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Sustainable Water Resources Management
Volume 1: Executive Summary

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REPORT SUMMARY

This report summarizes the findings of a three-phase research project investigating sustainable water management. The report will be of value to all parties interested in the water aspects of sustainable development. As it contains information at various scales of water management, the report will be of interest for those involved with green building projects, the public water supply, stormwater management, wastewater treatment, and the electric power sector. In addition, the report provides valuable insight for government agencies involved in water regulation and policy.

Background

In 2006, Congress appropriated money to USEPA to fund a National Decentralized Water Resources Capacity Development Project (NDWRCDP). The web site for the program is located at www.ndwrcdp.org. NDWRCDP is a cooperative program that supports research and development to improve understanding, training, and practice in the field of onsite/decentralized wastewater and stormwater treatment. The Water Environment Research Foundation (WERF) administers the program. One of the principal cooperators in the Program, as designated in the appropriation, is the Electric Power Research Institute (EPRI). EPRI's involvement in NDWRCDP is based on the water sector's use of electric power and the strong interdependencies between electric power and water sustainability with respect to community social and economic vitality. This report is the result of a research project initiated and managed by EPRI with NDWRCDP funds.

Objectives

- To summarize the elements of the Sustainable Water Resources Management Study
- To analyze the relationship among community water resource management, green building, and watershed sustainability and evaluate the role of green building rating systems in that relationship

Approach

The overall report is divided into three volumes. Volume 2 and 3 are detailed reports of the two major phases of the study. Volume 2 evaluates the relationship among green building practices, green building rating systems, and water resource sustainability. The evaluation is based on case studies of three diverse commercial green building projects. Volume 3 explores what is known as the "new paradigm" for water resource management at the community level. This paradigm is built around the concept of water resource sustainability. Volume 3 is based on a workshop that reviewed the water management practices and strategies of two very different communities. This volume, Volume 1, summarizes the other two volumes as well as two meetings of the advisory committee to the overall study.

Results

This body of work illuminates the need to work across current boundaries to achieve the most sustainable outcomes. As illustrated by the green building case studies, the outcomes for a project are better when driven by local water priority issues rather than by a green building rating system based on universal criteria. Likewise, more sustainable approaches to water management at the local level can be achieved when the plan includes stakeholders involved with all facets of water—supply, use, treatment, stormwater management. Oftentimes, the best approaches are contradictory to one or more existing regulations, codes, rules, or rating systems that do not take into account new technologies and practices and limitations on water availability.

EPRI Perspective

As many of the current approaches to water management become unsustainable, it is becoming increasingly important to look for innovative solutions that may be drastically different than the current management paradigm. To truly implement best practices, it is critical to bring together all stakeholders and to develop integrated approaches. Implementation of sustainable approaches may require more geographically specific or project specific plans and guidelines than are currently supported by many regulatory and green-building rating systems. Future efforts should continue to focus on practical means for replacing non-sustainable practices and institutional approaches with new ones more in line with an ever-changing environment. The electric sector needs to understand the perspectives of the water sector and work to create and test new collaborative water resource management approaches to achieve energy/water sustainability.

Keywords

Water sustainability
Water sector infrastructure
Water supply
Wastewater treatment
New water management paradigm
Green building
Low impact development

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BACKGROUND

A major societal challenge is how to protect the environment and human heath while meeting the growing demand for water and development that is driven by population growth and affected by climate variability and land use change.

The green building movement, along with various rating systems for energy efficiency, is changing the way construction is being performed in the United States. However, green building rating systems and practices may not adequately incorporate important principles of sustainable water cycles and hydrology. The area of water sustainability has many constituencies, but has no centralizing core.

EPRI created a project encompassing the concept of establishing a strong connection between green buildings and sustainable water infrastructure, creating a new paradigm in which sustainable water cycles and systems are at the heart of building and development systems.

The project concept was developed based on the output from a series of workshops on the topic of Integrated and Decentralized Water Resource Infrastructure, organized by the Coalition for Alternative Wastewater Treatment.[1] The need for a project of this nature was further endorsed by the USEPA 1997 Report to Congress.[2]

This project was organized in a phased approach. The first phase was focused on examining the current state of affairs in the area of water management and green building. Its objective was to define work needed to improve the connection between water sustainability efforts and green building.

To provide this guidance, a stakeholder group was formed and two workshops were held. The initial workshop was facilitated and led to the initiation of two additional projects that would illuminate sustainable water management from different perspectives. Meeting notes from the first workshop are included as Appendix A in this report. The second workshop served as a review of the two projects while they were underway. At the second workshop, the stakeholder advisory group provided input to complete the three phases of work in a manner that would result in a comprehensive review of sustainable water resources management. A meeting summary from the second workshop is included as Appendix B.

[1] Nelson, V.I., Priorities in Research, Institutional Reform, and Outreach: Recommendations of a Workshop Series on Integrated and Decentralized Water Resource Infrastructure., Workshops held November 2005 – January 2006.

[2] Response to Congress on Use of Decentralized Wastewater Treatment Systems, EPA Report 832-R-97-001b, April, 1997.

The main finding from the first workshop was that work needed to be done to look at real world situations. This should occur at two scales, at the community level and at the individual building level. To meet this need, EPRI organized two projects, which became phases two and three of the overall study.

One project was formed to evaluate three case studies of green building projects that had been recently completed. These projects are varied in the nature of their end use and location. The details of these case studies are available in Volume 2[3] of this report.

The other project was aimed at pulling together various stakeholders concerned with sustainable water management and holding a retreat to examine a new water management paradigm. This retreat included two case studies from different communities facing different water challenges. The work from this project is reported in Volume 3[4] of this report.

An overview of each phase of the overall study is included in this summary report.

[3] Sustainable Water Resources Management, Volume 2: Green Building Case Studies, EPRI , Palo Alto, CA: 2010. 1020602

[4] Sustainable Water Resources Management, Volume 3: Case Studies on New Water Paradigm. EPRI, Palo Alto, CA: 2010. 1020587

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PROJECT SUMMARY

The first objective of this project was to bring together stakeholders and experts involved in various aspects of sustainable development and explore what research was needed to advance development that supported water resource sustainability. This group was brought together for a workshop in early 2008. Prior to the workshop, a literature review was conducted to provide background material for initial discussions. That literature review is summarized in Section 3 of this report. The group discussed many issues surrounding sustainable water management and how it was and was not supported by current building approaches. The details of the discussions that took place are captured in Appendix A.

At the conclusion of the first workshop, participants identified two areas for research focus; exploring implementation of sustainable water management through examination of real green building projects, and working with water supply and wastewater treatment agencies to evaluate a new paradigm to sustainable water management at the community level.

In response to these recommendations, two projects were started that would proceed in parallel. One project was aimed at exploring green building projects and the other was focused on community water management.

In the first project, three buildings that had been completed within the last 10 years were evaluated. A summary of this review is included in Section 4, and a detailed account is found in Volume 2 of this report. This evaluation captured successful approaches to sustainable water management within these buildings. In each case, decisions were made to include water management strategies specifically aimed at addressing high priority water issues for the local area. It is important to note that while each of the three buildings attained Leadership in Energy and Environmental Design (LEED) certification, the water management approaches that had the biggest impact on local issues were not driven by the desire to attain points in the LEED rating system. The evaluation also revealed that in some cases better outcomes can be achieved by taking a systems approach, rather than by focusing separately on individual facets of water sustainability.

The second project convened a group of experts for an intensive retreat to examine a new water management paradigm. Two communities participated in the retreat and served as real world examples of new paradigm concepts. A summary of this project is included in Section 5 of this report and details of the project including a full description of each community and notes from the retreat is found in Volume 3 of this report.

The proposed new paradigm for water that was produced as a result of this effort encompasses many ideas that will allow a changed approach to water management, bringing more resources to

innovative solutions and looking beyond the boundaries of current regulations, codes and sometimes single issue approaches.

This body of work illuminates the need to work across current boundaries to achieve the most sustainable outcomes. As illustrated by the green building case studies, the outcomes for a project are better when driven by local water priority issues, rather than by a green building rating system alone. Likewise, more sustainable approaches to water management at the local level can be achieved when the plan includes stakeholders involved with all facets of water (i.e., supply, use, treatment, stormwater management). Oftentimes, the best approaches are contradictory to one or more existing regulations, codes, rules, or rating systems.

As many of the current approaches to water management become unsustainable, it will become increasingly important to look for innovative solutions that may be drastically different than the current paradigm. To truly implement the best practices, it is critical to bring together all stakeholders and to develop integrated approaches. Implementation of sustainable approaches may require more geographically specific, or project specific plans and guidelines which are currently not supported by many regulatory and green building approaches. This report highlights areas where exceptions or changes to the governing approaches could yield better outcomes.

Future efforts should continue to focus on practical means for replacing old practices and institutional approaches with new ones in line with an ever-changing environment.

The electric sector needs to understand the perspectives of the water sector and work to create and test new collaborative water resource management approaches to achieve energy/water sustainability. Opportunities to both save energy through better water management and to save water through better energy management exist.

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LITERATURE REVIEW

In preparation for the initial workshop, a literature review was conducted to prepare a white paper that would serve as the starting point for discussion topics. The information gathered and disseminated to workshop participants prior to the first meeting is included here.

Water Sustainability

Discussion questions: *Sustainability involves the sum of all the impacts and interactions among many sectors, decisions and technologies. Water is a shared resource. Best management practices are site based, individual and from the bottom up. The notion of sustainability is a broad overview from the top down of the need to balance resource supply and demand for the present and the long term and the need to sustain the ecosystem in which all of our activity takes place. How do we bridge these two useful approaches?*

What are the impacts on the watershed of each individual application? What are the opportunities to aggregate many best management practices into a larger whole that moves toward environmental, economic and social sustainability? How can this be encouraged? What research is needed in this area?

Water sustainability is the driving force for including water considerations in green building approaches. Water sustainability encompasses both the concept of water availability and water usability or quality. When considering the impact of green development on water sustainability it is important to consider the boundary placed around the system.

Understanding the water balance in a region is an important piece of the puzzle needed to develop a picture of sustainable water resources. Water conservation, reuse and recycling are feasible approaches for increasing available surface water and groundwater supplies.[5]

Land use management is one of the dominant factors affecting both water quantity and quality. Cumulative effects of land use change on water resources include changes in available water quantities, shifts in frequency and timing of runoff and infiltration, and shifts in the spatial distributions of available water affecting both terrestrial and aquatic ecosystems. Land management programs, such as hubs and corridors, working lands, and aquifer protection programs, all affect water resources and their sustainability. Land use changes can impede or contribute to sustainable water, so sustainable water resources management also must include integrated watershed management.

[5] Moving Toward Sustainable Water Resources management: A Framework and Guidelines for Implementation, WERF, 00-WSM-6b, 2006

While many design efforts, standards, best practices and technologies are aimed at individual buildings or small developments, it is widely recognized that regional scale or watershed based consideration is important for considering sustainability. Regional hydrologic landscapes represent management units that are large enough to include regional groundwater aquifers, surface water basins, and large-scale patterns of precipitation and evapotranspiration. The hydrologic cycle represents the interactions among surface water, groundwater, and atmospheric vapor.

The USGBC Research Committee has created a green building research agenda.[6] This national research agenda is intended to identify and catalyze funding, research, development, and deployment activities that are necessary for achieving a transformative leap in building performance and sustainability. The water use and management section is aimed at reducing potable water use in the operation of buildings and grounds. The research plan addresses five goals:

- Create metrics for evaluating building-related water use;
- Compile baseline data on water consumption in and around buildings;
- Develop strategies and tactics for minimizing water use;
- Ensure water quality and availability;
- Disseminate information and incorporate technologies into practices.

In the various approaches to green building, water conservation is a key concept. Water conservation within each unit may be necessary, but may not be sufficient to ensure water sustainability at a watershed level.

A literature review did not identify any work done to link the improvements achieved through green building best practices to the improvement to overall water sustainability within a watershed. This may be an area for further research.

Current Standards

Discussion questions: *Do current green standards, LEED etc. cover the key aspects of water sustainability? A policy that manages water just from the supply side or just from the demand side will not lead to sustainability. What is missing and needs to be included in the suite of guidelines now being used? What research is needed in this area?*

[6] A National Green Building Research Agenda, USGBC Research Committee, February 2008

LEED

There are many standards and codes being applied to water efficiency in green building. The most popular of these is the Leadership in Energy and Environmental Design (LEED) Green Building Rating System.[7] This system is developed and maintained by the U.S. Green Building Council. The LEED Green Building Rating System is a voluntary, consensus-based national rating system intended to develop high performance, sustainable buildings. LEED addresses strategies in five areas: sustainable site development, water savings, energy efficiency, materials and resources selection and indoor environmental quality.

LEED supports many different types of development, with guidance available during design, construction and operation phases.

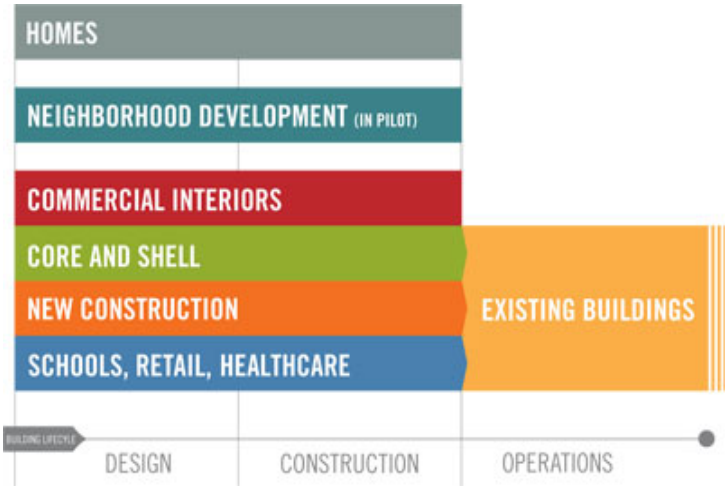

Figure 3-1
LEED Green Building Rating System

LEED Rating Systems are in place or being developed for:

- New Construction
- Existing Buildings
- Commercial Interiors
- Core & Shell
- Schools
- Retail
- Healthcare
- Homes

[7] www.usgbc.org

- Neighborhood Development

Water sustainability is addressed through several aspects in the LEED system, for example, in the LEED for Homes point system the Sustainable Sites rating includes consideration of landscaping to reduce water usage and surface water management to minimize erosion and run-off. The Water Efficiency rating includes water reuse, the irrigation system and indoor water use.

LEED for New Construction v2.2 awards points for stormwater design, water efficient landscaping, innovative wastewater technologies and water use reduction.

For existing buildings, the LEED checklist for sustainable sites includes stormwater management, where water efficiency credits are given for indoor plumbing fixture and fitting efficiency, water performance measurement, water efficient landscaping, cooling tower water chemical management and use of non-potable water source.

The LEED for Neighborhood Development was being developed by USGBC in partnership with the Congress for New Urbanism (CNU) and the Natural Defense Council (NRDC). LEED for Neighborhood Development will recognize development projects that successfully protect and enhance the overall health, natural environment, and quality of life of communities. This system was in its pilot period during the first workshop. In its draft form, proximity to water and waste infrastructure as well as wetland and water body conservation are required. In the area of green construction and technology, points are awarded for LEED certified green buildings, reduced water use, stormwater management and wastewater management.

ASHRAE/USGBC/IESNA Standard 189.1P

A proposed standard is being developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the Illuminating Engineering Society of North America (IESNA) and the U.S. Green Building Council (USGBC).

This proposed standard is intended to define high-performing buildings in code-intended language. Proposed Standard 189.1, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, at the time of the first workshop was open for its second public review for a 45 day commenting period.[8]

Proposed Standard 189.1 will provide minimum requirements for the design of high-performance, new commercial buildings and major renovation projects, addressing energy efficiency, a building's impact on the atmosphere, sustainable sites, water use efficiency, materials and resources, and indoor environmental quality. The proposed standard is also intended to provide indoor water savings of 35 percent for an office building and 26 percent for a multifamily building.

This standard encompasses many aspects of water efficiency including site development to retain rainfall, manage stormwater and reduce water demand from landscaping. Irrigation is to be

[8] Press Release (http://www.ashrae.org/pressroom/detail/16656) Proposed Standard for High Performing Buildings Open for Public Review, February 28, 2008

optimized and buildings are to reduce water usage through plumbing fixtures and fittings. The use of Energy Star appliances is promoted. The standard also encompasses design and operation of pools, fountains and cooling towers.

Federal Energy Management Program (FEMP) Facility Water Management Planning Guidelines

The U.S. Government is going through a national effort to promote energy efficiency and sustainable actions in the country's 500,000 Federal buildings and facilities. To address water, the Federal Energy Management Program (FEMP) has produced Facility Water Management Planning Guidelines. These guidelines promote best practices around water efficiency.

Water Efficiency Improvement Best Practices in 10 areas:

- Public Information and Education Programs
- Distribution System Audits, Leak Detection, and Repair
- Water-Efficient Landscape
- Toilets and Urinals
- Faucets and Showerheads
- Boiler/Steam Systems
- Single-Pass Cooling Systems
- Cooling Tower Systems
- Miscellaneous High Water-Using Processes
- Water Reuse and Recycling

In reviewing facilities, the compliance with these best practices is reviewed and documented.

National Green Building Standard

The National Association of Home Builders Research Center is developing a National Green Building Standard.[9] This is intended to be an ANSI standard for green home building construction practices. Final ANSI approval was expected to be complete by the end of 2008. The result will be a voluntary green home building standard that can be adopted by local green home building programs or local building departments as a conformance guide. After completion of the ANSI process, the code will be promulgated as a joint publication between NAHB and the International Code Council (ICC).

- Chapter 8 deals with indoor and outdoor water use and addresses the following topics:

[9] www.nahbrc.org

- Reduce indoor hot water use
- Water conserving appliances are installed
- Install food waste disposer attached to primary kitchen sink
- Low flow showerheads
- Low flow faucets
- Low flush volume for water closets and urinals
- Low volume irrigation systems, use of smart controllers, separate irrigation for turf and bedding areas
- Rainwater collection
- Gray water reuse
- Composting or waterless toilets
- Automatic shutoff water supply devices

This is not an exhaustive list of standards or rating schemes. Activity in green building continues to grow and various standards are being applied in different localities. Most systems involve elements of water conservation and stormwater management.

Several of the rating systems reviewed involve a 'point' system, where points are awarded for different practices. The total points achieved by a project often determine if the project qualifies as sustainable. It may be possible to achieve a good rating with one or more elements of sustainability not being addressed. It's difficult to weigh the relative impact of all the elements included in each rating system. It is likely that the real importance of each type of best practice should be weighed on a project specific basis. For example, energy efficiency may not be as impactful in a region with plentiful renewable resources, and water conservation may be very important in areas with unsustainable population growth.

Potential research in this area could entail compiling (if it doesn't already exist) a database of LEED projects and examining (by looking at the amount of points awarded) how much emphasis has been put on water relative to other aspects of green building.

A database including GIS information could also allow an overlay of projects with significant attention to water conservation with regional water sustainability information that has previously been developed by EPRI.

Site Specific Considerations

Discussion questions: *How do differences in local geography, existing infrastructure, size of project, or different water demands of different sectors play into the discussion of water resource sustainability. Each particular use (urban, agriculture, energy, industry, mining, etc) has different needs for water and different impacts on the watershed. What role do regional cultures and economics play in the ease of discovering and implementing positive innovations? What research is needed in this area?*

Environmental impacts of development can be local, regional or global.

For example, some impacts like CO_2 emissions are considered global, because the release of CO_2 in one location impacts the CO_2 globally. In the case of greenhouse gasses it is widely considered that reductions in emissions in any location are equally important.

In the case of water, the impact is more localized. In areas where water availability exceeds water withdrawals, conserving water is not as critical as in areas where withdrawals exceed available water. Most of the standards currently in place have no consideration for the relative importance of the various elements of green building.

The LEED certification system has been criticized for lacking sensitivity to context. Considerations such as cost, interaction with utility systems and policies, availability of renewable resources, and existing codes can all dictate what practices are feasible and meaningful in different settings.[10]

For the 2008 revision cycle, USGBC is considering region-specific LEED credits based on proposals made by individual regions to meet their unique needs. Proposals in the arid Western Region, for example, include eight region-specific changes addressing water use.[11]

This aspect of green building ratings becomes very important when impact is considered at the regional or watershed level. This aspect could be demonstrated further through case studies of sustainable development in various watersheds.

[10] LEED-ING By Example: Green Building Grows Up, David Giles, http://www.citylimits.org/content/articles/viewarticle.cfm?article_id=3263

[11] Presentation: One Planet Communities, Greg Searle, Executive Director, BioRegional North America

4
CASE STUDIES ON GREEN BUILDING APPROACHES

Three case study projects were reviewed to better identify the impact of green building approaches. This phase of the project also examined some of the real world considerations including incentives and barriers. The three projects, which were all completed within the last 10 years, were chosen to cover a range of:

- Building uses
- Geographical locations
- Innovative sustainable water management techniques

This study evaluates these buildings in two ways. First, it attempts to gauge their impacts within their local watersheds and attempts to quantify the environmental benefits of their water management practices. Secondly, it evaluates these case studies in the context of three green building rating systems:

- Building Research Establishment Environmental Assessment Method (BREEAM);
- Leadership in Energy and Environmental Design (LEED) for New Construction; and
- Green Globes.

The detailed evaluation of each of these case studies is available in Volume 2 of this report.

The Merrill Center

The first project reviewed was the Merrill Center in Annapolis, Maryland. This building houses 80 employees of the Chesapeake Bay Foundation (CFB), an advocacy group for restoration and protection of the Bay. The building is located on 33 acres on the shore of the Chesapeake Bay. The building is 31,000 square feet on two floors. Some of the features incorporated into this project include a large cistern, an open plan, composting toilets, and a green roof.

Upon completion, the Merrill Center achieved Platinum certification from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System for New Construction, the highest level conferred by LEED.

The paramount environmental issue in this area is protection of the health of Chesapeake Bay, specifically nutrient and sediment loading to the Bay. For this project, this is magnified by the fact that protection of the bay is aligned with the business mission of the Foundation that would occupy the facility and that the project is directly on the shoreline.

In building their headquarters, CFB wanted to make a statement about the importance of water management and ensure they minimized their contribution to the ongoing issues plaguing the Bay. The CFB Board made a decision to achieve LEED certification (which was on the horizon at the time of initial planning) for the building. They identified four stated goals for the facility:

- to create the best workplace for staff;
- to be a good neighbor;
- to create the most environmentally sensitive building possible; and
- to lead by example so that others might create other green buildings.

While no green building rating system alternative to LEED was deemed well-known enough at the time to be a viable measure of success, the project team had a basic approach to the project more compelling even than LEED: they devised a clear vision of locally based environmental goals and then met them. This internal goal-setting became the basis for the Merrill Center's sustainable achievement, and LEED Platinum followed from that. Especially in water management, goals like nutrient reduction were met with tangible strategies like the use of composting toilets and stormwater management practices. Regional and site specific content, whether in terms of planting schedules, remediation strategies tailored to the site, or maximum use of prevailing breezes informed design decisions. This specificity gives the Merrill Center a sense of achievement beyond LEED.

Of the types of water – drinking water, grey wastewater, and stormwater – used or produced onsite, drinking water has a conventional source (a private onsite well) and a portion of greywater has a conventional destination, back to the public sewer system. Although potable water is not a resource under particular local stress, the Merrill Center captures stormwater from the roof and stores it in cisterns to minimize its reliance on its well. The cisterns supply the Merrill Center through separate piping with non-potable uses, including hand washing and laundry. This captured rainwater, if used internally in the building rather than for site uses, as well as potable, well-supplied water, is sent to the public sewer system.

In recognizing and sharing a larger concern for excessive nitrogen levels within the watershed, CBF's environmental goals for the Merrill Center precluded sending human waste to treatment plants. The direct result of this goal was that all toilets in the project are composting toilets. Water conservation alone does not necessarily work toward nutrient load reduction goals. Less water with the same usage will produce a smaller volume of waste, but the same organic and nutrient load. However, composting toilets result in a direct load reduction. With the composting toilets in place, the Merrill Center produces no blackwater.

CBF implemented many best management practices (BMPs) with respect to stormwater. The overall plan focuses on maintaining as much open space as possible (84 percent of the site) and restoring the site's wetlands, meadows, forests, and beach. The emphasis is not only on water conservation – it is on site remediation and restoration. The Merrill Center goes considerably beyond the LEED water credits in this respect. The restoration is intended to have beneficial effects watershed- and community-wide.

The path of water moving onsite is established by the bioswale at the building's front entry. Bioretention is the cornerstone of onsite BMPs, through swales and dry ponds. There are three bioretention collection points onsite. The bioretention swales throughout include native plantings and grasses which slow down the flow, allowing it to be gradually infiltrated onsite -- or else passed on to a sand filter. The site stormwater does not tie to the public wastewater system. Any greywater not site-absorbed or stored for interior uses flows eventually to the tidal waters of the Bay, but the lengthy run through a rill of native plantings and grasses acts to cleanse it of nutrients.

The Merrill Center had several obstacles to overcome in the path of implementing its planned solutions. These issues were worked through until an acceptable approach was agreed upon. To address concerns about harvested rainwater being used for had washing, signs are posted at the sinks advising that this is rain water and not to drink. To address concerns raised by the Fire Marshall about the potential for someone to dispose of a lighted cigarette in the composting toilet system, the shafts were installed with a 'fire-rating' – enclosing them and the composting chamber in a non-combustible material that separated them from the rest of the building, inhibiting any potential spread of fire.

To monitor performance there are many sensors installed in the building including water use monitoring. One challenge for operations is making use of all this information and responding to it. Considerable adjustments to operations are necessary and time consuming. The building operators have additional tasks not shared by more conventional buildings. These include periodic cleanout of the compost from the toilets and maintenance of stormwater filtration devices like the onsite sand filter.

For the Chesapeake Bay Foundation, the Merrill Center has been a successful expression of the work and goals of the organization. The building occupants are happy with the operation of the facility and find the building to be a great educational center for environmental issues. Visitors come to tour the building for its sustainable practices and it remains a catalyst for regional sustainability initiatives.

Wetland Studies and Solutions

The second project evaluated was an office building for Wetlands Studies and Solutions, Inc. (WSSI) in Gainsville, Maryland. WSSI is a natural resources consultancy whose services include delineation of wetlands and streams, assessments, restorations, and permitting aid. It is staffed by a multi-disciplinary team of scientists, engineers, architects, regulatory specialists, and archeologists who provide their services to developers and public works agencies throughout the Chesapeake Bay region. The WSSI facility is a two-story, 44,645 square foot building that is typically occupied for 45 hours per week, with 73 full-time employees. Low impact development (LID) was the guiding principle informing the building's design and its public image and goals. WSSI strives to promote its mission and values through its building.

Obtaining LEED certification was not initially a priority for this project. Design of the building was primarily guided by LID principles; the project also looked to its own institutional principles for guidance. LID was very important because it is consistent with the work carried out by WSSI, and was thus linked to WSSI's business goals and growth. The building was meant to be

a case study exhibit of LID principles for the public, but also for potential WSSI clients. After the project was started, a decision was made to obtain LEED certification and in 2006, WSSI became the first LEED Gold rated project in Virginia.

Similar to the Merrill Center, water conservation, while an important overall goal, is not the most significant local issue for the WSSI site. The more critical concern for this area is the effect of the wastewater effluent load and stormwater runoff on downstream water resources, which include several streams and rivers, and ultimately, the Chesapeake Bay.

Water is supplied to WSSI by the Prince William County Authority. The Authority has no sources of its own, but purchases water from Fairfax Water and the City of Manassas. The county and state generally embrace water conservation. Although the county does not have green building requirements, there is an awareness of environmental conservation including a required limitation on landscape irrigation (odd/even days).

WSSI incorporated a number of practices that were projected to reduce interior potable water use by an estimated 50 percent. This reduction was achieved primarily through the use of low flow flush and flow fixtures — through fixture efficiency. The only complication created by the use of water-saving features came from waterless urinals. They require that the cleaning contractor be trained to appropriately clean them to maintain effectiveness.

Additional reductions have been made through the installation of a cistern for rainwater collection and reuse, which is used exclusively for flush water. The 4,000-gallon cistern collects roof runoff for flush fixture use. The cistern water is treated for sediment and solid removal through a vortex filter.

County officials required that clear signage be posted above every toilet to indicate that the water is non-potable. The cistern is projected to be empty only 4 days/yr, and any overflow water is routed to an underground cistern. In conjunction with the use of waterless urinals, WSSI has effectively eliminated all potable water use for flush fixtures.

Remaining fixtures such as bathroom sinks, kitchen sinks, and showers are low flow and sensor controlled where appropriate. In its present state, WSSI has reduced its potable water use beyond the LEED documented 50 percent potable water use reduction, which was attained before the installation of the toilet cistern. Wastewater is processed by the local wastewater treatment plant, rather than on-site.

Stormwater management is the bigger issue for this site. There are two intermittent streams abutting the WSSI site. These streams converge to form the Rocky Branch. The Rocky Branch flows into two detention ponds where stormwater constituents settle. The water then exits via a large culvert and flows approximate 2.5 miles into the Broad Run River. The Broad Run eventually converges with the Cedar Run River to form the Occoquan River at the Occoquan Reservoir. The Occoquan Reservoir serves as a major source of drinking water for parts of Fairfax and Prince William Counties, in Virginia. After passing through the Occoquan Reservoir, the Occoquan River flows into the Potomac River and eventually to the Chesapeake Bay.

In 2006, the USEPA approved fecal coliform bacteria Total Maximum Daily Loads (TMDL's) for impaired water bodies within the Occoquan River Watershed. One of the bacteria-impaired segments is located immediately downstream of the WSSI site.

Numerous mammals, birds, and plants reside in the riparian areas of the Broad Run River Watershed. Many of these species are listed by the State of Virginia as "in need of conservation" and are affected by stream bank erosion, sediment deposition, changes in water quality, and the loss of natural riparian vegetation that degrades many streams in Northern Virginia. These impacts can be attributed in part to changes in land cover, runoff patterns, and stream flows associated with increased development. In addition, increased sediment loads resulting from the loss of natural riparian vegetation and construction in the Broad Run River Watershed are transported downstream, contributing to degradation of the Potomac River and Chesapeake Bay.

The WSSI site incorporates many stormwater management practices to lessen its impact on these downstream issues. The project includes a variety of LID features, such as various types of impervious paving as well as stormwater quantity and quality treatment methods. A gravel bed detention system is the largest component of WSSI's stormwater management plan. It collects runoff from the roof, parking, and rain garden areas. It also functions as an overflow reservoir for other stormwater management subsystems and is connected to the various parking surfaces through a system of underdrains. To assist with controlling the velocity of stormwater, it is sized to retain the volume of water associated with a 1-year storm and then release it over a 24-hour period at a slow speed and acute angle to an existing stream's flow path through a 1.65-inch pipe sized specifically for this purpose. This approach minimizes stream erosion.

The WSSI parking area is composed of a variety of pervious parking surfaces and conventional asphalt. Asphalt parking surfaces drain primarily to the gravel bed detention system, and then the bioswale or floodplains located to the north of the site.

The company, in the spirit of experimentation, decided to use a mix of pervious parking techniques to conduct on-site case studies and evaluate the successes of each. The pervious parking areas are paved with 1,273 square feet of typical gravel and 19,862 square feet of GravelPave2, a product that provides a filter fabric backed mesh to hold gravel in place. These surfaces are highly permeable and drain directly to the gravel layers below the surface. Standard gravel paved parking was only intended for infrequently used areas for WSSI equipment, such as trailers and All-Terrain Vehicles. The GravelPave2 area is located to the rear of the site. Areas paved with these two systems also collect runoff from the impervious asphalt parking areas and drain into the gravel bed detention area.

The two more permanent pervious parking surfaces include 3,342 square feet of pervious concrete and 5,502 square feet of concrete pavers. The pavers contain spaces within the joints, which effectively amount to 10 percent open space and are filled with gap graded gravel that allows infiltration into the gravel bed below.

Due to the site's high clay content and limited infiltration capacity, all parking areas contain underdrains that channel water to the gravel bed detention area. Some issues have been encountered with the gravel parking areas, such as gravel migration and inconsistent coverage. In retrospect, WSSI indicated that they would have preferred to use more concrete pavers and less gravel. Maintenance costs and considerations would have been fewer, since gravel systems

proved less consistent in their performance, and installing the concrete pavers was actually at lower cost than initially estimated by the contractor.

The rain garden provides a vegetated area for stormwater collection and pollutant filtration. It receives runoff from the surrounding asphalt parking area and indirectly from the roof through an 8,000-gallon cistern buried below grade within the garden. The soil and plant composition filter the runoff before it is directed to the gravel bed detention area, and then back to the neighboring stream. It is populated with vegetation appropriate for occasional flood conditions, has pleasing aesthetic qualities, and aids in pollutant filtration. Success of the rain garden required that a curb not be installed at the parking area's perimeter; this exception to local codes for vehicular parking was made.

The rain garden cistern is then used to irrigate vegetation through a highly efficient drip irrigation system. Using this system results in the reuse of captured nutrients contained within the runoff, which are then fed to the site vegetation and prevented from entering the local streams. The cistern also collects overflow water from the indoor cistern and itself overflows to the rain garden and then to the gravel bed detention system.

As a part of its roof runoff collection systems, the WSSI building has a green roof located above the first floor corrugated roof deck. It contains both intensive, less than 4" soil depth, and extensive, greater than 4" soil depth; sections covered in vegetation; as well as patios and a small constructed wetland. A conference room on the second floor opens to the green roof, which is also visible from various offices. Because the team chose native and site-specific green roof vegetation, it neither needs nor has any permanent source of irrigation. Rain overflow from the green roof flows into the rain garden cistern, which is used for occasional watering.

A swale is located on the eastern perimeter of the parking area and collects runoff from impervious asphalt parking surface. It serves to slow and filter pollutant runoff as it progresses through vegetation media and a series of check dams and eventually into the stream.

As a community resource, the building is accessible to visitors and local businesses. It hosts the County's Green Breakfast Group monthly and also allows local businesses to hold events. Both are held in the large second floor conference room, which looks out onto the verdant roof.

WSSI now serves as a local green building knowledge base for Prince William County. As a result of having to evaluate the project, a number of County officials are now familiar with LID design principles. WSSI is currently working with the state and local government to facilitate greater understanding of green building techniques. The building currently serves as an example and teaching resource for the Northern Virginia Regional Commission, which is working to issue LID recommendations for the region.

Millennium Tower Residences

The third project reviewed was the Millennium Tower Residences, a luxury, high-rise residential building located in Battery Park, New York. As one of the southernmost buildings in Battery Park City (BPC), Millennium Tower Residences overlooks the New York Harbor and the Statue of Liberty. Brick-clad and 35-stories tall, the building houses 234 residential condominium units.

The property site is 22,610 square feet and the building area is 442,099 square feet. The building officially opened in January 2007.

Millennium Towers was one of the first residential buildings in the city to achieve a LEED Gold rating and it exceeds current New York State codes. The environmental challenges associated with such high density development are substantial. In contrast to the previous two case studies, the primary water management challenge facing BPC is the capacity of the combined sewer system and water quality problems associated with combined sewer overflows (CSOs).

In much of New York City, stormwater and domestic wastewater are collected in the same sewers and conveyed together to the City's treatment plants. This design is known as a combined sewer system. Precipitation events can cause these sewer systems to fill to capacity, making them unable to transport all of the combined sanitary sewage and stormwater runoff to the treatment facilities. When this occurs, the mix of excess stormwater and untreated sewage is discharged directly into the City's waterways. In NYC, overflow events can be triggered by as little as 0.1 inches of rain and occur an average of once per week.

CSO discharges can be minimized by reducing the volume of stormwater runoff and the volume of wastewater discharged into the combined sewer system.

A key feature of Millennium Tower Residences is onsite blackwater reuse. The building has a 25,000 gallon per day (gpd) design capacity blackwater reuse system housed in the basement. The plant is designed for high-level removal of organic material (commonly measured as biochemical oxygen demand or BOD) and nitrogen using a membrane bioreactor design. Wastewater from the building is collected in an aerated 9,500 gallon feed tank and flows to a trash trap to remove larger non-biodegradable solids. A three-stage biological system consisting of an anoxic tank, an aerobic tank, and a membrane filter removes BOD, nitrogen, and solids. Ozone is added for color removal and UV light is used for disinfection. The piping in the mechanical room is delineated by color to assist operations and maintenance workers. The black pipes are used to mark water coming from toilets to the treatment plant; purple pipes designate greywater that is coming from sinks and showers to the treatment plant.

Millennium Tower Residences uses a water management strategy that integrates efficiency and sustainability in both interior and exterior water use.

Water use reduction within the building is accomplished by installation of water efficient fixtures and reuse of treated blackwater for toilet flushing and maintenance activities. Water fixtures for the Millennium Tower Residences were chosen on the basis of their efficiency and their ability to earn LEED credits in the water efficiency credit category. Because the building is a luxury residence, residents' comfort was also a key and equal design consideration.

Green features external to the Millennium Tower building include a green roof and a rain garden. The green roof is a water management strategy, not a resident amenity. In addition to the green roof, the rain garden in the front of the building provides pervious cover to help reduce runoff. The blackwater reuse system is used exclusively for non-potable purposes within the building, and not used for irrigating the green roof or landscaped areas. Irrigation needs of the green roof and rain garden are met by capture, treatment, and recycle of stormwater onsite. A rainwater catchment system collects all water from the roof and directs it through a cartridge filtration and

UV disinfection system located in the basement of the building. This treated water is stored until it is needed for irrigation of the green roof and rain garden. In addition to meeting all irrigation needs of the building's gardens, the stormwater storage tank has the potential to help reduce the pulse of stormwater runoff from the building's impervious surfaces. Until recently, however, the tank was generally kept full to ensure water availability for irrigation, which left little residual volume to capture stormwater runoff. As a consequence, most runoff bypassed the tank and drained directly to the combined sewer system, which frequently overflowed.

Given that stormwater runoff is a greater resource concern in NYC than water use, this management choice was incongruent with local priorities. Managing the fill level of the stormwater tank to optimize irrigation water availability and stormwater control requires an active approach. Based on preliminary recommendations from this study, building staff recently instituted weekly drawdowns of the tank during dry weather. Based on the impact assessment, this practice will provide at least as much control over runoff peaks as the green roof and rain gardens combined.

To date, the 17,000 gallons per day (gpd) of reuse water allocated for cooling tower use has not been treated or used on site. The original building manager resisted the use of reuse water for the cooling tower citing potential problems with scale build-up. It was reported that an average of 8,000 gpd was treated by the plant; 6,000 of which was used for toilet flushing and 2,000 for wash down of the maintenance room flow. The plant is operated so that when the 9,000 gallon treated water storage tank is full, untreated wastewater flows into the public sewer system.

Green Building Project Findings

These three studies illustrate the importance of operational practices, in addition to design, on the resulting impact from the project. In some instances, operating practices differed from design plans and resulted in less of an impact than originally envisioned.

Through evaluating these three different projects, four important recommendations for improved approaches emerged.

1. **Consider relationship between the universal standards and local/regional priorities.** The three projects evaluated were all successful in addressing water management issues that were relevant to local water priorities. In the area of water management, the weaknesses of green building rating systems are partly due to their reliance on practices considered to be universally correct. This study suggests that rating systems can incorporate regional standards by allowing credit weightings to be determined regionally.
2. **Consider distribution of point values among water management credits to reward practices with the greatest potential for environmental good**. The proportional rewards for certain practices should be higher in some cases to reflect the impacts on the highest priority issues. Buildings like the Merrill Center, WSSI, and Millennium Tower Residences use onsite water management practices considerably to lessen and even undo their watershed impacts. This study not only quantifies this reduction in harm, it projects the benefits of onsite management approaches if adopted more widely

   All three green building rating systems evaluated give more points for water saving fixtures

than they do for reductions in stormwater rate, improvement in stormwater quality, or for onsite strategies like water capture, treatment, or reuse.

3. **Consider establishment of a water management plan a prerequisite to certification.** It is possible to achieve certification in each of these rating systems merely by demonstrating a reduction in water use. Green building rating systems could go further in requiring a water management plan of each applicant at the building level. This investigation has reviewed several situations where systems were not achieving design characteristics due to changes in operations.
4. **A checklist approach to green building rating systems and to codes and regulations for water management does not foster the best overall solutions**. Consideration of single issues without regard for synergistic impacts compromises truly sustainable solutions. There is need for inter- or multi-disciplinary judgments particularly in local building and zoning considerations for water management. In the cases of Merrill Center and WSSI, building, fire, and zoning codes were in occasional conflict with environmentally beneficial project details. Mandates for curbs could have compromised WSSI's stormwater strategies. At the Merrill Center, the width of the waste shafts contradicted building code restrictions on openings, and could have resulted in the elimination of composting toilets there.

5
CASE STUDIES ON NEW WATER PARADIGM

Communities face many challenges with respect to meeting their water needs. These challenges include increased water scarcity and/or flooding associated with climate variability, economic uncertainty, a complex web of regulations and bureaucracy, aging and degrading infrastructure, pollution and impaired water resources, and a broad range of stakeholders with poor understanding of water issues. The objective of this study is to create a platform for communities to overcome these challenges through organizing around and operating under key sustainability principles and practices. The effort uses examples and perspectives from two case study communities to offer real world context.

The establishment of a water management paradigm for a community works in synergy with green building approaches to achieve a more sustainable outcome.

To explore a new water paradigm, the project team recruited two communities and an expert advisory panel to participate in a retreat to flesh out ideas. The retreat took place in Hebron, Kentucky from June 1 – June 3, 2009.

Experts in a variety of disciplines and organizations related to water infrastructure were recruited to form an advisory panel. The panel consisted of engineers, planners, scientists, sustainability consultants, governmental agency representatives and non-governmental agency representatives. Thirty-five people comprised of research team members, case study community representatives, and expert advisory panelists attended the retreat.

The real-life circumstances for each of the two case study communities provided a basis for discussion to define a new water management paradigm. The details of the communities, the advisory panel participants and the discussions at the retreat are documented in Volume 3 of this report.

Case Studies

Tucson-Pima County

The first case study community is Tucson-Pima County. Pima County covers 9,200 square miles of arid western land in Arizona. Approximately 42 percent of the county is Native American land, 44 percent is public land, and only 14 percent of the land is in private ownership.

The population in the county is roughly one million, with 742,000 living in the City of Tucson. There is rapid growth around Tucson, including satellite areas that pose special problems for utilities.

The arid west is defined by rainfall. Annual rainfall recorded in the metropolitan area averages about 12 inches. There are three distinct rainfall seasons: June to September is characterized by intense thunderstorms; October to November has occasional storms from Pacific hurricanes; and December to March can have large slow-moving storm fronts. Pima County's drainages all flow northward. Despite the intensity of storms, they are infrequent and drought conditions frequently pose challenges to the region.

Tucson's potable water system serves approximately 800,000 customers and is comprised of 212 production wells and 65 water storage facilities. The City also has a reclaimed water system comprised of 160 miles of pipeline, 5 reservoirs, a 10 million gallon/day filtration plant, and recharge and recovery facilities. Reclaimed water is used at approximately 820 sites including 18 golf courses, 47 parks, 61 schools and 704 single family residences. Pima County adds 11 wastewater reclamation facilities, including over 3,400 miles of sewer pipe, 64.8 million gallons per day of treated wastewater, and about 30 dry tons per day of biosolids to be applied to agricultural lands. In addition to using reclaimed water for park and golf course irrigation, effluent discharges are utilized for riparian restoration and aquifer recharge.

Currently the large majority of the total water volume used in Tucson-Pima County comes from the Central Arizona Project where Colorado River water is diverted to groundwater storage facilities for future use, with the remainder coming from local groundwater, reclaimed effluent, a replenishment district and incidental recharge.

There are significant water regulatory challenges associated with arid Arizona land. All of the water is allocated or owned through water rights. This includes groundwater rights and effluent entitlements.

Water quality issues in the region include high levels of salinity (from the Colorado River water), impacts of nutrients, pesticides, perchlorate and endocrine disrupter compounds (EDCs). Additionally, rainfall can be so intense that stormwater runoff overwhelms internal storm drains causing flooding, and erosion and sedimentation in stream channels. Wildfires also alter watershed conditions and subsequent runoff quality.

Other challenges that Tucson-Pima County face include regulatory requirements (the Clean Water Act was generally created for non-arid lands). The community believes that improved science and policy are needed for effluent-dependent and ephemeral streams.

Northern Kentucky

The second case study community is Northern Kentucky. This community is located east of the Mississippi River where precipitation is considerably higher, precipitation events are spread throughout the year, perennial stream flow is abundant, and most of the land is under local jurisdiction.

The area referred to as Northern Kentucky in this case study is approximately 229 square miles and is comprised of three counties—Boone, Kenton, and Campbell. The current population of these counties is approximately 350,000 with the City of Covington being the largest municipality at 40,000 people. The region is part of the growing Cincinnati metropolitan area—overall growth rate for the area was 27 percent between 1990 and 2008, with Boone County experiencing 100 percent growth during that period. A portion of the area is known as the "golden triangle" for its economic activity; it is home to the Cincinnati Airport (Delta/Comair hub) and Northern Kentucky University, as well as significant businesses including Fidelity Investments, Toyota, and Citigroup.

Sanitation District No. 1 of Northern Kentucky (SD1) was established as a special district in Kentucky and has been in existence for over 60 years. It is responsible for providing sewer services to most of the Northern Kentucky region, and it also oversees stormwater management for the region. SD1 oversees more than 1,600 miles of sewer pipeline, and two regional water reclamation facilities with a third under construction. It currently has 50.5 million gallons per day (MGD) of treatment capacity which discharges to the Ohio River and Twelve-mile Creek (which eventually flows into the Ohio River).

Many of the areas near the City of Cincinnati have older sewers that are in deteriorating condition. The system is prone to inflow and infiltration, and it has limited capacity to handle wet weather flows. Combined sewer overflows (CSOs) from 97 locations have totaled an estimated 1.8 billion gallons annually. Another 240 million gallons annually is attributed to sanitary sewer overflows (SSOs) at 126 locations. This has contributed to a number of streams being placed on the State's 303(d) list of impaired waters for bacteria and dissolved oxygen. Other causes of impairment include stormwater runoff, septic systems, agricultural land runoff, and severe stream bed erosion.

SD1 is under a Consent Degree with USEPA and the Kentucky Department of Water, with a compliance deadline of December 2025. They are required to develop "Watershed Plans" every five years that describe how the District is to address CSOs and SSOs. These plans have led to the development of sustainability initiatives including gray, green and watershed controls.

Water supply is managed by the Northern Kentucky Water District (NKWD), which operates three water treatment plants and oversees 20 storage tanks, 15 pump stations and 1,192 miles of water main pipes. The plants draw their water out of the Ohio and Licking rivers, and water is provided for about 300,000 people. Service includes the Cincinnati metropolitan airport. NKWD's challenges include aging infrastructure (water mains are over 100 years old in some areas).

NKWD is governed by a Board of Commissioners comprised of representatives from Campbell and Kenton counties and is regulated by the Kentucky Public Service Commission. Planning is reviewed and updated about every 5 years, resulting in a 20-year list of improvement projects and initiatives to meet needs categorized as regulatory compliance driven; capacity from growth; repair and replacement of aging infrastructure; enhancements to level of service for customers; and improvements to communication technology. NKWD is migrating toward a performance driven asset management program that will assist in prioritizing projects.

New Paradigm

The two communities offer a broad spectrum of physical and cultural differences for consideration of concepts to be applied to a new paradigm.

During the retreat, the group first discussed conceptual model components in the context of each community and then worked together to generate ideas for a broadly applicable model for the new paradigm.

Based on input received at the retreat and follow-up research, the research team defined the new paradigm as a composite of five integrated components:

1) Sustainability Goals

The first component of the new paradigm involves communities adopting and defining sustainability goals. If there is to be a new way of thinking, then communities need to establish goals that will guide them toward more sustainable solutions and outcomes. Formally establishing collective sustainability goals among core community government institutions and agencies (including those involved with water infrastructure) as well as the broader populace engages the community by raising awareness and obtaining up front consensus for making decisions down the road that will lead to more sustainable practices and outcomes.

2) Sustainability Operating Principles

While these principles were derived from discussion involving the two case study communities, they are recommended for any community striving for sustainability and as such they constitute the second component of the research team's definition of the new paradigm. Like the example provided in the previous paragraph, each of these principles can be linked to multiple goals. There are too many connections to list them all, so just a few will be discussed to provide illustration.

Value the resource

A core principal for the new paradigm is to recognize all water as a valuable resource including stormwater and wastewater. Water is vital for life, and water in its various forms contains valuable resources such as nutrients, and energy. From an environmental perspective we need to value the entire water cycle, recognizing the importance of precipitation, interception, storage, infiltration, runoff and evapotranspiration processes to sustaining a strong triple bottom line. There is also social and economic value to the beauty and community that water can create (e.g., parks, beaches, hiking and boating areas).

How is this different from the current paradigm? The linear way that water is frequently managed now provides a good example. Under the current paradigm, communities typically extract, treat and distribute water for one-pass use, treat the resulting "waste" water, and return it to the environment. Under the new paradigm, cyclical or systemic ("closed loop") water management is emphasized; i.e., resources in "wastewater" (reclaimed water, nutrients, carbon,

metals, biosolids) are recovered for beneficial uses including potable water offsets (e.g., irrigation), fertilizers, and generating power. Additionally under the new paradigm, stormwater is harvested for water supply, irrigation, and infiltration benefits as opposed to the current tendency to convey stormwater offsite as quickly as possible with little or no regard for maintaining the hydrological integrity of the ecosystem.

Aspire to higher objectives that spawn better outcomes

The core of this principle with regard to water infrastructure is that designs should add value and provide multiple benefits (for example, natural treatment systems that double as recreational spaces or bioretention areas that serve as public art for the community). A key part of this higher objective is integrating the built environment with the natural environment. Under this principle, communities should consider life cycle impacts of actions beyond their local boundaries (for example, looking at impacts of local water infrastructure decisions on global climate change, or controlling water quality in the Ohio River to minimize the hypoxic zone in the Gulf of Mexico).

One way that this is different from the current paradigm is how this new way of thinking affects the complexity of design. Under the current paradigm, there is a tendency for administrative agencies and decision-makers to favor more well-known, less complex, standard infrastructure designs and technologies. Under the new paradigm, new technologies and strategies that may integrate several disciplines or institutional silos are encouraged where better outcomes are needed which cannot be provided using standard approaches.

Another example of this change in thinking involves the design of water collection and distribution systems. Most current pipeline systems are designed for one-way transport from supply side to a single use, or to treatment and disposal. Under the new paradigm, a higher objective is placed on reuse and reclamation. Communities use water multiple times, reclaiming treated water for the supply side of the infrastructure.

Consider context at multiple scales

Local actions can have implications at every scale; some impacts occur on site, some at the watershed scale, some regionally and some globally. For example, excess runoff from a developed site can erode soil on site, the excess runoff in turn destabilizes downstream channels adding further sediment to the water column at the small watershed scale, and the pollutants associated with the sediment combine with other runoff to impact water quality at the regional scale. Similarly, we are often reminded that energy consumption at our water and wastewater treatment facilities may lead to additional CO_2 emissions.

This principle brings us back to green building issues. Building design decisions, including water infrastructure, need to be made in the context of critical concerns for a given community. Watershed-based assessments are needed to identify thresholds for variables such as pollutant loads so that performance standards can be established locally, and building decisions are made to support neutral or restorative measures. Decision-makers need to avoid “one size fits all” solutions, instead staying attuned to ecological, social and economic opportunities, issues and constraints associated with their community.

Build intellectual infrastructure

To support new paradigm approaches, communities need to foster and support research, development and new ideas for water infrastructure management. Finding good triple bottom line solutions will often be challenging, and use of research and demonstration projects, and the compiling of a knowledge base of new technological approaches will facilitate success.

Additionally, communities need to build knowledge about their specific water resource issues. This means investing in maintenance of watershed characterization decision support tools. Monitoring and modeling systems (that can predict future conditions, support performance standard development, and help evaluate alternative water infrastructure management options) are both important in this regard.

Integrate water management decisions with all aspects of community planning and development

Under the new paradigm, all community decision-making must consider water. This is different from most community projects that currently do not consider water directly or treat it as an afterthought when issues arise. Valuing water and understanding that most infrastructure projects will affect the natural hydrologic cycle means addressing these issues up front in the planning and design phases. In particular, land use planning and water resource management must be coordinated.

Share responsibility and risk throughout the community

Under the new paradigm, the process of informing and engaging stakeholders regarding water infrastructure management should be transparent and inclusive. Too often under the existing paradigm, stakeholders are only informed when approval of pre-chosen solutions is required. Under the new paradigm, stakeholders are engaged in the decision-making process from the beginning. The open process is more likely to result in shared responsibility and risk, which helps the community move more as a whole toward sustainability goals. A part of sharing responsibility and risk involves building and relying on local capital for creative and science-based decision making. This also creates a greater stake in the outcome, which helps to focus efforts. Additionally, the inclusive and transparent approach is more likely to serve the overarching economic justice goal, deriving solutions that share cost across the community.

Recognize true costs and maximize value/benefits

Under the new paradigm, communities use triple bottom line principles to plan, design and manage water systems. Current infrastructure management decision-making often relies heavily on capital and recurring (e.g., operation & maintenance) cost as the primary quantitative factor for cost-benefit analysis. The new way of thinking incorporates use of full life cycle costs over a long-range (e.g., 100-year) life cycle to evaluate water resource management decisions. This information takes into consideration the external social and environmental impacts. Through this approach communities are more likely to be able to adequately assess whether they are meeting their overarching goal of having the value of services exceed the monetary cost of alternatives.

Choose Smart, Clean and Green

"Smart" infrastructure uses information and signaling (e.g., real-time meters) to modify water use behavior and treatment, supporting efficient use of resources. "Clean" infrastructure uses resources and methods that are resource efficient and avoids use of harmful substances. "Green" infrastructure learns from and works with nature and uses soil and vegetation to manage water and restore natural ecosystems. These new paradigm approaches differ from the existing paradigm approaches that tend to favor gray infrastructure approaches (linear, single-pass, centralized systems). Smart, clean, and green approaches are directly linked to the overarching environmental, social and economic goals because they emphasize efficiency, conservation, low environmental impact, healthy living, and an economy with more emphasis on clean industry.

Adapt and evolve

Change is inevitable. Even though the perceived risk of change is often high, continuing under the current water management paradigm may be riskier as waterbodies become more polluted, the cost of infrastructure management increases, and resources are depleted. The new paradigm recognizes this by emphasizing flexible systems that can adapt and evolve over time. Communities need to implement management approaches that monitor performance so that progress toward goals can be assessed and corrections to plans, designs and operations can be made as needed.

3) Integrated Technological Architecture

New technological approaches into the following four categories:

- Resource efficiency, recovery and recycling—in addition to water, other waste-related resources should be used as efficiently as possible, while resources in waste should be recovered and recycled.
- Distributed resource management—a combination of infrastructure scales, from decentralized to centralized, should be used as appropriate; managing resources closer to the source of generation and reuse of the resource is often more efficient.
- Multi-benefit infrastructure solutions—infrastructure solutions can and should provide a multitude of benefits spanning the triple bottom line of environmental, societal and economic attributes.
- Design new water systems that mimic and work with nature—these systems will both protect public health and safety and will restore natural and human landscapes. Nature and man can cooperate to rebuild healthy communities and restore natural ecologies through incorporation over time of sustainable infrastructure designs and principles, with water at the center of these designs.

While each of these four approaches has merit on its own, the new paradigm emphasizes integrating across the spectrum of approaches as appropriate for the context within each community. Additionally, since technological approaches are applied with the objective of attaining certain levels of performance to achieve triple bottom line goals, the new paradigm

emphasizes monitoring outcomes and adapting these technological approaches to enhance performance over time.

4) Institutional Capacity

This component of the new paradigm involves building the institutional capacity to facilitate operating under new paradigm principles and integrating new paradigm technologies and architectures. Although there are innovative and effective technologies available that recover and reuse water, mimic and preserve ecological functions and services, and holistically integrate water, stormwater, and wastewater management, most utilities still rely on conventional technologies. To shift to the new water infrastructure management paradigm, we need to bring together site-scale innovation driven by the green building movement with integrated infrastructure and watershed management planning. This water paradigm shift will depend, in great part, on institutional change and building the capacity to support sustainable operations. The results of these discussions and follow-up by the research team led to defining several key areas where communities in general can focus on building their institutional capacity, including:

- Integrated Planning and Smart Growth
- Watershed Scale Planning and Management
- Full Life-Cycle Costing
- Improved Regulations
- Enhanced Community Engagement
- Investment in Intellectual Capital
- Market Mechanisms

5) Adaptive Management

The fifth and final component defined by the research team for the new paradigm involves evaluating the outcomes of a community's water infrastructure management approach and adapting goals, policies, tools, methods and/or operations as needed where performance assessments indicate an unacceptable shortfall from established goals and objectives. Outcomes are often uncertain when charting new waters, so monitoring results allows plans to be incrementally adjusted over time to reduce uncertainty and improve outcomes.

Summary

Many of the core principles defined for the new paradigm contrast with past and current practices, for example, in valuing all water as a resource, moving toward a performance-based regulatory framework, aspiring toward better outcomes, and recognizing true costs while maximizing the value of action.

This effort produced a framework for supporting a new sustainable water infrastructure paradigm. The framework includes as core elements an integrated planning structure that

connects current institutional silos, a technical toolbox to use in the context of performance-based requirements at the watershed and community scale, regulatory flexibility to encourage innovation and affect better outcomes, research and demonstration to build knowledge and capacity, new partnerships and funding mechanisms, and a variety of means for engaging the community stakeholders to broaden support and affect better outcomes.

A
WORKSHOP ONE MEETING SUMMARY

A diverse stakeholder advisory council was established to guide this project and provide input. The members of the advisory group are listed in Table 3-1.

The first stakeholder workshop was held March 18-19, 2008 at EPRI's office in Palo Alto, California. The mission of the first stakeholder workshop was to identify procedures and incentives (or lack thereof) that are presently in place to encourage consideration and utilization of decentralized approaches to water/wastewater management in new and infill development, with a specific focus on water/wastewater management within watersheds. The group also endeavored to evaluate the effectiveness of those procedures/incentives and the resulting benefits. The procedures/incentives needed to encourage the increased or more widespread use of a combined water/wastewater management approach were to be identified. The group was also charged with identifying specific goals and tasks to be addressed in subsequent projects and at the second workshop.

The first workshop was focused around six main areas of discussion:

- Water Sustainability
- Current Standards
- Role of Technology
- Role of Codes and Standards
- Incentives
- Site Specific Considerations

Initially, it was planned to hold a second workshop three months later to continue the dialog with a goal of identifying the work plan for the remainder of the project. Since the first workshop was successful in identifying the work plan for phases two and thee and since no new information would be available until those two projects were underway, the group decided to postpone the second workshop and repurpose it to allow for project review and guidance after the other two phases were in place. This resulted in Workshop 2 being held in the summer of 2009.

Table A-1
Stakeholder Advisory Group Members

Name	Organization
David Berry	Facilitator
Bob Goldstein	EPRI
Tina Taylor	EPRI
Valerie Nelson	Director, Coalition for Alternative Wastewater Treatment
Steve Moddemeyer	Seattle Public Utilities
Michalene Reilly	Hoosier Energy
Ray Ehrhard	Washington University
Scott Drake	East Kentucky Power Cooperative, Inc
Mike Luzier	President, National Association of Home Builders Research Center
Jerry Stonebridge	President, National Onsite Wastewater Recycling Association
Juli Beth Hinds	South Burlington, VT
Marita Roos	Andropogon (Sustainable Sites)
Neil Weinstein	Low Impact Development Center

Welcome and Meeting Introduction

Bob Goldstein (EPRI) gave a brief summary of the role of EPRI and proceeded to outline the objectives of the workshop. Sustainability of water resources is of great interest to EPRI and the power generating industry partly because about 40% of all freshwater withdrawals in the U.S. are for the cooling of thermoelectric power plants.

The ecosystem, the social system and the economic system work together – and it is important to understand how the three systems work and interconnect. The figure below shows the concept proposed by several theorists and used by the Sustainable Water Resources Roundtable. The economy is embedded in the social system (the economic system is a created by society to facilitate commerce) and the social system is constrained by the ecosystem or biosphere.

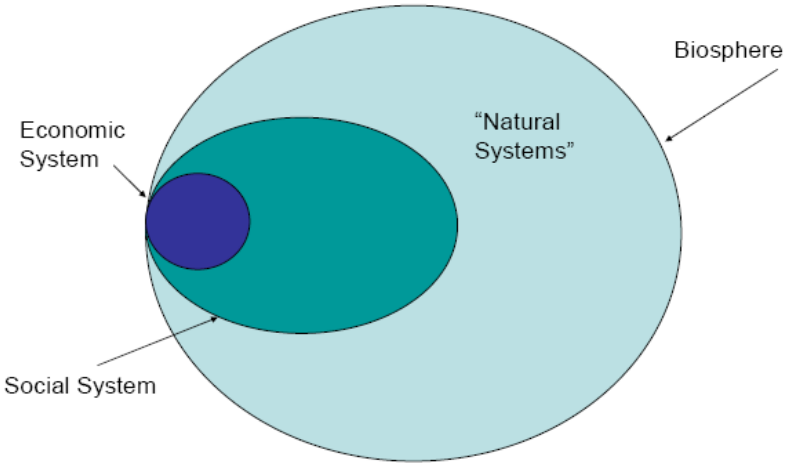

Figure A-1
The ecosystem, the social system and the economic system are interconnected

Sustainability of water resources occurs when water supply and demand (including ecosystem demand) balance. Conservation is a necessary factor for sustainability – but if demand outstrips supply – you still won't have enough water. So the challenge is to work with both supply and demand to get a balance that is sustainable.

The group was reminded that EPRI and WERF had interest in identifying what was known and not known about increasing the sustainability of water resources related to buildings and urban development and identifying a research agenda to fill the gaps.

There were six overarching topics on the agenda and we would attempt to discuss each topic before we looked at summarizing specific follow-up projects. The summary of the discussions of the six principal topics as reported in this document reflect their free ranging nature and the diverse perspectives of the participants. No attempt was made to reach consensus regarding these multiple viewpoints. The only consensus desired was with respect to the research plan to be implemented.

The participants each took five minutes to share the perspectives and experience they brought into the meeting related to water sustainability in the context of building and development. Several interesting ideas emerged during the short presentations:

- How do utilities and builders become more sustainable over all – not just looking at one issue and then the next and the next?
- The home building industry is really starting to look at water sustainability more carefully although some are still in denial – so this is an exciting time to work on these issues.
- The Secretary General of UN recently declared that the most important environmental issue for the UN is sustainability of water resources.
- There are opportunities to look differently as to how society handles water. More efficiency in use, more reuse, less losses in the systems to leakage and evaporation all can play a part. One participant pointed out that China is looking at decentralized treatment and distribution

systems for water. The view was expressed that the US should explore this and other means to use water resources more sustainably.

- How do ideas get communicated most effectively? Use of jargon does not help the public and officials understand issues, analyses and solutions. Individuals are starting to be interested in these issues – but they still need to be clearly communicated.
- The participants were informed about and invited to participate in the Sustainable Water Resources Roundtable (www.acwi.gov/swrr)
- A guide for the group discussions: Since EPRI and WERF are not-for- profit research institutions, they do not take advocacy positions with respect to policy and regulations; however EPRI and WERF can involve themselves in educational activities.

Water Sustainability

The comments and questions participants had in advance were: Sustainability involves the sum of all impacts and interactions among many sectors, decisions and technologies. Water is a shared resource. Best management practices are site based, individual and from the bottom up. The notion of sustainability is a broad system overview from the top down of the need to balance resource supply and demand for the present and the long term and the need to sustain the ecosystem in which all of our activity takes place. Participants were asked to consider how to best bridge top down and bottom up approaches. Questions to stimulate discussion included: What are the watershed impacts of each individual application? What are the opportunities to aggregate best management practices into a larger whole that moves toward environmental, economic and social sustainability? How can this be encouraged? What research is needed in this area?

Brief opening comments were made by Valerie Nelson, Ray Ehrhard, Steve Moddemeyer, and Jerry Stonebridge. The following is a synopsis of those comments and the discussion they stimulated.

The group heard how climate change could worsen current water supply/demand imbalances. The issue of sustainability is much more complex than just balancing supply and demand. Ideas of sustainability depart from the more common single project/single issue focus of some engineers and authorities. Sustainable water resources will require a paradigm shift towards 'water centric thinking' about natural and social systems. In nature water is managed not one part at a time, but in processes that are much more multi-operational, and take place in a much larger context. Participants agreed that a useful approach would be not just to consider supply/demand questions, but how infrastructure is designed built and used in a way that is more holistic and integrates and creates multiple benefits. One approach is that total water management at local, smaller scales can result in more value with more green space, less heat in the cities, etc. Watershed plans that work in an urban area may need to be modified for rural and suburban areas.

The group discussed the many sectors that use water: power, agriculture, industry, etc. and how these all interact, impact and affect each other. Future population increases will mean an increase in energy and water needs in all of these sectors but many communities and regions are already

at a point where they face significant water constraints. There would be benefits from sharing technologies and ideas among sectors and stakeholder groups. There is a need to better scope what project or policy an organization is trying to do. There is not a choice between top down and bottom up, both approaches are needed and goals for sustainability can be the same.

"Who's going to pay for it all?" is a question that needs to be answered for all policies and technological changes. The issues of technology affordability and public acceptance need to be addressed in the many approaches that can be considered:

- Matching water treatment technologies to their intended use
- Models – how to make them more robust and integrated
- New treatment technologies
- Demonstrations of multiple treatment and water re-use technologies
- Nano-scale research

The group summarized some issues and obstacles to the shift toward sustainability. Sustainability is not an abstract concept but begins with very practical matters right "in our own back yard." In the meeting the suggestion was made that to a water utility person, sustainability might just mean how to deliver water in an affordable, efficient way now and in the future. It's a challenge to communicate the more complex opportunity that sustainability is. Whether or not a large number of people understand the big picture, it is still important that individuals and organizations see their own responsibility and opportunities to move toward sustainability.

Obstacles to sustainability include many different aspects of our legal, social, economic and technological systems:

- Sometimes outdated regulations impede something being implemented that would support sustainability. The conditions of the site itself and the conditions of the watershed where the site is located are better determinants of what is appropriate to a project there than a regulation never designed for sustainability. For example natural soils are needed to support a healthy hydrologic cycle and if an infrastructure project destroys the soils, it takes forever to replace them and to replace the function they served.
- The human component often gets forgotten. One example given was that a call for energy efficiency is great but if a family has kids who don't close doors to the outside, all the energy goes out the door. If people don't heed calls to conserve water, a public policy can fall short of meeting its goal. We need to empower people to understand what they can do personally.
- Small incremental benefits for behavior change will not be sufficient to get an individual to make a shift. A meaningful shift in practices must be for whole communities. The average person expects water to be clean and available whenever the tap is turned on. People need to be motivated to invest in better technology or modify their behavior. Water is often subsidized and delivered at less than what free market prices would be. Before conservation can actually happen, real market prices may be needed for some to raise their awareness. For example, a tax on stormwater is being developed in Philadelphia. This gives an economic impetus to manage stormwater.

- The length of the capital budget process is often an issue with implementing change. In many areas, authorities are continuing to invest in big pipe systems. While alternatives are indeed coming on line, communities will continue to live with the effects and costs of existing infrastructure for a long time.
- Often a general solution developed at a national level is not appropriate at the local/regional level. Watersheds, infrastructure in place, weather patterns and local water uses are not the same.

In summary, the group thought there were several areas to consider for improving sustainability of water resources in the context of green building and development.

1. A range of sustainability solutions will be needed and an understanding of how to work with the existing system. A variety of approaches will be needed which one participant called a "tool box of technologies".
2. Consider management of distributed systems and other less water intensive approaches
3. Promote efficiency and water reuse technologies including natural water system retrofits especially in infill and suburban development environments
4. Acknowledge that energy is a significant input to water supply and vice versa. (Twenty percent of total energy use in California is for water pumping, moving, and end use).
5. Improve and zone for healthier small urban watersheds
6. Draw attention to infiltration

Current Green Building Standards

The comments and questions the participants had in advance were: How does the Green Building Movement work as a system? How has it been successful in bringing together a wide range of divergent interests and in spreading into applications so fast? Do current green standards, (LEED, etc.) cover the key aspects of water sustainability? If not, what would a green standard that included water sustainability look like? To what extent would it focus on a development? To what extent would it include specifics of each watershed? A policy that manages water just from the supply side or just from the demand side will not lead to sustainability. What is missing and needs to be included in the suite of guidelines now being used? What research is needed in this area?

Brief opening comments were made by Juli Beth Hinds, Mike Luzier, Neil Weinstein, Valerie Nelson, and Jerry Stonebridge. The following is a synopsis of those comments and the discussion they stimulated.

LEED and the ANSI standards currently being developed are the most visible standards for green buildings. LEED is already in widespread use, primarily by architects. The ANSI standard is based on a large consensus-building process, with stakeholders at the table. The group was told that while ANSI is not perfect for water issues it has more comprehensive coverage on water than LEED. The cost of compliance with the ANSI standard is about the same as LEED. ANSI had eight "buckets" of categories and a minimum score in each category and a cumulative score

that determines level of green achievement. Levels are bronze, silver, gold and emerald. Water is currently included in three of the buckets: design, site evaluation and energy efficiency.

ANSI differs from LEED in that transaction fees are less. Builders tend to go along with the ANSI rating program because they believe that as long as there is a voluntary program, they won't have a regulatory program. Participants were invited to review the ANSI standard and comment at http://www.NAHBgreen.org . Builders are more likely to incorporate sustainability into their designs if they have a set, easy to understand standard. Whatever the standard used, there should be a "building owners manual" for the homeowner or building owner, educating them on how to keep their building efficient and non-toxic.

The group heard that the LID Center says that the coverage of water in the LEED standard is prescriptive rather than performance based. It was thought to be better to develop management systems with opportunities for improvement along the way. The best models are adaptable. So that diverse areas and organizations could train their staff to look at different "concerns" and find ways to improve. This is a local or regional approach because what "green" is can vary from one location to another. The standards could be transformed to a business or management model.

Concern was expressed in this session over perverse incentives in some rating systems to use greenfield sites when what makes more sense from a sustainability point of view is to use brownfields. One person pointed out that rating systems, themselves, can distort behaviors. Instead of designing a building to get the most points it could be better to design to a standard; for example, to use a reduced percentage of the energy used in old designs. Since we still don't know what sustainable is, it's hard to say we can choose a method for reaching it, but continual improvement may be what we need instead of thinking that we have to get to a known point.

Other examples were given of green building standards that were not discussed at length: the

Seattle Green Factor found at http://www.seattle.gov/dpd/permits/greenfactor and the Ahwahnee principle for resource development and livable communities at: http://www.lgc.org/ahwahnee/.

EPA has Energy Star ratings for waste water treatment plants, which can be found at http://www.energystar.gov/index.cfm?c=government.wastewater_drinking_water .

In summary the group said we can't get back to lower populations and unaltered ecosystems, so we need to start where we are and change the way things are done whether that be technological improvement or behavioral change. Human communities will always have managed ecosystems. Rating systems can be useful in bringing about some of the changes through redesign of individual projects. Other changes must be community-wide. For example, the area now occupied by Seattle went from 15% surface runoff in its natural state to 70% with development. To return to the pre-development state would be unlikely, but if Seattle could reduce runoff to 45% through capture and evaporation it would be a significant improvement. Perhaps rating systems need to be modified to apply to each municipal system individually. Rating systems may be improved by having more variables included or by showing monetary and other benefits that come from using the systems rather than just an evaluation of or rating. The most thorough evaluation of a project is full lifecycle analysis, but it is rare that an organization will take the time and spend the money to do it. So life cycle analysis gets suggested but not mandated or

applied. A good rating system is a lower cost surrogate for a full life cycle cost accounting and makes a positive impact at lower cost.

Role of Technology

The comments and questions participants had in advance were: The role of technology within the context of sustainability of water resources is in development. What is happening in various sectors (e.g. building, manufacturing, energy, and transport)? What technologies are being applied at various scales (from small new decentralized waste water management programs to retrofits on major urban systems)? What are the obstacles to implementing the best technologies? What don't we know how to do? What research is needed in the technology area?

There were brief opening comments from Bob Goldstein, Scott Drake, Ray Ehrhard, Mike Luzier, and Neil Weinstein. The following is a synopsis of those comments and the discussion they stimulated.

The participants looked at the role of utilities. Electric power utilities would get a better return on their investments in energy efficiency campaigns if these efforts also included water. Much is happening in the area of technology improvements for water utilities but it is very fragmented. Identifying and disseminating successful innovations could be a good research project idea.

Having the appropriate technology to do treatment is important to water utilities. There are efficiency losses if the water is over or under treated. Decentralization is being used more for smaller systems. Infrastructure is the main place research money is being spent but research is also needed at smaller scales, including the residential sector.

In the private sector, some large industries have sustainability goals and are ahead of the game. For example, the Dow Chemical CEO set a goal 30% reduction in energy and 40% reduction of water use in one year and made great progress, but such efforts have to be cost effective. Small to medium industries are usually doing much less than more advanced large companies. In the power industry, water usage is critical. The work of the Water/Energy Nexus (Sandia National Labs Website http://www.sandia.gov/energy-water/nexus_overview.htm) has been a central mover on this.

The group discussed the Land Resources and Water Management Summit that took place last year. At the Summit, a list of research issues came up including the importance of public education on water quality or water management. There is always the problem of inertia that resists change: the idea that "we have always done it that way; that's just how we do it."

With respect to public education, the group discussed the importance of learning through experience how to best communicate with stakeholder groups, what will motivate them, and what will de-motivate them. It is important not be presumptive about what they know or don't know.

In what areas of basic scientific research is there an apparent deficit?

- Microbial fuel cells

- Cascading benefits of technologies working together
- What are the elements of sustainable systems – close loop, etc?
- Working with a sector that could move things forward a great deal – building sector.
- How do sustainable systems operate and how do we integrate these systems?
- Desalinization with less energy
- How to manipulate microbial populations to remove toxic wastes from water?.
- Greatest weakness in watershed models is in data. Remote sensing could be the answer.
- Climate adaptation
- How would the green factor apply in different types of climates?
- Are there enough savings in energy costs in decentralized systems to defray dollar costs of investment in these systems?

In summary, even if using technology for building green may cost more for the building itself and some research has shown that this may not be the case on a well planned project, there are also additional external savings beyond the specific project that may not be reflected in the initial calculations. Using decentralized controls may allow communities to get regulatory approvals when other such savings are available.

Role of Codes and Standards

The comments and questions participants had in advance were: What are the roles of codes, standards, regulations, systems and policies in development both in support of and as obstacles to sustainability? Are any innovations appearing in the US or elsewhere in building codes or laws that should be emulated around the country? What are the obstacles to implementing the best innovations in this area? What research is needed in this area? Brief opening comments were made by Juli Beth Hinds, and Steve Moddemeyer. The following is a synopsis of those comments and the discussion they stimulated.

In the discussion on the role of codes and standards, participants agreed that outdated regulations and zoning can be big obstacles to innovation and sustainability. Parking requirements could be called “public enemy #1” with regard to large impermeable surface run off. Some regulations related to the free flow of traffic are outdated. Some codes are based on public health and safety with wide impermeable streets required for easy access of fire and emergency vehicles when in a suburban neighborhood a ‘”pipe stem” street with much less impervious surface would be quite adequate for access. Similarly renovations of older buildings often need to be facilitated by regulation or code changes that get rid of outdated standards.

Seattle has made it a requirement that any new buildings over 9 stories downtown must use LEED standards. They have also required the use of “Go Green” in certain buildings. For subsidized housing there is an ability to get more funding if you use the “green factor”, so it becomes a de facto code.

Rainwater harvesting for irrigation is very cost effective and yet this is often not covered in the codes and regulations. Landscaping improves the score on rating systems so everyone does landscaping. This includes multiple vegetation layers, permeable pavement, green roofs, vegetative walls (based on a square foot standard), and rain water reuse. Stormwater planters get double credit for their larger depth of soil and the water capture ability. Besides the rating systems, it is helpful if landscape design is required to be part of the original project. It ahould be part of the building permit, design permit, and occupancy permit which require that the project be inspected and approved along the way. Administering this is easy. People in government like that aspect but these innovations are not part of codes across the United States yet.

The group agreed that many good things are happening with codes around the country and discussed how to get information on these practices out to other cities. An award for performance is one way. Ranking the cities publicly has had a positive effect. Now there is competition among mayors trying to "out green" each other. The greening of cities has hit critical mass and something also hits with developers and lately they want to be "regulated or coded" so that their competitor has to do it also and not have a cost advantage. The science of diffusion of innovation was discussed as a background to the spread of ideas and practices. It was related to codes and standards as well as the other issues of this meeting. There is current research on the role of communication and a report can be found on the NAHBRC website.

Bringing a project to an area where the codes do not promote these ideas and finding a way to make them work by persuading the community is a challenge. There was a discussion of the Table Rock project in Missouri which served as an example.

Economic Incentives

The comments and questions participants had in advance were: In the context of Sustainability of Water Resources what is the role of economic incentives and disincentives to the application of best practices and changes in laws? Are "perverse subsidies" driving unsustainable practices? What incentives would make the most difference on the ground? Do current economic incentives reflect the value of the resources? What research is needed in this area? Brief opening comments were made by Marita Roos, and Michalene Reilly. The following is a synopsis of those comments and the discussion they stimulated.

The group discussed the predominant culture in organizations which often will not innovate unless there are clear short term economic benefits. This is a set-back for the implementation of new Best Management Practices, especially those that require maintenance and for which the economic benefits are long term.

Home Owners' Associations (HOAs) have multiplied. There are many private neighborhoods and a transformation of the local government into micro-governments. Attention was drawn to the book 'HOAs: Private Neighborhoods and the Transformation of Local Government' by Robert H. Nelson. The HOAs rarely address water issues. HOAs may not be an appropriate vehicle for management. Some think that for effective management for the long term it is better to have the decision-making about maintenance as far away from the ratepayers as possible so that the funds will get allocated, not postponed.

Sustainability often requires a diversity of solutions applied appropriately to a variety of local circumstances. It is not easy to plan for or create a flexible enough set of regulations and standards. For example, the complexity of the public/private management structure & ownership of decentralized systems is greater than for conventional large public systems managed by one central authority.

There was a discussion of the relative roles of regulatory vs. economic incentives in the move towards sustainability. There is interest in creating a nexus of utilities to address broad community outcomes. As one participant put it "There are much greater reasons to do integrated water systems than just the water itself." The group agreed that incentives should be designed to put attention on the triple bottom line and not just on economic factors.

Site Specific Considerations

The comments and questions participants had in advance were: How do differences in local geography, existing infrastructure, size of project, and water demands by different sectors play into the larger context of water resource sustainability? What role do regional cultures and economics play in the ease of discovery and implementation of innovations? What research is needed in this area? Brief opening comments were made by Marita Roos and Scott Drake. The following is a synopsis of those comments and the discussion they stimulated.

The group learned that the asset management approach in Seattle did not stress economic incentives. Communities were asked to volunteer and in return were given payments for roads and sidewalks. The communities are still responsible maintenance. A participant asked "How is this not an economic incentive, if the City paid for it?"

Subsidies for wastewater and potable water programs create huge disincentives for innovation because there is a huge bias toward Publicly Owned Treatment Works (POTW). Several participants stated that subsidies and tax incentives should be opened to the green building industry and not restricted to builders and operators of large water infrastructures. States and the federal government should give more consideration to use of green approaches and technologies in setting priorities for project approval and support.

With respect to Public/Private property concerns, requiring private entities to improve public space (such as between the sidewalk and the street) is a problem and private entities suing the city can be an issue.

Generally incentives are in place to continue using water the way we have always used it. If social and environmental benefits of green projects are coupled with economic benefit, the total benefit would be increased. There is a need to identify and communicate financial benefits for a different way to put in systems or of using an alternate system. It should be understood to whom any financial incentives accrue. Multiple stakeholders are coming to the table. How do they fit with one another and what are their patterns, roles and benefits?

In many organizations, whether or not they are an elected body, there is a risk aversion toward innovation based on fear of a making a decision that becomes a public failure. This concern for

avoiding failure serves to limit innovation. There is less risk in doing things the way we have always done them.

A multi-stakeholder process can reduce the fear of innovation. The group discussed an exercise called "Open space 2100". Citizens were asked to envision what they would like their community to be like by 2100? It was common to have a green vision of integrated development with a lot of water included. Such community visions can serve as a launch point to set the direction for development.

Often current standards and measures do not work toward determining if a specific growth issue is sustainable. One project from the Lady Bird Johnson "foundation" looks at a project to assess whether a project does no harm and moves the community further along a trajectory they want to be on. The group agreed that performance needs to be measurable. LEED is at least setting a bar; it is a low and incomplete bar with respect to water but it is a place to start. There was a consensus that no single rating system should be the unique path to sustainability.

With respect to site specific considerations, the group agreed that the area of focus needs to be broader than the site itself. It must be at least a community and perhaps the watershed. Local geography matters in exploring how a project affects the water flow and whether water is returned to its source. Most people do not think about the entire water cycle when designing a project. In the Southwest, water efficiency is a major concern. Wet weather and stormwater issues are different in different localities and localities have different standards. The whole area of wastewater has been lacking in standards. For more efficient water use and reuse, a set of communication tools is recommended to identify dysfunctions and illustrate benefits from alternate treatment scales and technologies.

The simplest examples to better explain the need to include water and wastewater in any green discussion would be to point to the places where major impacts are occurring (i.e. where groundwater is being depleted and combined sewage overflows occur). There is not a compelling public connotation in the phrase "Disrupted Hydrology", but when hydrologies are disrupted, the public can understand the severe implications for communities which possess depleted groundwater reservoirs and polluted streams.

How many more people could a city support if alternate technologies such as decentralized wastewater were applied? A problem is that there is no universal site case; there is a good deal of variability. But there are universal actions that apply anywhere. For example it is generally better to recharge groundwater.

Site-based practices that can be encouraged are reduction of stormwater flows and increasing rainwater harvesting and wastewater recycling.

Participants in the meeting thought there is a need to find ways to inspire people around the concepts of green development. We need to identify economies of scope as well as economies of scale. We don't have a consistent set of metrics for what constitutes "sustainable site development".

Some participants thought that LEED's focus on measurability is why it's less relevant to water issues beyond the individual project. The amount of water flushed can be measured so the

standard stays with that. Site and watershed impacts are harder to measure, so they do not show up in the LEED standards. LEED has created a market; but the measurement system is not sufficient for site & water considerations.

Creating an approach to encourage people to care about place and maintain it would support sustainability; what are the metrics of how much emotional investment people will have in alternate water approaches and outcomes?

The participants discussed what outcomes could come from this meeting:

- Are we creating a rating system for site & water? Probably not
- Are we seeking to encourage public officials to be visionary? We hope so.
- How do we create a project that will inspire public officials? That is the ongoing work

How do we increase the awareness of the need for water sustainability among visionaries and leaders in the utility, engineering & public official communities? A national 'one size fits all' regulation is not an ideal solution to a variety of site specific and regional problems. Local programs and policies are where innovation can occur and fortunately sometimes does.

Summary Discussion

The comments and questions participants had in advance were: What have we learned and what did we miss? Do we better understand how the various aspects of Green Development can contribute to the larger systems picture of Sustainability of Water Resources? Are there any topic and issue areas that we should discuss now or at the June meeting in Washington? Has a research agenda begun to emerge?

The group moved quickly to decide whether or not to recommend some specific research projects on the role of sustainable water in the green building movement. First there was a general discussion to summarize what we had covered. The following comments represent the opinions of individual participants. They do not represent a group consensus.

With regard to ratings, the participants discussed whether there is a complementary system that could be developed to go with LEED? Some advised against that approach because of the complexity of having multiple systems. One participant asked "Is it the rating system itself that makes the difference or is the real need for visionary public officials?"

The group agreed that engaging local government and educating public officials is important. They discussed approaches to creation of a "program" that would affect public officials. Builders themselves may open the market for these sustainable ideas and leadership can come from many sectors. Participants asked "who is the target audience for this work? How can this project innovate and educate regulators? Prepping the civic and private sector leadership may be the main objective."

We may not know what the best evaluation systems are but we can explore what can we do to solve problems and how do we best evaluate how well the solutions are implemented. We may

need to wait for a crisis to focus government and public attention on the key issues of sustainability, but should have a response strategy available now.

Next Steps

The group proposed two important efforts for moving forward. Contractors for both studies would be chosen through Requests for Proposals (RFPs). The RFPs would be fairly open, encouraging responders to be creative in their proposals.

The suggested studies were:

1. Developing the paradigm: The plan is to hold a four day intensive retreat to define and clarify the new water infrastructure paradigm. The retreat would consider one or more model communities with respect to how they were incorporating water resource sustainability goals into their overall water supply, wastewater treatment and stormwater management strategies and practices.

   A group of questions that could be addressed by the retreat included:

   - From a practical standpoint, what is the most effective way to take ideas for sustainability to a not very progressive or innovative community or organization, and present them as an attractive practical alternative to what it is currently doing?
   - What is the best way to define overall goals?
   - How do you capitalize on the external benefits that would come from a paradigm shift such as green jobs, reduced warming, and reduction of stormwater runoff? Over time they could lead to a shift of how public water utilities function, away from a centralized construction and management role to an oversight role of a variety of decentralized systems.
   - When recommendations to apply alternate technologies are made, are people who can install and maintain the systems available in order to make the recommendations a reality?

   The advisory group agreed to suggest a list of names of potential participants for the retreat as RFP recipients. Valerie Nelson and Tina Taylor agreed to work together to on the retreat RFP.

2. Green building practices: This effort would evaluate how a diverse set of green building projects were addressing water sustainability and the strengths and limitations of different green rating systems with respect to these projects.

   There was agreement in among the advisory that its second workshop would be held after the new paradigm retreat and potentially after bids are solicited for a green building project.

   In the meantime, the advisory group will continue to provide guidance to EPRI through the stages of issuing RFPs and selecting contractors. At the next workshop, the group will discuss how to move the results of the retreat into the outside world. This group might develop a communication plan.

B
WORKSHOP TWO MEETING SUMMARY

Between the first and second workshops, EPRI initiated two projects. The first project was the project approved to hold a retreat focused on the new water paradigm. The second project was focused on reviewing 3 case studies on green building. In addition to members of the original stakeholder advisory group, researchers working on these two projects participated in the second workshop.

Table B-1
Workshop 2 Participants

Name	Organization
Jeff Moeller	Water Environment Research Foundation
Bob Goldstein	EPRI
Tina Taylor	EPRI
Valerie Nelson	Director, Coalition for Alternative Wastewater Treatment
Trevor Clements	Tetra Tech
Tracy Mehan	The Cadmus Group
Victoria Kiechel	The Cadmus Group
Scott Drake	East Kentucky Power Cooperative, Inc
Mike Luzier	President, National Association of Home Builders Research Center
Jerry Stonebridge	President, National Onsite Wastewater Recycling Association
Juli Beth Hinds	VHB
Laura Dufresne	The Cadmus Group
Neil Weinstein	Low Impact Development Center
Rustom Meyer	The Cadmus Group
David Bailey	EPRI

Project Background

Tina Taylor and Bob Goldstein presented a general overview of the funding structure, history, and goals of the Sustainable Water Resources Management Project. This project is part of the

larger National Decentralized Water Resources Capacity Development Project (NDWRCDP). Congress appropriates funds for the NCWRCDP to the Environmental Protection Agency's Office of Research and Development (EPA-ORD) to be administered by WERF. EPRI is the principle investigator for the Sustainable Water Resources Management Project.

The Sustainable Water Resources Management Project began in 2006 with a constraint that all funds be spent by 2010. The overall project goals are to protect the environment and human health while meeting the growing demand for water. Recognizing that buildings play a key role in water management, the original project plan was to create a methodology to evaluate, rate, and certify water related building features - essentially to develop a new rating system. Based on input from WERF and discussion with other stakeholders, the project team has moved from their original goal to evaluating what exists in the green build industry today. While green build rating systems encourage water conservation and efficiency, there is a concern that they do not consider technology availability and limitations, long-term requirements with respect to operational cost and maintenance, and efficacy with respect to community/watershed/regional water sustainability. The objective of the revised project plan is to develop and test a methodology to link the certification and rating systems with these three issues.

The revised scope for the project specified its implementation in three phases as follows, with the outcome of the Phase 1 to be used to define Phases 2 and 3:

- Phase 1: Review available information, develop stakeholder advisory group, and hold workshop (workshop 1) for stakeholder advisory group to define needs for the project
- Phase 2: Define a new water infrastructure paradigm by selecting community case studies and organizing and facilitating a retreat for a diverse group of stakeholders
- Phase 3: Evaluate green building projects

EPRI representatives noted that Phase 2 is essentially a top-down approach to the issue, where as Phase 3 is a bottom-up approach looking at specific building projects.

As presented by Tina Taylor to the workshop participants, the Request for Proposal (RFP) issued for Phase 2 requested proposals to: (1) organize and hold a 4 day retreat that convened a diverse group; and (2) prepare and facilitate a workshop that allows in-depth exploration of water management approaches and outcomes (e.g., community case studies). Many firms were invited to respond to the RFP and submitted good proposals; EPRI ultimately selected Tetra Tech for Phase 2, to begin selecting case studies in February of 2009. The retreat was held in early June 2009 and Tetra Tech is currently preparing the retreat summary and Phase 2 report.

The objective of Phase 3 is to evaluate green water management practices by applying a variety of green practice rating systems to one or more pilot projects where these practices are proposed. Such an evaluation would provide greater insights into the efficacy of these practices and the relative strengths and limitations of the rating systems with respect to achieving water sustainability on the community level. Similar to Phase 2, many firms were invited to respond to the RFP and submitted good proposals; EPRI ultimately selected Cadmus for Phase 2, who began work in May 2009.

The main objectives of this workshop (workshop 2) are as follows:

- Provide an update to the stakeholder advisory group on Phases 2 and 3 of the project.
- Allow the stakeholder advisory group to provide comments on progress and plans; suggest improvements; and look for linkages, similarities, and missing pieces between the three phases.

During this introductory portion and throughout the workshop, participants noted that context for the pilot projects are very important. What is "green" in terms of sustainable water management for a building depends on the climate, location in the watershed, local resource scarcity, and other watershed-specific issues. For example, while nutrient removal from water is very important in Ohio, nutrient removal is counterproductive in Tucson, AZ where they use gray water for irrigation.

Water Sustainability Initiatives in the United States

On the morning of Day 1 of the workshop, Tracy Mehan spoke with the workshop participants about water sustainability initiatives in the United States. Tracy noted that the implementation of the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) by separate EPA divisions has created a "stove pipe" approach for regulating water. To achieve sustainable water management, it is critical that individual agencies responsible for drinking water, wastewater, and stormwater work together. Other government agencies that influence water such as transportation, parks, public works, and development should be brought to the table. Workshop participants expressed concern that the existing regulatory structure inhibits a holistic approach. Water management needs to be approached in a centralized way. Tracy noted that he remained skeptical that there will be "one voice" for water in the regulatory community.

Tracy discussed the cost effectiveness of "designing in excellence" the first time instead of designing out flaws. Green infrastructure had the advantage of not only being less expensive in many cases, but it is favored by the community over piped solutions.

Tracy discussed examples of communities that are taking comprehensive approaches to implementing green infrastructure solutions or low-impact development practices. In Philadelphia, the water department took the lead in this effort in 2000 by reorganizing into the Office of Watersheds. The new office focuses on regional integration of water, wastewater, stormwater, and watershed protection for drinking water. In Portland, city officials use a top-down approach, requiring all agencies to incorporate stormwater management in every project. Maryland requires that developers emulate pre-development hydrology onsite. Milwaukee has identified sources of pollution and developed key indicators for water quality. Trevor Clement commented that a focused group of individuals at the community level is critical to sustainable water management. Agencies need to have the flexibility for scaling up and down smoothly. For example, it is important for the water department to focus on its primary mission but also important for it to cooperate with other agencies and share information easily.

The workshop participants discussed the importance of education. Tracy noted that large water and wastewater utilities have the resources to implement civic education and strategic communications. There may be ways to incentivize them to promote education (education should come out of basic budget to meet water quality objectives).

An important question raised during this discussion was "who is the leader" in implementing the new water paradigm. Scott Drake noted that water systems shoulder a big part of the responsibility, but are resistant to implement decentralized technologies because of management and liability issues.

Valerie Nelson noted that phosphorus recovery will become increasingly important in the future as the supply of phosphorus in the environment dwindles. Phosphorus recovery is an excellent example of how water resources can be managed in such a way that they are self sustaining and restorative.

Report on Phase 2

Trevor Clements (Tetra Tech) distributed to workshop participants the following documents:

- A draft outline for the final report: Case Studies on New Water Paradigm
- A June 30, 2009 draft of the 21st Century Water Infrastructure – Catalyst Document with a note to reviewers regarding the status of the document and purpose of its three major sections.

Trevor provided an update on work completed to date on Phase 2. He noted that although the project plan had originally called for a 4-day retreat, after contacting key individuals it became clear that convening experts for this many days would be extremely difficult. Instead, Tetra Tech reduced the retreat duration to 2 ½ days and conducted a pre-retreat conference call to orient and engage participants.

The retreat occurred on June 1 – 3 in northern Kentucky and hosted a diverse group with a total of 35 in attendance. It began with presentations to set the stage, including background on the two case studies and vision for the future of sustainable water infrastructure. Day two of the retreat was more of brainstorming session on how to achieve this vision with discussions on planning, community engagement, regulatory and programmatic change, management, and financing. Day three (1/2 day) focused on forming the broader vision and developing recommendations for the new paradigm. Trevor reported excellent workshop attendance and participation.

Trevor noted that two diverse communities were selected for the case studies: Tucson, AZ, which is located in the Colorado River watershed and gets only 13 inches of rain per year in a few events; and a community in northern Kentucky which gets 40 to 50 inches of rain per year and faces serious combined sewer overflow (CSO) problems. Background papers for these two community case studies will be included in the Phase 2 report.

The workshop participants provided input on the June 30, 2009 draft of the catalyst document:

- Neil Weinstein would like the report to emphasize ways to get green, clean, cheap, reliable water. He would like the report to be from the perspective of water being a necessity. He also emphasized the importance of providing cost information.
- Trevor clarified the target audience for the catalyst document. It is not intended for the general public; instead, the document is intended to be a tool for champions of the new

paradigm. Trevor also noted that his group intentionally avoided using scare tactics in the document (i.e., if you don't do this you will run out of water).

- Tina Taylor emphasized the need for a new paradigm that is unified as opposed to a collection of different issues. Bob Goldstein stressed the importance of consistency in the final report.
- Valerie Nelson noted that much of the success of the new paradigm rests on green building rating systems that let developers know what is needed.

Comments on "The Future of Water Infrastructure:"

- Valerie Nelson suggested reducing the number of bullets and focusing on more general topics that specify how to apply the sustainable water infrastructure tenets.
- Valerie also recommended that the report advocate more complex solutions than just "cheap and clean." It should detail multiple benefits from one outcome. The benefits should be reliable, make the link to context of watershed, and make a link to sites.
- Neil Weinstein recommended adding information on the timeframe of examples. For instance, over the last three years communities have used x to solve problem y and it is working.

Comments on "The Emerging New Paradigm:"

- The participants discussed the advantages and disadvantages of explaining the first four paradigms before presenting the new fifth paradigm. This type of background information may interfere with the delivery of the main message by asking the reader to absorb information about multiple paradigms. Providing the historical background, however, emphasizes that we have changed paradigms before and shows our evolution.
- Tina Taylor and Neil Weinstein suggested that the fifth paradigm be presented as flexible and able to adapt to new circumstances. Tina noted that optimal solutions are based on value. The old paradigms were optimal when water had no value.

Comments on "Tenets of the New Paradigm:"

- Tina Taylor and Trevor Clement noted the importance of getting consensus on this section.
- Workshop participants discussed the relevance of the tenets. How do they help communities reach their sustainable goals?
- Valerie Nelson commented that although resource management is included and that community scale is emphasized, the site scale and value of decentralization should be emphasized more.

Report on Phase 3

Laura Dufresne and Vicky Kiechel (Cadmus) presented findings to date for Phase 3 of the project. Laura Dufresne provided an introduction and overview of the presentation. Vicky Kiechel presented preliminary findings of the three case studies. Laura presented the approach

for the impact assessment. Vicky ended Day 2 of the workshop with a presentation on the green building rating systems.

Introduction

An important goal of Phase 3 is to compare green building rating systems to the tenets of water sustainability and identify if / where gaps exist. Workshop participants believe that green build rating systems should be linked to community objectives. This was a comment made by many participants throughout the workshop.

Stakeholder advisory group members requested that the Phase 3 report describe what an ideal building would look like in terms of water sustainability. This ideal would go beyond the LEED platinum standard ("LEED diamond" or "LEED squared" were identified during the workshop as possible names of this ideal building system) and would represent water management that is not just ecologically neutral but ecologically restorative. This key point was made multiple times during the workshop.

Valerie Nelson provided the following examples of ecologically restorative approaches to water:

- Dockside Green in Victoria, BC
- The Solaire building in Battery Park City
- Work by Steve Moddemeyer in Seattle, WA (the Green Factor).
- ECO Block in China

Juli Beth Hinds noted that universities, Fine Homebuilding, and This Old House are advocating water sustainability that is ecologically restorative. We need to move beyond universally applied best management practices (e.g., green roofs throughout a city) to an approach that considers local context. Tina Taylor recommended that the Cadmus report first identify what the very best systems do for water management then determine how the green build rating systems could be used to support these models. Are current rating systems driving us to the ultimate goals? If not, where are the gaps?

Valerie Nelson noted that the people developing green building rating systems do not understand water and water professionals do not understand green build rating systems. Vicky Kiechel commented that until the last several years, water management was not emphasized in architecture programs. Water management had little effect on building design. The workshop participants discussed the need to provide incentives to architects to consider water sustainability without being prescriptive.

Case Studies

Case Study 1: The Chesapeake Bay Foundation Merrill Center

Vicky Kiechel presented findings to date for the first case study: The Phillip Merrill Center of the Chesapeake Bay Foundation (CBF). The site is located directly adjacent to the Chesapeake

Bay. This is not considered a good site in LEED terms; however, the CBF was asked by the community to purchase the site from the existing business to prevent it from being further developed. The previous site consisted of several buildings and a pool and any redevelopment would have likely had a negative environmental impact. The CBF are very aware of the relationship between their building and the specific issues surrounding the Bay.

The Merrill Center was added as a case study late in the project to substitute for the originally selected site, Sidwell Friends School in Washington, DC. Sidwell Friends had agreed to participate in the study when approached by Cadmus during the proposal phase. However, when Cadmus contacted them to begin work, they reported that the earliest they could provide case study information would be January 2010, which is too late for this project. It is believed that the onsite bioswale has failed and that Sidwell does not want to provide data for a case study until it is repaired and working properly.

Workshop participants noted the importance of highlighting barriers to implementing green water management in the Phase 3 report. The local health department resisted CBF's proposed use of treated rain water for hand washing. The Fire Marshall told them that the diameter of the opening of the composting toilets was too large (there is a rule that a shaft can be no larger than 4 inches in diameter and the composting toilets require a 10 inch shaft). CBF was required to fire-rate the shafts. Employees also resisted the use of composting toilets; however, operations staff report that they have been operating well and complaints are minimal.

Neil Weinstein questioned the validity of using three case studies to inform Phase 3 of the project. Do three studies make a big enough sample set? Workshop participants agreed that it is important to frame the findings from the studies carefully (not broad conclusions but possibly lessons learned from three illustrative examples).

Workshop participants discussed how LEED could promote advanced technologies. How do you get credits for using state-of-the-art water management systems? LEED does not currently address this issue. Participants noted a possible tradeoff in higher energy requirements for advanced water treatment such as ozone disinfection.

Case Study 2: Wetland Studies and Solutions

At the beginning of Day 2, Vicky Kiechel presented preliminary findings for the second case study, Wetland Studies and Solutions, Inc. (WSSI). WSSI is a for-profit enterprise that is in the business of water management. The owner, Mike Rolband, has his eye on the bottom line while promoting green. He wanted his office building to look "normal" as opposed to the Merrill Center where the CBF was trying to showcase their green initiatives. WSSI was certified under LEED commercial interiors (CI).

WSSI has been very happy with performance of the pervious pavers and wishes that they had installed more. The WSSI office also has a lush green roof that is used by residents. Mike Rolband reported that he did not see the green roof as being cost effective. However, there were unanswered questions during the workshop regarding how Mike came to this conclusion (did he look at energy saving issues and life cycle materials assessment?). Stakeholder advisory group

members reiterated the importance of not extrapolating this conclusion to the entire green building universe (green roofs are likely more cost effective in urban areas).

The WSSI case study highlights regulatory barriers to implementing green site features. The County originally wanted curbs on all parking spaces, which would have interfered with the flow of water to the rainwater catchment system. Workshop participants speculated that the requirement for curbs is antiquated because it is no longer needed for safety (i.e., to prevent cars from rolling). There is also an argument that the pavement will ravel without curbs, although workshop participants had not seen any examples of this. Similar to the Merrill Center case study, WSSI also encountered resistance to using treated rainwater for toilet flushing.

Case Study 3: Millennium Tower

Vicky Kiechel presented a summary of the Millennium Tower Case Study. Battery Park City Authority has very stringent requirements for water conservation and management in new buildings. For this case study, the neighborhood scale is driving water management objectives. Workshop participants believe that the water management by Battery Park City is driven in part by rising cost of water in New York City.

Workshop participants are concerned that some of the best management practices for green buildings are decorative rather than functional or if they are functional, they are not the most cost effective strategy for the building. Tina Taylor noted that life cycle analyses are a good tool for comparing different approaches for water management. She expressed interest in which features generate points for green building rating systems compared to how significant the features are with respect to local water issues.

Vicky Kiechel reported that even though the black water treatment system at Millennium Towers can treat up to 25,000 gallons per day, much less is reused in the building because they do not reuse this water for cooling or irrigation. In contrast, another building in Battery Park, the Solaire, is using recycled water for cooling and possibly for fire suppression, irrigation and laundry. Stakeholder advisory group members recommended that Cadmus contact Ed Clerico at the Solaire to understand why the black water treatment units in the two buildings are operated so differently. Juli Beth Hinds suggested that Cadmus also contact Mike Hoover at NC State to discuss this issue.

Cadmus should consider using the Solaire as an example of what can be achieved. Valerie noted that a significant lesson from the Solaire story is the importance of people from different disciplines sitting in the same room to come up with the best solution. The Solaire also shows the limitations of LEED and importance of a champion. Millennium Towers also illustrates stove pipe thinking between various building systems. Why not irrigate green roof with treated wastewater?

Stakeholder advisory group members discussed metering of individual apartment units as an incentive for residents to conserve water (as noted later in the workshop, LEED does not give points for sub-metering). They also recommended that Cadmus look for reports that compare energy required for advanced onsite treatment to energy required for municipal water and wastewater.

Jeff Moeller suggested that water management be explored from the city perspective. Some cities want the sewer fees and some arid regions need the water. Other cities may be facing capacity problems in their wastewater collection and treatment systems. Juli Beth Hinds noted that combined sewer overflows are a priority problem in New York. Just 1/10 of an inch of rain will cause the combined sewers to overflow. Juli Beth recommended that Cadmus talk to the New York City Department of Environmental Protection and other relevant organizations to discuss CSO issues. She also recommended that Cadmus talk to the Mayor's office and the state to get their perspectives. The City can also provide a good perspective on water conservation goals.

Impact Assessment

Laura Dufresne presented Cadmus' proposed approach for conducting the impact assessment for each case study. Neil Weinstein recommended that Cadmus review recent NRDC reports for information on the amount of energy used for treating water. Juli Beth Hinds and Cadmus agreed on the need to examine the actual discharge to the sanitary sewer compared to the amount of black water treated.

Juli Beth recommended that Cadmus consider modeling the impact of the site on the local hydrology. Bob Goldstein noted that there are difference scales of concern. Bob asked how Cadmus proposed to relate the design and operation of each building to the watershed. Cadmus is considering evaluating hypothetical watershed impacts if say 30 or 50 percent of the buildings in that watershed implemented the same stormwater management practices.

The stakeholder group agreed that while it would be informative for Cadmus to model things like pre- and post-development stormwater runoff, the focus of the impact assessment should be on the pertinent issues of the area. Do the green buildings make an impact on the priorities for a specific case study?

Neil Weintein and Juli Beth Hinds questioned Cadmus' recommendation to use the P8 model for stormwater impacts. Laura Dufresne explained that the P8 model was selected because it can assess impacts of stormwater best practices in series and can evaluate impacts on both quantity and quality of runoff. Neil noted that other models may be more appropriate for looking at the relationship between the building and the site. Tina Taylor suggested that she arrange for a follow-up call with the Cadmus modelers and stakeholder advisory group to explore this issue further.

Green Build Rating Systems

Vicky Kiechel presented an overview of the three green build rating systems being evaluated in the Cadmus project: LEED, BREAM, and Green Globes. She provided a detailed comparison of requirements for obtaining water credits under these three systems.

Workshop participants expressed concern that while the green building movement does provide some incentives for water, it is not addressed sufficiently. Water should be central instead of add-on points and consideration should be given to local context and long-term operation. More

monitoring of the performance of water conservation/management systems is needed. Workshop participants also expressed the opinion that it is easy to "cheat" in LEED. A building can meet the minimum requirements for water and be LEED certified without doing very much.

The workshop participants also expressed concern that recertification is not required by any of the rating systems. There are currently no incentives to recertify. Participants found it very troubling that Millennium Towers was certified with the black water treatment system at full capacity but is currently only operating at a fraction of that capacity because of water quality problems with respect to reuse in cooling towers. Vicky Kiechel noted that attention has been paid to this discrepancy for energy but not for water. The stakeholder advisory members were also concerned about the baseline calculation in LEED being for pre-development of the specific project as opposed to an undeveloped site. For example, if the pre-developed site had significant impervious area, credits would be received for reducing the impervious area.

Stakeholder advisory group members suggested that Cadmus evaluate the Austrian rating system and compare it to LEED, BREAM, and Green Globes. The Australia system is more focused on water sustainability because of their recent drought.

Workshop participants discussed ways in which LEED could encourage a more regional approach to water sustainability. Ideas included requiring that the building tie into an existing community level water plan and requiring that the operation of any onsite water system meet certain metrics. The water category within the rating system could be entirely local with some universal credits. Education was seen as key – a basic understanding of the hydrologic system of the water supply, wastewater treatment, and watershed issues could go a long way. Guidance on a regional/local approach to water sustainability could be incorporated into a revised LEED reference manual. Vicky Kiechel noted early in the workshop that the U.S. Green Building Council recognizes this issue and has taken an initial step to address it by allowing regional chapters of USGBC to allow double points for certain credits depending on regional priorities.

Discussion of Final Report Dissemination

The final report will pull together results from the three project phases. The specific format is yet to be determined. Jeff Moeller noted that EPRI owns the copyright to the final report. WERF will post and distribute the report, but EPRI can do so as well.

Workshop participants discussed ideas for communicating major findings from the project to the public. Valerie Nelson suggested that the report be electronically accessible by section or chapter and hyperlinked. The group agreed on the value of summary fact sheets to communicate key findings. Jeff Moeller referenced executive summaries that are prepared for WERF reports. Juli Beth Hinds noted that it would be useful to have fact sheets. Fact sheets could be developed on specific topics from the report such as the paradigm, the case studies, and evaluation of the green building rating systems.

Post-Workshop Activities

Tina Taylor distributed copies of the slide presentations to workshop participants and other members of the stakeholder advisory group following the meeting. The stakeholder group convened via conference call on Tuesday, July 14, 2009 to discuss the selection of the model for the Cadmus stormwater impact assessment. Valerie Nelson provided to the Cadmus group contact information for Ed Clerico, engineer for the Solaire; Steve Moddemeyer who works in Seattle on the energy / water nexus; and Goen Ho, professor of Murdoch University in Australia who is working on Australia's green building rating system.

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