An Integrated Approach to Asset Management and Sustainability to Achieve Best Management Practices Through a Triple Bottom Line Approach

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Introduction

Both public and private agencies are operating in a world that is much different than it was even a few short years ago. The world is unprecedentedly more connected and transparent, driving increased awareness and the need for organizations to respond to a greater set of stakeholders, while also managing an expanding list of resources that are critical and vital for long term operational success. This change has driven organizations to view themselves as a responsible citizen, consulting with and held accountable to a much wider range of stakeholders than in years past. This new dynamic also requires organizations of all types and sizes to operate in a global economy that is facing increasingly strained resources, both natural and capital. With this new reality, both enterprise and governmental organizations have been reaching for operational and decision methods that help navigate this complex set of circumstances. Both asset management and sustainability frameworks have emerged to effectively serve this purpose.

The term sustainability has been emerging for the past 30 years with the internationally accepted definition described in the Bruntland Commission’s 1983 publication of Our Common Future as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. Key concepts that are inclusive to strategies for sustainability include ethics, governance, transparency, business relationships, financial stewardship, economic development, value, employment practices, and environment stewardship. While these considerations are inherent to sustainability, in practice both public and private agencies often focus on environmental stewardship in their sustainability efforts and consequentially miss their opportunity to broader, integrated solutions.
Asset management has also been an emerging concept for the past 25 years, evolving to a broadly defined system that is to “provide a desired level of service through the management of assets in the most cost-effective manner for present and future customers” (NAMS, 2006). This definition is equally interpretive as the definition of sustainability since assets are all uniquely defined based on the organization’s views and practices. In its broadest sense, asset management aims to ensure good decision making, minimize lifecycle costs, evaluate, understand and manage risk, improve reliability, enhance knowledge management and decision making, improve communications with internal and external stakeholders and the public, and make effective use of infrastructure’s lifecycle. Conversely, a narrow interpretation focused solely on existing physical assets limits broader goals and outcomes that are attainable through the asset management framework.

While asset management and sustainability are both sometimes limited in practice, integrating the two frameworks proves to be a robust and effective use of best management processes which better meets the intent of both frameworks. In this paper, the authors address the concept of an integrated asset management and sustainability framework in which the two terms are synonymous for one another. Globally, while many utilities are, in fact, viewing asset management and sustainability as one and the same, the authors feel that this practice is not yet widely embraced, especially in the United States (US). In many utilities, sustainability and asset management functions are in disparate parts of the utility or are lead by separate directors (Sustainability Director, Asset Management Director), and these functions tend to compete for resources (namely funding), rather than work together. As a consequence, these utilities are not able to achieve the full range of benefits that are possible from an integrated asset management and sustainability framework. This paper will look at the high-level function of sustainability and asset management, demonstrating how integrating the two frameworks guides
effective best management practices at all phases in the lifecycle, and advocate for the use of this approach within utilities that are not using an integrated framework.

**Approach**

The integration of asset management and sustainability is possible due to the overlap of core concepts inherent in both frameworks. A key element, although there are many, of both approaches is the focus on lifecycle (planning, design, construction, operation, maintenance, repair and replacement, disposal). Figure 1 illustrates the core elements of each framework, demonstrating their overlap. The emphasis on lifecycle serves as one point of intersection from which the sustainability and asset management frameworks can be integrated.

**Figure 1**
Both asset management and sustainability are intended to be robust frameworks which address multiple objectives, and these overarching themes are shown in Figure 2. In outlining several of the traditional core components of the two frameworks, this graphic also illustrates the two distinct approaches each framework takes in reaching their overlapping goals. For example, a primary objective of sustainability is to minimize the use of natural resources. Efforts are made in planning, design, construction, operations, and maintenance to reduce the use of those resources that are mined, extracted, or produced such as water, energy, materials, etc. Equally, asset management aims to minimize lifecycle costs by extending the life of an asset, and thus reduce the use of materials and consumables which results in improved reliability and reduced cost throughout all the lifecycle phases. Both sustainability and asset management drive optimum lifecycle decisions that maximize shareholder wealth by minimizing the long term use of scarce resources.

Figure 2

<table>
<thead>
<tr>
<th></th>
<th>SUSTAINABILITY</th>
<th>ASSET MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste &amp; Replacement Management</td>
<td>• Waste stream management</td>
<td>• Optimal equipment replacement</td>
</tr>
<tr>
<td>Utilities &amp; Natural Resource Consumption</td>
<td>• Nature resources management</td>
<td>• Efficiency</td>
</tr>
<tr>
<td>Cost &amp; Risk Management</td>
<td>• Reduced unintended consequences</td>
<td>• Probability of failure related to consequences of failure</td>
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<td></td>
<td>• Sustainable return on investment</td>
<td>• Cost management</td>
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<tr>
<td>Environmental Quality &amp; Compliance</td>
<td>• Water quality &amp; ecosystem protection</td>
<td>• Maintain permit requirements</td>
</tr>
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<td></td>
<td>• Pollution mitigation</td>
<td>• Regulatory impacts on operations</td>
</tr>
<tr>
<td>Stakeholders &amp; Customers</td>
<td>• Quality of life (customers, community &amp; workforce)</td>
<td>• Levels of service</td>
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</table>
Both asset management and sustainability aim to achieve enhanced performance in these core components, however, strict, traditional interpretations of sustainability and asset management drive narrow solutions that focus on only half of the issues inherited in these core components. The integration of frameworks allows for a systematic approach to address the comprehensive set of concerns that ensure resource stewardship, effective cost and risk management, outstanding regulatory performance, stakeholder engagement, and customer satisfaction.

Recognizing the inherent relationship between asset management and sustainability allows for a broadened definition of an asset as infrastructure, or even more specifically, a piece of equipment, a structure, or a pipe, to encompass an organization’s people and natural resources. This pushes asset management into a more holistic framework, driving a greater set of operational goals than capital stewardship alone. By expanding the definition of an asset as discussed, an asset becomes synonymous with a resource. Sustainability, in its strict interpretation, is focused on natural or environmental resources. By expanding the definition of a resource to include people and economics, sustainability becomes more holistic as well. The expansion of the terms asset and resource also serves to provide almost complete alignment with each other and can be expressed simply by the triple bottom line framework, which addresses social, environmental, and economic perspectives, such that both asset management and sustainability are centered around optimizing financial/economic, environmental/natural resources, and social/staff aspects, now and into the future, as shown in Figure 3.
By taking an approach that integrates sustainability and asset management, which are viewed as essentially synonymous with definition expansion, through the use of the triple bottom line framework, a project or organization is applying best management practices that provide a better outcome by optimizing economic, social, and environmental factors in a win-win-win fashion. Some combined asset management and sustainability roles and functions are being to emerge in the US. Examining these case studies through a lifecycle perspective illustrates the benefits and viability of an integrated framework at each stage of a project's life.

### Planning, Design, and Construction

In taking a lifecycle perspective to discuss the integration of sustainability and asset management, planning, design, and construction provide key opportunities for the benefits from an integrated approach to be achieved. In addition, by comprehensively addressing opportunities from these benefits in the initial planning, goal setting and decision-making, greater synergy between asset management and sustainability can be achieved.
Planning is a vital part of the lifecycle in which to apply an integrated approach because all subsequent phases of the lifecycle follow from planning – so, by using the integrated approach, asset management and sustainability will be incorporated to an extent throughout the rest of the lifecycle. Design is equally as important as it will dictate operations, maintenance, repair/rehabilitation, and eventual replacement or disposal phases throughout the life of the asset and how those phases of the lifecycle will be tied to fiscal, employee/social, and environmental/natural resource impacts. Construction is the physical manifestation and therefore extension of the design, in addition to having direct impacts to the neighborhood, local ecosystem, and cost of its infrastructure. The fundamental components of the approach address the triple bottom line framework in planning, design, and construction in how to provide community benefits and reduce risk, protect natural resources, and strengthen the local economy while minimizing lifecycle costs.

There are numerous opportunities to apply this integrated approach in planning, which include: incorporating community or regional partnership opportunities to reduce risk, lower costs, strengthen the local economy, and enhance the community; planning for durability, flexibility, and adaptability with the long view in mind, such as addressing climate change impacts by considering siting vulnerabilities and future capacity needs; and incorporating the triple bottom line framework into decision making by performing business case evaluations to determine the solution with the best cost to benefit ratio while reducing risk and engaging stakeholders to create greater support/buy in and meet level of service goals.

The integrated approach can be applied to design through designing for efficient operations, system optimization, and use of resources to meet level of service goals, lower costs, and reduce the use of water, energy, and virgin materials, long asset life and extension to reduce costs, increase reliability, and decrease environmental impacts due to material, energy, and fuel use, the use of renewable energy/energy efficient and sustainable equipment and materials to reduce costs, reduce greenhouse
gas emissions, and improve the workplace environment, end of life recycling or alternate use opportunities to reduce costs, reduce the use of natural resources, and benefit the community.

Construction opportunities include: optimizing logistics to minimize community disruption (noise, dust, light, odor, traffic) and reduce costs and impacts to the environment by reducing the use of energy and fuel; using locally sourced materials to strengthen the local economy, increase reliability, reduce costs associated with shorter distances required for transportation, and reduce fuel consumption/greenhouse gas emissions that negatively affect the environment; maximizing onsite infiltration of stormwater runoff and conserving water to reduce treatment and infrastructure costs, replenish groundwater supplies, and reduce negative environmental impacts; reducing waste, recycle, reuse, and salvage materials to reduce disposal costs and offset the need to buy additional materials or equipment and eliminate the need to extract virgin materials; and addressing traffic to reduce congestion, provide multimodal options, and improve local quality of life for the attraction and retention of employees. Many of the same opportunities for applying the integrated approach to the construction phase of the lifecycle also apply to the replacement phase.

Case Study

The Greenroads™ Rating System is a decision tool that can be used by roadway owners, transportation planners, designers, contractors, developers, policy makers, and materials suppliers for planning, roadway design and construction projects. Greenroads™ is a collection of best practices that apply to roadway design and construction, much like the Leadership in Energy and Environmental Design (LEED) Rating System for buildings. It can be used in the planning stages to consider a variety of potential elements to include in the project, in the design stages to incorporate specific elements, and in the construction stage for material choices and best management practices.
The tool focuses on five areas that touch all three areas of the triple bottom line approach (economic, environmental, social) - Environment & Water, Access & Equity, Construction Activities, Materials & Resources, and Pavement Technologies. The intent is to encourage responsible decision-making by including various elements into planning, design, and construction, such as a lifecycle cost analysis for pavement section and stormwater elements, having a pavement management system and a roadside maintenance plan, connecting habitat across roadways, performing roadway safety audits, promoting community values, reducing emissions with quantifiable methods, improving pedestrian, bike, and transit accessibility, using alternative fuels in construction equipment, using recycled or reusing materials for new pavement, using regional materials to reduce transportation, improving energy efficiency of operational systems, designing pavements for long-life, reducing the urban heat island effect, and relating construction to performance data (www.greenroads.org).

Using the Greenroads™ tool for roadway planning, design, and construction yields many documented benefits including:

- Lower capital costs because recycled materials are less expensive and using resources more effectively results in less waste and therefore lower disposal costs. Better planning and designs eliminate the need for additional infrastructure (i.e. installing a proper drainage system initially prevents future problems).

- Lower operations and maintenance costs because the materials, technologies and systems used are designed to last longer.

- Fewer traffic impacts because a longer lasting roadway requires fewer construction projects to repair issues.

- Higher property values for commercial and residential properties surrounded by smart and durable infrastructure.
• Fewer environmental impacts due to less stormwater runoff and improvements to sensitive ecosystems.

• Better eligibility for grant funding such as the Transportation Investment Generating Economic Recovery grants, United States Department of Transportation Tiger and Tiger 2 grants, and some state Department of Transportation (Oregon, Washington) (www.greenroads.org).

Specific projects that have used the Greenroads™ tool that demonstrate the benefits of an integrated approach include the 14th Street, Market Street to Colfax Avenue project by the City and County of Denver, Colorado. This project reused existing pavement, resulting in the extension of the of the road’s remaining useful life and the use of less virgin material, employed condition assessments to develop pavement deterioration curves and project remaining useful life to optimize lifecycle costs through better timing and planning for repairs, enriched the community through educational outreach and public art installations, and using permeable pavement to reduce environmental impacts (Weiland, 2010).

The Oregon Department of Transportation US 97: Lava Butte – S. Century Drive Section project used non-potable effluent for water needs resulting in reduced contractor costs and the conservation of potable water and reused onsite vegetation material, such as grinding tree stumps for mulch, to offset the purchase cost and the environmental impacts of transporting mulch. The project also sourced materials locally to increase the reliability of materials, reduce costs, and minimize environmental impacts, such as greenhouse gas emissions due to shorter transportation distances. Other project components included the installation of long life pavement for extended asset life and lower lifecycle costs, the reuse of pavement, which resulted in saving $10-$15 dollars per ton of pavement as well as using less virgin materials, and the use of native, non-invasive vegetation species and undercrossings to
help connect wildlife areas and save animal lives, reducing property damage and risk of human injury from fewer animal-vehicle collisions (Scarsella, 2010).

**Operations and Maintenance**

It is well understood that the operations and maintenance phases of the lifecycle represents the longest, often most costly, and most critical in an asset’s lifecycle. Therefore, thoughtful consideration of operations and maintenance during the planning, design and construction phases can provide significant opportunities for sustainability and effective asset management during the majority of the life of the asset. Because these phases of the lifecycle are so significant, a continuous improvement approach for managing the triple bottom line aspects are critical, and there are various benchmarking frameworks for continuous improvement. Continual “practices” improvement is important. These frameworks, along with the adoption and ongoing use of performance management systems and key performance indicators (KPIs), can support efficient and effective operations and maintenance.

From an operational perspective, the use of operation optimization efforts can significantly impact triple bottom line management efforts. A formal program typically focuses in the areas of water, energy, chemical, and fuel usage in an effort to reduce use of resources and minimize impacts on the environment and annual operating costs. Optimizing system operations has resulted in reduced maintenance issues, which reduces costs, improves reliability, and contributes to the extension of asset life and its associated benefits (less use of virgin material, lower costs, etc). In addition, these optimization efforts can result in significant changes in standard operating procedures, minimizing the time systems are in use which reduces the need for redundant equipment, and therefore the need to use virgin materials to create a new asset, increasing reliability and maintaining levels of service, and prolonging asset life and thus saving both money and natural resources.
Utilizing a proactive maintenance program provides another significant opportunity to achieve triple bottom line benefits, such as lifecycle savings and improved customer levels of service through improved system reliability, reductions in the use of natural resources, and asset life extension. Increasingly, there is a trend to conduct maintenance management benchmarking studies in an effort to move from reactive to proactive maintenance programs, with the support of computerized maintenance management systems (CMMS) and activities such as condition assessments. Using KPIs to set goals around the triple bottom line framework and the CMMS for tracking, continual improvement of maintenance activities can lead to the realization of the integrated approach benefits.

The maintenance initiatives employed often include both preventive and predictive maintenance programs, which are designed to ensure effective equipment health and performance monitoring. Predictive maintenance leverage technologies such as oil analysis to help forecast appropriate maintenance activities. For example, where historically preventative maintenance approaches used a time based schedule for oil changes (every three months), the oil analysis results indicate the need for changing the oil based on the condition of the oil. By understanding the condition of the oil, oil changes are only completed when necessary, resulting in a significant reduction in the number of oil changes needed. The benefits from the predictive maintenance approach are reductions in the use of oil, and therefore lower costs and less impact to the environment, more efficient use of maintenance staff and increased reliability since staff can focus on the assets that actually require maintenance, reduced risk from the avoidance of costly and catastrophic failures, and the extension of asset life. In addition to oil programs, there are other technologies that monitor performance and condition such as energy usage/efficiency, vibration, heat and flows that are used to help provide early detection of inefficiencies and failure, resulting in lower costs, fewer environmental impacts and improved levels of service. Many of the benefits that can be achieved through the application of the integrated approach for maintenance are also attainable for the repair and replacement phase of the lifecycle.
Using a work management planning and scheduling function for operations and maintenance activities enables efficient scheduling and planning of resource use for staff and materials, as well as increased reliability and decreased risk of failure. Through the use of CMMS and KPIs, the effective use of planning and scheduling can, in effect, increase staff availability and prolong asset life.

**Case Study**

The use of a maintenance management benchmarking exercise can offer an effective approach in designing and implementing a comprehensive and integrated improvement program. A large wastewater utility in Ohio embarked on such a journey in the mid-1990’s. Their program has evolved over time through the inclusion of a continuous improvement cycle as a core element. Today, their program includes best practices such as:

- CMMS optimization
- KPI development
- Establishment of a formal planning and scheduling group
- Preventive maintenance task analysis
- Predictive maintenance program development
- Lubrication/oil standardization and consolidation
- Operations optimization reviews

By implementing benchmarking recommendations, this organization has been able to realize the following benefits:

- Staffing resource efficiencies and cost savings through the use of a CMMS and formal planning and scheduling functions
• Improved reliability and extended asset life and through proactive preventative and predictive maintenance programs

• Reduced waste and use of resources as a result of the lubrication/oil and operations optimization efforts

Decommissioning and Disposition

Decommissioning and disposition at the end of the lifecycle also marks an important stage in which a combined asset management and sustainability approach produces strong benefits. Disposition itself, more so than other stages in the lifecycle, has a relatively balanced approach in management practiced because environmental remediation and project management costs are both high priorities. Depending on the nature of the site, one priority can easily dominate the other. If a site contains hazardous materials such as a nuclear or weapons facility, environmental remediation becomes the primary objective. Likewise, disposition of a commercial site might be solely driven by costs and schedule, especially if the local ordinances do not require demolition material to be recycled. Decommissioning typically has strong focus on legacy, seeking to either prepare the site to be redeveloped driving economic growth, or to restore the land to a natural state, persevered for wildlife and recreation, providing both social and environmental benefits.

Decommissioning and disposition goals and results tend to be focused on one or two aspects of the triple bottom line approach; however, they have the opportunity to fully integrate economic, social and environmental objectives. Using an asset management and sustainability framework for disposition allows for resources to be recovered and either sold or reused, enhanced environmental protection of the land and water bodies, as well as an increased focus on safety of workers resulting in fewer injuries,
maximized schedules and minimized costs. Asset management and sustainability focused
decommissioning can result in the creation of multiuse sites, encouraging redevelopment, driving
economic growth, and creating recreational space with restored natural habitats while also creating
space for cultural facilities.

Disposition Focused Case Study

Rocky Flats Nuclear Weapons Plant, a former plutonium and uranium weapons component plant, began
it disposition and decommissioning in July of 1995, including the processing, stabilization, and
disposition of more than 14 metric tons of fissile and nuclear materials and disposition of more than 800
facilities. With innovating performance based contracting that drove the remarkable results, Rocky Flats
closure was a unique project that exemplified the robust benefits that are produced when economic,
environmental, and social objectives are equally weighed and considered. Significant savings were
achieved, in part, through streamlined site operating and safety procedures and the elimination of
unnecessary requirements, as site risks were reduced. Environmental quality was ensured through the
stabilization and packaging of 106 metric tons of high-plutonium-content residues for disposal. Safe
storage, packaging, and disposition of 21 metric tons of SNM (highly enriched uranium and plutonium)
were completed more than a decade ahead of schedule (beating the regulatory milestone by 10 years).
Resource recovery was achieved through the resale/reuse of uranium to brokers from Rocky Flats,
including 2.5 percent enriched uranium for fuel products, highly enriched uranium for use in the Naval
Reactor Program, and depleted uranium for use in making armor and weapon projectiles. This
experience enabled material that had previously planned for disposition to be appropriate for
commercial sale.
Success at Rocky Flats freed up $600 million per year for the United States government to use on other projects. Previous Department of Energy estimates projected the closure of Rocky Flats by 2065 at a cost of $36 billion. With the innovative approach that was used, the Rocky Flats Closure Project was completed in October 2005, 60 years ahead of original government estimates and $550 million less than the final contract budget. Allen Schubert, Director of Strategic Planning, Rocky Flats Project commented on the project’s approach that yielded many triple bottom line benefits by stating “The program motivated employees to think of creative ways to get the job done... employees began to sit back and think about how can I get this particular work done in a way that I could save money and be safer? A number of significant innovations were born, resulting in many, many hundreds of millions of dollars in savings.”

Triple bottom line benefits for the Rocky Flats Closure Project include the total cost was $30 billion less than the initial contract budget, the completion date 65 years earlier than projected saved $100 million in security per year alone, 283 million square feet of land was decontaminated and the area is now a wildlife refuge, pollution per gram of soil decreased by over 95% (44% below target), the safety rate improved by over 400% ($300,000 rebate from insurance), in 1995 there were 900 employee grievances and in 2005 there were only a handful, there were over 200 innovations developed in conjunction with the Department of Energy, including glove box decontamination from one per year to three per day, and 20% of profits were paid to ALL employees, including union.

**Decommissioning Focused Case Study**

In downtown Milwaukee on the Menomonee River, 140 acres had a long history of being dedicated to the locomotive industry. With such a history, the land was contaminated with heavy metals, petroleum, chlorinated organics, and asbestos. In 2003, this riverfront was an underserved area, lacking
commercial or residential use. With a vision for redevelopment and the leadership to drive implementation, the City of Milwaukee received the property via condemnation. Focused on decommissioning with strong triple bottom line legacy components, the City began planning an integrated development plan to create the Menomonee Valley Industrial Center, rich in recreational, economic, and natural assets. The project grew out of a 1998 City-adopted plan that recommended the City acquire and redevelop the 133-acre vacant Milwaukee Road Shops facility, abandoned in 1985. (http://city.milwaukee.gov/MenomoneeValleyIndustrialCenter.htm)

Much like Rocky Flats Closure Project, the Menomenee Valley Industrial Center decommissioning was focused on innovated approaches to achieve triple bottom line result. Developing a first of its kind onsite management plan with the site’s regulatory agencies, $15 million of savings was realized by successfully negotiating through the onsite stabilization and encapsulation of asbestos containing materials. In addition, more than $25 million was saved through value engineering, new-found revenue streams, and reuse of materials—recycled glass, timber, and brick, which was otherwise destined for a landfill. Green infrastructure (wetlands, open space, and other previous space) was used to manage stormwater, create habitat and return native species to the area landscape. This approach also allowed for a new “green” recreational spaces for the community—including bike and walking trails, soccer fields, tennis courts, pedestrian bridges, fishing areas, and access to the cleaner river via canoe ramps. What was once unusable land will bring as many as 1,500 jobs to Milwaukee and create an increase of more than $120 million in recreational, aesthetic, and ecological value for the people of Milwaukee due to the City’s leadership.

Summary

Both asset management and sustainability are holistic, systematic approaches that should be highly integrated to achieve best management practices, and, with expansion of the terms “asset” and
“resource”, these two approaches are essentially identical. The integrated asset management and sustainability framework addresses the triple bottom line approach through a variety of mechanisms, such as:

- significant reduction in the use of natural resources, such as of water, energy, chemicals, materials, and land and waste generation (and thus cost),
- reduced costs of constructing and operating capital facilities over their full lifecycles through sustainable supply chain management and optimization of fleet, operations, and maintenance processes,
- systematic and consistent compliance with safety, availability, performance, and environmental requirements,
- improved accountability, service management, risk management, and financial efficiency,
- effective information retention and improved regulatory compliance,
- increased environmental benefits,
- improved community engagement, level of service delivery, and public safety, and
- reduced disruptions from as noise, air, dust, odor, traffic, crime, and longer service life for facilities and infrastructure.

It should be noted that organizational effectiveness and leadership, along with supporting information and management systems, are key ingredients to sustaining an integrated asset management and sustainability approach. The authors hope that the highlighted case studies demonstrate the potential benefits that can be achieved through an integrated approach, thereby providing compelling support for the acceptance and use of this framework as a new global standard for utility management.
Customers, stakeholders, communities, and the public are asking enterprise and governmental organizations to do more with less in a responsible manner. Both asset management and sustainability, used conjunctively in a robust framework, provide that answer with greater value, demonstrating good decision making and an effective means to plan, document, and communicate the vision, goals, progress, and successes both internally and externally. Regardless of which phase in the lifecycle, this approach can be successfully applied to achieve economic, environmental and social benefits.

References

http://city.milwaukee.gov/MenomoneeValleyIndustrialCenter.htm


www.greenroads.org