable Infrastructure Approach:

- Investment in stormwater treatment and detention doubles as investment in public amenities along the Central Waterfront (trees and other plantings)

3.2.4 Yesler Terrace: Pedestrian Amenities and Demand Management

Concept description: Seattle Housing Authority is redeveloping Yesler Terrace, the first public housing development in Washington State. SHA proposals include 5,000 new dwelling units and 1,000,000 square feet of office space, as well as 5-8 acres of public open space. Redevelopment will require an estimated $82 million in new and replaced infrastructure, which presents an opportunity to include sustainable practices such as district energy systems, rainwater harvesting, and pedestrian improvements.

Alternatives:

- Conventional redevelopment: emphasis on vehicular circulation, drain and pipe stormwater management, standard electric distribution
- District energy using heat pumps, sewer heat recovery, solar collectors, and/or recycling energy among uses
- On-site stormwater management including rainwater harvesting and reuse, infiltration, biodetention/retention
- Green streets and other pedestrian amenities, including a pedestrian crossing over I-5 and green midblock corridors

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Projected energy demand of future development
- Projected energy savings through use of various district energy strategies
- Relative installation and maintenance costs of energy distribution systems
- Projected GHG reductions of district energy
- Average annual stormwater volume for site
- Total annual cost for stormwater treatment at West Point
- Same water quality/quantity parameters as Central Waterfront Promenade
- Per unit cost of harvesting rainwater
- Current walking trips/day/resident
- Projected walking trips/day/resident with improved pedestrian amenities

Benefits of Sustainable Infrastructure Approach:

- Reduced annual energy costs
- Reduced net GHG emissions
- Investment in stormwater treatment and detention doubles as investment in public amenities (trees and other plantings)
- Reduce the frequency of CSO events, improving water quality in Puget Sound
- Improved livability and pedestrian safety

3.2.5 Othello Street Station Area: Water, Energy, and Green Jobs

Concept description: The station area planning process is intended to help accommodate anticipated population and business growth around Seattle's new light rail stations. This process presents an opportunity to look for comprehensive opportunities in rapidly developing areas. While the infrastructure around the Othello Street Station (MLK and Holly St) has started expanding to allow new development, various systems are still in need of major renovation. Various opportunities exist for energy savings and/or green stormwater infrastructure. The latter could build drainage capacity while creating public amenities. Further, while traditional infrastructure needs maintenance from heavy equipment, much of the maintenance for green stormwater infrastructure comes in the form of landscape care, creating a potential for green jobs.

Alternatives:

- Finish expanding conventional infrastructure: higher-capacity power lines, larger stormwater drains and drainage pipes
- Build capacity through district energy: recycle waste heat from UW laundry facility and/or sewer heat recovery to heat local homes and businesses
- Reduce load on partially separated sewer system and Lake Washington through use of green stormwater infrastructure.

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Construction and maintenance costs for necessary electric and drainage infrastructure improvements
- Construction and maintenance costs for alternatives meeting the same capacity targets
- kW hours saved through district energy
- Reduced GHG emissions
- Total planted area that would be added to the right-of-way if stormwater were managed through green stormwater infrastructure rather than pipe and drain
- Number of hours landscape maintenance needed annually to maintain green stormwater infrastructure
- Translate hours to number of potential full-time or part-time jobs

Benefits of Sustainable Infrastructure Approach:

- Reduced annual energy costs
- Reduced net GHG emissions
- Investment in stormwater treatment and detention doubles as investment in public amenities (trees and other plantings)
- Create green jobs for community members
- Improved livability and pedestrian safety

3.2.6 Deep Water Thermal: Heating University Buildings, Cooling Water

Concept description: The University of Washington is exploring using thermal energy from waters of the Lake Washington Ship Canal to heat buildings. Rising water temperatures in Lake Washington and the Ship Canal are thought to contribute to declining salmon populations; by slightly cooling the water at the eastern end of the canal, UW may contribute to the health of this highly altered water system. Protecting and restoring salmon migratory routes is a priority of Seattle Public Utilities, Restore Our Waters, and the Office of Sustainability and Environment.

Alternatives:

- Continued use of gas and electricity for heating
- Use of thermal energy and a heat pump system for heating (not cooling) buildings

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Relative costs of conventional vs. thermal heating systems
- Size of net GHG emission reduction
- Decrease in temperature of Ship Canal waters, and the distance around thermal collectors that this difference would take effect

Benefits of Sustainable Infrastructure Approach:

- Reduced annual energy costs
- Reduced GHG emissions
- Reduced water temperature, beneficial impact on fish

3.3 Projects Dropped from Further Evaluation

3.3.1 Northgate Park & Ride Site: Park Development

Concept description: The Metro Park & Ride lot on 5th Avenue NE just north of Northgate is slated for closure and redevelopment as a mixed use development. Part of the site was historically a bog, and this area may be excluded from future redevelopment. Also, there is a stormwater collector that runs underneath 5th NE, eventually draining to Thornton Creek. Complete the design and construction of the planned park at the Northgate Park & Ride site, building in consideration of the significant stormwater flows adjacent to the site and the Green Factor installations that will be required for the private development currently slated for the parcel bordering the park on its west side.

Partner agencies: SPU, DPR, DPD

Alternatives:

- DPR "stand-alone" park development
- "Parks Plus"
    - Stormwater control structure
    - Stormwater water feature
- Coordination with adjacent private development
    - Optimal location of "Green Factor" landscape features
    - Bog preservation for water flow regulation
- Sidewalk alternatives to enhance reach of 5th Ave NE and Northgate Way project

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Runoff flows from 5th Ave NE and their schedule
- On-site park-like detention facility and flow attenuation water feature options
- On-site irrigation needs
- SPU system flow reduction and attenuation impacts of water features
- Per unit costs of detention facility and water feature options

- Sidewalk impermeable, permeable and decorative pavement unit costs

Benefits of Sustainable Infrastructure approach:

- Water quality and flow control protection of Thornton Creek
- Open space provides public amenity (meeting objectives of Parks and/or private developer while providing utilitarian function for SPU

Reason dropped: Nearby private development in the same drainage basin has recently partnered with SPU to build a large, park-like stormwater treatment and detention system. This facility (part of the Thornton Place development) treats much of the same stormwater volume as the Sustainable Infrastructure Park and Ride proposal.

3.3.2 Optimal Mix of Sedan Types in City Fleets

Concept description: FFD provides a fleet of vehicles to support the City's various departments, some housed centrally and some on site, depending on the purpose. For uses requiring sedans, FFD has to choose between models with a low initial cost and high operating-plus-environmental costs and those with a higher initial cost and low operating-plus-environmental costs. As described in the City's "Green Fleet Report," FFD considers environmental impacts in its choices among fuels and among vehicle types for various fleet assignments. The choice of sedan inventory, in particular, provides an opportunity for FFD to both a) incorporate research findings on the health and greenhouse gas costs of vehicle emissions and b) apply "optimal mix" principles more commonly used in electricity facility dispatch situations.

Partner agencies: FFD

Reason dropped: This illustrative example served well to point out how optimal strategies could be changed by including triple bottom line impacts. However, it was deemed to be too narrowly defined to qualify as a candidate for Sustainable Infrastructure – the costs and benefits predominantly fall within one department.

3.3.3 Hillman City Fire Station: Water Use Capture

Concept description: FFD is in the midst of a program to upgrade or replace many of the City's fire stations. In addition to the stations' primary uses - to house fire suppression and life safety equipment and staff in strategic locations – the stations are the site for other related day-to-day activities, including vehicle and equipment cleaning that uses and releases a considerable amount of water on site. Currently, the water is simply drained into the City's stormwater and combined sewer collection systems.

The use and disposal of significant amounts of water defines an inter-departmental opportunity for FFD, SPU, and others. Capturing and reusing this water reduces the use of potable water; reduces pressure on the City's drainage system, freeing capacity and reducing overflows; and reduces pressure on King County's sewage treatment plant.

Partner agencies: FFD, SPU, King County

Alternatives:

- Fire Station based solely on SFD least cost
- Fire Station with water recapture for hose drilling and truck washing
- Fire Station with water recapture for hose drilling and truck washing, and a pocket park on SW corner of parcel
- Fire Station with site mitigation for slide and environmental risk reduction:
    - Slope stabilization through drainage
    - Slope stabilization through reinforcement
    - Environmental mitigation through invasive species removal

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Water use for standard Fire Department site use and for expanded station hose drilling use
- Cost of water recapture facility installation at construction
- Area and configuration of land potentially available for shared use with Parks
- Site-specific runoff and slide risk information
- Cost of slope reinforcement and runoff collection alternatives

Reason dropped: Sustainable Infrastructure analysis was applied too late in the planning process. Plans for the project had developed to a point that opportunities for water re-use were substantially reduced.

3.3.4 Denny Street Substation Potential Multi-Use Site

Concept description: SCL is planning to construct a new substation on a parcel it has acquired on Denny Street west of Olive Way. The SCL parcel encompasses a closed street segment and the substation would only require the area on one side of the street right-of-way. In addition, the substation will generate a substantial amount of heat as a byproduct of operation, which may simply be released, or vented if the facility is built underground.

As the owner of the parcel, the City can coordinate the diverse opportunities that will arise as a substation is developed on part of the property. The street right-of-way could be opened to expand transportation flow options in the area, or retained as a non-vehicle pedestrian mini-corridor. The new parcel area across from the substation site could be developed in a variety of ways. Heat generated by the substation could be captured and used within any development on the new parcel area, and if the substation is underground, the surface area could be developed as a small park. Various combinations of these opportunities could be developed, to find a solution that provides the best triple bottom line outcome.

Partner agencies: SCL, SDOT, SPR

Reason dropped: This project was seen as having too many potential difficulties in realizing benefits from multi-departmental reuse. While not rejected as a future project, it was felt not to be ready for development as a potential Pilot Project.

3.3.5 Pioneer Areaway Stormwater Storage

Concept description: Pioneer Square still has many aging underground areaways. Many are unused, and in some instances require filling with shotcrete to provide structural support for the sidewalks above. Both SPU and King County have planned waterfront CSO projects in the same area. Preliminary staff estimates suggest that the storage capacity in available areaways could provide a significant amount of storage, potentially reducing the necessary size of facilities to be built in the area. By targeting structurally weak areaways, such a decentralized storage strategy may also replace structural shoring needs.

Partner agencies: SPU, SDOT, King County

Alternatives:

- Central storage and treatment facility
- Decentralized on-site installations
- Cluster Neighborhood storage
- Street (re-)design for detention
- Opportunity-driven sites and projects (e.g., Areaways)
- Strategies that address more than one problem (e.g., Areaways)

Key Parameters to be Considered in Triple Bottom Line Analysis:

- Areaway storage volume not reserved for other uses
- Stormwater flow distribution in gravity-fed basin area
- Costs of installed tanks and influent lines
- Costs of effluent filtration and pumping facilities
- Unit costs of other storage alternatives
- Decrement in projected basin storage need
- Potential effluent flow distribution for water features

Reason dropped: Further analysis of this concept suggested that it would not be feasible for a variety of reasons. Fluctuating water levels are likely to exacerbate structural problems rather than reduce them, and the historical protections on these areaways make utilities work very difficult.

4 Conclusions

4.1 Lessons Learned

Seattle's Sustainable Infrastructure initiative is beginning to demonstrate the potential benefits of a new approach for making capital investment decisions. Although the City of Seattle may be unique in some ways, many of the lessons learned have relevancy, and can be applied to the decision making processes for a wide range of other municipalities.

The pilots described in this report are still being explored and final results are not complete. However, in developing them and evaluating other candidate projects, a number or recommendations and lessons learned are already apparent. We share them below, recognizing that these insights may change or need to be amended.

1. Consider all city land, staff, and funding resources for a whole-city systems approach to infrastructure

The City of Seattle owns a highly interconnected network of roads, open spaces, parks, public property, and utility corridors that provide multiple services to city residents. However, these networks have not been optimized to address the diversity of community needs. Roads are more than habitat for automobiles, trucks and buses - they must also become fully participating elements of the city's open space network. In a sustainable city, roads would also provide human habitat, street side vegetation and paving that cleans the water and cools the air. Parks are not only recreation facilities but in a sustainable city they may host temporary uses such as stormwater control during extreme events.

2. Expect that investments in one infrastructure system could and should have multiple triple bottom line benefits

Enlightened infrastructure investments will deliver system robustness, livability and cost control. When investments in one infrastructure system routinely provide multiple benefits, then cities can get more value for the money they spend. Where quantitative information is not available for environmental or community costs and benefits, we recommend using qualitative values. The port electrification example above highlights this issue. By only looking at power utility issues, the human health impacts of non-utility uses were not included in the original analysis. By the same token, the land use planning department did not factor in air pollution concerns or alternatives to port and utility operations when designating Seattle's Center City as the locus of increased population growth.

City capital investments tend to focus on a single line of business with no expectation or requirement to look at the full range of city services that may be served by any investment. We marginalize non-quantified values such as the need for a beautiful, livable, and sustainable city; externalities such as these don't show up in project pro formas. Looking at impacts and benefits outside of a particular entity's line of business must become routine in order to truly develop a triple bottom line sustainability solution for capital investments.

3. Broaden the alternatives considered beyond the traditional discipline

Another key element of a sustainable infrastructure approach is to consider a broader range of alternatives. Seattle Public Utilities' Triple Bottom Line Guidebook (SPU, 2005) identifies the appropriate range of alternatives to consider, such as capital-intensive vs. operations and maintenance; centralized vs. decentralized; department-alone vs. collaboration; traditional vs. natural/green; supply enhancement vs. demand management; and City staff vs. contracted performance. When reviewing these alternatives there is an off-ramp for elimination of inferior alternatives that do not require more in depth analysis for an accurate determination.

4. Consider decentralized options that can nest into existing infrastructure

In developing integrated alternatives that are consistent with sustainability, it is important to consider decentralized options that can cost-effectively nest into existing infrastructure. These approaches shrink the ecological footprint of the infrastructure and provide as many infrastructure services on site as cost-effectively possible. Examples of decentralized options such as green roofs and rain gardens not only control flows and improve water quality, but they provide habitat, urban cooling, and aesthetic relief to urban inhabitants. On site waste water treatment can lower demands on centralized wastewater systems, reduce potable water use, and provide high quality effluent suitable for irrigation and toilet flushing. Solar hot water heaters or geo-exchange heat pumps use the energy of the sun or the earth to provide onsite heating and cooling and remove thermal loads from centralized power distribution systems or oil and gas systems. Onsite photovoltaics or plug-in electric hybrid vehicles linked with a smart grid can control demand for centralized power distribution and production systems. Indeed, even decentralized concepts like pedestrian improvements that make walking enjoyable can minimize demand for centralized transportation systems and their associated costs and environmental impacts.

Since decentralized alternatives are inherently smaller in scale than centralized infrastructure, they can be constructed in appropriately sized, cost-effective increments as demand justifies the investment. Strategic investments in decentralized options can often eliminate or significantly delay the necessity for costly expansion of traditional infrastructure systems. Over the last nine years, Seattle Public Utilities has begun to move more readily towards these nested solutions as a normal part of utility management expectation. It is anticipated that other City departments will have similar or even quicker levels of adoption of these broadly defined decentralized/demand management options.

5. Partner with city planners responsible for land use, comprehensive planning, and urban design

Utility planners hoping to implement progressive and integrated infrastructure practices must collaborate with the land use authorities responsible for land use, comprehensive planning and urban design. Seattle's Comprehensive Plan encourages sustainable practices but needed new land use codes to implement these practices. Because state-wide growth management controls direct growth into existing urban areas like Seattle, there has been a decades-long shift from green field development to much more complex urban redevelopment with higher densities. Local residents have often supported this growth as long as it generates improved amenities and open space in the neighborhood.

Redevelopment in dense urban areas can, by its very nature, be complicated. Given Seattle's progressive citizens, developers are finding that public acceptance of new growth can be increased through use of green strategies. For example, Seattle has adopted the Seattle Green Factor, a landscape code that encourages builders to construct green roofs, porous paving, vegetated walls and rain gardens. The Green Factor provides benefits not only to gardeners, but to water utility systems and even sewer systems by encouraging practices that divert some of the flow into water vapor or ground water and away from combined sewers. It allows developers to get credit for meeting street tree and tree protection requirements, and also can be used to help meet a project's drainage requirements. At

the same time, it helps neighbors to be more accepting of new development as the Green Factor explicitly encourages landscaping of the public right of way.

6. Use GIS tools to identify spatial overlaps in infrastructure investments

GIS mapping tools can play a critical role in helping to identify where multiple departments are expecting to construct capital projects in the same location over different time periods. Sustainable Infrastructure data gathering must work with capital projects reporting systems to define processes for adding spatial and time-oriented information across departments, for future as well as existing projects. As part of the Sustainable Infrastructure Initiative, the Seattle Department of Finance developed a capital improvement project map that included all capital projects geo-located for all departments, while the Department of Planning and Development developed a complementary map that included all city ownership. This data allowed the utilities to effectively identify where a small shift in scheduling could permit multiple projects to proceed in tandem, avoiding the unnecessary construction costs otherwise incurred by digging up the same right-of-way multiple times. The next step is to use the Department of Planning and Development's mapping of anticipated private construction activity, as well as long-term development activity projected to be driven by the targets of the Comprehensive Plan, as a tool to systematically determine where and when future infrastructure investments should be directed.

7. Convene an integrated expert team from multiple disciplines and City departments

To achieve robust alternatives analysis and to include the full array of possible infrastructure issues for capital spending, it makes sense to convene an integrated expert team from multiple disciplines and City departments. While some individuals who are subject matter experts prefer to remain issue-specific in their focus, there are many others who are attracted to an interdisciplinary approach. During Seattle's pilot process, these interdepartmental teams have been project specific. In other jurisdictions, such as San Francisco, California, the city has a Coordinated Capital Program expert team that works across a number of issues and coordinates with project staff (Coordinated Capital Planning, City of San Francisco, 2007). This more centralized approach should be considered if a city decides that a majority of capital spending needs to be coordinated across the city. Another advantage to this approach is that the metrics used to measure project costs and benefits can be consistently applied across city departments.

8. Collaborate two or three years in advance

A key element of Seattle's Sustainable Infrastructure approach is to encourage generation of alternatives well in advance of the actual project implementation. If a project is already assigned to a project manager whose job is to get the project done on time and on budget, they will not have the luxury of thoughtful analysis of alternatives. However, almost every capital project starts as an idea before it is funded. It is at this early stage that capital coordination has the potential to pay off. To alleviate this issue, the Sustainable Infrastructure process must identify emerging projects two to three years out, where the solution has not already been determined and where funding is still fluid.

9. Consider implications of long-range strategic planning projections

Although capital planning is done with a four to six year planning horizon, utilities must make long range projections about impacts twenty years or more in the future. Large infrastructure investments are designed to have lifespans of many decades, and all utilities develop strategic plans with these longer time horizons in mind. Individual projects are seldom defined with any specificity in these forecasts. Nevertheless, the projections of anticipated future needs should be considered when developing alternatives for near-term infrastructure investments. For example, with Linden Avenue, Seattle City Light's strategic plan described the need for future expansion to the distribution system, and the ensuing clearances and right-of-way that would be needed to provide sufficient separation between power lines. The CIP plan did not look far enough into the future to highlight this issue; a design that did not consider the long term implications of constructing a second transmission line would have led to a very poor design decision on the current placement of streets, sidewalks and utility right of ways.

10. Develop funding agreements to overcome funding constraints

Funding that is bound to certain purposes is often a barrier to implementing an integrated approach to infrastructure development. Funds raised for stormwater control cannot be spent on recreation facilities; while parks departments could include drainage facilities in their parks if they choose, they may have precious few funds to apply to regional drainage when their own budgets are already tight. Thus to do an integrated project, different departments must have the budget to participate, the time to collaborate, and the tools to make agreements for funding responsibility.

11. Overcome the inertia of past practice

There is a certain inertia that can set in. Experienced government employees base their expectations for future projects on past practice, since these practices have already proven to be successful within the established work regime. When a sustainable infrastructure approach is adopted the criteria for success must be broadened to include a number of additional benefits to city spending. Not only do we need to meet our identified levels of service for our particular line of business, but we must also meet expanded criteria for sustainability and livability. These expanded criteria are not always well defined, and may raise ambiguous issues that have not been clearly spelled out in policy terms. Furthermore, some of these criteria can bump up against regulatory boundaries that complicate coordination and collaboration. Strategies to deal with this inertia can be addressed by leadership, executive direction, and staff investment in working through issues, whether technical, operational, or policy.

12. Work to overcome regulations that may be barriers to innovation

As a local government entity, Seattle can work with other regulators to change regulations if they preclude sustainable solutions. For example, in Seattle, rainwater harvesting strategies were severely constrained by the determination by the State Department of Ecology that an expensive and onerous water rights permit was needed to legally harvest rainwater. Many in the development community were not prepared to use rainwater harvesting while this interpretation was in effect. To overcome this regulatory hurdle, Seattle was able to successfully negotiate a water right for much of the city. Already

major new projects, including the Gates Foundation's world headquarters, are taking advantage of this regulatory relief.

13. Require interdepartmental collaboration as a performance expectation

During the early stages of Seattle's Sustainable Infrastructure Initiative, one participant expressed a private concern that by coordinating with other departments, their department might be forced to accept a less than optimal outcome. This represents a very real challenge to coordination and collaboration. Sometimes departments are encrusted with years of competition that manifest as a chronic tug of war between the need for one urban service versus another. Some staff in the trenches may perceive these conflicts as a zero-sum game where one department can only prevail if the other department loses. Accountability agreements need to emphasize that collaboration with other departments to provide multiple benefits is an expected element of departmental performance and city spending.

14. Increase awareness of or expectation for integrated solutions

There is a growing awareness of alternatives to traditional practice, particularly in the water sector. However, use of these alternatives is only now becoming a standard consideration for many utility engineers. Professionals in other departments are not aware or confident in these alternatives. Many need to see actual projects built in their own locality before assuming that these approaches have merit. Field trips, invited expert speakers, brown bag lunch series can be helpful. Demonstration projects can build local confidence. Leadership from the top can inspire risk adverse government employees to consider new alternatives. Regulators, too, must be educated to help remove potential regulatory barriers to innovation.

4.2 SUMMARY

Though Seattle is well underway with this experiment to implement a consistent, City-wide approach for encouraging Sustainable Infrastructure investments, we have much to learn before we claim success. It is almost certain that some percentage of the integrated alternatives we are evaluating will not pencil out. Yet for the alternatives that do, we believe Seattle will have increased value for each dollar spent. If we can successfully make this approach part of our everyday capital budgeting processes, we hope to make these processes fundamental to City-wide decision making. By leveraging our capital spending to get sustainable outcomes, we will be making our city more sustainable every day.

While a sustainable infrastructure approach may be a start, it is important to recognize that much more work remains to be done to address the overwhelming scale of the climate change and urbanization issues facing cities. By leveraging every infrastructure investment for sustainable outcomes we will also be building a charming, healthy, and sustainable city that works. Utility officials working in concert with regulators, land use entities and private developers must play a leadership role to guide and inspire an integrated approach to city infrastructure services. If we do not create the tools and methods, if we do not build the demonstration projects, if we do not reach out to city planners, energy providers, and transportation system experts, then who will?