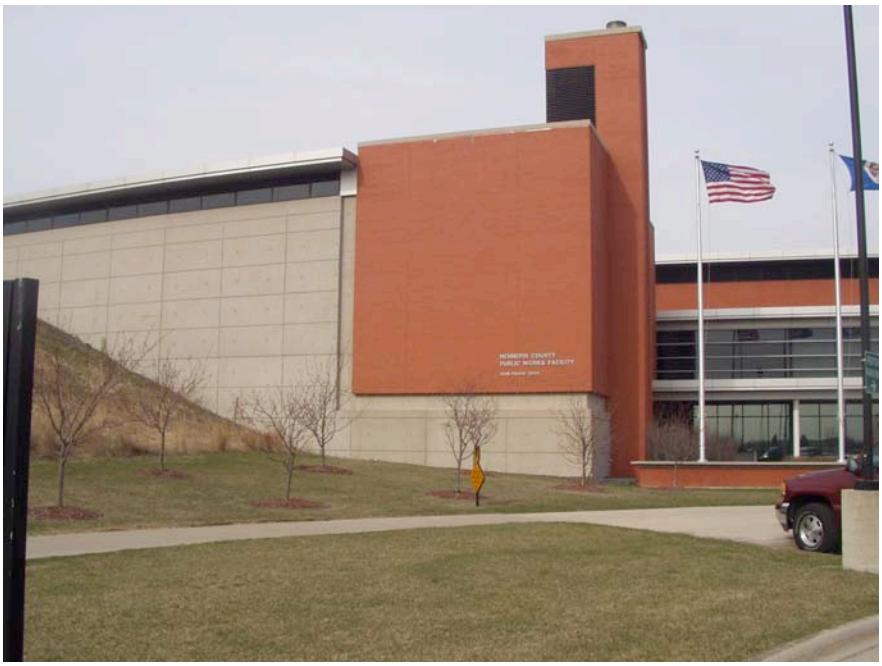
# Post Occupancy Evaluation

## *Hennepin Public Works Facility*
## *Medina, Minnesota*



*Prepared for the*

**Solid Waste Management**
**Coordinating Board**

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## ACKNOWLEDGMENTS

The Hennepin County Public Works Facility Post Occupancy Evaluation (POE) is one of five studies of sustainable building pilot projects by the University of Minnesota team. We would like to thank the Solid Waste Management Coordinating Board (SWMCB) for funding these studies, and the SWMCB committee for their guidance and direction. Committee members included Leslie Wilson, Carver County; Warren Wilson, Dakota County; Sue Doll, Anoka County; Paul Kroening, Hennepin County; Nicky Stewart, Washington County; Cathi Lyman-Onkka and Michael Reed, Ramsey County; Erin Barnes-Driscoll and Laura Millberg, Minnesota Office of Environmental Assistance; and Jan Lucke, Richardson Richter and Associates.

The study would not have been possible without the participation and cooperation of numerous individuals at Hennepin County. We appreciate the time and input of Greg Karr, Project Manager, Hennepin County Design and Construction, and Ted Walker, Facility Manager, Hennepin County Medina Public Works Facility. We also appreciate the insight and assistance provided by the architect, Peter Vesterholt, Architectural Alliance.

# Executive Summary

The Solid Waste Management Coordinating Board (SWMCB) is committed to the reduction of non-municipal solid waste (non-MSW) specifically generated through building projects in its constituent counties. To address this issue, the SWMCB funded the Center for Sustainable Building Research (CSBR) at the University of Minnesota to provide design assistance to the counties on several pilot projects. To learn from these projects, the SWMCB asked CSBR to conduct Post Occupancy Evaluations (POEs) of selected projects across the counties. The Hennepin County Public Works Facility was selected as one of these projects.

The POE research methodology consisted of general building data gathering, observational walkthroughs, plan and specification reviews, and collection of energy, water and waste data. Interviews were conducted with key participants including the County project managers, facility manager and architect.

### PROJECT DESCRIPTION

Hennepin County's transportation functions—which had operated out of a 166,085-square-foot facility in Hopkins for nearly 40 years—moved to the new Hennepin County Public Works Facility in June 1998. The 242,205-square-foot facility is located in Medina, Minnesota on a 146-acre site southwest of the intersection of Highway 55 and Arrowhead Drive. The facility was designed within a $23,900,000 construction budget and was built in 19 months. Final construction cost was $23,500,000. The furnishings and equipment budget was $1,435,000. This project was one of the earliest projects incorporating sustainable design in the region. Hennepin County has continued to apply sustainable construction guidelines and practices to subsequest projects such as the Brookdale Service Center and the Eden Prairie Library.

The Hennepin County Public Works Facility (PWF) is located on an existing plateau which allows the existing wetlands to remain undisturbed. The PWF follows the shape of the plateau in a gentle sweep. Buildings and site retaining walls integrate with the landscape and present a positive image to the community. The PWF yard areas are screened from view by the buildings, retaining walls, berms, and landscaping. Site and internal building circulation are developed to provide clear organization and orientation. The facility has its own internal sewage treatment plant and allows re-uses of cleansed domestic water for the flushing of toilets in the facility. Recycled and recyclable building materials in the new PWF are important features. Recycled content in excess of 15% is used in building materials, furnishings and finishes.

### SUSTAINABLE PROCESS

The Hennepin County Public Works Facility project was started before tools such as the Minnesota Design Guide were in existence. In spite of not having tools to facilitate the sustainable design process, the project team showed a strong commitment to the pursuit of sustainable design strategies on the project. In addition, there was no funding or program available from the local utility such as Energy Assets. The County championed the use of recycled-content materials on this project and the design team responded to the regulatory challenge of not having permitted access to the sewer by installing innovative graywater systems.

## SUSTAINABLE OUTCOMES

During the one-year period from March 2003 through February 2004, Hennepin County Public Works Facility spent a total of $261,258 or $1.08 per square foot on total energy costs.

This represents a total of 98.0 KBTU per square foot. Of that, 36% was electricity and the remaining 64% was natural gas. During this same period the peak electric demand was 2.6 Watts per square foot.

The total construction budget (building and site improvements) for the Hennepin Public Works Facility was $23,900,000 or $98.68 per square foot of building. The building construction costs were $88.15 per square foot of building and site construction was $2,550,000 or $0.41 per square foot of site.

The total cost for landfilled operational waste over the year 2003 was $783.73 per month. Hennepin Public Works Facility was charged $76.21 per ton of landfilled waste. Recycling service is provided by Hennepin County Environmental Service and the Medina Facility is not charged directly for service. By recycling 14% of the total waste over the course of one year, they achieved an average monthly savings of $50.03 per month. According to waste information received, the average monthly quantity of waste produced was 4.8 tons. Total waste generated per person is 34 lbs per month.

The facility's water is supplied by the City of Medina and there are five meters on site to accommodate the different functions of the facility. The water data collected is from January 2003 through December 2003. The average cost for total water use is $112.30 per month. The main building water use per month costs $58.91 or $0.21 per person. The vehicle wash station averages $39.00 per month and the fill station averages $14.39 per month. Over a one year period from January 2003 through December 2003, the total monthly water consumption was 44,212 gallons. The facility's water usage is divided into three areas, the usages for the main building was 22,479 gallons per month or 80 gallons per person per month, the vehicle wash station averages 15,537 gallons per month and the fill station uses 6,198 gallons per month.

The facility is not connected to a municipal sanitary sewer system; instead there is an on-site leech field and graywater treatment system from Zenon Environmental Inc. Graywater treatment costs include weekly inspections and maintenance, 24 hour on call service and a state DMR report. The graywater treatment costs $2994.76/month or $10.70 per person per month. The system does not treat the vehicle wash station waste water. Instead, that water is collected in tanks and hauled off site when needed by a septic service company and averages a cost of $925.62 per month. Total sewer costs equal $3,920.38 per month. The water and sewer costs are affected by the fact that there is vehicle washing on the facility and there is no sewer connection to the facility). These costs are offset by the lack of investment in the extending the sewer. The total water treated by the graywater system equals 22,479 gallons per month. The vehicle wash station waste water equals 18,479 gallons per month according to the bills for that service.

## RECOMMENDATIONS

There are several key elements that enable a County to successfully design, build and maintain sustainable projects while creating an ongoing process of improvement. These are listed below with recommendations for the County to achieve them.

1. *Adopt sustainable design guidelines or standards and ensure they are followed on all projects.*

   It is recommended that the County consider adopting the new Minnesota Building Design Guidelines (B3 project). These guidelines provide a detailed process and method of tracking project outcomes that will be used consistently for state funded projects (www.msbg.umn.edu). These guidelines are

also transparent to LEED which counties may wish to use to receive national certification of exemplary green building projects.

Note: Hennepin County has been a leader in developing and applying sustainable design standards and guidelines. The Public Works Facility was built before any guidelines existed.

2. *Select consultants with sustainable design experience.*

   Counties should have language in their Request for Proposals that requires an experienced sustainable design team.

   Note: For this project, sustainable design experience and qualifications were not included in the RFP.

3. *Find and empower a champion within the County to ensure follow through and success.*

   A successful sustainable project needs an informed and enthusiastic champion with decision making authority. Even if there is a champion leading sustainable design, there must be clear support from the County and all parties must buy in to the process.

   Note: For this project, there were champions and support from County leadership.

4. *Follow an integrated design process beginning in early planning stages.*

   Integrated design means involving the entire team as early as possible in the process. Ideally, sustainable design goals should be set at a kick-off meeting during planning stages before program and budget are firmly established.

   Note: In this project, some of the sustainable design strategies were introduced midway through the process. Some principles of integrated design were followed even though there was no explicit process.

5. *Conduct energy analysis and specification review.*

   During the design phase in all projects, it is particularly important to conduct energy use analysis during to identify and document savings. In addition, conduct a rigorous specifications review and require that sustainability criteria be included in the specification sections as appropriate.

   Note: Energy analysis was not performed in this case.

6. *Conduct periodic post occupancy evaluations on all buildings.*

   Post occupancy evaluations should be conducted periodically on all buildings as a tool for continuous improvement and to assess actual building performance. Whenever possible, performance results on one building should be compared to those for other similar buildings. Key performance indicators include energy and water consumption and waste generation. If possible, track employee satisfaction, absenteeism, turnover, and health care costs. Identify appropriate measures of productivity and assess employee performance. Track performance of sustainable design strategies over time and document the costs and benefits of particular features to inform future facility development.

   Note: It was not possible to conduct surveys on the building. This is recommended in the future. Comparison of this facility to other similar buildings is also recommended.

7. *Educate the public.*

   Continue to educate staff and public on sustainable strategies used to increase awareness of the benefits of sustainable design, and encourage public support of investing in sustainable design for the benefit to the community now and in the future.

   Note: Displays in this building demonstrate the use of sustainable materials. It is a widely publicized case study.

# Chapter 1. Introduction

The Hennepin County Public Works Facility in Medina was selected as one of several County building projects to be evaluated in the metropolitan area served by the Solid Waste Management Coordinating Board (SWMCB). In this section, the building project is described followed by background information, methodology and objectives of the study.

## PROJECT DESCRIPTION

Hennepin County's transportation functions—which had operated out of a 166,085 square foot facility in Hopkins for nearly 40 years—moved to the new Hennepin County Public Works Facility in June 1998. The new 242,205 square foot Facility is located in Medina, Minnesota on a 146-acre site southwest of the intersection of Highway 55 and Arrowhead Drive. The facility was designed within a $23,900,000 construction budget and was built in 19 months. Final construction cost was $23,500,000. The furnishings and equipment budget was $1,435,000. This project was one of the earliest projects incorporating sustainable design in the region. Hennepin County has continued to apply sustainable construction guidelines and practices to subsequest projects such as the Brookdale Service Center and Eden Prairie Library.

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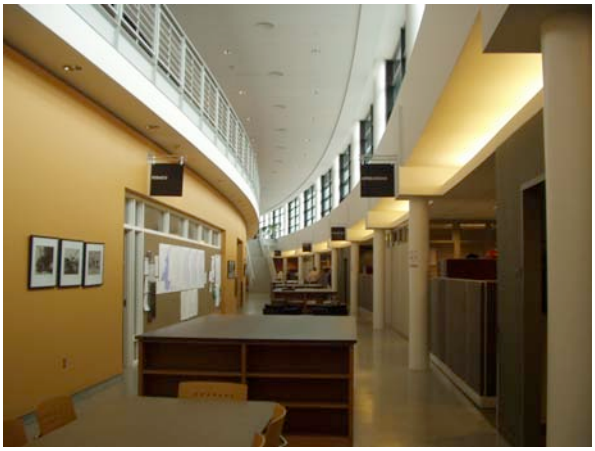

**PROJECT DATA**

| | |
|---|---|
| **Project Name:** | Medina Public Works Facility<br>1600 Prairie Drive<br>Medina, MN 55340 |
| **Building type/function:** | Public works, Hennepin County's transportation functions |
| **Building Area:** | 242, 205 sq. ft |
| **Site Area**: | 146 acres |
| **Number of stories:** | 1-2 story |
| **Owner:** | Hennepin County |
| **Project Management Team:** | Greg Karr, Project Manager, Kari Fasth, Interior Project Manager |
| **Current Facility Manager:** | Ted Walker |
| **Full Time Equivalent Staff:** | 5.2 |
| **Total Payroll:** | Data not available |
| **Annual Operating Cost:** | Data not available |

**Project Construction Timeline:** Fall 1996 to June 1998

| | |
|---|---|
| **Project Cost:** | $23.9 million including $1.34 million for furnishings and equipment |
| **Architect**: | Architectural Alliance<br>Peter Vesterholt, Project Architect<br>400 Clifton Ave. S<br>Minneapolis, Minnesota 55403 |
| **Mechanical, Electrical and Structural Engineer:** | Dunham Associates Inc.<br>8200 Normandale Blvd.<br>Suite 500<br>Bloomington, Minnesota 55437 |
| **Civil Engineer**: | PPG Barton-Aschman Associates Inc.<br>Minneapolis, MN |
| **General Contractor**: | Knutson Construction Services<br>5500 Wayzata Blvd<br>Suite 300<br>Minneapolis, Minnesota 55416 |
| **Site Construction:** | Enebak Construction Company<br>32825 Northfield Blvd North<br>Northfield, Minnesota 55057 |

## BACKGROUND

The Solid Waste Management Coordinating Board (SWMCB) is committed to the reduction of non-municipal solid waste (non-MSW) specifically generated through building projects in its constituent counties. To address this issue, the SWMCB funded the Center for Sustainable Building Research (CSBR) at the University of Minnesota to advise on several pilot projects. To learn from these projects, the SWMCB asked CSBR to conduct Post Occupancy Evaluations (POEs) of selected projects across the counties. This report will contribute to a knowledge base that county agencies can use to provide more sustainable buildings that represent the best investment of county money over the lifecycle of each project.

According to data collected by the Minnesota Pollution Control Agency (MPCA), the region landfilled approximately 1.2 million tons of non-MSW, in construction, demolition, and special waste landfills in 1997. In addition to landfilling, non-MSW was managed through processing, incineration and beneficial reuse (e.g. land application).

The Regional Solid Waste Master Plan is the basis for managing the six-county metropolitan area's solid waste through the year 2017. The Regional Solid Waste Master Plan was prepared by the SWMCB, a joint powers board of the counties of Anoka, Carver, Dakota, Hennepin, Ramsey and Washington in conjunction with the Minnesota Office of Environmental Assistance (OEA) and the Minnesota Pollution Control Agency (MPCA).

The Master Plan recognizes, for the first time, that non-MSW should receive greater attention in regional decision making. It recognizes that in order to develop non-MSW policies and programs, however, it will be necessary to collect data, evaluate environmental impacts and regulatory issues, and identify best management practices. It also establishes expectations that government, businesses and the waste industry take responsibility and make decisions in a manner that will minimize environmental harm and encourage reuse, recycling and resource recovery.

The **Intermediate Non-MSW Management Outcome #5** in the Regional Master Plan states that *by 2005, 80% of the region's public entities will evaluate and where feasible, incorporate sustainable architectural guidelines in the planning process for construction and remodeling of government buildings.*

It also states: "Hennepin County anticipates completion of the Sustainable Design Guide and Rating System by the end of 1998. The University of Minnesota has received a grant to continue enhancing the Sustainable Design Guide and Rating System and establish case studies and training programs. From this model, guidelines will be developed. In order to achieve this outcome, the SWMCB will need to collaborate with others, provide input into guideline development, and adopt guidelines as a regional policy. These guidelines will 1) help reduce the amount of waste generated from construction and deconstruction of buildings, 2) reduce the toxicity of the materials used, 3) encourage the use of recycled products, and 4) provide reuse options for construction materials."

The **Negotiated County Outcomes** in the SWMCB Regional Master Plan include the following specifically with respect to Dakota County:

"Ramsey, Carver, Dakota and Washington Counties will:

- Evaluate and, where feasible, incorporate by December 31, 2005, sustainable architectural guidelines in the planning process and procurement of architectural services for the construction and remodeling of all County government buildings and other County projects using public financing.

- Undertake efforts so that public entities in the county incorporate sustainable architectural guidelines in the planning process for the construction and remodeling of all government buildings, including projects using public financing."

## METHODOLOGY

The intention of a Post Occupancy Evaluations (POE) is to learn from an existing building so its operation may be improved and lessons can be applied to future projects. The design and delivery of buildings is a complex process whose outcomes are affected by numerous factors not all of which are within the control of team or individuals responsible for the process. The scope of a POE can vary widely. Within a limited budget and scope, the SWMCB POEs attempt to integrate an assessment of sustainability with the building performance concerns of traditional POEs. The research methodology consisted of general building data gathering, observational walkthroughs, plan and specification reviews, and collection of energy, water and waste data. Interviews were conducted with key participants including County project managers, facility managers, and the architect. In this case, surveys on indoor environmental quality were not given to building occupants because of time constraints and logistics.

## OBJECTIVES

Sustainable development seeks a balance between first cost and lifecycle economics, environmental responsibility, health and well being of human occupants, and community values and needs. To relate these broad concepts to the building development process, sustainable development goals are often organized by categories of Site, Water, Energy, Indoor Environmental Quality (IEQ), Materials, and Waste. All phases of development potentially affect sustainable performance from planning, pre-design (site selection and programming), design, construction and commissioning, and operation. To assess how well these goals are achieved on a particular project, the report is organized around these fundamental questions:

- What sustainable strategies were used? Were there any issues or barriers with implementation of the strategies?

- How effective was the process used to achieve the sustainable development?

- What are the outcomes of sustainable development in terms of the "Quadruple Bottom Line" — economics, environment, human occupants, and community?

The SWMCB POE analysis team describes The Quadruple Bottom Line (QBL) as "a variation on the commonly referenced 'Triple Bottom Line' used in sustainability literature. The 'Triple Bottom Line' refers to accountability to all of the value systems of a sustainable society -- human and ecological performance in addition to economic performance. The 'Quadruple Bottom Line' divides the 'human' category into 'human occupant' and 'community' in order to reflect the very different way architecture affects individuals who inhabit the building versus the buildings impact on the larger local and global communities.

# Chapter 2. Sustainable Strategies

In this section, the sustainable strategies considered and implemented on the Hennpin County Public Works Facilty project are listed with reference to the strategies of the Minnesota Sustainable Design Guide (MSDG) <www.msdg.umn.edu>. Though the MSDG was not formally used to drive the project efforts, it is the tool that SWMCB has been referring to in their Regional Master Plan. On the Hennpin County Public Works Facility, a set of sustainable strategies were developed by the design team to advance implementation of sustainable design on Hennepin County projects.

## SITE STRATEGIES

### MSDG Strategy 1.1: Direct Development to Environmentally Appropriate Areas

**Description**
- The building was placed to avoid an existing wetland on site.

**Implementation Issues**
- The site infrastructure has had settling problems, probably from the fill. Frost heave in sidewalks, driveways, and other places has been reported.

### MSDG Strategy 1.2: Maintain and Enhance the Biodiversity and Ecology of the Site

**Description**
- The building blends with the surrounding landscape by being low in height and hugging the land.
- The project construction required minimum alteration to site topography.

**Implementation Issues**
- Water run-off from the roof of the salt shed has created erosion problems on the east hillside. The lawn area in back of the salt shed was removed and replaced with compressed gravel two years ago.

### MSDG Strategy 1.3: Use Microclimate and Environmentally Responsive Site Design Strategies

**Description**
- Cut-off light fixtures were used on the site to reduce light pollution.

**Implementation Issues**
- No problems have been reported with the cut-off light fixtures.

### MSDG Strategy 1.4: Use Native Trees, Shrub, and Plants

**Description**
- The project re-established a prairie landscape on the site.
- There is no irrigation system on site.

**Implementation Issues**
- Prairie restoration has proved expensive for operation due to need for controlled burns or at least mowing. There is no real program for prairie maintenance or restoration. Some areas around building

and roads originally planted with prairie plants were removed and replanted with lawn due to concerns about burns coming too close to the building.
- There is a weed problem on site and the facility needs to have someone come in every year to spray weeds. The facilities personnel watch for thistle but do not have resources to do a full noxious weed control. Weeds are difficult to control due to the agricultural setting of the project's surroundings.

**MSDG Strategy 1.5: Use Resource Efficient Modes of Transportation**

**Description**
- There is no access to the site by bus line or other mass transit to the visitor center area.
- There is no carpool incentive for employees.

## WATER STRATEGIES

**MSDG Strategy 2.1: Manage Site Water**

**Description**
- All stormwater run-off is caught by sediment ponds/ retention ponds and by the gray water system.

**Implementation Issues**
- There are not large amounts of sediment in the retention ponds and it is expected by the maintenance staff that it will take about 10 years for cleaning to be required.
- All staff are trained in spill control.

**MSDG Strategy 2.2: Use Gray Water Systems**

**Description**
- The gray water system was designed to contain all fuel spills in the facility and salt stormwater run-off.
- The gray water recycling system is designed to reclaim water and to reduce water consumption by 75%.

**Implementation Issues**
- The gray water system was installed to minimize water entering the on-site sewage system. After installation it was discovered that the problem with the gray water system design was that not enough consideration was given to the amount of water gained by the system in truck wash bays from snow and water on trucks. The vehicles were meant to be washed with recycled water, but the furnace meant to burn and filter out the salt did not work properly. Consequently, the wash water contained salt that is harmful to the vehicles. In addition the system was very expensive to maintain. Another solution tried was to rinse the vehicles with fresh water, but that increased the overall consumption of water. Finally a 10,000 gallon storage tank was installed to collect the water from washing of vehicles. The water from the tank is picked up from a vendor when the tank is full and sent to a facility that is connected to the public sewer system.
- The toilet gray water system, different from the exterior gray water system, works but requires more maintenance than a regular system. The facility has an outside service contract for system.
- In general the water systems have been perceived by the maintenance staff as "a major headache."

**MSDG Strategy 2.3: Use Biological Waste Treatment Systems**

**Description**
- There is an on-site sewage treatment system that requires no access to the public sewer system. The on-site sewage treatment system was required because they were refused access to the public sewer system. In the future, if a connection were to be made Metropolitan Council and City of Medina approval would be required.

**Implementation Issues**
- Operationally, the on-site sewage treatment system is expensive and currently efforts are ongoing to get permission to connect to the public sewer system.

**MSDG Strategy 2.4: Conserve Building Water Consumption**

**Description**
- Low-flow toilets and faucets have been used.

**Implementation Issues**
- No implementation issues have been reported.

## ENERGY STRATEGIES

**MSDG Strategy 3.1: Optimize Building Placement and Configuration for Energy Performance**

**Description**
- The building's circular and narrow configuration allows for optimum daylight conditions in the building.

**MSDG Strategy 3.2: Optimize Building Envelope Thermal Performance**

**Description**
- Overhangs and blinds have been provided to reduce thermal gain in summer.

**MSDG Strategy 3.3: Provide Daylighting Integrated with Electric Lighting Controls**

**Description**
- Extensive daylighting through windows and atrium helps to reduce use of electric lighting.

**Implementation Issues**
- Adequate lighting control systems were not included in the original design to take advantage of the extent of daylight available in the building,
- Lumen sensors were added in the atrium space so electric lights are automatically controlled. A lighting control system was added in conference rooms to reduce air conditioning. Definite savings have been made that are being tracked.

**MSDG Strategy 3.4: Provide Efficient Electric Lighting Systems and Controls**

**Description**
- No strategies reported.

**MSDG Strategy 3.5: Maximize Mechanical System Performance**

**Description**
- A heat recovery ventilation system is installed in the building to reduce heating loads.
- A thermal storage system (ice storage tanks) is provided to reduce peak summer cooling needs.
- The building has an energy management system.

**Implementation Issues**
- The building's energy management system has been very useful in terms of money savings due to performance.
- The heat recovery system is maintained regularly, works well and is viewed as a success.
- The thermal storage system works well. The switch from heating to cooling is seamless and the ice storage tanks really help. The only downside is that they do not qualify for cost savings due to reduced peak demand because the power company, Wright Hennepin Co-op, does not offer the incentives that Xcel does for such performance. The maintenance staff believes that in the future as the area and co-op grow there will be more incentive programs available.

**MSDG Strategy 3.6: Use Efficient Equipment and Appliances**

**Description**
- The building uses some Energy Star-rated equipment.

**Implementation Issues**
- No issues have been reported with the energy efficient equipment.

**MSDG Strategy 3.7: Use Renewable or Other Alternative Energy Sources**

**Description**
- No renewable energy systems have been used on this project.

**Implementation Issues**
- Not applicable.

**MSDG Strategy 3.8: Integrate All Systems and Reduce Total Energy Use**

**Description**
- A routine energy load calculation was done on the building by the mechanical engineer.
- There was no comprehensive energy simulation conducted on the building.

**Implementation Issues**
- No issues have been reported.

## INDOOR ENVIRONMENTAL QUALITY (IEQ) STRATEGIES

**MSDG Strategy 4.1: Provide a Clean and Healthy Environment**

**Description**
- Sources of pollution were isolated as much as possible.

**MSDG Strategy 4.2: Control Moisture to Prevent Microbial Contamination**

**Description**
- Moisture control best practices such as air and vapor barriers, proper flashing, waterproofing and drainage have been used in the building.

**Implementation Issues**
- No leaks or moisture issues have been reported in the building.

**MSDG Strategy 4.3: Provide Ample Ventilation for Pollutant Control and Thermal Comfort**

**Description**
- Positive air stream separation is employed. Exhaust and fresh air streams do not mix in the building.
- Air intakes have been separated from pollution sources.
- Ducted returns are used within the building.
- Internal duct insulation was eliminated.

**Implementation Issues**
- No implementation issues have been reported.

**MSDG Strategy 4.4: Provide Appropriate Thermal Conditions**

**Description**
- Temperature controls have been provided throughout the building. The temperature settings have been set in accordance with County policy influenced by budget cuts.

**Implementation Issues**
- The newly regulated temperature settings have been a source of discomfort to some employees in the building.

**MSDG Strategy 4.5: Provide Effective Lighting**

**Description**
- Extensive daylighting is available in the building.
- Overhangs and blinds have been provided in the building to control daylight and reduce glare.

**Implementation Issues**
- It is reported that the staff make good use of daylighting in the atrium.
- Office areas are comfortable to work in with no glare problems because they are mainly north facing, and overhangs protect from glare. On the other hand, usually full electric lighting is used in office space.

**MSDG Strategy 4.6: Provide Appropriate Building Acoustic and Vibration Conditions**

**Description**
- No strategies reported.

**Implementation Issues**
- No issues have been reported with acoustic quality.

### MSDG Strategy 4.7: Provide Views, Viewspace and Contact with the Natural Environment

**Description**
- There are ample views to the outside from the office areas.
- Some employees have installed bird feeders outside the office windows that attract local birds to them providing more interest to the restored prairie landscape.

## MATERIALS STRATEGIES

### MSDG Strategy 5.1: Use Materials with Low Impact During Their Life Cycle

**Description**
- No life-cycle assessment tools were used.

### MSDG Strategy 5.2: Use Salvaged and Remanufactured Materials

**Description**
- No strategies reported.

### MSDG Strategy 5.3: Use Recycled Content Products and Materials

**Description**
- 700+ gallons of recycled paint were used in the building.
- Terrazzo containing 15% post consumer glass was used in the building.
- Carpet made of 100% post consumer plastic was used in the building.
- Resilient flooring made from 97-100% post consumer tires was used in the building.
- Panel fabric textiles made with 100% post consumer plastic was used in the building.
- Gypsum board made with 15% post consumer newspaper was used in the building.
- Acoustic ceiling tiles made with 4-21% post consumer newspaper and 30-90% post industrial steel slag was used in the building.
- Reinforcing bar made from 100% post industrial and post consumer steel was used on the project.
- Bituminous pavement made from 5-10% post consumer glass aggregate, up to 90% post industrial and reused bituminous was used on the project.
- Structural steel made from 90% post industrial and post consumer steel was used on the project.
- Porcelain tiles made from 90% post industrial waste were used in the building.
- Aluminum louvers made from 90% post industrial aluminum were used in the building.
- Toilet partitions made from 10-50% post-industrial waste were used in the building.
- Millwork made from 90% post industrial forestry product and resin was used in the building.

**Implementation Issues**
- In the future it is recommended to be careful where the recycled paint is used in the facility because it does not wash well due to being flat. The maintenance staff recommends it should be used as a primer rather than as a finish coat
- It is reported that the terrazzo may have a possible installation issue. In some sections where it has been installed a polyurethane type excretion has surfaced in line forms. A foresnic expert consultant was appointed to identify the source of the problem and the source was narrowed down to the waterproofing compound used in the base layer.
- The recycled content carpet is very durable and easy to clean.

- Resilient flooring made from post consumer tires has to be cleaned differently than other floors but does not require extra maintenance. (The rubber does not mop well.)
- Panel fabric textiles made with post consumer plastic have worked well.
- Bituminous pavement made from post consumer glass aggregate, post industrial and reused bituminous had problems with glass popping out of the pavement. A top finish coat had to be added and it has worked well since then.
- The recycled plastic content toilet partitions hold a static charge and as a result toilet paper dust sticks to it causing a thin white film that has to be wiped down adding work for the custodians. It is not clear if this phenomenon is due to the recycled content or due to the plastic in general.
- Millwork made from 90% post industrial forestry product and resin works fine except, since it was a special order, it is difficult to locate the same kind of millwork when additions or matches need to be made.

**MSDG Strategy 5.4: Use Materials from Renewable Sources**

**Description**
- No strategies reported.

**MSDG Strategy 5.5: Use Locally Manufactured Materials**

**Description**
- No strategies reported.

**MSDG Strategy 5.6: Use Low VOC-emitting Materials**

**Description**
- All steel office partitions used high-solids paint to reduce VOC emissions.

**MSDG Strategy 5.7: Use Durable Materials**

**Description**
- Durable materials such as steel construction terrazzo flooring were used on the project.

**MSDG Strategy 5.8: Use Materials that are Reusable, Recyclable or Biodegradable**

**Description**
- Concrete and carpet are recyclable.
- Counter tops, partitions, wood paneling, windows, and sheathing are potentially deconstructable and reusable.
- Brick can be deconstructed and re-used.
- Office furniture can be disassembled and reused.

## WASTE STRATEGIES

**MSDG Strategy 6.1: Reuse Existing Buildings**

**Description**
- Not applicable.

**MSDG Strategy 6.2: Design for Less Material Use**

**Description**
- No strategies reported.

**MSDG Strategy 6.3: Design Buildings for Adaptability**

**Description**
- The building can accommodate future expansions.

**MSDG Strategy 6.4: Design Buildings for Disassembly**

**Description**
- Most of the building elements are deconstructable and can be salvaged for reuse.

**MSDG Strategy 6.5: Salvage and Recycle Demolition Waste**

**Description**
- Not applicable.

**MSDG Strategy 6.6: Reduce and Recycle Construction Waste**

**Description**
- No strategies reported.

**MSDG Strategy 6.7: Reduce and Recycle Packaging Waste**

**Description**
- No strategies reported.

**MSDG Strategy 6.8: Reduce and Recycle Waste from Building Users**

**Description**
- Waste is compacted and picked up by the County.
- Recycling goes into a holding area and is picked up each week (includes newspaper, glass, plastic, paper, aluminum).

**MSDG Strategy 6.9: Reduce and Properly Dispose of Hazardous Waste**

**Description**
- Hazardous waste is managed carefully on site and in the building.

# Chapter 3. Process Issues

## INTRODUCTION

This portion of the post occupancy evaluation is directed at the building delivery process. As key participants in the process were interviewed, they were also asked some general questions about the building design.

Interviews were conducted with Hennepin County's project manager for the Medina project, Greg Karr, Hennepin County Property Services; and Ted Walker, Facility Manager and Occupant. Also interviewed was the project architect, Peter Vesterholt (Architectural Alliance).

In each interview, participants were asked the following questions:

- How was sustainable design included in the design process? (i.e. committee structure, decision makers, timing issues)
- Who were the champions of the process that led to successful sustainable design?
- What were the barriers to including sustainable design?
- Were sustainable design tools or standards used? Which ones and to what extent?
- How did outside technical consulting firms contribute to the sustainable design process?
- Were there any issues related to regulatory requirements that affected sustainable design?
- Were there any capital budget issues?
- Were sustainable requirements incorporated in the RFP and contract requirements? If so, were they followed?
- What was the role of first cost versus life cycle cost analysis in decision making?
- What are the best features of the process?
- What are the worst features of the process?
- What do you think are the important lessons from the project?
- What are the best features of the building?
- What are the worst features of the building?
- Are there major or common complaints from the users of the building?
- Have there been any building alterations?

Responses are summarized in the following sections.

## EVALUATION BY KEY PARTICIPANTS

**1. How was sustainable design included in the design process? (i.e. committee structure, decision makers, timing issues)**

The Hennepin County Project Manager said that sustainable design was made a priority at the Design Development phase. He also mentioned that architects were very open to addressing sustainable design in the project.

The Medina Facility Manager and building occupant said that the "County has been very aggressive in incorporating sustainable design in their projects."

The architect felt that the sustainable approach was to be "very respectful to site" and by the intention to create a nice office/ work environment with ample daylight and using energy saving strategies. The architect also felt that the County really wanted to promote their reuse and recycling principles and that there was "broad support for using recycled content materials."

**2. Who were the champions of the process that led to successful sustainable design?**

The Hennepin County Project Manager mentioned the following names as people who were champions of sustainable design in the County and were responsible for it being considered on the Medina Public Works Facility: Randy Johnson, Commissioner; Vern Genzlinger, Head of Public Works; Janet Leick, Department Manager of Environmental Services; Paul Kroening, Principal Planning Analyst.

The architect felt that their firm, Architectural Alliance, acted as a champion for sustainable design for the project. They really wanted to integrate project with the landscape, preserved wetlands, wanted a minimal impact on the site. They did a lot of research for the project and learned a lot. At the same time the County was a champion by really emphasizing recycled materials use.

**3. What were the barriers to including sustainable design?**

The Hennepin County Project Manager listed the following barriers to including sustainable design:
- Did not include sustainability early enough on the project.
- The Project type (public works, maintenance facility) limited the implementation of some strategies.
- There were not enough sustainable products tested at the time the project.

The architect felt that they "wanted to do Energy Assets" but that Wright-Hennepin, the energy provider did not offer a program like that.

**4. Were sustainable design tools or standards used? Which ones and to what extent?**

The Hennepin County Project Manager said that no tools or standards for sustainable design were used.

The architects said no tools for sustainable design were "available at the time" when the project was being designed.

**5. How did outside technical consulting firms contribute to the sustainable design process?**

The Hennepin County Project Manager mentioned the following outside consultants that contributed to sustainable design goals of the project: architects, civil engineers, and product manufacturer representatives.

The architects mentioned critical roles played by Dunham Associates, civil engineers for wetland management and by Barton Aschman who brought in environmental consultant from east coast who brought in Zenon for the graywater system. Ground source heat pump was considered for the project but engineers determined that it would not be efficient with the air flow rates needed for this type of facility.

**6. Were there any issues related to regulatory requirements that affected sustainable design?**

The Hennepin County Project Manager mentioned wetlands as the main regulatory requirement that affected sustainable design on the project.

The Medina Facility Manager and building occupant said that the sewage was a regulatory issue that affected the project – they were "denied access to public sewer system" and the County is still negotiating the issue.

The architect referred to wetlands and sewer access as some of the areas where regulatory requirements affected the project. The design process was put on hold while sewer problems were being figured out. "The City of Medina was worried about building a public works facility on land that could have more residents. Public Works is not taxpaying, but they tried to make the building fit the landscape as much as possible in order to be good neighbors."

**7. Were there any capital budget issues?**

Regarding capital budget issues, the Hennepin County Project Manager mentioned that the building was redesigned at one point but that did not affect sustainable design on the project.

The architect felt that there were budget issues including the nine-month hold on the project which caused the project budget to be reassessed.

**8. Were sustainable requirements incorporated in RFP and contract requirements? If so, were they followed?**

According to the Hennepin County Project Manager no sustainable requirements were incorporated in RFP and contracts.

The architect said there was no formal RFP or language in the contract requirements, just mutual understanding to make sustainable design a priority.

**9. What was the role of first cost versus life cycle cost analysis in decision making?**

According to the Hennepin County Project Manager, mechanical consultants did a routine analysis of cost-benefits that identified first cost vs. life cycle cost. In addition, the County had a RBA (Request for Board Action) that was approved. This meant that the project could incur up to 10% more for the purposes of sustainable design.

The Medina Facility Manager and building occupant quoted "Operation costs: political decision to put building on this site is now absorbing cost of not being connected to public sewage treatment" and "the payback for the onsite sewage treatment system is not good" as issues regarding life-cycle costs.

The architect said life-cycle costs were considered on the "mechanical side" by doing a cost-analysis for ice storage and ground source heat pump. A lot of thought was put into appropriate material selection and low maintenance was an important criteria in the project.

**10. What are the best features of the building? Of the process?**

The Hennepin County Project Manager identified the following as the best features of the project:
- Daylighting
- Graywater system
- Site use and landscaping

The Medina Facility Manager and building occupant quoted the following as the best features of the project:
- Design on site/ lot/ architectural features
- Flexibility on site
- Room for future expansion
- Comfortable building to work in
- Serves purpose well
- Received well by community

The architect quoted the following three best features: "Really successful integration to landscape." "Nice work on environment: respectful of environment, wetland management. Reduces burden of sanitary sewer treatment with on-site facility." In terms of the process the architect felt they had an excellent working relationship with county and city.

**11. What are the worst features of the building? Of the process?**

The Hennepin County Project Manager identified the following as the worst features of the project:
- Building type not best suited for sustainable design.
- Need to start considering sustainable design goals earlier in the project
- Design and delivery process.

The Medina Facility Manager and building occupant quoted the following as the worst features of the project:
- Sewage system issues
- A lot of roof area, maintenance issues, lots of impervious surface on site due to roof and all of the paved areas for vehicles

The architect mentioned the following as the worst features: "Budget cut backs may have resulted in loss of building space and amenities for workers, and air conditioned maintenance space. Some had to do with the County and their standard practices. Maybe maintenance areas could be air conditioned."

**12. Are there major or common complaints from the users of the building?**

The Medina Facility Manager and building occupant quoted the following as the common complaints from the building users:
- They feel the building is too far out of town, long commute.

- A lot of initial complaints – no concrete complaints about the building.
- Lots of complaints about the temperature, but they are adjusting to it. They have the system set to 69 degrees in winter, and 75 degrees in summer – set for budget, began 2004.

**13. Have there been any building alterations?**

The Medina Facility Manager and building occupant listed the following as the building alterations:
- Very minor, structurally minimal changes.
- Site – added the parking space.
- Added lighting controls.
- Prairie Drive, was cul-de-sac, now extended to gravel pits to the northwest, eventually the road will become the frontage road for Highway 55.

The architect mentioned possible future alteration including "Discussion of expanding the building, possibly turning cold storage into semi-heated storage."

**14. What do you think are the important lessons from the project?**

The Hennepin County Project Manager listed the following as the most important lessons from the project:
- Incorporate sustainable goals earlier in the project design and delivery process.
- Support from the commissioners for sustainable design is important for County projects.
- Need to be careful while working with recycled content products (especially when there is not adequate proven performance).

The Medina Facility Manager and building occupant listed the following as the important lessons:
- Better gray water design
- Made good use of recycled content products
- Good design, met objectives
- Used all downlighting on site so it would not give off a lot of light
- Probably could do more with noxious weed control
- Lots of wildlife, water fowl

The architects felt the following lessons were important:
- Design matters, example of well executed project the way the building fits the site.
- Learned a lot of sustainable design.
- County should be commended their push for recycled content materials.

# Chapter 4. Outcomes

The intention of sustainable design in the broadest sense is to enhance the environment, the economy, the community, and the health and well-being of people. Sustainable development goals, or strategies are often organized into categories of Site, Water, Energy, Indoor Environmental Quality (IEQ), Materials, and Waste. While progress towards sustainability is often measured by achievement of a particular set of strategies, whenever possible they should be measured against the actual "sustainable outcomes." This chapter attempts to evaluate the ***"Quadruple Bottom Line"*** of economic, environmental, human, and community performance for this project. It should be noted that incomplete or unavailable data makes it impossible to do a complete accounting, but this type of information should be collected for future projects.

The outcome statements below, summarize the key findings from the outcome data analysis and put them into context. Some outcome units may not apply to this project if data was not available. The outcomes shown are based on what is tabulated in more detail in the "Outcome Data Sheets" which are included in the appendix.

Operational comparison to similar buildings, or *benchmarking,* can be a useful comparison point. When benchmarking, it is important to use caution, and take into consideration the many differences that affect operation of a facility, including variations in program specifics, hours of operation, and other factors that influence results, but do not indicate quality of construction or operation. To make benchmarks comparable for buildings of different sizes, the units are often translated into per square foot values or per full time equivalent (FTE) occupant values. Per square foot values are for the gross area as built unless noted otherwise. FTE occupant values are based on a survey of occupancy patterns, with average total people-hours per week divided by 40 hours to get a comparable number of full time equivalent occupants. This allows per-person comparisons across buildings which may have different operating hours.

There was no benchmark available for comparison with Hennepin County Public Works Facility for this study.

## ECONOMIC OUTCOMES

As part of the POE, a variety of economic indicators were analyzed to help identify the overall performance of the project towards desired economic outcomes. Documents used in the analysis include: utility bills, waste and recycling hauling bills, third party consultant reports, and other project documentation.

**Operating Energy Cost:**
Operating energy costs are based on total utility bills including any basic charges, peak demand charges, taxes, etc. Utility bills include gas and electric.

During the one-year period from March 2003 through February 2004, Hennepin County Public Works Facility spent a total of $261,258 or $1.08 per square foot on total energy costs.

**Spatial Cost:**
Construction $ per FTE occupant, puts the issue of space utilization into economic terms; if the building is half occupied, it cost twice as much per person served.

The total construction budget (building and site improvements) for the Hennepin Public Works Facility was $23,900,000 or $98.68 per square foot of building. The building construction costs equaled $88.15 per square foot of building and site construction was $2,550,000 or $0.41 per square foot of site. Based

on average occupancy of employees the total construction cost per person equaled $85,357. Note that the low occupancy of some areas such as the maintenance garage and car wash area make this number seem higher than for some other building types.

**Construction Waste Cost:**
The project has no documentation of construction waste practices or costs available at this time.

**Operational Waste Cost:**
Depending on what activities are generating waste, operating waste cost may be more applicable to report in either a per square foot basis or a per person basis.

According to the facility manager, the total cost for landfilled operational waste over the year of 2003 was $783.73 per month. Hennepin Public Works Facility was charged $76.21 per ton of landfilled waste. Recycling service is provided by Hennepin County Environmental Service and the Medina Facility is not charged directly for service. By recycling 14% of the total waste over the course of one year, they achieved an average monthly savings of $50.03 per month. The total waste cost per person is $2.80 per month.

**Water and Sewer Cost:**
Depending on building activities, building water costs may be more applicable to report in either a per square foot basis or a per person basis.

Storm water cost impacts were not studied.

The facility's water is supplied by the City of Medina and there are five meters on site to accommodate the different functions of the facility; two meters for the main building area, two for the truck wash station, and one for the fill station. The water data collected is from January 2003 through December 2003. The average cost for total water use is $112.30 per month. The main building water use per month costs $58.91 or $0.21 per person. The vehicle wash station averages $39.00 per month and the fill station averages $14.39 per month. The facility is not connected to a municipal sanitary sewer system; instead they have an on-site leech field and graywater treatment system from Zenon Environmental Inc. Graywater treatment costs include weekly inspections and maintenance, 24 hour on call service and a state DMR report. The graywater treatment costs $2994.76 per month or $10.70 per person per month. The system does not treat the vehicle wash station waste water and therefore that water is collected in tanks and hauled off site when needed by a septic service company and averages a cost of $925.62 per month. Total sewer costs equal $3,920.38 per month.

## ENVIRONMENTAL OUTCOMES

As part of the POE, a variety of environmental indicators were analyzed to help identify the overall performance of the project towards desired environmental outcomes. Documents used in the analysis include: utility bills, waste and recycling hauling bills, and other project documentation. In addition, the estimated energy savings impact on other environmental outcomes was modeled using Athena Life Cycle Analysis Software.

**Operating Energy:**
Operating energy impacts are based on Athena™ Environmental Impact Estimator Software Version 3.0 from the Athena Sustainable Materials Institute. The impacts associated with energy generation,

distribution, and consumption are typical for Minneapolis. The outcomes are a sum of the gas and electric impacts.

The data collected for Medina is from the sixth year of operation. During the one-year period from March 2003 through February 2004, Hennepin County Public Works Facility used a total of 98.0 KBTU per square foot. Of that, 36% was electricity and the remaining 64% was natural gas. During this same period the peak electric demand was 2.6 Watts per square foot.

The total electric and gas energy use during this period resulted in environmental outcomes of 140.1 KBTU per square foot of primary energy, 3.7 lbs. per square foot of solid waste, an air pollution index of 2.2 per square foot, a negligible water pollution index, 20.7 lbs. per square foot global warming potential, and 46.9 lbs. per square foot of weighted resource use.

**Spatial Measures:**
The ratio of net building area (area of main building excluding circulation, mechanical, and toilets) to main building area is 85%. The ratio of gross building area to site area is 12%.

The total gross area per person (FTE employee) is 865 square foot. The net area per person is 739 square foot. Note that the occupancy density varies in different areas of the building such as office versus maintenance garage.

**Construction Waste:**
The project has no documentation of construction waste available at this time.

**Operational Waste:**
Depending on what activities are generating waste, operating waste may be more applicable to report in either a per square foot basis or a per person basis.

Waste quantities for the Public Works Facility were not collected from bills. Landfilled waste amount was provided by the facility manager. Recycling quantities are based on driver estimated amounts collected weekly from the Medina Facility; various recorded volumes were translated into tons by Sandra Nussbaum at Hennepin County Environmental Services.

According to waste information received, the average monthly quantity of waste produced was 4.8 tons. Of the total waste produced, 14% was recycled including glass, plastic, aluminum and cardboard. Total waste generated per person is 34 lbs per month.

**Water & Sewer:**
Depending on building activities, building water use may be more applicable to report in either a per square foot basis or a per person basis.

Site design for water issues should consider both irrigation and stormwater management. Gallons irrigation water per non-built site area is an indication of the potable water efficiency of the site design. Stormwater outcomes were not calculated for this analysis.

Over a one year period from January 2003 through December 2003, the total monthly water consumption was 44,212 gallons. The facility's water usage is divided into three areas, the usages for the main building was 22,479 gallons per month or 80 gallons per person per month, the vehicle wash station averages 15,537 gallons per month and the fill station uses 6,198 gallons per month.

The facility is not connected to a municipal sewer system, instead there is an on-site leech field and graywater treatment facility. Graywater is reused in toilets and finally sent to a leech field on the property. The quantity of water treated by the graywater system is assumed to be equal to the quantity consumed by the main building area because vehicle wash station waste water is collected and hauled off site by a septic service company and the fill station water is used off site. Therefore the total water treated by the graywater system equals 22,479 gallons per month. The vehicle wash station waste water equals 18,479 gallons per month according to the bills for that service.

## HUMAN OUTCOMES

No survey was given to the occupants of this building because of time limitations and logistical problems. Some occupant comments and complaints are identified in the strategies and process sections of the report.

## COMMUNITY OUTCOMES

There are many possible outcomes in this category. Reduced water and energy use can contribute to less community expenditure on infrastructure. Reduced waste can reduce the need for landfills. A project may also serve as a vehicle for raising community awareness about sustainable design.

# Appendix A: Specification Review

| Division | Section | Comments |
|---|---|---|
| Introductory Information | 00030 - Advertisement for Bids (Public Bid Project) | No mention of requirements |
| | 00120 - Supplementary Instructions to Bidders | No mention of requirements |
| | 00800 - Supplementary Conditions (to the General Conditions) | No mention of requirements |
| Division 1 | 01010 - Summary of Work | No mention of requirements to meet any criteria (esp. MSDG) |
| | 01300 - Submittals | Listed submittals for recycled materials certifications and summaries |
| | 01400 - Quality Control | No mention of requirements for 3rd party testing or on-site testing of any environmental characteristics |
| | 01500 - Construction Facilities and Temporary Controls | No special scheduling or protection information, or issues with air quality during construction process |
| | 01505 - Construction Waste Management | Very comprehensive information for recycling materials and waste management program (see Appendix A from HC) |
| | 01600 - Material and Equipment | Only mention of avoiding hazardous materials (typ. asbestos, PCBs) Nothing about specific substitutions meeting requirements of MSDG, and yet other technical sections reference procedures in 01600 for submitting products with recycled content, etc. |
| | 01710 - Final Cleaning | No mention of requirements, staging, scheduling of wet finishes |
| All technical sections | | At PART 2 – PRODUCTS, each section includes recommendations to use recycled content materials wherever feasible. However, no specific requirements for levels of PI or PC content are called out (e.g. 67% minimum for steel) for most sections, except for a maximum of 15% fly ash in concrete or 10% in brick. |
| Division 2 | 02110 - Site Clearing | Tree protection required |
| | 02200 - Earthwork | Use of recycled materials identified, where appropriate and practical |

| Division | Section | Comments |
|---|---|---|
| | 02231 – 02505 – 02510 Base, Aggregate, Asphaltic Concrete Paving | Use of recycled materials identified, where appropriate and practical |
| | 02520 - Portland Cement Concrete Paving | Use of recycled materials identified, where appropriate and practical<br>Fly ash not allowed due to contaminants from nuclear plants (?) |
| | 02900 – Landscape | Steel edging spec'd in lieu of plastic; plastic fiber mats spec'd; prairie grasses and wildflower mix spec'd; typical bluegrass turf; rock mulch also spec'd – which is 90% PI brick chips (from Iowa plant), not just biodegradable wood; coco-bean mulch (imported) also spec'd. |
| Division 3 | 03100 – Concrete Formwork/03200 – Concrete Reinforc. | Nothing mentioned specifically about reusability of forms or recycled content in rebar – but it could be submitted with back-up documentation to meet requirements of MSDG |
| | 03300 – Cast in place Concrete | Up to 15% flyash allowed (not necessarily 'required'.) Microsilica admixture specified for corrosive environments. |
| | 03450 – Precast Concrete | No requirements for using fly ash, which, if used in the 03300 concrete might cause a color differential. |
| Division 4 | 04300 – Unit Masonry Assemblies | 10% recycled content called for in Face Brick.<br>Molded polystyrene insulation units in CMU for more complete insulation of exterior wall. |
| Division 5 | 05120, 05210, 05311, 05400, 05500, 05510 | Use of recycled materials identified, where appropriate and practical, but no minimum limits set.<br>Finishes: Field finishing indicated in many cases, where shop-finishing might have been a better choice environmentally.<br>Owner reports 90% PI steel overall. |
| Division 6 | 06100 – Rough Carpentry | Preservative and Fire-retardant treatments: No mention of ACQ, rather than arsenic-based (this is a 1996 spec, however.) |
| | 06125 – Wood Decking | Wood (not FSC – 1996 spec).<br>Pre-finish factory-applied coating called for. |
| | 06400 – Architectural Woodwork | Environ, from Phenix Biocomposites spec'd – renewable, local<br>Nothing in requirements for particleboard, MDF about low-formaldehyde, or sealing edges<br>Trespa Panels spec'd – environmental product (high durability, inclusion of wood fibers, recycled content) |
| Division 7 | 07110 – Sheet Membrane Waterproofing | Prevent moisture migration to interior<br>Use of asphaltic products |
| | 07210 – Insulation | Insulations state requirement for "measurable level" of recycled content<br>Nothing about protective care during installation of fiberglass insulation, other than manufacturer's recommendations |

| Division | Section | Comments |
|---|---|---|
| | 07421 & 07465 – Metal Wall Panels | Steel is recyclable; factory finished; aluminum 10% PI content |
| | 07514 – Built Up Roofing System | Asphaltic materials, 4 ply; creates air quality issues at exterior; medium to long term durable system |
| | 07532 – Single Ply Ballasted Membrane Roofing System | Medium durability; membrane could be recycled |
| | 07900 – Sealants | Many products spec'd – some meet low-VOC requirements, but no over-riding requirements for low-VOCs or installation at appropriate time for off-gassing, or recommendations for timing installation of wet finishes. |
| Division 8 | 08210 – Wood Doors | Nothing about FSC certified (or DNR wood); maple – plain sliced – basic, non-wasteful choice, readily available, but not inherently sustainable choice. |
| | 08520 – Aluminum Window Units | Are these as energy efficient as an aluminum-clad wood window?<br>Factory-finished.<br>Low-E coating on glass units, 2 paned, no argon-fill. |
| Division 9 | 09260 – Gypsum Board Systems | 100% recycled content paper-facing on all boards (20% of total material) |
| | 09300 – Tile | Floor tile is an environmental product, using PI content. |
| | 09440 – Thin-set Terrazzo | Epoxy terrazzo is durable, easy to clean; but has high embodied energy and causes some IAQ issues until set (fast cure time.)<br>Aggregate is partially recycled glass content. |
| | 09510 – Acoustical Ceilings | Tile from PC newsprint is noted in final project, but not spec'd; nor is mineral wool product from slag; may have been an addendum item. |
| | 09650 – Resilient Flooring | PVC vinyl sheet spec'd.<br>Linoleum spec'd.<br>Recycled content rubber flooring spec'd.<br>Rubber base (not vinyl) spec'd.<br>Nothing about low-VOC adhesives or installation to prevent off-gassing absorption. |
| | 09680 – Carpet | Requirement to install after wet finish work is completed.<br>One type has 100% recycled fiber (PET); other is Antron Legacy Nylon 6.<br>Nothing about recycled backing. |
| | 09900 - Painting | Alkyds and solvent-based paints spec'd. No comments about low-VOC products or using specific recycled content paints for even primer coats. (Although, they used remanufactured paint.) |
| Division 10 | 10100 – Visual Display Devices | Cork used as backer to fabric-wrapped boards. |

| Division | Section | Comments |
|---|---|---|
| | 10170 – Toilet Partitions | Measurable recycled content (10% minimum.) |
| | 10200 – Louvers | Not indicated, but manufacturer states 50% PI aluminum content |
| | 10270 – Access Floor System | Used to reduce churn costs and materials |
| | 10610 – Demountable Partitions | Used to reduce churn costs and materials |
| Division 11 | 11452 – Residential Appliances | Nothing about EnergyStar appliances. |
| Division 12 | 12301 – Metal Casework | Metal has higher recyclability than plastic laminate casework. |
| | 12500 Furnishings | Not included in specifications reviewed. |
| | 12672 – Floor Mats | Reclaimed tire components |
| Division 15 | Various – Plumbing Fixtures and Equipment | Nothing about EnergyStar labels or low-flow requirements. These may be inherent in the products selected, but not called out as requirements to be specifically met if substitutions are submitted. |
| Division 16 | 16500 - Lighting | Nothing about EnergyStar labels or high efficiency operations. These may be inherent in the products selected, but not called out as requirements to be specifically met if substitutions are submitted. |

# Appendix B: Outcome Data Sheets

The outcome data sheets that follow show the final outcomes calculated and important calculation notes or limitations to the numbers. The key data and observations from this analysis has been included in the outcomes section of the report. Notes on the units used are in the outcomes section of the report.

MPW Hennepin County Public Works Facility - Medina, MN

| | |
|---|---|
| TBD | process, and/or data needs clarification; |
| | Data not gathered at this time |
| | Not Applicable |

| | | | MPW | Benchmark | MPW % savings | Notes | Comments |
|---|---|---|---|---|---|---|---|
| **Operating Energy** | | | | | | | Note per sq.ft is based on **Gross Area** |
| Site Energy | KBTU/Sq.Ft. | /Period* | 98.0 | | | | Site energy = electric Kbtu/ sq.ft + gas Kbtu/sq.ft |
| Electric KBTU | KBTU/Sq.Ft. | /Period* | 34.97 | | | | Elec % of KBTU = (electric KBTU/sq.ft.) / (Site Energy KBTU/sq.ft) |
| Gas KBTU | KBTU/Sq.Ft. | /Period* | 63.05 | | | | |
| Elec % of KBTU | | | 36% | | | | Peak Electric Demand = Converted peak kw to Watts (divided by 1000), then divided by bldg sq.ft |
| Peak Electric Demand | Peak W/Sq.Ft. | /Period* | 2.6 | | | | |
| *Period represents 1 yr of usage from March 2003-March 2004 | | | | | | | |
| **Athena Life Cycle Measures (electric & gas operating energy)** | | | | | | | Athena Measures based on total Wright-Hennepin electric and total CenterPoint gas usage over 366 day period or 1 yr |
| Primary Energy Consumption | KBTU/ sq.ft.** | /Period* | 140.1 | | | | |
| Solid Waste | lb/sq.ft** | /Period* | 3.7 | | | | |
| Air Pollution Index | unit/ sq.ft.** | /Period* | 2.2 | | | | |
| Water Pollution Index | unit/ sq.ft.** | /Period* | 0.0002 | | | | |
| Global Warming Potential | lb/sq.ft** | /Period* | 20.7 | | | | |
| Weighted Resource Use | lb/sq.ft** | /Period* | 46.9 | | | | |
| *Period represents 1 yr of usage from March 2003-March 2004 | | | | | | | |
| **Design Energy Improvements (Estimated from Energy Assests)** | | | | | | | |
| Initial Report Cost Base Peak Electr | W/sq.ft | | | | | | |
| Initial Report Peak Electric | W/sq.ft | | | | | | |
| Estimated Savings from Strategies | % | | | | | | |
| Expected strategy peak **savings** | kW | | | | | | |
| Achieved strategy peak **savings** | kW | | | | | | |
| Percent achieved | | | | | | | |
| **Design Spatial Measures** | | | | | | | |
| Net Area | Sq.Ft. | | 207,039 | | | | Net area (gross minus circulation, toilet, mechanical), provided by architect. |
| Gross Area | Sq.Ft. | | 242,205 | | | | Building Footprint provided by architect |
| Net to Gross Percentage | | | 85% | | | | |
| Building Footprint | Sq.Ft | | 178,620 | | | | |
| Numebr of FTE Occupants | | | 280 | | | | FTE occupant number provided by facility manager. Full time assumed to be based on 40 hrs/wk, few part time employees included in 280, number unknown. |
| Designed Peak Occupancy (not including toilets, mech rms) | | | | | | | |
| Actual Peak Occupancy | | | | | | | |
| Gross Area/ designed peak person | Sq.Ft./Peak People | | | | | | |
| Gross Area/ actual peak person | Sq.Ft./Peak People | | | | | | |
| Gross Area/ FTE Occupants | Sq.Ft/ FTE Person | | 865 | | | | Site Area = 46 acres 1 acre = 43,560.2 sq.ft. (46*43,560.2=2,003,768 sq ft) |
| Net Area/ FTE Occupants | Sq.Ft/ FTE Person | | 739 | | | | |
| Total Site Area | | | 2,003,768 | | | | |
| Area Gross Bldg / Site % | | | 12% | | | | |
| Area Bldg Footprint / Site % | | | 9% | | | | |
| **Construction Waste by sq.ft.** | | | | | | | |
| Recycled Waste | cu. yds/Sq.Ft. | | | | | | |
| Landfilled Waste | cu. yds/Sq.Ft. | | | | | | |
| Total Waste | cu. yds/Sq.Ft. | | | | | | |
| % recycled | % by volume | | | | | | |
| **Operating Waste** | | | | | | | Waste pick-up service provider unknown. Weight information given by facility manager. No bills reviewed. |
| Recycled Waste | tons | /Month* | 0.7 | | | | |
| Landfilled Waste | tons | /Month* | 4.2 | | | | Recycling service provided by Hennepin County Environmental Services. Recycled material includes: newspaper, office paper, glass, plastic, aluminum, corrugated cardboard. |
| Total Waste | tons | /Month* | 4.8 | | | | |
| % recycled | % by weight | | 14% | | | | |
| Recycled Waste | tons/Sq.Ft | /Month* | 0.00003 | | | | |
| Landfilled Waste | tons/Sq.Ft | /Month* | 0.00021 | | | | |
| Total Waste | tons/Sq.Ft | /Month* | 0.00024 | | | | |
| * Based on 30 day month,does not represent annual average, from data gathered over 152 day period from months Jan-May | | | | | | | |
| **Operating Waste by Person** (Person = FTE Occupants found on 40hr/wk basis) | | | | | | | Scrap metal recycling (plow blades and other misc. metal), total for county equals 112.87 tons. Unknown how much can be attributed to Medina Facility therefore it is not included in totals. |
| Recycled Waste | lbs/Person | /Month* | 4.8 | | | | |
| Landfilled Waste | lbs/Person | /Month* | 29.7 | | | | |
| Total Waste | lbs/Person | /Month* | 34.5 | | | | |
| * Based on 30 day month,does not represent annual average, from data gathered over 152 day period from months Jan-May | | | | | | | |
| **Water & Site** | | | | | | | Graywater gallons are lower than total water used, because graywater does not include vehicle wash statioin water or fill station water. |
| Main Building Water Use | Gal | /Month* | 22,479 | | | | |
| Vehicle Wash Station Use | Gal | /Month* | 15,537 | | | | |
| Fill Station Use | Gal | /Month* | 6,198 | | | | |
| Total Water Use | Gal | /Month* | 44,215 | | | | |
| Graywater Treatment Waste Water | Gal | /Month* | 22,479 | | | | |
| Vehicle Wash Waste Water | Gal | /Month* | 18,479 | | | | Medina has graywater treatment system and reuses graywater in toilets before waste water is sent to leech field. |
| Total Waste Water (graywater + vehicle waste water) | Gal | /Month* | 40,959 | | | | |
| Water Use (main bldg + vehicle wash) | Gal/Sq.Ft. | /Month* | 0.16 | | | | |
| Total Waste Water (graywater + vehicle waste water) | Gal/Sq.Ft. | /Month* | 0.17 | | | | |
| Irrigation Water | lbs/site Sq.Ft. | /Month* | | | | | |
| Landscape Chemicals | lbs/site Sq.Ft. | /Month* | | | | | |
| *Based on 30 day month, does not represent annual average, from data gatheredover 204 day period in months Sept-Apr | | | | | | | |
| **Water & Site by Person** | | | | | | | |
| Main Building Water | Gal/Person | /Month* | 80 | | | | |
| Graywater Treatment | Gal/Person | /Month* | 80 | | | | |
| *Based on 30 day month, does not represent annual average, from data gatheredover 204 day period in months Sept-Apr | | | | | | | |

**Economic Data**

MPW Hennepin County Public Works Facility - Medina, MN

| Key | |
|---|---|
| TBD | process, and/or data needs clarification; |
| | Data not gathered at this time |
| | Not Applicable |

| | | | MPW | Benchmark | MPW % savings | Notes | Comments |
|---|---|---|---|---|---|---|---|
| **Operating Energy Cost** | | | | | | | |
| Electric Consumption | $/Sq.Ft. | /Period* | 0.40 | | | | Electrcity proviced by Wright-Hennepin. Gas Service provided by CenterPoint Energy. |
| Electric Peak | $/Sq.Ft. | /Period* | 0.23 | | | | |
| Total Electric | $/Sq.Ft. | /Period* | 0.62 | | | | |
| Gas | $/Sq.Ft. | /Period* | 0.46 | | | | Energy Costs based on 1 yr period from March 2003-March 2004 |
| Total Energy | $/Sq.Ft. | /Period* | 1.08 | | | | |
| Total Energy | $ | /Period* | 261,258.19 | | | | |
| *Period represents 1 yr on usage from March 2003-March 2004 | | | | | | | |
| **Design Energy Improvements Cost (Estimated from Energy Assests)** | | | | | | | |
| Added Cost(bundle 2) Compared to initial design | $ | | | | | | |
| Adjusted Added Costs (with incentive) | | | | | | | |
| Initial Estimated Total Energy (cost base) | $ | /Yr | | | | | |
| Initial Estimated Total Energy | $ | /Yr | | | | | |
| Estimated Annual Energy Savings Compared to cost base | $ | /Yr | | | | | |
| Estimated Payback for Added Features | Years | | | | | | |
| Estimated Payback for Added Features with Incentive | Years | | | | | | |
| **Design/Construction Measures Cost** | | | | | | | |
| Total Improved Site Area | Sq.Ft. | | 6,359,785 | | | | |
| Bldg Ft. Print | Sq.Ft. | | 178,620 | | | | |
| Non-building Improved Site Area only | Sq.Ft. | | 6,181,165 | | | | FTE occupant number provided by facility manager. Full time assumed to be based on 40 hrs/wk, few part time employees included in 280, number unknown. |
| Gross Bldg. Area | Sq.Ft. | | 242,205 | | | | |
| Net Bldg. Area | Sq.Ft. | | 207,039 | | | | |
| Total Construction Cost | $ | | 23,900,000 | | | | |
| Buidling Construction Cost | $ | | 21,350,000 | | | | Building sq.ft information provided by architect. |
| Site Improvement Costs | $ | | 2,550,000 | | | | |
| Year Completion | | | 1998 | | | | |
| Building Construction Cost- Net Bldg Area | $/Sq.Ft. | | 103.12 | | | | |
| Building Construction Cost- Gross Bldg Are | $/Sq.Ft. | | 88.15 | | | | |
| Designed Peak Occupancy (not including toilets, mech rms) | | | | | | | |
| Number of FTE occupants | | | 280 | | | | |
| Total Construction Cost per person | $/Designed Occupancy | | | | | | |
| Total Construction Cost per person | $/FTE Occupant | | 85,357 | | | | |
| Total Construction Cost per Sq.Ft | $/Sq.Ft | | 98.68 | | | | |
| Unit Cost- Site Improvement | Area | | 0.41 | | | | |
| **Construction Waste Cost** | | | | | | | |
| Recycled Waste | $ | | | | | | |
| Landfilled Waste | $ | | | | | | |
| Total Waste | $ | | | | | | |
| $ Savings from Recycling | $ | | | | | | |
| **Operating Waste Cost** | | | | | | | |
| Recycled Waste | $ | /Month* | 0.00 | | | | Standard waste service provider unknown. Total cost for 2003 was provided by facility manager. |
| Landfilled Waste | $ | /Month* | 783.73 | | | | |
| Total Waste | $ | /Month* | 783.73 | | | | |
| $ Savings from Recycling | $ | /Month* | 50.03 | | | | |
| Recycled Waste | $/ton | | 0.00 | | | | Recycling service provided and paid for by Hennepin County Environmental Service. MPW is not billed for recycling service, internal cost to Hennepin County not known at this time. Direst costs to facility would include janitorial staff costs for emptying building bins, that data not collected. |
| Landfilled Waste | $/ton | | 76.21 | | | | |
| $ Savings from Recycling | $/ton | | 76.21 | | | | |
| Recycled Waste | $/sq.ft | /Month* | 0.00 | | | | |
| Landfilled Waste | $/sq.ft | /Month* | 0.003 | | | | |
| Total Waste | $/sq.ft | /Month* | 0.003 | | | | |
| * Based on 30 day month, over 2003 year | | | | | | | |
| **Operating Waste Cost by Person** | | | | | | | |
| Recycled Waste | $/Person | /Month* | 0.00 | | | | |
| Landfilled Waste | $/Person | /Month* | 2.80 | | | | |
| Total Waste | $/Person | /Month* | 2.80 | | | | |
| * Based on 30 day month, over 2003 year | | | | | | | |
| **Water & Site Cost** | | | | | | | |
| Main Building Water Use | $ | /Month* | 58.91 | | | | |
| Vehicle Wash Station Use | $ | /Month* | 39.00 | | | | |
| Fill Station Use | $ | /Month* | 14.39 | | | | Water is supplied by the City of Medina. There are 5 meters on site: 2 meters for standard building water, 2 meters for the vehicle wash station and 1 meter at the fill station. |
| Total Water Use Cost | $ | /Month* | 112.30 | | | | |
| Graywater Treatment Waste Water | $ | /Month* | 2994.76 | | | | |
| Vehicle Wash Waste Water | $ | /Month* | 925.62 | | | | |
| Total Waste Water Cost (graywater + vehicle waste water) | $ | /Month* | 3920.38 | | | | Medina Facility not connected to municipal sewer system. Onsite graywater treatment system in place, from Zenon, Costs for graywater system include labor for 1 visit/wk and 24 hr on call service, mainenance, and lab fee for Minnesota DMR report. |
| Water Use Cost (main bldg + vehicle wash) | $/Sq.Ft. | /Month* | 0.0004 | | | | |
| Graywater Treatment Waste Water Cost | $/Sq.Ft. | /Month* | 0.0124 | | | | |
| Vehicle Wash Waste Water Cost | $/Sq.Ft. | /Month* | 0.0038 | | | | |
| Total Waste Water Cost (graywater + vehicle waste water) | $/Sq.Ft. | /Month* | 0.0162 | | | | Vehicle wash water can not be treated by graywater system, costs added to have water hauled off site by Duane's Septic Services |
| Irrigation Water | $/site Sq.Ft. | /Month* | | | | | |
| Landscape Maint/ Chemicals/ etc. | $/site Sq.Ft. | /Month* | | | | | |
| * Based on 30 day month, represents 1 year period from Jan 2003-Jan 2004 | | | | | | | |
| **Water & Site Cost by Person** | | | | | | | |
| Main Building Water | $/Person | /Month* | 0.21 | | | | |
| Total Graywater System | $/Person | /Month* | 10.70 | | | | |
| * Based on 30 day month, represents 1 year period from Jan 2003-Jan 2004 | | | | | | | |

# Appendix C: Key to Life Cycle Assessment Units

***The following is an excerpt from Athena™ Version 2.02 Software Help Section:***
**Interpreting Results**

As output, the model produces a detailed life cycle inventory for an entered design. It also generates a set of summary results in graphical and tabular form showing:

· aggregate ecologically weighted resource requirements;
· embodied energy inputs by type;
· global warming potential;
· an index of water pollution effects;
· an index of air pollution effects; and
· solid wastes.

This section briefly describes the six environmental measures used to summarize the environmental assessment results provided by Athena™.

**Embodied primary energy** is reported in Mega-joules (Mj). Embodied primary energy includes all energy, direct and indirect, used to transform or transport raw materials into products and buildings, including inherent energy contained in raw or feedstock materials that are also used as common energy sources. (For example, natural gas used as a raw material in the production of various plastic (polymer) resins.) In addition, the model captures the indirect energy use associated with processing, transporting, converting and delivering fuel and energy.

**Solid waste** is reported on a mass basis in kilograms and is generally self-explanatory. No attempt has been made to further characterize emissions to land as either hazardous or non-hazardous.

All other measures are indices requiring more explanation and interpretation. They have been developed because of the difficulty of using and interpreting detailed life cycle inventory results. For example, it takes considerable expertise to understand and appreciate the significance of the individual emissions to air and water. Both categories encompass a relatively large number of individual substances with varying environmental impacts. In the case of raw resource use, there is no real basis for comparison from one material to another in terms of environmental impact. The model therefore compiles related numeric results into indices that summarise the results by indicating potentials for environmental impacts.

**Raw resource use** can be measured in common units such as tonnes, but a unit of one resource like iron ore is not at all comparable to a unit of another resource life timber or coal when it comes to environmental implications of extracting resources. Since the varied effects of resource extraction, (e.g., effects on bio-diversity, ground water quality and wildlife habitat, etc.) are a primary concern, we want to make sure they are taken into account. The problem is that while these ecological carrying capacity effects are as important as the basic life cycle inventory data, they are much harder to incorporate for a number of reasons, especially their highly site-specific nature.

Our approach was to survey a number of resource extraction and environmental specialists across Canada to develop subjective scores of the relative effects of different resource extraction activities. The scores reflect the expert panel ranking of the effects of extraction activities relative to each other for each of several impact dimensions. The scores were combined into a set of resource-specific index numbers, which are applied in Athena™ as weights to the amounts of raw resources used to manufacture each building product. The Weighted Resource Use values reported by Athena™ are the sum of the weighted resource requirements for all products used in each of the designs. They can be thought of as "ecologically weighted kilograms", where the weights reflect expert opinion about the relative ecological

carrying capacity effects of extracting resources. Excluded from this measure are energy feedstocks used as raw materials. Except for coal, no scoring survey has been conducted on the effects of extracting fossil fuels, and hence, they have been assigned a score of one to only account for their mass. The weighting factor for each raw material is set out below:

Weighted Resource Use

Same as normal resource converted to mass quantities except:

1. LIMESTONE * 1.5
2. IRON ORE * 2.25
3. COAL * 2.25
4. WOODFIBER * 2.5

**Global Warming Potential** (GWP) is a reference measure. Carbon dioxide is the common reference standard for global warming or greenhouse gas effects. All other greenhouse gases are referred to as having a "CO2 equivalence effect" which is simply a multiple of the greenhouse potential (heat trapping capability) of carbon dioxide. This effect has a time horizon due to the atmospheric reactivity or stability of the various contributing gases over time.

As yet, no consensus has been reached among policy makers about the most appropriate time horizon for greenhouse gas calculations. The International Panel on Climate Change100-year time horizon figures have been used here as a basis for the equivalence index:

CO2 Equivalent kg = CO2 kg + (CH4 kg x 23) + (N2O kg x 296)

While greenhouse gas emissions are largely a function of energy combustion, some products also emit greenhouse gases during the processing of raw materials. Process emissions often go unaccounted for due to the complexity associated with modelling manufacturing process stages. One example where process CO2 emissions are significant is in the production of cement (calcination of limestone). Because Athena™ uses data developed by a detailed life cycle modelling approach, all relevant process emissions of greenhouse gases are included in the resultant global warming potential index.

**The air and water pollution measures** are similarly intended to capture the pollution or human health effects of groups of substances emitted at various life cycle stages. In this case we used the commonly recognised and accepted critical volume method to estimate the volume of ambient air or water that would be required to dilute contaminants to acceptable levels, where acceptability is defined by the most stringent standards (i.e., drinking water standards).

Athena™ calculates and reports these critical volume measures based on the worst offender -- that is, the substance requiring the largest volume of air and water to achieve dilution to acceptable levels. The hypothesis is that the same volume of air or water can contain a number of pollutants. However, there are concerns about the cumulative or synergistic effects of some substances and we therefore expect to further refine our approach in the future.

Air Pollution Index = maximum of the following, divided by 1000:

i) SULPHUR OXIDES (g) / 0.03
ii) PARTICULATES (g) / 0.06
iii) CARBON_MONOXIDE (g) / 6
iv) NITROGEN OXIDES (g) / 0.06
v) VOLATILE ORGANICS (NMHC) (g) / 6
vi) PHENOLS (g) / 2

Water Pollution Index = maximum of the following divided by 1,000,000

i) DISSOLVED SOLIDS (mg) / 5000.0
ii) POLYNUCLEAR AROMATIC HYDROCARBONS (mg)
iii) CYANIDE (mg) / 0.05
iv) PHENOLS (mg) / 0.01
v) AMMONIA/AMMONIUM (mg) / 20.0
vi) NITRATE NITRITE (mg) / 20.0
vii) HALOGENATED ORGANICS (mg) / 0.2
viii) CHLORIDES (mg) / 2500.0
ix) ALUMINUM (mg) / 1.0
x) OIL and GREASE (mg) / 10.0
xi) SULPHATES (mg) / 5000
xii) SULPHIDES (mg) / 0.5
xiii) IRON and other HEAVY METALS (mg) / 3.0

# Appendix D: Occupant Survey Form

**Solid Waste Management Coordinating Board**
**Post Occupancy Evaluation**

(1) What is your primary workspace?_____

**For the following questions please circle a number from 1-7 that best reflects your response to the question.**

(2) How healthy do you feel after completing your work in the building each day?

Very unhealthy 1 2 3 4 5 6 7 Very healthy

(3) How healthy do you feel when you are not in the building?

Very unhealthy 1 2 3 4 5 6 7 Very healthy

(4) To what extent do you think your productive work is affected by the interior environmental conditions of the building?

Greatly decreased 1 2 3 4 5 6 7 Greatly increased
no effect

(5) How satisfied are you with the quality of sound environment in your workspace? This includes sounds like echoes, equipment, HVAC, foot traffic, furniture movement, etc.?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(6) Do you notice vibration (e.g., from mechanical systems) in the building?
(Please check one.) _____ Yes _____ No

If you checked Yes, go to Question 7. If you checked No, go to Question 8.

(7) If you notice vibration (e.g., from mechanical systems) in the building how annoying is it?

Not at all annoying 1 2 3 4 5 6 7 Highly annoying

(8) How satisfied are you with your workspace furnishings?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(9) What kind of view of the outdoors do you have when you are seated in your workspace?

No view 1 2 3 4 5 6 7 Panoramic view
Very slight Expansive

(10) Do you have an operable window in your workspace?
(Please check one.) _____ Yes _____ No

(11) To what extent are you satisfied with the overall lighting in your workspace?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(12) How much natural light do you have in your workspace?

None 1 2 3 4 5 6 7 Almost like the outdoors

(13) How much glare do you experience in your workspace?

No glare 1 2 3 4 5 6 7 Very noticeable glare

(14) How satisfied are you with the temperature in your workspace during **the heating season (winter months)**?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(15) How satisfied are you with the temperature in your workspace during **the cooling season (summer months)**?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(16) How satisfied are you with the air quality in your workspace during **the heating season (winter months)**?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(17) How satisfied are you with air quality in your workspace during **the cooling season (summer months)**?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(18) How satisfied are you with the ventilation system in your workspace?

Very dissatisfied 1 2 3 4 5 6 7 Very satisfied

(19) Do you have any additional comments on building performance? Do you have any suggestions for how the building and/or landscape could be improved? If so, please explain them and rank the improvements in order of importance to you.

_____
_____
_____
_____
_____
_____
_____
_____
_____