

# King County Facilities Green Operations & Maintenance Guidelines Handbook

**Prepared for the 2008 King County  
Green Building and Sustainable Development Ordinance**

**Priorities and Guidelines for High Performance Operations and  
Maintenance of Existing King County Buildings and Facilities**



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# Introduction

According to the U.S. Green Building Council (USGBC) the built environment has a profound impact on our natural environment, economy, health, and productivity. In the United States alone, buildings account for:

- 72% of electricity consumption
- 39% of energy use
- 38% of all carbon dioxide (CO<sub>2</sub>) emissions
- 40% of raw materials use
- 30% of waste output (136 million tons annually)
- 14% of potable water consumption.

King County operates and maintains thousands of buildings, facilities, and assets, each with very unique asset management requirements. The operation and maintenance of these facilities can have a significant impact on energy, material, toxic chemical, and water use. Over the past several years, the County has implemented several initiatives addressing these issues including the Climate Change Plan, Energy Plan, and Green Building Initiative. The 2008 Green Building and Sustainable Development Ordinance (the Ordinance) includes direction on improving sustainable operations and maintenance practices in facilities.

These enhanced operations and maintenance (O&M) guidelines were developed in response to the new Ordinance and are designed to help King County operations and maintenance staff develop or update their own enhanced O & M plans and manuals with best management and sustainability practices. The primary goal of these guidelines is to maximize the use of sustainable O&M practices in all King County facilities while facilitating compliance with the Energy Plan. In addition, building operations and maintenance practices are directly tied to ongoing building costs and the internal occupant comfort and external building environment. County-wide implementation of these O&M guidelines can therefore lead to substantial economic, social, and environmental benefits.

## Background

In early July of 2008, King County passed Ordinance 16147. This ordinance requires the use of green building and sustainable development practices in all capital projects that the county plans, designs, constructs, remodels, renovates and operates. The ordinance also covers buildings which the county lends or grants funds to or executes long-term leases or other legal financial instruments causing the construction of capital projects, as long as certain financial requirements are met.

*“The Green O&M Guidelines contain a wealth of information that provides an excellent opportunity to incorporate with existing maintenance management systems to enhance and customize a more useful and user friendly tool.”*

*-Jerry Rutledge  
Power and Facilities Manager  
Metro Transit*

To help achieve a standard level of green building operations in existing buildings, the ordinance requires that a set of priorities and recommended green building O&M guidelines be developed for divisions to incorporate into their facility O&M procedures. The ordinance directs the guidelines to provide instruction on the use of green practices for minor remodels and renovation, water and energy conservation, waste reduction and recycling expectations, green cleaning standards, and retrocommissioning, to improve facility operating performance.

Goals outlined in the ordinance include using sustainable practices to reduce greenhouse gas emissions, reduce pollution, reduce the use of natural resources, reduce energy and other operating costs, enhance asset value, optimize performance, promote cultural sustainability by

### The purpose of these O&M Guidelines is to:

- Help achieve a standard level of green building O&M at all King County facilities.
- Provide guidance to O&M staff in developing sustainable O&M practices for their facilities.
- Serve as a resource for updating existing O&M plans to meet the new goals identified in the 2008 King County Green Building and Sustainable Development Ordinance.

preserving historical resources, and create healthier and more appealing environments for King County employees and the visiting public.

Existing buildings need to be elevated to higher energy efficiency standards in order to have a real impact on reducing carbon emissions and improving energy efficiency. Many of the guidelines in this document may immediately reduce energy use in King County facilities when implemented. Other guidelines will help buildings transition toward future energy use reductions in order to help meet the goals outlined in the 2010 King County Energy Plan, including a ten percent normalized net reduction in energy use in County buildings and facilities by 2012. The plan also calls for the County to produce, use or procure renewable energy equal to 50 percent of total County energy requirements by 2012.

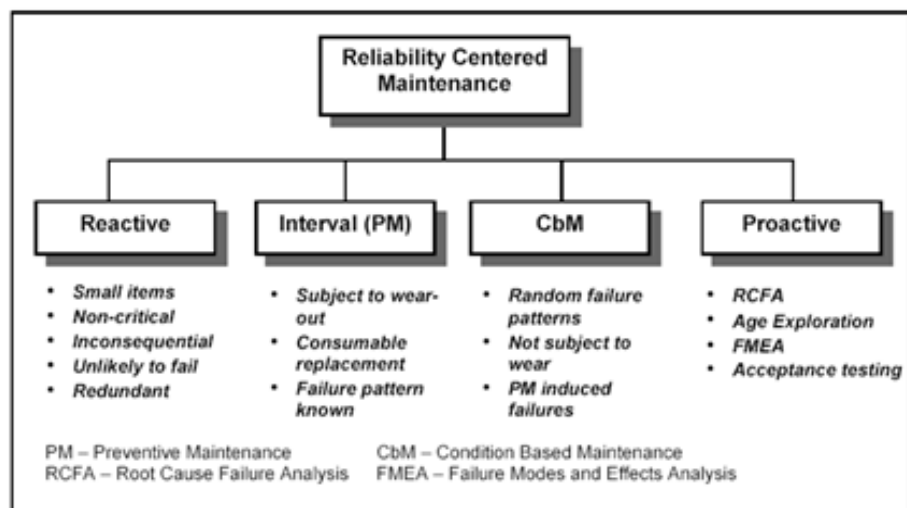
Operations & Maintenance comprise the day-to-day activities necessary for built systems to perform their functions. O&M has developed into one term because a system cannot operate without being maintained. The enhanced guidelines in this document differ from typical O&M practices because of the underlying goals of sustainable practices mentioned above. A shift from reactive to preventative maintenance has already happened in most King County facilities. Predictive and Reliability-Centered Maintenance are further progressions that can improve practices and potentially conserve costs and resources.

## Maintenance Practices & Approaches

There are four distinct maintenance approaches:

- **Reactive maintenance** is sometimes referred to as breakdown maintenance or "replace on failure." It is not a desirable approach as it guarantees interruption of service. Equipment life may be significantly shortened due to lack of regular maintenance, and costs end up higher in the long run.
- **Preventive maintenance** refers to performing regularly scheduled tasks and equipment replacements to avoid problems before they occur. Examples of preventive maintenance include replacing fan belts annually or replacing AC units every ten years. It is possible that the replaced equipment could operate longer, but the odds of a failure and the frequency of repairs increase as the equipment gets older. Replacement decisions must balance with the resource efficiency of utilizing a material or system for longer.
- **Predictive maintenance** relies on monitoring or testing to predict problems and deal with them before they become too big. Predictive maintenance tasks can include measuring vibration, temperatures, efficiency or other characteristics and comparing them to engineering limits. Equipment is repaired or replaced when results exceed limits.
- **Reliability-Centered Maintenance (RCM)** is the optimum mix of reactive, time- or interval-based, condition-based, and proactive maintenance practices.

Reliability-centered maintenance offers a better approach to preventive maintenance. Reliability-Centered Maintenance (RCM) is the optimum mix of reactive, time- or interval-based, condition-based, and proactive maintenance practices. The basic application of each strategy is shown in **Figure 1**. These principal maintenance strategies, rather than being applied independently, are integrated to take advantage of their respective strengths in order to maximize facility and equipment



**Figure 1: Integrated Approach to Maintenance Using RCM** (Whole Building Design Guide)



reliability while minimizing life-cycle costs.

RCM is an advanced maintenance approach that King County would like to investigate further and it is recommended that all facility managers investigate, develop, and begin implementing the RCM approach at their facilities. Another overarching strategy that should drive O&M decisions is the 80/20 rule. This rule suggests that O&M staff allocate 80% of their time maintaining the top 20% of most critical equipment to achieve the most benefit from maintenance and operations practices.

The Whole Building Design Guide provides good basic information about the RCM process. The combined approaches of RCM produce an integrated maintenance system that maximizes facility and equipment reliability. However, this approach only provides guidance at the preventative and predictive levels.

RCM includes reactive, time-based, condition-based, and proactive tasks. In addition, a user should understand system boundaries and facility envelopes, system/equipment functions, functional failures, and failure modes, all of which are critical components of the RCM program.

### LEED for Existing Buildings: Operations & Maintenance (LEED-EB: O&M)

*“These Guidelines provided a very useful framework for completing necessary plans as part of LEED-EB:O&M certification for the Black River Building.”*

*Denise Thompson  
Capital Project Manager  
Facilities Manager Division*

LEED-EB: O&M is a green building rating system developed by the US Green Building Council. It is intended to help building operators reduce the environmental impact of their practices — and achieve recognition for their efforts. The six categories of the rating system are site, water, energy, materials (purchasing and solid waste), indoor environmental quality, and innovation.

This standard provides useful guidelines to help King County facilities achieve a number of goals including: reducing the amount of energy, water and other resources they use, reducing operating costs, and improving the health of occupants and facilities staff. LEED-EB: O&M requires 11 plans & policies in the following areas: building exterior and site maintenance programs; energy systems and policies; water fixtures, irrigation systems and process

use; the purchase of environmentally-preferred products and food; waste stream management; and, cleaners and other products that affect the quality of the indoor environment. It also requires meeting minimum energy performance using Energy Star Portfolio Manager with a minimum ES score of 71, and the rating system includes 9 pre-requisites.

In contrast to LEED for New Construction (NC), which is only available to new buildings, LEED-EB: O&M is available to almost any building in operation. As long as the building meets the program prerequisites, including minimum energy performance, any project may be certified.

Throughout this guide you will see boxes such as the one to the right that highlight LEED-EB: O&M plan and policy requirements. These may be useful for certification or simply for developing a thorough plan. For every plan, LEED-EB: O&M requires that the following are included: scope, performance metric, goals, procedures and strategies, responsible party, and time period.

#### LEED-EB: O&M Reference Key

**SS = Sustainable Sites**

**WE = Water Efficiency**

**EA = Energy & Atmosphere**

**MR = Materials & Resources**

**EQ = Indoor Environmental Quality**

**IO = Innovations in Operations**

King County has already required that new county buildings achieve LEED-NC Gold. Thinking about LEED-EB: O&M requirements and including the recommended components in King County facility O&M plans may help a facility prepare for potential future King County requirements related to LEED EB.

## How to Use This Document

The intent of this document is to provide guidance on O&M procedures applied in all County facilities, to achieve high performance and sustainable practices in our existing buildings. The guidelines herein are meant to work alongside or in place of already existing practices, and facility staff can identify and select to implement any or all of the guidelines as they apply, if they augment practices already in place. The Chapters or guidelines from this document can be copied directly into existing facility manuals, or can be customized for a particular building in order to create facility specific high performance O&M practices. Exactly how this document is used is up to the discretion of facility staff and depends on practices and requirements already in place. There are references to frequencies of actions that may not be applicable or possible for your facility or asset. Consider the frequency that is most appropriate for your own conditions.

This is a working document that will be updated frequently, at least annually. Future versions will likely include additional chapters, including tenant behavior and minor remodel strategies, and additional tools such as the King County Life Cycle Cost Analysis ([LCCA](#)) tool.

The legend below identifies symbols that are used throughout this document to identify whether an action is related to maintenance (a wrench symbol) or operations (a clock symbol). The distinction between maintenance practices vs. operations practices likely differs between facilities, depending on custom facility practices and staff responsibilities. However, these symbols serve as initial guidelines when assigning tasks and responsibilities.

Actions that are deemed to provide the most benefit with the least amount of effort have an exclamation point to show that these are priority guidelines. Effort should be made to implement these first.

### Legend:



Maintenance Guideline



Operations Guideline



Priority Maintenance Guideline



Priority Operations Guideline

Throughout the document and in Part II are sample worksheets as well as a sample O&M plan template that facility staff can use to highlight their O&M practices and accomplishments in their annual reports. These are useful tools to use when asked to report on the implementation of high performance O&M techniques based on the Green Building Ordinance. A combination of blank and sample completed templates are inserted throughout the document to provide real-world examples of how to implement these guidelines.

# **Part I:**

# **Operations & Maintenance Guidelines**



# Retrocommissioning

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## Introduction

Improving building comfort and achieving energy savings in King County buildings begins with a process for identifying existing building energy performance. Retrocommissioning, also known as existing building commissioning, is a systematic investigation process for improving and optimizing a building's performance according to the owner's desired operating requirements. Retrocommissioning typically focuses on energy-using equipment such as lighting, HVAC, and building controls with the goal of identifying maintenance and operational changes to improve building comfort and energy savings. Retrocommissioning can increase the energy efficiency of buildings by 5-10% or more.

Depending on the project scope and owner's desired outcomes, retrocommissioning can include a range of actions from small scale efforts such as building scoping, equipment repair and tune-up activities to more comprehensive efforts which include functional testing of equipment and systems, analyzing test results, repairing equipment, replacing failed parts, adjusting equipment schedules and tuning operation, and re-testing equipment and systems to verify results.

The question of the scale of the effort and who should conduct retrocommissioning can be addressed once the objectives and budget have been established. Some facilities have in-house capability to successfully retrocommission their own equipment, while others will need the assistance of a service provider (e.g., mechanical contractor) or commissioning agent. Service providers have different approaches to improving energy performance. Resources for service and commissioning provider qualifications are listed in the resource section below.

Whether small or large, retrocommissioning activity is critical to ensuring energy efficient operation. If executed properly, it can result in:

- Substantial cost savings from extended equipment life;
- Increased tenant satisfaction through improved space comfort;
- Substantially better energy performance;
- Improved indoor air quality; and,
- Fewer O&M emergency calls.

### Tips for LEED-EB: O&M

LEED EB includes a credit related to commissioning. Keep the following details in mind when creating your Retrocommissioning plan so that your facility could easily meet this pre-requisite:

#### **EA Credit 2.1: Existing Building Commissioning (Cx): Investigation and Analysis**

##### Option A: Commissioning Process

- Develop a retrocommissioning, recommissioning, or ongoing commissioning plan for the building's major energy-using systems.
- Conduct the investigation and analysis phase.
- Document the breakdown of energy use in the building.
- List the operating problems that affect occupants' comfort and energy use, and develop potential operational changes that will solve them.
- List the identified capital improvements that will provide cost-effective energy savings and document the cost-benefit analysis associated with each.

##### Option B: ASHRAE Level II, Energy Audit

A building investigation looks for opportunities to reduce energy waste in many ways, including:

- **Equipment Scheduling** – Equipment runs when it is not needed, including lighting that is on when it is not needed.
- **Sensor Error** – Erroneous sensor data causes increased heating, cooling, or equipment operation, which can affect occupant comfort.
- **Simultaneous Heating and Cooling** – The same air gets heated and cooled, or hot and cold air streams get mixed together to make warm air.
- **Outside Air Usage** – Economizer does not function optimally, or excessive outside air causes increased heating and/or mechanical cooling, and sometimes too little air compromises indoor air quality.
- **Air filtration** – Infrequent filter changes may result in fan energy demands to compensate for excess pressure that are more significant than the cost of changing the filters.

## Retrocommissioning Guidelines

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- 🕒 **!** Establish key performance indicators for the building equipment and systems identified in the operations manual. Routinely track the indicators to ensure performance is being met.
- 🕒 **!** Augment the building systems operations manual to include information that documents **operating schedules, set points** and **sequences of operation** for the building's water, waste, and IAQ performance (see the Black River sample Operating Schedules Form on the following page).
- 🕒 **!** Augment the performance indicators established for energy use to include the building's water, waste, and IAQ performance. Performance indicators might include one or more of the following: tracking water and waste bills; water and waste benchmarking; trend logging; and/or air quality monitoring. Routinely track the indicators to ensure performance goals are being met.
- 🕒 Conduct an investigation of the building's energy-using systems, such as:
  - **HVAC Equipment and Systems:** Packaged Air Conditioning Systems, Fan Coils and Unit Ventilators, Variable Air Volume Systems, Chilled Water Systems, Hot Water Systems, Air Filters, Ducts, and Economizers.
  - **Lighting Equipment and Systems:** Lamps, Luminaires, Exit and Emergency Lighting, and Lighting controls including Occupancy and Motion Sensors, Timers and Timeclocks, and Daylighting Controls.
  - **Controls Equipment and Systems:** Computerized Maintenance Management System, Energy Management Control System, Building Management Control System, and all of their components.
- 🕒 Conduct annual occupant surveys to assess satisfaction with building energy performance. Suggested categories of inquiry among others could include thermal comfort, lighting, and air quality.
- 🕒 Conduct a building scoping walk-through to identify maintenance and operational improvements for landscape management and irrigation, waste collection and management, and air quality condition. Prepare a scoping report that identifies needed repairs, basic maintenance problems, and operational improvements such as scheduling and optimization. Consider using an impartial consultant or other third party to prepare the report.

### Tips for LEED-EB: O&M

LEED-EB: O&M rewards facilities that conduct a commissioning process, implement improvements based on the result, and create an ongoing commissioning plan to repeat the process at least every two years.

#### EA Credit 2.3: Ongoing Commissioning

This LEED-EB: O&M credit requires a plan for ongoing commissioning that includes

- Building equipment list
- Performance measurement frequency
- Steps to respond to deviation

## Sample Operating Schedules

<b>BLACK RIVER BUILDING OPERATING SCHEDULES</b>							
Requirements	Typical for Building	HVAC control by area or unit					
		Lobby	South AHU-1	North AHU-2	Office Space	3rd flr Server Rm	2nd flr Server Rm
Normal operating schedule for occupancy	Monday - Thursday 5:45am - 6:15pm	Same	Same	Same	Same	Continuously	Continuously
Weekend schedule	N/A	Off	Off	Off	Off	Continuously	Continuously
Holiday schedule	N/A	Off	Off	Off	Off	Continuously	Continuously
Air temperature requirements - cooling season	occupied: 72 deg non-occupied: Ventilation off	72	70 / 55 as needed	70 / 55 as needed	72	68	68
Air temperature requirements - heating season	occupied: 72 deg non-occupied: Ventilation off	72	70 / 55 as needed	70 / 55 as needed	72	68	68
Humidity	None						
Dehumidification	None						
Pressure relationship	0.025"	Same	N/A	N/A	N/A	N/A	N/A
Filtration	4" pleated MERV 8	Same	Same	Same		2" media filters	2" Pleated MERV 8
Ventilation	20% outside air min.	Same	Same	Same	Same	0	0
Cleaning Schedule	Monday - Thursday: 3:30pm - 12:00am Friday: 9:00am - 5:30pm						
Lighting levels	Fixed by area						
Parking lot lighting	photocell controlled						

## Retrocommissioning and Building Investigation Resources

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- ☞ Whole building Design guide (equipment reliability): [http://www.wbdg.org/design/func\\_oper.php](http://www.wbdg.org/design/func_oper.php)
- ☞ Whole building Design guide (Life-Cycle Costs Analysis): <http://www.wbdg.org/resources/lcca.php>
- ☞ King County Energy Plan: <http://your.kingcounty.gov/dnrp/measures/documents/pdf/KC-Energy-Plan-2008.pdf>
- ☞ Energy Star's Retrocommissioning Chapter  
[http://www.energystar.gov/ia/business/EPA\\_BUM\\_CH5\\_RetroComm.pdf](http://www.energystar.gov/ia/business/EPA_BUM_CH5_RetroComm.pdf)
- ☞ Commissioning Provider Qualifications: [http://www.cacx.org/resources/provider\\_cert.html](http://www.cacx.org/resources/provider_cert.html)
- ☞ Energy Efficiency Service Providers: <http://www.neec.net>
- ☞ Service Contract Provisions for Enhanced O&M:  
<http://www.betterbricks.com/DetailPage.aspx?ID=489#ServiceContracts>
- ☞ Energy Performance Indicators: <http://www.betterbricks.com/DetailPage.aspx?ID=491>
- ☞ Key Performance Indicators for Major HVAC Equipment:  
<http://www.betterbricks.com/DetailPage.aspx?ID=492#HVACSystemsAndMajorEquipment>
- ☞ Building Scoping and Tune Up: <http://www.betterbricks.com/DetailPage.aspx?ID=490>
- ☞ Energy Tune Up Document:  
[http://www.betterbricks.com/graphics/assets/documents/OOpImprv\\_1.pdf](http://www.betterbricks.com/graphics/assets/documents/OOpImprv_1.pdf)
- ☞ Building Systems Operations Map: <http://www.betterbricks.com/DetailPage.aspx?ID=492>
- ☞ Staff Training:  
<http://www.betterbricks.com/DetailPage.aspx?ID=489#StaffAssessmentAndProfessionalDevelopment>
- ☞ A 4-Step Process for Retrocommissioning: Source: A Practical Guide for Commissioning Existing Buildings. Haasl, T. and T. Sharp. 1999. <http://www.osti.gov/bridge/servlets/purl/15043-chw4bd/webviewable/15043.pdf>
- ☞ Building Commissioning Resources:  
<https://netforum.avectra.com/eweb/DynamicPage.aspx?Site=BCA&WebCode=ResourceCenter>
- ☞ The Top Four Energy Wasters:  
<http://www.betterbricks.com/DetailPage.aspx?ID=492#TheTopFourSavingsOpportunities>
- ☞ Energy Performance Symptoms for Equipment Scheduling:  
<http://www.betterbricks.com/DetailPage.aspx?ID=689>
- ☞ Symptom Diagnosis Tool: <http://www.betterbricks.com/DetailPage.aspx?ID=493>



# Landscaping

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## Introduction

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Green landscaping principles help protect both the health of people and environment. From landscape design to the choices made in maintenance, our natural environment can be preserved while waste and pollution are reduced.

Landscaping practices often rely heavily on chemical fertilizers, pesticides, and herbicides which can reach local waterways and threaten human and ecosystem health. Exotic and invasive species perpetuate these problems and intensify management and maintenance requirements, including irrigation demands. Green landscaping practices, on the other hand, respect soil, ecosystem, and human health and decrease the demands on, and threats to, precious water resources.


## Landscaping O&M Plan

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The first influential step toward green landscaping is creating a green landscaping operations and maintenance plan. A green landscaping operations and maintenance plan helps to fully realize the intended state of a building's landscaping while also protecting local and regional ecosystem and human health. Landscaping should be maintained to maximize the health of plants and people, while also reducing impacts on the planet and your budget (profit). Additionally, a well-executed O&M plan will improve the beauty and life of the plantings. The ultimate goal in developing this plan is to create an effective maintenance program that keeps plants healthy while reducing needed resources.

 **!** Prepare or update the landscape O&M plan for your facility. Include strategies to reduce the need for pesticides, fertilizers, water, and maintenance, and to preserve natural resources. The plan should cover all aspects of grounds maintenance including plant care, turf management, irrigation, pest management, and hardscapes. The plan should include the following sections:

- Landscaping maintenance goals;
- Responsibilities;
- Landscape documentation;
- Maintenance task list and schedule;
- Evaluation task list and schedule;
- Recordkeeping process; and,
- Maintenance system audit.




 Implement plan in conjunction with staff training and goal-setting.

## General Landscaping O&M Guidelines

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The goal of routine maintenance in natural areas is to protect, conserve and enhance native plants, water quality, soil, sensitive areas, and wildlife (including fish). The goal of design and routine maintenance in formal landscapes is to promote the health, safety, and longevity of landscapes that enhance the aesthetic beauty of King County facilities with a minimum of resources used.





General Landscape Operations and Maintenance Guidelines include:

-  **!** Increase the use of native plants, increase irrigation efficiency to reduce water use, give better plant care in order to reduce pests and diseases and thereby minimize pesticide use.
-  **!** Follow the King County [Best Management Practices Manual 2004](#) for BMPs related to IPM, turf placement and maintenance, species selection and care, irrigation systems and schedules, and maintenance guidelines.
-  Identify and assess the components and layout of the landscape. Assess its geographic location and microclimates, inventory the plants, and identify soil types.

## Integrated Pest Management

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Well-chosen plants and a well-maintained landscape dramatically reduce the need for pest control. Appropriate selection of plants, irrigation, application of mulch and/or fertilizer, mowing and other practices all help landscapes withstand pest pressures and support natural predators.

-  **!** Verify that your facility is following [King County's IPM program](#) and [Commercial Best Management Practice \(BMPs\) of the King County Stormwater Pollution Prevention Manual \(SPPM\)](#) .
-  **!** Train appropriate staff how to identify pests and work within an IPM Program. All staff associated with design, construction, and maintenance of parklands, landscaped buildings, facilities and other areas where pests must be controlled, or vegetation managed, should receive an orientation to the IPM policy and its guidelines.
-  **!** Use pesticides only as a last resort. When they are used, select the least-toxic product.
-  Collect and maintain pest management records. Include date, specific location, name, reference used for identification, corroborating expert (as needed), stage of lifecycle, extent of pest presence and other pertinent information. Include any control methods implemented, details about pesticide applications and on-going monitoring. See [Best Management Practices Manual 2004](#) for more details.

### Tips for LEED-EB: O&M

The LEED EB credit related to an IPM plan required the following to be included:

#### **SS Credit 3: Integrated Pest Management (IPM), Erosion Control and Landscape Management Plan**



The plan must include:



- Outdoor IPM including preventative strategies, pest monitoring and the use of least-toxic chemicals
- Erosion and sedimentation control
- Diversion of landscape waste from landfills/incineration
- Guidelines for chemical fertilizer use

## Native and Drought-Tolerant Plants vs. Invasive Plants

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Key to reducing maintenance needs is to choose the proper plant for the site. Select native plants and/or drought-tolerant plants that have proven their toughness and ability to thrive with minimal care.




-  **!** Do not plant any species listed as a noxious weed on the current complete [King County List of Noxious Weeds](#) on King County properties
-  Select plants on the basis of their function, adaptability to the site, resistance to diseases and pests, and the amount of care required.

-  Integrate native and/or drought tolerant plants into existing landscapes as appropriate for the area and landscape design.
-  Determine if noxious or invasive species should be removed from the site. See King County weed [control best practices](#) for more information.

## Turf

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Turf areas vary widely in grass type and function, from highly-maintained athletic fields to park meadows, and each type of turf requires distinct maintenance.

-  ! Do not use pesticides to control pests on King County turf. Manage turf pests, including weeds, through good practices.
-  ! Do not seed turf grass within one foot of a fence line or structure. Replacing turf with a properly installed gravel strip or equivalent minimizes landscaping maintenance by simplifying the mowing process. Avoid using pesticides and opt for manually removing any weeds from this strip.
-  Write and follow a section in the O&M plan to include turf mowing, edging, fertilizing, reseeding, irrigation and, based on use, top dressing, dethatching, and aerification.

## Trees

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The health of King County ecosystems and the recovery of salmon largely depend on the health of King County's urban forests. Trees slow down and soak up stormwater, keep salmon streams healthy, provide wildlife habitat, and shade urban streets while they enhance the natural beauty of Puget Sound country. Selecting healthy trees, planting them in appropriate sites, and nurturing them when young will prolong their lives and reduce the maintenance needed to keep them safe and healthy for humans to enjoy.

-  Review landscape designs with a horticultural professional familiar with the site, soils, and species to ensure that the selected trees can achieve the design goal with minimum care, before the design is approved.
-  Promote training of tree care specialists by requiring arborist certification through the International Society of Arboriculture.
-  Tree management priorities should emerge from establishment of a King County tree inventory and regular monitoring of trees on the inventory.
-  Maintenance schedules and procedures shall be based upon priorities established in the Landscape O&M Plan written for the site.

## Plant Beds

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Plant beds are generally designed as focal points or visual frames in more formal parks and around buildings. As such, they require a high level of maintenance and can include both native and ornamental species. These beds contain trees, woody shrubs, and herbaceous perennials that die down in the winter. Maintenance should focus on ensuring the right plant is in the right place and enhancing existing soils by mulching for water retention and weed control. Actual maintenance given to a plant bed will vary depending on location, type of site, design goals, and species.










-  Shrub bed designs should be reviewed by a horticultural professional familiar with the site, soils, and species selected before the designs are approved. The goal is to install a shrub bed that can achieve the design goal with a minimum of care.
-  Maintenance schedules and procedures shall be based upon priorities established in the Landscape O&M Plan written for the site.

## Irrigation


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Drought-resistant landscaping should be utilized as much as possible; however, inevitably some landscaping will require irrigation. A wide variety of King County properties use automatic irrigation systems to maintain their turf, shrub beds, annual plantings, hanging baskets, and generally large and small parks. Unfortunately, this demand has wasted precious water which often carries chemicals into nearby lakes, streams, and the Puget Sound. The goal of landscape management must be to provide suitable water to plants, but not enough to provide runoff and waste.

The irrigation system is a management tool and cannot replace the sound judgment of trained professionals. The best-designed irrigation system will fail without regular maintenance.

-  **!** Update and retrofit existing irrigation systems and equipment to take advantage of new water-saving technology, such as rain shut-off devices and drip irrigation.
-  **!** In order to conserve water and save salmon, move toward using reclaimed water to operate irrigation systems, where this will not cause harm to human life or other species.
-  **!** Report irrigation leaks and shut off the water as soon as possible to prevent water waste. Make repairs as soon as feasible to maintain plant health.
-  Include the following features with irrigation controllers and systems:
  - Use a flow sensor to monitor how much water is being used and communicate this to a controller with a master valve.
  - The master valve should be able to shut down zones or systems due to unscheduled flow conditions, main line brakes, or increased flows due to broken sprinkler heads.
  - Use a rain sensor to shut off the controller due to rain.
  - Use a remote hand controller as a useful tool for sprinkler head and maintenance inspections.
  - Use a central control irrigation controller with ET-incorporated data only when maintenance staff are properly trained to support this advanced and beneficial system.
-  Have a trained irrigation operator perform audits of existing irrigation systems and controllers for performance and efficiency, annually in the spring. Ensure that systems are operating at top efficiency during the dry season.
-  Periodically verify that plant material is healthy and that soil moisture is adequate. Use a soil probe to visually inspect root depth, soil structure and moisture.
-  During the dry season, water deeply but infrequently. Do not exceed one inch per week (including rainfall).
-  Train staff responsible for maintaining and scheduling irrigation systems on the following topics:
  - Irrigation system maintenance and how to conduct water conservation audits
  - Scheduling based on evapotranspiration and seasonal fluctuations.
  - Backflow prevention.
  - Plant health issues when watered by automatic systems. (Generally these systems are run daily, with short intervals, resulting in shallowly-rooted plants susceptible to drown or drought.)
-  Use a preventative maintenance program for irrigation systems:
  - **Perform regular inspections to optimize irrigation equipment:**
    - Equipment maintenance should be performed on a weekly basis, which includes checking equipment for damage, leaks, or adjustments, and then performing the adjustment or repair necessary.

- Perform in-depth inspections of irrigation systems after annual activation in the spring, and bring systems up to specified operating conditions.
- Prioritize future irrigation system improvements by maintaining a record of repairs that are needed, especially for large irrigation systems.
- Sub-meter landscape if possible for water budgeting and leak detection.
- Have a certified landscape irrigation auditor conduct a thorough and comprehensive efficiency check for properties that are one acre or larger at least once every five years.
- Adjust water pressure as needed. Make sure that water pressure is properly set to minimize wind effects. Make sure that the water supply and pressure meet design specifications. Differences in the sprinkler system's required design operating pressure and actual water pressure can affect operation and efficiency. Install pressure reducing valves (PRVs) where needed to stop misting due to excessive pressure.
- **Perform regular and annual inspections of system components to confirm that equipment and equipment components meet the original criteria for efficient operation and uniform distribution of water, including:**
  - Water valves: Adjusted for proper flow and operation and to ensure proper shutdown of valves.
  - Sprinkler heads: Adjusted properly and cleaned to remove debris that might cause blockage or buildup.
  - Sensors: Adjusted properly and calibrated according to specifications.


 Select a reliable, licensed, experienced and reputable irrigation maintenance contractor.


## Green Roofs


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Green roofs describe a roofing system that is a combination of biology and engineering. There are two types of green roofs: extensive and intensive. Intensive systems have deeper soil to allow for larger planting types as well as sometimes serving as rooftop gardens. Intensive systems are heavier than extensive systems so require more structural support. Extensive systems are very shallow and much lighter and can be comparable in weight to a slate roof. Extensive systems are more practical for residential construction. Both green roof systems are designed to absorb and slow down roof runoff and have many benefits including:

- Storm water reduction
- Creating habitat
- Indoor noise reduction
- Greater roof insulation values (potentially)
- Durable longer-lasting roofs
- Absorption of solar gain and reduction of “urban heat island effect”

 Adhere to designers' and manufacturers' operations and maintenance requirements.


 Regularly inspect green roof system components, as prescribed by the designer's or manufacturer's guidelines.

 Clear drain inlets of any debris at least twice per year, or as prescribed by the designer's or manufacturer's guidelines.


## Bio-swales/ Rain gardens

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Rain gardens are shallow depressions that can hold and soak up water runoff from roof tops, driveways, patios and other impervious surfaces. Rain gardens have deep, compost-amended high infiltration rate soils, and are landscaped with native or adapted plants. By holding and naturally infiltrating runoff, rain gardens filter oil and grease from driveways, pesticides and fertilizers from lawns as well as other pollutants before they reach the storm drain and eventually streams, wetlands, lakes and other marine waters.

 Mulch as needed to prevent erosion and weeds.

 Regularly inspect and keep inlet and outlet well protected with rock and clear of debris.


 Water as needed until native or adapted plants are established.


## Hardscapes


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Hardscape describes the non-living parts of the landscape, such as pavement, walls, fences, pavers, decks, flat roofs, and driveways. Hardscapes provide some of the most visible utilitarian areas on facility sites. However, they also contribute to increased stormwater flows and sediment/contaminant loads, and can promote heat island effects unless they have a high Solar Reflectance Index (SRI). Minimizing the amount of hardscape can improve local hydrologic cycling.


Proper hardscape use and care can minimize their negative impacts, and keeping them clean and well maintained is important for safety and aesthetics. Hardscape maintenance includes garbage and recycling, graffiti removal, cleaning, repairs, and sealing.


 **!** Include hardscape maintenance in the landscape O&M plan that includes routine maintenance, cleaning, sealing, inspections, graffiti removal, trash and recycling.

 **!** Avoid graffiti removal systems that contain phosphates, chlorinated hydrocarbons, xylene or other products known to cause health or disposal problems. Rather, use products that are biodegradable and meet EPA standards for VOCs.


 Conduct daily inspections of hardscape for hazardous materials and waste pickup.

 Schedule routine cleaning.

 Conduct daily inspections for graffiti and immediately submit request for removal.

 Inspect landscape irrigation systems frequently to reduce water runoff and prevent hardscape damage.

 Minimize the use of potable water to clean hardscapes.

 Install recycling receptacles adjacent to exterior trash receptacles to encourage recycling. Dispose of trash and recycling on a regular basis.

 Minimize the use of blacktop and dark-colored hardscapes.

 For new work, specify a high Solar Reflectance Index concrete when possible.

### Tips for LEED EB: O&M

This LEED EB credit should be attainable for King County buildings that implement an O&M plan following the suggested O&M guidelines & priorities.

#### **SS Credit 2: Building Exterior and Hardscape Management Plan**

Employ an environmentally sensitive, low-impact building exterior and hardscape management plan that helps preserve surrounding ecological integrity. The plan must employ best management practices that significantly reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and / or chemical runoff (e.g. gasoline, oil, antifreeze, salts). The plan must address all of the following operational elements, as applicable:

- Maintenance equipment;
- Snow and ice removal;
- Cleaning of building exterior;
- Paints and sealants used on building exterior; and
- Cleaning of sidewalks, pavement and other hardscape

## Landscaping Resources

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- ☞ Best Management Practices (BMP) Activity Sheets – King County Stormwater Pollution Prevention Manual (SPPM) :  
<http://www.kingcounty.gov/environment/waterandland/stormwater/documents/pollution-prevention-manual/commercial-bmp.aspx>
- ☞ Integrated Pest Management (IPM) for noxious weeds:  
<http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-control-practices/ipm.aspx>
- ☞ Native Plant Resources for the Pacific Northwest: [www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/native-plant-resources-nw.aspx#other](http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/native-plant-resources-nw.aspx#other)
- ☞ Choosing Garden Plants website: [www.savingwater.org/outside\\_garden.htm](http://www.savingwater.org/outside_garden.htm)
- ☞ Ecologically Sound Lawn Care for the Pacific Northwest,  
[www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/ecological\\_200312021255394.pdf](http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/ecological_200312021255394.pdf)
- ☞ Natural Lawn Care, [www.naturallandscapes.org/content/natural\\_lawn\\_care/naturallawn.htm](http://www.naturallandscapes.org/content/natural_lawn_care/naturallawn.htm)
- ☞ Saving Water Partnership, <http://www.savingwater.org/>
- ☞ Washington Irrigation Contractors Association, <http://www.wica-web.org/>
- ☞ Irrigation Water Management Society, [http://www.iwms.org/seattle\\_area.asp](http://www.iwms.org/seattle_area.asp)
- ☞ EPA WaterSense, <http://epa.gov/watersense/>
- ☞ Hardscapes for Sustainable Landscapes, Patios, Decks, Walkways, and Driveways,  
<http://extension.oregonstate.edu/catalog/pdf/ec/ec1535.pdf>
- ☞ US EPA – GreenScapes <http://www.epa.gov/epawaste/conserves/rrr/greenscapes/index.htm>
- ☞ Collaborative for High Performance Schools, Best Practices Manual  
<http://www.chps.net/dev/Drupal/node/288>
- ☞ Stop Waste website, [www.stopwaste.org/docs/bay-friendly\\_landscape\\_guidelines\\_-\\_all\\_chapters.pdf](http://www.stopwaste.org/docs/bay-friendly_landscape_guidelines_-_all_chapters.pdf)
- ☞ Commonwealth of Pennsylvania – The Pennsylvania Green Building Operations and Maintenance Manual  
[http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green\\_building\\_maintenance\\_manual/254756](http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green_building_maintenance_manual/254756)
- ☞ Grounds Maintenance Magazine, <http://grounds-mag.com/>
- ☞ US Department of Interior – Integrated Pest Management  
<http://www.fws.gov/contaminants/Documents/GuidanceIPMPlan.pdf>
- ☞ US Green Building Council, <http://www.usgbc.org>
- ☞ Green roof resource [www.greenroofs.com](http://www.greenroofs.com)
- ☞ Green roofs for healthy cities [www.greenroofs.org](http://www.greenroofs.org)
- ☞ Managing storm water at home [www.seattle.gov/util/rainwise](http://www.seattle.gov/util/rainwise)
- ☞ Natural Garden care <http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden.aspx>
- ☞ Native plants <http://www.wnps.org>
- ☞ Seattle Public Utilities Natural Drainage Systems <http://www.seattle.gov/util/naturalsystems>
- ☞ Compost sources and protecting water resources <http://www.soilsforsalmon.org>





# Building Envelope

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## Introduction

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The building envelope separates the conditioned inside occupied space from the outside natural space (or from unconditioned spaces). From an energy standpoint, mechanical systems only exist because of deficiencies in the envelope. The degree to which heat, water (liquid or vapor), and air can transfer between the inside and outside dictates the amount of energy inputs required by mechanical equipment. Minimizing the use and maintenance of HVAC equipment is therefore directly related to the quality and upkeep of the envelope. Ideally, the envelope has been properly designed and built, but this opportunity rarely exists in reality. Therefore, proper maintenance and potential retrofits are critical to optimizing the building envelope.


Maintaining the building envelope is essential to ensuring continued energy efficiency, indoor air quality, and occupant comfort. A proper inspection program is an important aspect of maintenance and can help identify problems before they impact energy use and occupants' health. Effective building O&M requires regular inspections, cleaning, and early detection of problems such as water penetration, air infiltration, structural damage, or insect infestation, all of which should be addressed in the Building Envelope O&M Plan.


## Building Envelope O&M Plan

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In order to optimally operate and maintain King County Facilities, O&M staff should first identify demanding and measurable envelope performance goals. **These goals should refer to and align with the King County Energy Plan to achieve 10% normalized net reduction in County energy use by 2012 and supply 50% of King County's energy use with renewable energy.** These performance goals will help O&M teams form the basis for a Building Envelope O&M Plan for each facility.


In addition to outlining envelope performance goals, the Building Envelope O&M Plan should include provisions for regular building inspections, and prescribe the frequency of inspection for each building component. Cleaning practices for the building exterior and site maintenance duties should also be identified. The plan should include procedures and forms for reporting problems, tracking the resolution of problems when they occur, and meeting the goals outlined by staff.


 **!** Prepare or update the building Envelope Maintenance Plan for your facility. Include the following sections: Exterior Walls/Foundation; Roofs; and Doors & Windows. Utilize the individual Foundation and Walls, Roofs, and Door & Windows forms included below in the corresponding sections or utilize the O&M Plan template provided in Part II.


 Identify the top 5 measurable goals for the envelope of the building (including time frames). For example: Daily Goal #1: Ensure all doors and windows are closed during heating or cooling season in order to minimize heat loss (or heat gain); Annual Goal #1: Improve the envelope infiltration efficiency by 10% as measured by an air infiltration test. See Table 1 for an example format and measurable goal. A larger template for this form is included in Part II.


**Table 1: Envelope Performance Goals**

Envelope Component	Measurable Goal	Purpose	Timeframe for Inspection/Maintenance	Actions / Notes
(example) Windows	No visible or reported water leakage at windows for 6 months	Improve durability of building, increase energy efficiency, and prevent mold & mildew growth	Weekly inspections during Summer; 3 inspections/week during rainy season.	Include inspection log and any notes in Building Envelope O&M Plan; involve occupants and other staff in the monitoring.

 **! Wall Maintenance:** identify and schedule regular inspections and maintenance for each exterior wall type (maintenance will vary based on façade type). Create a detailed annual schedule that includes inspecting, painting, and refinishing vertical wall surfaces.

 **! Foundation:** Develop a foundation inspection schedule that is appropriate for your building and interior uses (for example, an office building is less likely to need frequent foundation inspections, whereas a truck bay with equipment might require weekly or monthly inspections).

 **! Roof Maintenance:** identify and schedule regular inspections and maintenance based on roofing type and weather conditions. Create a detailed annual schedule that includes RCM or preventive maintenance and utilizes outside qualified contractors to check for leaks or damage through advanced techniques such as thermal imaging.

 **! Windows and Doors:** Create an inventory of all existing windows and doors and identify the most appropriate inspection and maintenance schedule for each window and door.

## Exterior Walls

The exterior walls should provide thermal resistance and a continuous barrier to moisture and air flows. Any weaknesses in these functions can wreak havoc on energy efficiency, durability, occupant health and comfort, and HVAC equipment lifespan.




### Tips for LEED-EB: O&M

This LEED-EB: O&M credit may be attainable for King County buildings that meet the following requirements.




#### SS Credit 2: Building Exterior and Hardscape Management Plan

Employ an environmentally sensitive, low-impact building exterior and hardscape management plan that helps preserve surrounding ecological integrity. The plan must employ best management practices that significantly reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and / or chemical runoff (e.g. gasoline, oil, antifreeze, salts) compared with standard practices. The plan must address all of the following operational elements that occur on the building and grounds, as applicable:









- Maintenance equipment;
- Snow and ice removal;
- Cleaning of building exterior;
- Paints and sealants used on building exterior; and
- Cleaning of sidewalks, pavement and other hardscape.


-  Check caulking, paint, stains and wood for damage. Immediately address problems that pose obvious current or near-future vulnerabilities to thermal, moisture, or air flows within the walls.
-  Clean exterior walls at least twice a year.
-  Utilize reliability-centered maintenance as described in the Introduction when possible.

## Exterior Wall Inspections


-  **!** Complete a visual inspection of the exterior of the building and look for changing conditions of the exterior walls and covering. Problem signs to look for include peeling paint, missing mortar or caulking between masonry joints, cracks that have appeared since the last observations, mildew or mold growing on walls or overgrowth of bushes and shrubs near the building's exterior.
-  **!** Ensure ground slopes away from building foundation and water drains away from the foundation.
-  Test for water intrusion through exterior surfaces, particularly around penetrations for conduit or refrigerant lines. A physical inspection alone may not detect moisture that is present in the building envelope. Accurate assessments and early detection test methods include:
  - Random core sampling-determines presence of moisture in insulation systems.
  - Moisture adsorption tests.
  - Infrared moisture surveys of substrate material.
  - Air and water infiltration tests.
  - Testing by outside professionals is often difficult to include in maintenance budgets, but will enable more advanced diagnostic evaluation in some cases.

## Exterior Wall Cleaning



-  **!** Adhere to the products specified in [King County's Environmentally Preferable Cleaning Products guidelines](#).
-  **!** Do not let chemicals or other hazardous waste run into storm drainage system or the indoor sanitary sewer system (must comply with EPA NPDES regulations).
-  Exterior cleaning should be performed at least twice a year, more frequently (four times a year) in marine or high-pollution environments.
-  For regular cleaning of sand and dirt, the building can be cleaned with desalinated water and a nylon brush. For marine climates, dried salt deposits and algae may be removed with a high-pressure wash. Try to utilize techniques that minimize the use of potable water.
-  Trim plants away from building for pest, rot, and moisture prevention.
-  Avoid sandblasting as this may leave permanent stains on the wall.
-  Avoid using solvent or acid-based cleaning products. Solvents or paint strippers can break down paints, but may discolor or permanently stain masonry surfaces. A high pressure water spray can remove dirt and stains from exterior walls.
-  Baking soda blasting can be used to clean many different types of exteriors including brick and stucco. Soda blasting can also be effective for paint, grime and dirt removal from these substrates, but is not recommended.

-  Cleaning graffiti may sometimes require repainting; if so, avoid sandblasting on the building exterior. Anti-graffiti sprays are available that can be applied over the existing finish to aid in the removal of future graffiti. The spray creates a layer between the graffiti and building surface, and can be applied to a variety of building surfaces.

### **Exterior Wall Preventive Maintenance**

-  Perform routine inspections to identify moisture control problems before they cause damage. Mold or fungi formation and wood rot are obvious signs of moisture problems. Other signs to look for include:
  - Cracked or blistered paint;
  - Cracked or missing sealant;
  - Water stains on the interior walls or ceilings; and,
  - Gaps that allow moisture to penetrate the walls.

### **Exterior Wall Retrofit Opportunities**

-  Weatherproof any exposed wood.
-  Consider thermal improvements and look for possibilities to add exterior insulation or cavity insulation to under-insulated walls, or to eliminate thermal bridging at metal studs.

The following Semi-Annual Foundation and Wall Inspection Log is provided for you to incorporate into your own Guidelines and working documents.



**King County**

Department of Executive Services  
Facilities Management Division  
**Building Services Section**  
500 Fourth Avenue, Room 201  
Seattle, Washington 98104

# Semi-Annual Foundation and Wall Inspection Log

**Building Name:** \_\_\_\_\_

**Year:** \_\_\_\_\_

**Purpose of inspection:** To improve and maintain the durability of the building, increase energy efficiency, and prevent mold & mildew growth.

**\*Common problems to look for:** Cracks in foundation or wall finishes, bulging, shrinkage, standing water, perimeter ground sloped down toward building.




**! Immediately report any leaks or problems to the building superintendent. !**

Month	Problem found*	Notes Recommendations, location of problem, complaints reported, other info	Inspected By
Apr			
Oct			

## Roofing









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The roof provides shelter from direct precipitation and provides a thermal barrier to heat loss in the winter and heat gain in the summer. Penetrations in the roof can cause a myriad of moisture, temperature, and energy use problems. Maintenance practices depend upon the specific type of roof at the facility. One of the most important aspects of a maintenance program for roofing is record keeping. Building Envelope O&M plans should include a record of all roofing work completed on a building as well as a bi-annual inspection checklist, which is roof type-specific (i.e., built-up, single ply, etc.). The National Roof Contractors Association (NRCA) is an excellent source for generic inspection forms.

-  **!** Identify and immediately address vulnerabilities to thermal, moisture, or air flows within the roof.
-  Perform both preventive and regular maintenance on all building roofs to ensure the safety of occupants, the durability of the structure, and efficient use of heating and cooling.
-  Keep a detailed record of all roof work completed as well as a roof-specific bi-annual inspection checklist.



## Roof Inspections

Inspection and maintenance procedures specific to a particular roofing product are often available from the manufacturer. If repair is required, it is often up to the maintenance staff to determine whether a roof can be repaired or should be replaced. Specific repair procedures depend upon the type of roof. For built-up roofs, hot tar is the acceptable repair method. For single-ply roofs, metal roofs and other types, manufacturers' recommended repair procedures should be followed. Maintenance procedures often must be in accordance with manufacturer's guidelines, so that the warranty is not invalidated. Routine inspections will identify problems before they impact energy use, comfort and air quality of the facility.

-  **!** Check the roof membrane for worn spots, holes, or deteriorated sections. Verify adequate drainage. Check for structural uniformity when walking over the roof. "Soft spots" in the roof can be an indicator of structural water damage, and give cause for further investigation.
-  Inspections should occur at least twice a year, including a pre-winter inspection in October or November.
-  Cap flashings are metal or other covers at terminations. They should be inspected for loose or missing fasteners, deformed metal, corrosion, loose covers, or cracking or weather aging of sealants.
-  Edge metal at the ends of the roof provides waterproof flashing (not true, technically). This area should be checked for loose or missing fasteners or flashing, corroded metal, gaps in the joint covers, or open joints showing signs of cracking or weathering.
-  Base flashings are at the connections at walls and curbs. They should have a secure seal with continuous adhesion to the substrate. (care should be taken not to seal the drainage path)
-  Check for loose membrane material and verify that the sealants are in good condition. The flashing material should be checked for signs of deterioration or building movement.
-  Penetrations such as pipes, drains and exhausts must be flashed properly. The drain clamping ring should be checked to ensure a watertight seal between the drain and the membrane. Adhesion of sealant inside pitch pockets and membrane adhesion outside should be verified. Pipe boot flanges should be tightly sealed to the roof membrane.
-  If a green roof is present, follow designer's and installer's recommended O&M procedures.

## Roof Cleaning









Adhere to the products specified in [King County's Environmentally Preferable Cleaning Products](#) guidelines.

-  For cool roofs with reflective coatings, the roof should be cleaned at least once a year with a high-pressure water spray. This should be done in compliance with manufacturer's recommendations, so that the warranty is not voided.
-  Clean all debris from the surface of the roof. This includes debris that has gathered behind HVAC units, pipes and pitch pans, and any other roof penetrations. Debris has a tendency to hold water, and water will expedite roof deterioration, especially if your roof is asphalt based such as a built-up roof or asphalt shingles.

## Roof Preventive Maintenance

The goal of the preventive maintenance program is to decrease the rate of "normal aging" of roofs and drastically reduce the amount of maintenance requests to repair leaks. Minor defects left unattended can escalate to cause widespread water damage. For roofs that are still under some form of warranty, there is typically a preventive maintenance requirement in order for the warranty to stay in effect.

In addition to inspections, the following will help maintain roof durability:

-  **!** Make sure there is proper drainage from the roof and away from the building.
-  Flashing construction and usage are vital. System manufacturers and the NRCA have more detailed information.
-  Minimize rooftop foot traffic and provide protective walkways where traffic is expected.
-  Water test any sump drains twice per year. If they don't drain properly, call a plumber and get them working properly. Drains will often leak if they are holding water.
-  Make sure roof edges are secured properly.
-  Trim back any overhanging tree branches away from the building.
-  Check the mortar on chimneys and parapet walls, both in between the brick and on top. If it's damaged or deteriorated, have it tuck-pointed. Hire a qualified professional mason to perform this work.
-  Keep all gutters free of debris. Make sure that the downspouts are draining properly by water testing them.

## Roof Retrofit Opportunities

If the existing roofing is determined to be beyond repair, or it is not economically feasible to continue maintenance activity, the roofing will need to be replaced.

Thermoplastic Polyolefin (TPO) single ply roofing is an excellent choice for re-roofing. It is lightweight and can be both highly reflective and emissive. Cool roofs are recommended for low-sloped roofs. Cool roofs will not only lower cooling loads, but will also reduce thermal stresses due to daily temperature cycles. Roof retrofits provide an opportunity to add considerable R-value to the roof, which can drastically reduce energy use in all seasons. Calculate the energy benefits when considering roof retrofits.

The following Semi-Annual Roof Inspection Forms A and B are provided for you to incorporate into your own Guidelines and working documents. The end of Part II provides a completed example.



**King County**

Department of Executive Services  
Facilities Management Division  
**Building Services Section**  
500 Fourth Avenue, Room 201  
Seattle, Washington 98104

# Semi-Annual Roof Inspection Form A

**Building Name:** \_\_\_\_\_

**Season/Year:** \_\_\_\_\_

**Inspected by:** \_\_\_\_\_

**Date Inspected:** \_\_\_\_\_

<b>General Roof Conditions</b>	
<b>Item</b>	<b>Remarks</b>
Debris on Roof	
Drainage	
Physical Damage	
Attic Conditions	
Structural Deformation	
Other	
<b>Flat / Membrane Roof</b>	
Condition of Coating	
Granular Loss	
Punctures	
Cracks / Alligatoring	
Blisters / Fishmouths	
Ponding	
Other	
<b>Sloped Roof</b>	
Roof Material	
Condition of Surface	
Deformed Edges	
Shingle: Buckled	
Curled	
Missing Tabs	
Granular Loss	
Metal: Corrosion	
Fasteners	
Other	
<b>Roof Features</b>	
Fascia	
Soffit	
Flashing	
Gutters / Drains, etc.	
Skylights	
Chimneys / Vents	
Fall Arrest Anchors	
Control Zone Access	
Drains / Vents	
Other	





**King County**

Department of Executive Services  
Facilities Management Division  
**Building Services Section**  
500 Fourth Avenue, Room 201  
Seattle, Washington 98104

# Semi-Annual Roof Inspection Form B

**Building:** \_\_\_\_\_

**Season/Year:** \_\_\_\_\_


Comment on changes from previous inspections, and overall roof condition. Indicate recommended action of roof repair and/or further assessment, and estimated remaining life expectancy of roof system. Include any photographs and thermography records in this report.


• Report rapidly deteriorating roofs and/or water damage to the Building Superintendent.

## Windows and Doors


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Windows provide views to the outside, daylight to the inside, and fresh air if they are operable; however, they can also act as big “holes” in the envelope and contribute to significant air infiltration, heat loss, and moisture flows. It is critical to ensure that windows are functioning optimally and that related problems are minimized through proper maintenance. Windows should be checked for air-tightness. Condensation within the airspace of dual-pane windows is indicative of a failed seal. Condensation on the interior face of windows is typically the result of extreme temperature differential between the inside and outside and sometimes an indication of excess humidity inside (though not always). Reports of drafts also may be an indication of a problem.


 **!** Perform both preventive and regular maintenance on all exterior windows and doors.


 **!** Immediately address vulnerabilities to thermal, moisture, or air flows around window and door openings.

### Window and Door Inspections


 Close windows and doors during the mechanical heating and cooling times. (The operability should not interfere with the HVAC system.)

 Routinely inspect exterior windows and doors for physical damage and proper seals, and weather-strip doors and windows with noticeable air/moisture leakage and ensure they close properly.


 Verify proper operation of operable windows and window and door hardware (hinges, locks, etc.) during inspection. Verify that exit or other doors intended to be self-closing operate properly.

 Check that window and door head flashing and window sill drips are clean and clear of paint accumulations, caulk, and other debris.


 Identify and address windows that are wet on the inside.


 Adjust location of security contact sensors as required to ensure full perimeter sealing. Verify door and window contacts through security panel.

### Window and Door Cleaning

 **!** Pay close attention to window manufacturer’s guidelines; some cleaning products may harm low-e coatings if low-e coatings exist on the outward-facing panes.

 Adhere to the products specified in [King County’s Environmentally Preferable Cleaning Products](#) guidelines.


 Keep sill and track areas clean and free of dirt and other debris. If required, use a King County-approved product to lubricate rollers and tracks. Keep weep holes—used to drain any moisture that gathers between storm and primary windows—clear.


 Clean frame surfaces, but avoid using petroleum-based cleaners and solvents.

 Never use a high-pressure spray nozzle when rinsing windows.

### Window and Door Preventive Maintenance

 Continuously check for air infiltration through doors and windows.

 Make sure that corners of mechanically joined frames are caulked to prevent water penetration.

 Check weather stripping around doors and windows during the building exterior inspection; these are typically replaced every five to 10 years.

### **Window & Door Retrofit Opportunities**

Window replacement with double-paned windows and low-e coatings will lower both cooling and heating costs and should be evaluated as part of a renovation. New windows provide better weatherization and energy savings for the facility. Recognize that factory applied paint finishes are permanent, eliminating the need for maintenance staff to sand or refinish frames. Consider the current and future uses of the building and analyze the amount and location of glazing and doors. Evaluate the possibility of improving the envelope through careful and limited use of glazing and increased wall insulation values.

The following Semi-Annual Window and Door Inspection Log is provided for you to incorporate into your own Guidelines and working documents.



**King County**

Department of Executive Services  
Facilities Management Division  
**Building Services Section**  
500 Fourth Avenue, Room 201  
Seattle, Washington 98104

# Semi-Annual Window and Door Inspection Log

**Building Name:** \_\_\_\_\_

**Year:** \_\_\_\_\_

**Purpose of inspection:** To improve and maintain the durability of the building, increase energy efficiency, and prevent mold & mildew growth.

**\*Common problems to look for:** Water or air leaks, missing flashing or caulking, door sweeps, broken seals around perimeter of openings, standing water on sills

**! Immediately report any leaks or problems to the building superintendent. !**

<b>Month</b>	<b>Problem found*</b>	<b>Notes</b> Recommendations, location of problem, complaints reported, other info	<b>Inspected By</b>
<b>Apr</b>			
<b>Oct</b>			

## Building Envelope Resources

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### Building Envelope O&M Plan Resources

- ☞ King County Energy Plan: <http://www.kingcounty.gov/environment/climate/king-county/2010-energy-plan.aspx>
- ☞ Whole Building Design Guide's Sustainable O&M Practices <http://www.wbdg.org/resources/sustainableom.php>
- ☞ Collaborative for High Performance Schools – Best Practices Manual: Maintenance & Operations <http://www.chps.net/dev/Drupal/node/39>
- ☞ Whole Building Design Guide's Resources – RCM: <http://www.wbdg.org/resources/rcm.php>

### General Envelope Maintenance Resources

- ☞ Whole Building Design Guide's Sustainable O&M Practices <http://www.wbdg.org/resources/sustainableom.php>
- ☞ Collaborative for High Performance Schools – Best Practices Manual: Maintenance & Operations <http://www.chps.net/dev/Drupal/node/39>
- ☞ Best practices for Controlling Energy Costs: A Guidebook for K-12 School System Business Officers and Facilities Managers <http://www.azdeq.gov/ceh/download/greenguide2.pdf>
- ☞ King County's Environmentally Preferable Cleaning Products: [http://www.kingcounty.gov/operations/procurement/Services/Environmental\\_Purchasing/Products.aspx](http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing/Products.aspx)
- ☞ National Roofing Contractor's Association: <http://www.nrca.net/rp/>



# HVAC Systems and Indoor Air Quality

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## Introduction

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Heating, ventilating, and air-conditioning (HVAC) systems account for approximately 39% of the energy used in commercial buildings in the United States. Significant energy savings can be realized by improving control of HVAC operations and improving the efficiency of the individual system components. Improvement in controls can also remedy indoor air quality concerns. Achieving best results in energy efficiency, effectiveness, and indoor air quality demands an overall systems approach that considers the interactions between all building systems.

**King County has established an Energy Plan for all county facilities. The plan calls for achievement of a 10-percent normalized net reduction in energy use in County buildings and facilities by 2012. The plan also calls for the County to produce, use or procure renewable energy equal to 50 percent of total County energy requirements by 2012.** These goals should drive both development of new, and updates of existing, operations and maintenance plans that are developed for all King County facilities.

The challenge is to optimize occupant productivity with energy savings, two forces that occasionally are in direct conflict with each other. It is important to remember that most buildings exist solely to enable humans to complete tasks. The financial benefits of improvements in productivity can sometimes far outweigh the energy impacts necessary to achieve productive work spaces. The O&M staff is tasked with finding the precious balance by optimizing HVAC systems **and** educating occupants.

## Computerized Maintenance Management System

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One potential strategy to manage this balance includes utilizing specialty software. Older buildings may not be equipped with digital controls and could benefit from the installation and responsible use of a Computerized Maintenance Management System (CMMS). CMMS systems automate most of the logistical functions performed by O&M staff and management. CMMS systems come with many options and have many advantages over manual maintenance tracking systems. One of the greatest benefits of the CMMS is the elimination of paperwork and manual tracking activities, thus enabling building staff to become more productive. It should be noted that the functionality of a CMMS lies in its ability to collect and store information in an easily retrievable format. A CMMS does not make decisions; it provides the O&M manager with the best information to affect the operational efficiency of a facility.

Benefits to implementing a CMMS include:

- **Detecting if impending problems** before a failure occurs resulting in fewer failures and customer complaints.
- **Achieving a higher level of planned maintenance activities** that enables a more efficient use of staff resources.
- **Affecting inventory control enabling better spare parts forecasting** to eliminate shortages and minimize existing inventory.
- **Maintaining optimal equipment performance** that reduces downtime and results in longer equipment life.

While CMMS can go a long way toward automating and improving the efficiency of most O&M programs, there are some common pitfalls:

- **Improper selection of a CMMS vendor.** This is a site-specific decision. Time should be taken to evaluate initial needs and look for the proper match of system and service provider.
- **Inadequate training of the O&M administrative staff on proper use of the CMMS.** Staff needs dedicated training on input, function, and maintenance of the CMMS.
- **Lack of commitment to properly implement the CMMS.** A commitment needs to be in place for the start up/implementation of the CMMS. Most vendors provide this as a service and it is usually worth the expense.
- **Lack of commitment to persist in CMMS use and integration.** While a CMMS provides significant advantages, it needs to be maintained. Most successful CMMS installations have a “champion” of its use who ushers and encourages its continued use.

## Indoor Air Quality

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HVAC O&M staff can influence indoor air quality (IAQ) in several ways, but their most important task is ensuring proper ventilation. Proper ventilation consists of a continuous supply of outside air at a rate that varies based on the space type and occupancy conditions. IAQ is a constantly changing interaction of a complex set of factors. The indoor environment in any building results from the interaction between the site, climate, building system, construction techniques, contaminant sources, and building occupants. The

### Tips for LEED-EB: O&M

This LEED EB: O&M prerequisite requires several documents and specifies what each should include. Keep these in mind if you are developing your own policies, so you could meet this prerequisite without much additional effort.

#### EA Prerequisite 1: Energy Efficiency Best Management Practices: Planning, Documentation and Opportunity Assessment

- Document sequence of operations for building.
- Develop building operating plan that includes an occupancy schedule, equipment run-time schedule, design set-points for HVAC equipment, and design lighting levels throughout the building.
- Systems Narrative that briefly describes the mechanical and electrical systems and equipment including heating, cooling, ventilation, lighting and building control systems.
- Create a narrative of the preventative maintenance plan for equipment described in the systems narrative and document the preventative maintenance schedule during the performance period.
- Conduct energy audit that meets needs of ASHRAE Level I walk-through analysis



following elements may contribute to indoor air quality problems. All must be considered to prevent, investigate, and resolve indoor air quality problems:

- **Source:** a source of contamination or discomfort indoors, outdoors, or within the mechanical systems of the building.
- **HVAC:** the HVAC system is not able to control air contaminants and/or ensure thermal comfort
- **Pathways:** one or more pollutant pathways connect the pollutant source to the occupants and a driving force exists to move pollutants along the pathway(s).
- **Occupants:** building occupants are present.


Optimizing the ventilation can be equally challenging with regard to providing for human productivity and comfort and managing energy use and it should be closely monitored.

The guidelines provided in this Chapter should help develop a combination of building O&M practices and schedules that best serve occupant needs and productivity, reduce energy consumption and environmental impacts, and maintain good IAQ.

## HVAC O&M Plan

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HVAC operation and maintenance practices vary depending on the type of equipment, building types, and existing envelope conditions, as well as building location, size, use pattern, and purpose. A dedicated O&M plan helps to fully realize the intended reliable, effective, efficient, and healthy operational state of a building's HVAC system, as well as lengthen system life. A template for O&M Plans is provided in the Appendix.

 Prepare or update the HVAC O&M plan for your facility, addressing the following topics:

- HVAC maintenance goals
- Demanding performance goals on both a daily and ongoing basis
- Responsibilities of O&M staff
- System documentation
- HVAC O&M task list, schedule, and evaluation criteria
- Recordkeeping process
- Maintenance system audit
- Performance measurement so that the building can be benchmarked against other buildings
- Changing occupant needs adjustment (in concert with lighting, electrical, telecommunications, safety, housekeeping, and building automation control systems)
- Repairs, upgrades, and recommissioning of building systems
- Preventing disruptive failures in the building and its systems
- Utilize the [PECI Fifteen O&M Best Practices](#) document in developing your maintenance plan

## HVAC O&M Goals

One goal is compliance with regulations, so list any codes that affect maintenance tasks. Another maintenance goal is **making sure that the HVAC system does not become a source of indoor air contaminants**. Inspection and periodic cleaning of the system, as well as the environments around outside air intakes, are important tasks to avoid potential problems. Conditions to avoid include standing water (could encourage mold growth) and idling vehicles near outside air intakes or entryways.

 **!** Include and clearly state the critical goals of operating and maintaining **indoor air quality, comfort, and energy efficiency** in the O&M plan. Set up the operating parameters and maintenance tasks with these goals in mind.

- 🕒 **!** Communicate the goals to all maintenance staff to provide them with guidance for their day-to-day maintenance decisions.

## Responsibilities

- 🕒 Appoint an Energy Manager, Resource Conservation Manager (RCM) or assign the function of energy use tracking within each section. This person should communicate and coordinate with the division's King County interdepartmental Energy Task Force representative.
- 🕒 Provide staff with diagnostic tools.
- 🕒 Provide training in energy-efficient and indoor air quality O&M strategies.
- 🕒 Indicate the responsible staff position for each maintenance task. This is as integral to listing the tasks themselves. Provide the training or skill set involved with each task to best equip the responsible staff.

## System Documentation

- 🕒 Develop and maintain a documentation and performance tracking system for continuity.
- 🕒 Utilize the King County energy accounting system to locate savings opportunities and to track and measure the success of energy-efficient strategies. Contact your division energy point person.
- 🕒 Identify in the plan which system documents are stored, where they are located, and who is responsible for maintaining and updating them. Information to collect and maintain includes:
  - "As built" blueprints, including modifications to reflect current conditions;
  - Up-to-date drawings of all tenants' build outs and interior renovations;
  - Records of major space use changes not reflected in original design;
  - Drawings of pressure relationships;
  - Historical Occupant IAQ complaint logs (if available); and,
  - Inventory of products and materials that are sources of pollutants, with MSDS sheets and related information.
- 🕒 In case all or a part of a system's documentation is missing, perform a survey of the systems to record equipment information, and research and record appropriate O&M procedures.





## HVAC O&M Task List and Schedule

- 🕒 Conduct an O&M-focused preliminary energy audit and site assessment. Evaluate whether this should be performed in house or by outside contractor.
- 🕒 Require an energy management plan that follows the King County Energy Plan.
- 🕒 Prioritize operations and maintenance tasks and adjust schedules to fit available staff time. When setting priorities, keep in mind the goals of indoor air quality, comfort, and energy efficiency to make sure they are not overlooked. Then create a list with specific maintenance tasks for the following system components, and indicate how often they need to be carried out:
  - Air Delivery Systems;
  - Outside Air Delivery;
  - Ducts;
  - Hydronics; and
  - Controls.


The type of information to be included for each task includes:

- Task description (e.g. inspect, measure, test)
- Detailed instructions or reference to location of instructions
- Appropriate corrective actions for typical problems (clean, lubricate, replace, adjust, tighten, program, schedule additional service)
- Tools required
- Notes about why the task is important or how it helps meet the goals
- Location of related system documentation
- Shut down/ start up issues
- A description of what, where, and how the records resulting from this task will be stored.


## Evaluation Task List and Schedule


-  Require service contracts that support sustainable building operation.
-  Investigate opportunities for automatic controls.
-  Develop a space use-based operations schedule and adhere to it.
-  In addition to regular inspections, include performance monitoring and system testing in the HVAC O&M plan, to ensure that the HVAC systems are meeting performance goals. This part of the plan should describe work required to evaluate the following performance characteristics:
  - Air quality
  - Thermal comfort
  - Energy efficiency
  - Noise

## Recordkeeping Process

-  For each task, record actions taken and reasons. Record the name and affiliation of the person performing the work and the date of response. Retain records for at least three years.


## O&M Audit Approach

-  Include an audit process to periodically review how well the HVAC O&M Plan is working. That audit plan should cover the following:
  - Completeness of procedures and checklists
  - Availability of procedures and checklists to the O&M staff
  - Training for staff
  - Discussion with O&M staff and occupants to find out if the procedures are being followed and comfort levels are maintained.

-  Stay current on routine maintenance practices.

## Additional Factors: Uncontrolled Appliances

Additional factors can impact HVAC performance in buildings, such as devices brought in by building occupants and fluctuating building conditions during the day. Occupant devices range from desk lamps, electric fans, and space heaters, to other devices. At best, these devices help provide occupants with the additional environmental controls that modern buildings have taken away. At worst, they are a nuisance, if not a fire hazard.





-  Address ways of dealing with devices brought by employees in the O&M Plan. Example steps to deal with external factors include:
  - Conduct a building survey to identify heating or cooling devices brought by building occupants, which may indicate the occupants have additional heating or cooling needs.

- Negotiate an agreement with all occupants where they can choose from a variety of energy-efficient devices to suit their needs.
- In exchange, reduce the zones' or building's heating or cooling to a lower level.
- Use a pilot program to identify individual devices that work.
- Set guidelines for employees regarding personal plug-in devices.

## HVAC Systems

---

General guidelines for HVAC systems include:

-  Where possible, provide temperature for zones/spaces according to their function to reduce HVAC loads (e.g., hallways can be cooler in the winter and warmer in the summer than office areas).
-  Allow occupants to self-regulate temperature within a predetermined range through better access to vents and thermostats.
-  Install blinds, window shades, and other devices to control HVAC loads in areas with load factors not considered in the HVAC control loop (e.g., leaky windows, heat gain in east, south, and west facing offices, poorly insulated walls).
-  Look for low-cost or no-cost system modifications, such as changing operation procedures or automating system settings.

An example of this is so called “night flush,” where maximum cool outside air is brought in to buildings late at night and early morning in hot seasons, to pre-cool buildings and maximize fresh air, when it is energy efficient and comfortable to do so.


The following sections highlight example types of HVAC systems and associated guidelines that should form a basis for customizing O&M manuals for each facility.


## Air Delivery Systems


### Packaged Air Conditioning Systems

Replacement of packaged air conditioning units is not usually cost effective based on energy efficiency alone, but if units are close to the end of their life then early (pre-failure) replacement may make sense. At time of replacement it is important to seal and insulate ducts and check for airflow constrictions. It is also critical to perform cooling load calculations to check whether a different capacity is appropriate: a smaller unit may cost less and perform better.

Packaged air conditioning systems are exposed to outdoor elements and require regular maintenance to ensure efficient operation and reliability.


-  Perform the following maintenance tasks (specify frequency of tasks in O&M Plan):
  - Replace air filters
  - Inspect and test economizer dampers
  - Check fan, belts, and bearings
  - Check coils and condensate drain pan
    - Clean coils on a regular schedule and as needed
  - Check control settings
  - Inspect acoustic isolators
  - Inspect refrigerant system fittings
  - Compressor maintenance
  - Check furnace operation
  - Check cabinet and ductwork for air leaks
  - Inspect piping insulation
  - Inspect electrical connections
  - Measure supply air flow
  - Check refrigerant charge using approved efficiency-improving methods
  - Check cooling efficiency
  - Setup performance monitoring


 Check for refrigerant leaks, and if found, fix immediately.


 Refer to the manufacturer's recommendations for each piece of equipment, modify the maintenance tasks as necessary, and include frequency requirements.


## Fan Coils and Unit Ventilators


These units consist of a fan and one or two coils. In some cases a single coil is used for both cooling (with chilled water) and heating (with hot water). In other cases the unit has two coils, one for cooling and the other for heating. These units also include filters and may have outside air economizers.

 **!** Confirm appropriate setpoints and control points.

 **!** Implement supply air pressure reset controls to save fan energy.

 **!** Reduce the supply fan minimum speed setpoint. Often this is set higher than necessary due to the default settings of the variable speed drive. Check with fan and drive manufacturer for actual limits.

 Analyze space use to determine best setting or strategy for conditioning (i.e., shade glazing to reduce loads on unit).


 Maintenance of fan coils and unit ventilators (notably filter changing and cleaning) is similar to Packaged Air Conditioning Systems, described above.


## Variable Air Volume Systems


Variable Air Volume (VAV) systems serve multiple zones with a single air handler. The amount of air supplied to each zone is controlled by a damper within a terminal unit (VAV box). These dampers, one for each zone, vary the airflow to maintain the space temperature setpoint. The supply air temperature leaving the air handler is held relatively constant, but is usually varied within a limited range ("reset") either automatically or manually depending on the amount of cooling required. Each VAV box usually has a minimum damper position or minimum airflow rate (if the box contains an airflow sensor) that ensures adequate ventilation is provided to each space. If a zone requires heating or has low cooling loads, then too much cooling may occur at the minimum airflow rate. Therefore, many VAV boxes include reheat coils, either hot water or electric, that increases the temperature of the air supplied to the zone to prevent overcooling.


As cooling loads drop and the VAV box dampers close, the total supply air flow through the central fan also drops. Without any controls, the pressure within the supply ducts would increase. To save energy, the central fan is usually controlled with a variable speed drive or inlet guide vanes to maintain a constant pressure within the supply duct. Therefore, as the VAV boxes close down, the central fan speed will drop or the inlet guide vanes will begin to close.


VAV systems typically have either a chilled water coil or a refrigerant coil to provide cooling. Heating may be from a hot water coil or a gas furnace, or in many applications, electric resistance heating may be applied at the VAV box (called terminal reheat). The appropriate list of maintenance tasks varies depending on the type of cooling and heating and on the type of control system. Older systems often have pneumatic controls, which use the pressure in compressed air lines to control dampers and valves. Newer systems typically have direct digital control (DDC) systems that use electrical connections between sensors and actuators and a digital controller. Dampers and valves are moved by electric motors.


 **!** Reduce minimum airflow settings for VAV boxes to the minimum required for ventilation. See the [Advanced VAV System Design Guide](#) for details of "dual maximum" control.

 Retrofit pneumatic VAV box controls with a DDC system including zone temperature sensors and electric damper actuators.

 Implement supply air pressure reset controls to save fan energy.

 Identify "rogue" zones that have either excessive cooling loads, undersized VAV boxes or other control problems that prevent the system from resetting either the supply air temperature or supply air pressure. These zones may not be meeting their temperature setpoints, requiring the supply air temperature to remain low, even though all the other zones could be satisfied with a higher supply air temperature.

 Malfunctioning VAV boxes can result in thermal discomfort and fail to prevent buildup of indoor air contaminants. It is important to insure that VAV box minimum settings (e.g., 30% of peak flow) combined with the outdoor air fraction provide enough supply air so that sufficient outdoor air enters the space at partial loads.

 Maintenance tasks should include those listed for Packaged Air Conditioning Systems, as well as:

- Determine appropriate control sequences; and,
- Verify VAV box operation, fan start/stop controls, supply air static pressure control, supply air temperature control.

## Outside Air Delivery








### Filters

An integrated indoor air quality approach includes outdoor air ventilation, pollutant source control, and air filtration. Filtration's first priority is to protect the HVAC system, keeping the fan, coils and ducts clean. Clean components perform better and are less likely to harbor mold or bacteria growth. Additionally, HVAC air filters reduce concentrations of particles in indoor air. Standard low-cost filters provide little benefit in this regard.

There are two commonly used filter performance ratings: **dust spot (or particle-size) efficiency** and **MERV (minimum efficiency reporting value)**. These ratings indicate the amount of particulate removed from the air stream. A higher efficiency filter removes more material. The dust spot efficiency is more common because it has been around longer, but the MERV rating provides a better indication of performance. See [ASHRAE Standard 52.2-2008](#) for details on dust spot (particle-size) efficiency and MERV ratings.

Several types of air filters are used in HVAC systems, including flat panels, pleated panels and bag filters. **Bag filters** are used only in larger air handlers with adequate space. Therefore, pleated panels are the appropriate choice for most air handlers. **Pleated panel filters** usually provide better filtration with lower air pressure loss compared to **flat panel filters**, because of increased surface area.


Other less commonly used products include electronic polarization filters and electrostatic filters. The **electronic polarization filters** create a high voltage electrical field to statically charge the particles, which then are more likely to collect on the filter medium. **Electrostatic filters** (also called electrostatic precipitators) charge the particles as they pass through and collect them on metal plates. Both of these types of filters require a small amount of electric energy. Both are also more efficient at removing particles when new, and their performance degrades over time. This is in contrast to a standard filter, which tends to filter more particles as it gets loaded (sometimes with adverse energy impacts). However, the electronic polarization and electrostatic filters typically create less pressure loss and may require less fan energy.

-  **!** Select filters that provide up to 85% or MERV 13 efficiency. Check with equipment manufacturers or HVAC designers to determine the proper filter system to maximize **both** filtration and energy efficiency. (Filters with efficiency lower than 45% are generally not effective in reducing concentrations of indoor particles and going beyond 85% may provide little additional benefit.)
-  Inspect and replace filters regularly, as described in the maintenance recommendations for specific systems elsewhere in this chapter. In general, change filters at least four times per year.
-  Select and use pleated panel filters whenever possible.
-  Turn off fan while replacing filters to prevent debris from entering the ductwork.
-  Clean and wash the filter area while the fans are off.
-  Use larger filter areas, don't block off portions of the filter bank unless excess airflow is a problem (which is not too common, and is better solved by adjusting the fan speed).
-  Make sure that filters are properly fitted to prevent air from bypassing the filter and check filter seals.


### Economizers

An economizer is a set of automatically controlled dampers that can open to draw 100% outside air when conditions are favorable for free cooling. Otherwise, when the outdoor air temperature is higher than indoors or when outdoor air is very cold, the outside air damper closes to a minimum position (for ventilation) and the return air damper opens up.

King County's climate is ideal for economizers. It's often cool enough outside for an economizer to be used frequently. The savings from this "free cooling" can be big. Some HVAC systems enable this function very easily. Even when adding more equipment and controls, an economizer can pay for itself in two to five years. They usually do require maintenance to work over the long term. An outside air economizer can be part of any air handler, from small packaged air conditioners to the largest VAV systems.

 Determine the type of economizer in use and verify proper operation, inspection, cleaning and lubrication of economizer.

 Perform periodic testing of economizer operation and make adjustments or repairs as needed.


 Regularly inspect, clean, and lubricate the systems.


## Duct Work


Sealed duct systems with a leakage rate of less than 3% will usually have a superior life cycle cost analysis and reduce problems associated with leaky ductwork. Duct leakage can cause or exacerbate air quality problems and waste energy. Common leakage problems include:


- Loose fitting joints.
- Leaks around light Troffer-type diffusers at the diffuser light fixture interface, when installed in the return plenum.
- Leaks in return ducts in unconditioned spaces or underground can draw contaminants from these spaces into the supply air system.


A small amount of dust on duct surfaces is normal. Parts of the duct system susceptible to contamination include areas with restricted airflow, duct lining, or areas of moisture or condensation. Problems with leakage and biological pollutants can be prevented through proper installation and ongoing maintenance inspections.

 **!** Isolate HVAC during construction or remodeling of specific areas. Enclose work area and tape over or seal all return diffusers within area. Change air filters after completion of work.


 **!** Ensure each section is pressure balanced to ensure adequate flow.

 Provide flush out period after installing new flooring or painting.

 Check the spread and throw of diffusers to ensure effective air mixing at point of use, and ensure comfort of occupants that are located near diffusers.


 Periodically perform a complete duct inspection. Identify if ducts need sealing and whether cleaning is required.


 Minimize dust and dirt build-up (especially during construction or renovation)

 Promptly repair leaks and water damage to keep system components dry (that should be dry)








 Routinely clean system components such as coils and drip pans


## Chilled Water Systems

 **!** Replace standard efficiency with premium efficiency motors for pumps with long run hours.


 **!** Wherever practical, replace single-pass water cooling schemes in chiller systems with other methods of heat rejection – they are very wasteful of water and energy, and are accordingly also expensive to operate.





-  Implement condenser water 'reset' strategies to allow the water to drop when this can result in efficiency gains: check with manufacturer to ensure the chiller can operate properly at lower temperature.
-  Trim the pump impeller rather than using a balancing valve to reduce flow in constant pump speed applications; this may reduce pump power significantly.
-  Replace 3-way valves with 2-way valves on cooling coils and implement variable flow control on the chilled water loop.
-  Install variable speed fan controls on cooling tower to reduce fan energy consumption.
-  Implement a performance monitoring system to verify that controls are properly implemented and to track chilled water plant efficiency.
-  Review chiller sequencing controls for plants with more than one chiller to determine the optimal strategy for efficiency.
-  Address tasks for chillers, cooling towers, pumps, chilled water piping, and valves in the HVAC O&M Plan.

 Typical maintenance tasks for chilled water systems should include:


- Chiller maintenance
- Cooling tower maintenance
- Pump maintenance
- Piping maintenance
- Air release valve and strainer maintenance
- Set up performance monitoring

 Refer to manufacturers' recommendations for equipment maintenance tasks.

 Consider adding a condenser water conductivity controller for bleed-off water. In some systems, this controller can save enough water for a 1-year payback.

 Where single-pass systems must be kept, consider reusing single-pass discharge water for other processes – Single pass water could be used for boiler make-up supply, landscape irrigation, preheated feed water to a process that requires heated water such as vehicle or equipment washing, and other plant utility purposes. Some single pass water may contain contaminants that will preclude its use in boiler make up or other uses.










 Refer to manufacturers' recommendations for equipment maintenance tasks.

 Consider adding a condenser water conductivity controller for bleed-off water. In some systems, this controller can save enough water for a 1-year payback.

## Hot Water Systems





Possible approaches to increase boiler efficiency include:

- **Reduce "on" time** – enable seasonal shut-down, if possible;
- **Reduce load** – eliminate unnecessary loads from the system;
- **Just meet loads** – lower steam pressure or water temperature to meet the actual load conditions.




-  **!** Increase boiler efficiency by reducing “on” time (enable seasonal shut-down); reducing load (eliminate unnecessary loads from system); and just meet loads (lower steam pressure or water temperature to meet actual load conditions).
-  **!** Replace standard efficiency with premium efficiency motors for pumps with long run hours.
-  **!** Perform boiler tune-ups once per year using combustion efficiency and emissions monitoring equipment. Train and equip staff for this task or hire professionals – large energy and cost waste are associated with mis-tuned boilers and water heaters.
-  Replace three-way valves with two-way valves on cooling coils and implement variable flow control on the hot water loop.
-  Pressure or temperature settings should be set no higher than required to avoid short cycling, or rapid on-and-off of the equipment. The system should be balanced to avoid this. When adjusting fuel/air ratios, check efficiencies and monitor stack temperatures.
-  Automate oxygen trim to operate with boiler controls.
-  Install turbulators to increase turbulence and efficiency (not all systems can have turbulators, Refer to the manufacturer’s specs.) Turbulence is not cost-effective if the increased turbulence greatly increases the combustion fan horsepower, increasing the electrical operating costs. Consult your boiler manufacturer.
-  Identify and implement opportunities for reducing pump power (with VFDs or control strategies).
-  Maintenance tasks for hot water systems should include:
  - Preventative maintenance
    - Boiler Maintenance
    - Pump Maintenance
    - Regular inspections
    - Record keeping
    - Accurate water treatment
    - Blowdown continuously, daily or weekly
    - Clean heat exchanging surface

## Controls

The initial cost of the implementation of CMM Systems (mentioned in the HVAC introduction) is generally high. Implementation costs for a CMMS are primarily driven by the cost of software and the cost of data collection. Likewise, the cost of data collection depends on the number of equipment items to be inventoried and the number of system features that will be utilized day-to-day. As the level of sophistication increases, so does the cost of implementation.

-  Complete a cost benefit analysis before implementing a CMMS system. The analysis should include a review of downtime reductions, improved quality control, and staff productivity.
-  Where appropriate, use a computerized maintenance management system (CMMS) to support the management and tracking of O&M activities
-  Perform periodic analysis on the CMMS in order to confirm or calibrate the monitoring and control of each system.
-  Many CMMS programs can now interface with existing energy management and control systems (EMCS) as well as property management systems. Couple these capabilities to allow for condition - based monitoring and component energy use profiles.

Controls are a retrofit option. The most basic function is connection to an Energy Management Control System (EMCS) for start/stop control. Energy savings will vary depending on how the existing system is being operated, but the EMCS connection may also offer savings in staff time. An EMCS can also be used for performance monitoring, in conjunction with or in place of a CMMS.

-  Check setpoint versus control point. Verify that minimum condensing pressures are being implemented.
-  Check controls periodically, as they often drift out of calibration.
-  Ensure controls adequately reflect the actual building conditions and needs.

## HVAC Resources

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- ☞ A Practical Guide for Commissioning Existing Buildings by Tudi Haas of Portland Energy Conservation, Inc. and Terry Sharp of Oak Ridge National Laboratory <http://epminst.us/otherEBER/RetroCommissioningGuide-w-cover.pdf>
- ☞ ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size <http://www.ashrae.org>
- ☞ Portland Energy Conservation, Inc (PECI) <http://www.peci.org/index.html>
- ☞ PECI, Fifteen O&M Best Practices for Energy-Efficient Buildings [http://www.peci.org/documents/PECI\\_15BestOM\\_0302.pdf](http://www.peci.org/documents/PECI_15BestOM_0302.pdf)
- ☞ PECI, Functional Testing Checklist Tool <http://peci.org/ftguide/ftct/ftct.htm>
- ☞ Better Bricks Symptoms-Diagnosis Tool <http://www.betterbricks.com/DetailPage.aspx?ID=493>
- ☞ U.S. DOE Federal Energy Management Program <http://www1.eere.energy.gov/femp/>
- ☞ Operations and Maintenance Best Practices Guide [http://www1.eere.energy.gov/femp/pdfs/omguide\\_complete.pdf](http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf)
- ☞ Types of Maintenance Programs [http://www1.eere.energy.gov/femp/pdfs/OM\\_5.pdf](http://www1.eere.energy.gov/femp/pdfs/OM_5.pdf)
- ☞ Whole Building Design Guide <http://www.wbdg.org>
- ☞ High-Performance HVAC <http://www.wbdg.org/resources/hvac.php>
- ☞ Reliability-Centered Maintenance (RCM) [www.wbdg.org/resources/rcm.php](http://www.wbdg.org/resources/rcm.php)
- ☞ Collaborative for High Performance Schools, Best Practices Manual <http://www.chps.net/dev/Drupal/node/288>
- ☞ Commonwealth of Pennsylvania, Pennsylvania Green Building Maintenance Manual [http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green\\_building\\_maintenance\\_manual/254756](http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green_building_maintenance_manual/254756)
- ☞ Oregon Office of Energy <http://www.oregon.gov/ENERGY/>
- ☞ Retrocommissioning Handbook for Facility Managers <http://www.oregon.gov/ENERGY/CONS/BUS/comm/docs/retrocx.pdf>
- ☞ Conservation Division, Commissioning Toolkit [http://www.oregon.gov/ENERGY/CONS/BUS/comm/Cx\\_Guide.shtml](http://www.oregon.gov/ENERGY/CONS/BUS/comm/Cx_Guide.shtml)
- ☞ Advanced VAV System Design Guide [http://www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006-07-12\\_workshop/reviewdocs/2006-12-07\\_ADVANCED\\_VAV\\_SYSTEM.PDF](http://www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006-07-12_workshop/reviewdocs/2006-12-07_ADVANCED_VAV_SYSTEM.PDF)
- ☞ Article describing importance of ongoing assessment to meet energy goals <http://www.facilitiesnet.com/designconstruction/article/Does-Your-Facility-Hit-its-Energy-Target--8965>

## IAQ Resources

- ☞ US Environmental Protection Agency <http://www.epa.gov/>
- ☞ Building Air Quality Action Plan [http://www.epa.gov/iaq/largebldgs/pdf\\_files/baqactionplan.pdf](http://www.epa.gov/iaq/largebldgs/pdf_files/baqactionplan.pdf)
- ☞ Building Air Quality: A Guide for Building Owners and Facility Managers [http://www.epa.gov/iaq/largebldgs/pdf\\_files/iaq.pdf](http://www.epa.gov/iaq/largebldgs/pdf_files/iaq.pdf)
- ☞ IAQ Management Checklist [http://www.epa.gov/iaq/largebldgs/pdf\\_files/mgmtlist.pdf](http://www.epa.gov/iaq/largebldgs/pdf_files/mgmtlist.pdf)
- ☞ Indoor Air Quality Building Education and Assessment Model (I-BEAM) <http://www.epa.gov/iaq/largebldgs/i-beam/index.html>

# Electrical Systems and Lighting

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## Introduction

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Lighting operations and maintenance practices significantly impact building energy use and can affect occupant productivity. Building's lighting systems - illuminating offices, hallways, reception areas, etc. - constitute the largest energy use in most office and commercial buildings. Energy used for lighting accounts for about 17% of all US electricity use, and this proportion can increase to 22% or more when

adding the energy used to cool heat generated by lighting systems. Appropriate lighting quality can improve employee productivity, and the increase in employee output can outweigh the incremental costs of workspace lighting improvements and retrofits. Interior and exterior lighting can also contribute to light pollution. The 2011 King County Lighting Implementation Plan as required by Ordinance 16769 emphasizes energy efficient lighting and a reduction in evening light pollution from County operations. Whereas Ordinance 16769 requires compliance with standards, these lighting guidelines offer best practices for ongoing operations and maintenance associated with lighting.

Electrical equipment and appliances in facilities also use significant amounts of energy. Building operators can achieve energy conservation and cost savings from various electrical systems through equipment selection and/or upgrades, maintenance, and encouraging occupant behavior changes.

Systematic lighting maintenance can help to extend product life, saving replacement effort and costs. Planned lighting maintenance can also significantly improve quality of light, by reducing recoverable light loss factors of:

- lamp burnout;
- lamp lumen depreciation (reduction in lamp light output over time);
- luminaire dirt depreciation; (dirt on lamps and fixtures blocking light) and
- room surface dirt depreciation (reduction in room surface light reflection from dirt).

Many lighting systems are overdesigned to account for light loss, thus another benefit of planned maintenance is reduction in the number of luminaires required in a space.


The actions discussed in this chapter allow building O&M staff to balance operational efficiencies with occupant lighting needs, and reduce cost.


## Lighting System O&M Plan

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Creation and implementation of an Electrical Systems and Lighting O&M Plan is fundamental to achieving energy efficiencies in existing buildings. The plan must contain facility-specific operations and maintenance details, as well as task responsibilities and schedules, and be accessible and easy to use for all staff responsible for lighting systems operations and maintenance. O&M staff should work together to produce this plan. An O&M Plan template is provided in the Appendix of this document.

As lighting systems are upgraded with newly-available lighting technologies, the plan should be updated. Likewise, O&M staff will need to be informed and trained in how to maximize the efficiency and output of the new systems. A successful and effective O&M Plan schedules regular audits, encourages feedback from maintenance staff and occupants, and identifies any areas that don't provide intended results or may be absent from the Plan.

 **!** Prepare or update the Electrical Systems and Lighting O&M Plan for your facility, including the following elements, and train staff to inform them of any changes.

 **!** Assess the scheduling of lighting systems – does the scheduling match the occupancy? If a digital scheduling system is not used, assign responsibility to appropriate parties. Are cleaning staff responsible for turning off lighting? Address these actions in the Lighting O&M Plan.

- Staffing and budget requirements for effective management of electrical systems and lighting.
- Reporting requirements and staff responsibilities for the tasks outlined in the plan.
- Inspection schedules and checklist for lighting systems and controls. Inspection, repair, and recalibration should be conducted at regular intervals, and at least annually, and the date of recalibration should be recorded.
- Relamping schedules and specific procedures, discussing both group and spot relamping, for each luminaire type present in the facility.
- Procedures for identifying and dealing with unexpected light inhibitors (such as a tree or shrub that has grown to block the light).
- Recycling and disposal plans for used lamps and ballasts, including toxic waste procedures.

- Equipment request/procurement information for lamps and other electrical system parts.
- Safety information for cleaning and repairs of electrical systems.
- Scheduled audits and feedback of the implementation and effectiveness of the maintenance plan, to identify any additional areas which need periodic or special lighting system corrections, repairs or upgrades. This review should capture any changes in occupant or task needs that will require lighting modification (for example, if a room becomes unoccupied for a period of time).
- Tracking sheets to record maintenance activities, including cost and cause of failure and replacement.
- Room surface cleaning schedules and procedures, including tools and proper cleaning supplies. Cleaning should be done at regular intervals.
- Update Electrical Systems and Lighting O&M Plan as lighting systems are upgraded or changed, and consider Energy Star equipment whenever possible. Inform all maintenance personnel of changes.

## Scheduling Group Relamping and Cleaning

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Properly maintained lighting systems cost less than poorly maintained lighting due to providing appropriate visibility for occupants, and preventing urgent maintenance, which can be costly and disruptive.


The combined effect of equipment age and dirt depreciation can reduce luminance by 25% to 50% or more, depending on the application and equipment used. Cleaning and replacement of bulbs is thus critical to ensure maximum utilization of a facility's lighting system.


### Group Relamping





Depending on building type and size, there may be cost benefits to initiating a group re-lamping maintenance schedule in the O&M plan, in place of an on-demand lamp replacement policy. Maintenance staff will appreciate a streamlined and more efficient workload with group relamping, while providing savings in overall maintenance labor costs. Group re-lamping will also maintain improved light levels by replacing lamps before their lumen output degrades further. Group relamping offers the following benefits:

- Overall maintenance labor costs savings (group relamping is more efficient than spot relamping);
- Improved, continuous light levels (lamps are replaced before lumen output s degrade);
- Fewer interruptions to occupants, as occurs with spot relamping;
- Longer ballast life; and
- Volume lamp discounts.



Proper planning of a group relamping schedule is critical. Waiting too long could result in a higher number of burnouts and increased maintenance costs. Setting the schedule requires a review of manufacturer information and coordination with maintenance staff. Building O&M staff should work together to estimate optimal group re-lamping, and then adjust schedules as actual operating conditions dictate actual bulb burn-out rates. Along with energy use data, lamps will also have associated data available indicating the typical % of lamp life at the time of a recommended group relamp. Better lamps will achieve up to 90% of lamp life before change out is required; this information is valuable when ordering new lamps and when considering consistency of lamps during a full relamp.

 **!** Inform maintenance staff of the ballast type during replacement in order to determine the proper disposal method. Maintenance staff should never disassemble ballasts for disposal. Old ballasts must be properly disposed, due to heavy metals and toxins concerns.






 **!** Determine appropriate locations for posting group relamping schedule, and include in lighting O&M Plan.

-  Set a group re-lamping point when 10 to 15 % of the lamps in an area start burning out on a regular basis. This is commonly at 70 to 80 % of the lamp's rated lamp life. (The rated lamp life is the point where 50 % of a group of lamps are expected to have burned out under normal conditions, which is typically available from the manufacturer.)
-  Maintain good relamping records to trigger the next scheduled group relamping.
-  During group relamping, save the best still-functioning lamps to use as spot replacements elsewhere.
-  Flickering lamps indicate that a dimming ballast is at the lowest end of the dimming range. The following steps will help identify and rectify the problem:
  - Consult the ballast manufacturer to ensure that the wiring is correct
  - Replace the ballasts
  - Consult with the operations team about increasing the lowest setting of the photo-sensor (must remain below 30%), if the problem appears to be related to the signal sent from the photo-sensor.

## Cleaning

-  Modify the building cleaning schedule to reduce after-hours lighting required. Building operators have an additional energy savings opportunity by encouraging cleaning schedules to occur during the day, rather than after-hours, to minimize need for after-hours lighting.
-  Cleaning procedures should also stress the importance of cleaning surface areas that help reflect light output, particularly in areas where indirect lighting is employed.

Periodic maintenance and cleaning of lamps and lenses adds to lighting efficiency; pair with group relamping or other ongoing strategy.

-  Clean luminaires at the time of relamping. Operations staff should coordinate with maintenance staff to schedule luminaire cleaning
-  General guidelines for cleaning include:
  - Use very mild soaps and cleaners, with a clean rinse on most surfaces;
  - Use a soft damp cloth and the mildest 0.5% solution for silver films;
  - Avoid strong alkaline cleaners or abrasive cleaners;
  - Use glass cleaners on porcelain – when using on glass an additional rinse is required (which wastes time and water);
  - Use anti-static cleaning compounds on plastics to avoid static buildup (which attracts dust); and,
  - Vacuum instead of drip drying or dry-wiping plastic after a rinse to avoid static and streaking.
-  Identify the appropriate cleaning solution for different luminaires to avoid lens and diffuser damage, and specify in O&M plan.
-  When cleaning reflectors, follow the manufacturer's recommendations to avoid etching and abrasion.
-  Minimize static build-up from dry-rubbing on plastic or glass during luminaire cleaning. Static build-up attracts dust particles.

## Bulb Disposal



The Electrical and Lighting Systems O&M plan should specify proper disposal procedures for all lamps present in the facility. For the proper procedures see Bulb Disposal in the Recycling and Waste Management chapter.


## Types of Luminaires


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### Fluorescent Luminaires


Fluorescent luminaires are one of the most common lamps for commercial interiors. They offer high efficacy and flexibility in size. The T8 (1 inch diameter) is the most efficient and most commonly used fluorescent luminaire, and is available in high performance varieties that offer increased efficacy, lower wattage, longer lifespan, and higher maintained lumens. Upgrading T12 luminaires to T8 with electronic ballasts can save up to 25% in energy use. Upgrading to high-efficiency T8 luminaires with the proper ballasts and controls can save up to 40%.


Fluorescent luminaires are typically in tube form with a ballast at the end of the fixture under a metal overplate. The ballasts must be compatible with the lamp and typically are not interchangeable with different lamp sizes. The ballast has a small capacitor that may contain polychlorinated biphenyls (PCBs), a hazardous substance. Ballasts made before 1978 probably contain oil with PCBs. Those after 1978 may be marked "Non-PCB", but may still contain the PCB replacement DEHP, a probable human carcinogen.

 **!** Hazardous fluorescent tubes from large King County facilities (exceeding HHW allowance) must go to either a recycler or a permitted hazardous waste treatment, storage or disposal facility. The lighting maintenance plan should specify details for these facilities.

 **!** Non-leaking used PCB ballasts: Recycle at a facility with EPA approval for recycling PCB ballasts. Use a firm that has an EPA PCB activity identification number as a transporter to transport them to the recycling facility. Non-leaking PCB ballasts that aren't recycled should be managed and disposed as hazardous waste.

 **!** Leaking used PCB ballasts: These should be handled with extreme caution to avoid exposure, contamination and liability. Leaking PCB ballasts must be managed as PCB waste and disposed in a facility regulated under the federal Toxic Substances Control Act (TSCA).

 **!** Non-PCB ballasts: The best option for non-PCB ballasts is recycling. For requirements to dispose of non-PCB ballasts in the garbage, call the King County Business Waste Line.


 Encourage building occupants to turn off fluorescent lights when the room will be empty for longer than 15 minutes.

### Screw Based Luminaires

Deciding what lamp to use in a screw-base socket (designed for an incandescent lamp) can decrease lighting costs significantly for many existing lighting systems, while still meeting the needs of the occupant. In general, efficient CFL lamps have low maintenance needs and reduce long term costs.

### Compact Fluorescent Lamps




CFL lamps have an average life of roughly 10,000 hours while an incandescent has an average life of 1,000 hours. While efficient CFL lamps cost more initially than incandescent lamps, their overall cost is usually less due to much lower energy costs and less required maintenance. Consider that a 13-watt compact fluorescent lamp replaces a 60-watt incandescent with a ballast loss of about 2 watts.

 CFLs with screw bases ("integral" means the lamp includes a ballast and has a screw base) will work in place of incandescent lamps in many locations, but building operators should consider the following when selecting the best type for the space:

- CFLs come in a wide variety of shapes and sizes with screw bases; one of these will reasonably fit into about any socket designed for an incandescent lamp, but the light output or the light distribution from the CFL may not be appropriate. Verify that the light meets the task requirements.
- Many CFLs used in commercial applications have 4-pin bases instead of screw bases.
- The power used by a CFL is about one third to a quarter of an equivalent incandescent lamp. Operators should select the CFL lamp power at about 30% of the incandescent rating. Or select about the same light output (lumens) as an incandescent lamp that provides adequate light.
- Reflector CFL lamps are available, and can work well to replace a wide beam R or PAR floodlight lamps ("R" means reflector lamp, "PAR" means parabolic aluminized reflector). A CFL cannot replace a narrow or sharply defined beam pattern reflector lamp.
- Dimmable CFLs require compatible ballast. Most CFLs do not work on dimmers, unless clearly noted on the packaging literature. Never use a CFL on a dimmer unless the lamp or directions specifically allow dimming.
- Frequent on/off switching can noticeably decrease the CFL life, so operators should be cognizant of the occupants' likely frequency of switching the light in the intended location.
- CFLs are now considered a "Universal Waste" and must go to a lamp recycler or a permitted hazardous waste disposal company. Landfills and transfer stations no longer accept CFLs from businesses.
- Some "green" or low-mercury lamps may be disposed of as solid waste in King County. Obtain a written waste clearance for this from Public Health-Seattle and King County's Waste Characterization Program.



## Incandescent Lamps




While CFLs are the preferred choice for energy efficiency, incandescent lamps do have performance benefits in some applications where a spot light or other narrow beam lighting is required for accent lighting. Building operators can help identify locations where incandescent bulbs better meet facility needs. Incandescent halogen lamps are slightly more efficient than standard incandescent, and are a good alternative to standard incandescents when CFLs cannot be used.

-  Maintain luminaires based on the lighting maintenance plan, including relamping, cleaning and replacing failures.
-  If incandescent bulbs are replaced with CFLs, operators should verify that the lighting levels meet the task requirements.
-  In general, use screw based compact fluorescent lamps (CFL) in screw-based sockets not designed for HID lamps, selecting the appropriate bulb and light output for the task.

## HID Luminaires


High Intensity Discharge (HID) lamps include several different types, and typically offer high efficiency lighting for industrial or other large-scale lighting applications. The different types of lamps include: **Mercury, Metal Halide, High Pressure Sodium, Non-Saturated High Pressure Sodium, and Twin Arc Tube High Pressure Sodium Lamps**. Advances in color, configurations and efficacy have increased HID opportunities for interior and commercial applications. Operators should select the HID lamp appropriate for the task requirements, keeping in mind that newer HID lamp types can save energy and maintenance costs compared to incandescent or older HID lighting systems. When considering replacements or upgrades, note that HID ballasts are usually very specific for a lamp type, and both lamp and ballast should have the same designation to be compatible.

-  When specifying HID lamp replacements or upgrades, ensure that the lamp and ballast are compatible. This should be specified in the lighting maintenance plan.
-  Maintenance staff should clean and replace HID lamps as identified by the lighting maintenance plan.

-  Replace ballasts and other failures according to the lighting maintenance plan, making sure that the ballast is compatible with the lamp.
-  Dispose of spent lamps according to the Universal Waste rules, as specified in the lighting maintenance plan.
-  Consider group relamping for Metal Halide lamps if the lamp color appearance needs to be uniform, making sure to save good used lamps for spot replacement of early failures in the next group.

## Mercury Lamps

In general, mercury lamps are an old, inefficient technology that should be replaced with a metal halide or high pressure sodium lamp.

-  Consider replacing any mercury lamps with MH or HPS, following appropriate retrofitting procedures outlined in the lighting maintenance plan.

## Metal Halide Lamps

Metal halide lamps (MH) offer white light with energy efficiency and relatively long lamp life, and are suitable for most lighting applications that require continuous operation. MH lamps come in a variety of shapes, colors, and technologies. Clear (uncoated) lamps are effectively a point source, making them good for accent lighting or controlled beam patterns. Ceramic MH technology is a good choice for situations that require warm temperatures and a high color rendering index. MH PAR and small tubular MH lamps can provide an energy efficient alternative to incandescent or halogen reflector lamps. Some MH lamps will operate properly in any position, while others work properly in one or two positions. In general, the position-oriented lamps offer better performance but cost more.


-  Consider scheduling group relamping for MH lamps if the lamp color appearance needs to be uniform to meet task requirements.

## High Pressure Sodium Lamps

**High pressure sodium (HPS) lamps** offer energy efficiency and long life, but the low CRI and "golden-white" light may not be acceptable for many applications. Those with improved CRI typically have a shorter lifespan and reduced efficacy. HPS lamps are typically used in road lighting and other outdoor lighting applications, where a high CRI is not critical. HPS lamps can cause a maintenance head-ache because they cycle when reaching end-of-life: they turn on and run for a few minutes, then spontaneously extinguish, starting the cycle again. This characteristic makes a lamp that needs replacing seem to operate fine at times, making it difficult to identify the problem.

**Non-saturated HPS lamps** have the same performance as regular HPS lamps; however they do not pose the cycling problem. Non-saturated HPS lamps also use less mercury, another environmental and health benefit.

**Twin Arc Tube High Pressure Sodium Lamps** are another type of HPS lamp has twin arc tubes to provide instant restrike from a momentary power failure. Their rated life (and cost) is much longer.

-  Avoid HPS lamps and choose non-saturated HPS lamps or twin arc tube HPS lamps whenever possible.







## LED Luminaires

Light Emitting Diodes (LED) provide more light production per watt than incandescent bulbs. Light can be emitted at an intended color without the use of color filters. Most high-power white LEDs have a long lifetime of around 30,000 hours and are ideal for use in applications that are subject to frequent on-off cycling. Additionally, LEDs can be dimmed with little impact to performance and lifetime. They are also impact resistance and difficult to damage with external shock, unlike fluorescent and incandescent bulbs which are fragile. Lastly, they contain no mercury so there are no disposal concerns.

While LEDs may be more expensive on a price per lumen or initial capital cost basis, the life cycle cost is likely much less than other lighting types. Considerations with LEDs include:

- Performance largely depends on the ambient temperature of the operating environment; be careful to not install LEDs in locations where heat build-up around the fixture may be a problem
- Currently, LEDs are more appropriate for direct- and task-lighting than diffuse, large-area lighting
- Depending on location and usage, LEDs may cause more light pollution
- LEDs mostly fail by dimming over time, rather than abrupt burn-out noticed with incandescent bulbs

Operations and Maintenance tasks include:



-  Follow lighting maintenance plan for scheduled checks and maintenance.
-  Because LED technology is advancing rapidly, LED technology should be re-evaluated when fixtures need to be replaced, as stated in the electrical and lighting systems maintenance plan.
-  Specify the frequency of periodic LED exit sign checks in the lighting maintenance plan.
-  Identify the appropriate age to plan for LED sign replacement, which is typically indicated in the sign (or retrofit) manufacturer's instruction sheet. Include in the lighting maintenance plan.
-  When using LEDs in outdoor applications, fully shield the LED to avoid light pollution.
-  Identify lamps in the facility that are subject to frequent on-off cycling, or require a long time before restarting, and consider whether LEDs would provide increased functionality.

## Exit and Emergency Lighting

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### Exit Sign Lighting


Exit signs typically operate at all times, representing a significant cost and energy savings opportunity. Light emitting diodes (LEDs) are the best light source for almost all exit signs, either red or green. LEDs provide an excellent combination of moderate first cost, low maintenance and tiny energy use (less than 5 Watts per face – or 5% of the energy used by incandescent exit signs). Incandescent exit signs that are replaced or retrofitted with Light Emitting Diodes (LEDs) will require almost no routine maintenance (just the periodic checks), and reduce energy consumption. LEDs are rated to last about 11 years of continuous operation; at that time almost all of them should still work, but their output will gradually degrade until the exit sign will not meet performance requirements.





-  **!** Retrofit any exit signs using incandescent lamps with LEDs.
-  Specify the frequency of periodic LED exit sign checks in the lighting maintenance plan.

### Emergency Lighting

Emergency lighting only operate a tiny fraction of the time, and incandescent bulbs are typical. Because of their infrequent use, periodic inspection will identify any lighting failures. Where operational verification is difficult, emergency lighting manufacturers offer computerized testing apparatus that will test on schedule, alerting the maintenance staff to any problems.

Emergency lighting typically relies on batteries and emergency generators during a power interruption which require monthly verification. Batteries gradually deteriorate, and the lighting manufacturer will indicate a typical battery life. Group battery replacement may be cost effective and minimize maintenance labor, and a life cycle cost benefit analysis can determine if this is the case. Many batteries contain toxic materials, and the lighting maintenance plan should specify the appropriate disposal policy.

-  Create a regular schedule for emergency lighting routine maintenance, including periodic testing and replacing failed components such as batteries. Include schedule in lighting maintenance plan.

-  Determine areas where operational verification of emergency lighting systems would be difficult, and obtain computerized testing apparatus from the manufacturer in lieu of manual testing. Include instructions and manufacturer contact information in the lighting maintenance plan.
-  Determine if monthly verification is required for batteries or an emergency generator. Include the schedule and verification procedures in the lighting maintenance plan.
-  Identify the toxic waste handling policy appropriate for emergency lighting batteries, and include disposal instructions in the lighting maintenance plan.
-  Perform a life cycle cost benefit analysis to determine if group battery replacement is cost effective.

## Lighting Controls:

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Lighting controls exist in many forms. The most basic is human control, which requires education and a sense of responsibility among occupants or O&M staff. To ameliorate the inherent shortcomings of human control, technological strategies such as occupancy and motion sensors, timers and timeclocks, and daylighting controls can help reduce the total run time of lighting.

### Occupancy and Motion Sensors

Occupancy and motion sensors can save energy and costs by automatically turning off lighting that is not in use. As a result, the maintenance needs and frequency of replacement of bulbs and fixtures may decrease. In addition, sensors may also provide security and comfort benefits for occupants. Occupant detector costs are low, particularly when compared to the energy savings they provide. Maintenance costs can increase, especially if a control such as an occupancy sensor is only marginally suited to an application.


Different models of occupancy and motion sensors provide different ranges of coverage and features. The following are examples of the best applications for the two most common types, infrared and ultrasonic:

- **Infrared sensors** - These are best used in the following applications: small enclosed spaces without obstructions, areas with high air movement (computer rooms), areas with high ceilings, hallways and storage aisles, spaces with areas of unwanted detection, and as wall switch replacements. Passive infrared sensors are less likely to detect motion as the distance between the object and the sensor increases, so are more susceptible to false-off readings.
- **Ultrasonic sensors** - These are best used in the following applications: large offices and classrooms, enclosed areas up to 2,000 sq. ft, storage areas with obstructions, enclosed hallways, and partitioned restrooms. Ultrasonic sensors are typically more vulnerable to 'false-on' readings resulting from air currents and traffic in adjacent corridors. Using manual-on switches in conjunction with the ultrasonic sensor will help prevent false-ons while saving energy by avoiding unwanted or unnecessary automatic activation.
- **Dual-Technology Sensors** – These combine the technology of ultrasonic and infrared, and tend to reduce and prevent both false-ons and false-offs. These sensors are more expensive than ultrasonic or infrared used alone.

Placement of occupancy and motion sensors and their settings provide different ranges of coverage and features. In general:


- **Ceiling mounted sensors** or high wall mounted sensors provide the best overall room coverage, and are the most versatile because their view tends to be less obstructed.
- **Switch replacement sensors or wall boxes** are a good option for retrofits, but are more prone to tampering and provide less room coverage. They also make sense for small, unobstructed spaces where tampering is unlikely to occur.
- **On-Off settings** can either be set to turn on and off automatically or manually set on and automatically set off. The manual-on option provides energy savings when placed in easy to access areas where occupants are aware of the setting, and how to properly use it, while auto-on sensors make more sense when placed in areas where occupants are unfamiliar with the layout and switch locations, or the switch is placed in an inconvenient location.


- **Sensitivity settings** determine the degree of activity that will trigger a response. Typical ranges for sensitivity settings are between 30 seconds to 30 minutes. In general, 15 minutes will offer a good balance of energy efficiency with user tolerance.


 General guidelines for lighting controls are:


- Check that motion sensors are installed in areas appropriate to their function. Spaces that are occupied intermittently, such as storerooms, warehouses, and corridors are examples where sensors would be a good fit. Ensure that occupancy and motion sensors are placed in areas appropriate for their function;
- Properly adjust, through commissioning;
- Use careful preventative maintenance to ensure proper use of controls and longevity of control life, through periodic tune-ups and verification; and,
- Solicit, listen, and respond to user observations.


Additional guidelines include:


 Check that motion sensors are installed in areas where accidental motion will not trigger the sensor, and take preventative action as needed. For example, motion outside windows may trigger the sensor, so partial shading of sensors may prevent accidental triggering.


 **!** Commission lighting controls upon installation.


 **!** Set up a regular periodic performance verification schedule to make sure that lighting controls effectively save energy over time and are operating properly

 Coordinate with the building maintenance staff to schedule annual verification. Although controls that need frequent adjustment may need attention sooner. Refer to the control manufacturer for more specific guidelines, and include schedule and details in the lighting systems O&M plan.

 Coordinate with maintenance staff to review to any control complaints in order to identify complaints that may be symptomatic of a larger issue.

 Respond promptly to any control complaints to prevent tampering. Listen to comments the users have about control operation and adjust accordingly. Ask users for comments if they do not volunteer any.


 Review manufacturer's information for estimates on performance levels for different spaces as guidance for the most effective location for the individual sensor.

 Check manufacturer recommendations and review occupant needs to refine the recalibration standards:


- **Ceiling-mounted occupancy sensors:** Start calibration with a time delay of 15 minutes and a medium-high sensitivity, and then adjust up or down as needed.
- **Wall-box occupancy sensors:** Select "manual on, auto-off" and set with a 15-minute time delay and a medium sensitivity.

*Note: time delays of less than 15 minutes will likely shorten the lamp life unless programmed ballasts are installed.*


The most common troubleshooting issues that operations & maintenance staff encounter with occupancy sensors are sensors turning lights on when not needed, and sensors turning lights off when occupants are still in the space.


 When troubleshooting sensors that turn lights on when not needed, the following troubleshooting steps may solve the problem:


- Start by reducing the sensitivity setting slightly, and reducing sensor sensitivity to motion;
- Ask if occupants are agreeable to switching the sensor to manual 'on' operation, if the sensor is connected to a local switch; and,
- Mask the sensor so that it does not detect motion outside the room.

 When troubleshooting sensors that turn lights off while occupants are still in the space, the following troubleshooting steps may solve the problem:

- Confirm that the sensor was not left in test mode
- Increase the sensitivity setting
- Increase the time delay (not longer than 30 minutes)
- Consider replacing infra-red sensors with more sensitive ultrasonic sensors
- To identify whether coverage is sufficient, evaluate the number and distribution of existing sensors, and identify barriers or obstructions to the sensor.

 Keep a copy of the manufacturer's brief control instructions with the control.

 If a control is accessible to room occupants, place contact information near the control to allow occupants to call for assistance. This encourages occupants to ask for assistance before manually disarming (or damaging) a control.

 Perform periodic performance verifications (adjustments) to make sure that lighting controls effectively save energy over time and operating properly. Verification schedule and process should be included in the lighting maintenance plan.

## Timers and Timeclocks


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Timers and timeclocks can save significant energy costs by automatically turning off lighting. As a result, the maintenance labor costs and frequency of replacement of bulbs and fixtures may decrease.


Keys to energy savings and overall effectiveness from timers and timeclocks include:


- Setting up a schedule that fits the facility's specific operations, so time controls turn lights on when needed and off when not needed.
- Proper initial adjustment;
- Maintain proper use of controls, and fine tuning and adjustments to appropriate levels to the occupancy, tasks or conditions (this may require training for maintenance staff); and
- Soliciting, listening, and responding to user observations.


Timers and timeclocks require some expertise for installation and maintenance and careful strategy analysis and maintenance verification. The more complicated the timer, the more important it is to ensure proper application, installation and continuing maintenance. Periodic performance verifications typically are weekly during general inspections, and seasonally for programming to specific, odd-hour needs.


 Schedule periodic performance verifications with the maintenance staff to ensure that lighting timers effectively save energy. Typical verification would be weekly during a general inspection, and seasonally for programming to a specific, odd-hour need. Include the schedule and procedures in the lighting maintenance plan.

 When installing a lighting timer or timeclock that might need adjustment or reprogramming in the future, place a copy or summary of the instructions with the control.

 Ensure that daylight's savings is captured in the timer settings, or if a manual reset is necessary, include this in the lighting maintenance schedule.









 Determine the appropriate level of expertise needed to maintain the facility's timers and timeclocks, and identify any necessary training for maintenance staff, or outside verification and maintenance services needed, to ensure proper maintenance procedures and programming. Include this information in the lighting maintenance plan, so any new maintenance staff can easily identify training needs and information.

 Respond promptly to any control complaints to prevent tampering. Listen to user feedback control operation and adjust accordingly. Ask users for comments if they do not volunteer any.

-  Keep a copy of the manufacturer's brief control instructions with the control. When installing a lighting timer or timeclock that might need adjustment or reprogramming in the future, place a copy with the control.

## Daylighting Controls

Daylighting controls can range from simple photoelectric switches to complex computerized energy management systems that turn off or dim the lights in response to the natural illumination available. While the simplest can, in some cases, save dramatic amounts of energy (10-60%), the more complicated ones can closely pattern lighting needs to save as much energy as possible. Most facilities try something in between. The goal of daylighting controls is to provide smooth and continuous dimming, to avoid distraction to occupant productivity. Key to energy savings and overall effectiveness from daylighting controls include:

- Initial commissioning (acceptance testing);
  - Tailored schedules of periodic tune-ups and inspection for all controls in the system, which may require training for maintenance staff; and
  - Soliciting, listening, and responding to user observations.
-  Be cognizant of daylighting control placement. If a daylighting control is exposed to room occupants, the user may try to adjust or disable a control that appears uncooperative. Attaching a label with the maintenance number, including a request to call for any adjustments, can help keep the controls operating properly and the users happy.
-  Solicit assistance from the control manufacturer to set up a performance verification schedule appropriate for each control. Schedules may differ among the controls, based on the type of control and its exposure to potential unauthorized fiddling by occupants.
-  Coordinate with maintenance staff to set up testing and verification schedules for interior and exterior controls. Include all verification schedules, test techniques and adjustment methods in the lighting maintenance plan.
-  For complex control systems, ensure staff are properly trained on maintenance procedures and special needs. Include this information in the lighting maintenance plan, so any new maintenance staff can easily identify training needs and information.
-  Respond promptly to any control complaints to prevent tampering. Listen to comments the users have about control operation and adjust accordingly. Ask users for comments if they do not volunteer any.
-  Identify location and number of photocells that are cadmium-sulfide cells. (Cadmium-sulfide cells degrade from exposure to sunlight and lose sensitivity after being in service for a few years, resulting in decreased savings from lighting being on longer than necessary.) Consider replacing cadmium-sulfide cells with electronic cells that use solid-state, silicon phototransistors or photodiodes, which do not lose sensitivity over time, and last longer, resulting in increased pay back in energy and labor savings.
-  Inspect exterior lighting controlled by photocells on a regular basis. An indication of photocell failure is when the outdoor lighting system is on during daylight hours. Include details on photocell testing in the lighting maintenance plan.
-  The following guidelines may help troubleshoot daylighting controls which dim the lights too much:
  - Verify that light levels meet the design criteria. If so, the issue may be window glare or excessive contrast, and the blinds or diffuse shades may need adjustment.
  - Verify with the manufacturer that the product has a continuous dimming response, instead of a threshold dimming response (which is appropriate for industrial spaces such as warehouses). Maximize the 'fade rate' so dimming is smooth and continuous.
  - Increase the time delay to 10 minutes so lights do not respond to sudden changes (such as a cloud moving over the sun).



- Verify that the photocell is properly located over a space that does not have day to day movement or changes.
- If necessary, recalibrate the photosensor at night and again during the daytime, following the manufacturer's procedures outlined.


## Residential Grade Appliances


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Residential grade appliances are frequently used in break rooms or other lower use areas of commercial buildings. Energy and cost savings can be achieved through product selection, as well as informing and encouraging occupants to operate appliances in the most energy efficient manner.

### Dishwashers

Replacing a dishwasher manufactured before 1994 with a new standard model can save more than \$30 a year in utility costs. Energy Star qualified dishwashers use at least 41 % less energy than the federal minimum standard for energy consumption and use much less water than new conventional models. Because they use less hot water compared to new conventional models, an Energy Star qualified dishwasher saves about \$90 over its lifetime.


 Run a dishwasher only with a full load. This is beneficial for both standard and Energy Star dishwashers, as most of the energy used by a dishwasher goes to heating the water.


 Do not use the heat-dry, rinse-hold and pre-rinse features whenever possible.


### Refrigerators and Freezers

Replacing a refrigerator bought in 1990 with a new Energy Star qualified model can save enough energy to light the average household for nearly four months. Newer Energy Star models consume half as much energy as models manufactured before 1993 (at least 1% less energy than required by current Federal standards and 40 % less energy than the conventional models sold in 2001) without sacrificing features. They also use high-efficiency compressors, improved insulation, and more precise temperature and defrost mechanisms to improve energy efficiency.

Qualified freezer models use at least 10 % less energy than required by current federal standards, and compact refrigerators and freezers use at least 20 % less energy than required by current federal standards. (Compacts are models with volumes less than 7.75 cubic feet.)


 **!** Replace aging refrigerators and freezers with Energy Star models, appropriately sized to meet facility needs.


 Encourage energy savings through occupant behavior: do not leave doors open while prepping food or removing content from containers.




 Set freezer and refrigerator at highest possible temperatures to keep food safely frozen or cold, without wasting energy.

### Clothes Washers and Dryers

Replacing a standard clothes washer manufactured before 1994 with an Energy Star model can save up to \$110 per year on utility bills. Most full-sized Energy Star qualified washers use 18 to 25 gallons of water per load, compared to 40 gallons used by a standard machine. They extract more water from clothes during the spin cycle (reducing energy need for drying), and they are available in both top-loading and front-loading designs. Energy Star does not label clothes dryers because most dryers use similar amounts of energy. Encourage energy savings primarily through occupant use.

 **!** Replace aging washers and dryers with Energy Star models.

 Encourage extra energy savings through occupant behavior: operate washers with full loads only and use cold water.












-  If the clothes washer has spin options, encourage occupants to select a high spin speed or extended spin option to reduce remaining moisture (to reduce energy need for drying).
-  Use the moisture sensor option to automatically shut off the machine when the clothes are dry.
-  Air dry clothes and fabrics whenever possible. If possible for the facility, inform and encourage occupant behavior to not use dryers through signage and inclusion in the tenant manual.

## Miscellaneous Electrical Equipment

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### Photovoltaic Arrays

Photovoltaic (PV) systems require very little maintenance once they are installed and tested for efficient performance. However, some key practices should be considered to ensure optimum performance and durability.

-  **!** Commission the system upon installation. Coordinate with maintenance personnel and the PV commissioning authority to ensure that the system is operating at full capacity, both upon installation and at least once or twice a year during inspections.
-  Work with maintenance staff to designate the staff responsible for the inspection of the PV panels and inverter at least once or twice a year.
-  Schedule PV panel inspections at least once or twice a year, and include schedule and inspection details in electrical & lighting systems maintenance plan.
-  Maintain photovoltaic (PV) systems by keeping panels clean and periodically checking that both panels and inverter are functioning to produce electricity at target levels and optimum efficiency.
-  Inspect the PV array surface for excessive dirt or debris (a thin layer of dust is not a concern); check with manufacturer for approved cleaning products.
-  Inspect the mechanical bolting system and wiring to see if anything is loose or damaged (sometimes vandalism can be a concern as well).
-  If work is done near the panels or system, check to ensure that the panels, wiring, mounting mechanism, and inverter were not disturbed, upon completion of the work.
-  If batteries are being used, inspect for corroded terminals and clean if required, and measure battery voltage to verify state of charge. Maintenance-free batteries should be inspected approximately once each year.
-  Seasonally adjust the PV array tilt angle to optimize energy output when applicable (this is cost effective for larger systems only).
-  If flooded batteries are being used, add distilled water if the electrolyte level is low. Flooded batteries should be inspected every three to six months.
-  Adhere the manufacturer's recommendation related to periodic care of the grid interfaces, and provide detailed instructions to maintenance staff.








### Office and Printing Equipment

Selecting energy-efficient office and printing equipment (personal computers (PCs), monitors, copiers, printers, and fax machines) and encouraging occupant and maintenance staff behavior (such as turning off machines when not in use) can result in enormous operational energy savings. A typical PC operating 9 hours a day will use only 38% of the power consumed by a computer operating 24 hours. Copiers, laser

printers, faxes, and other office equipment can save up to 66% of their 24-hour power consumption by keeping them on only during office hours.




As energy efficiency equipment demand has increased, products have become more efficient. The Energy Star product label can help identify efficient products. An Energy Star copier saves 40% of the energy over a standard copier. The Electronic Product Environmental Assessment Tool (EPEAT) is a valuable tool to evaluate and compare electronic computing products.

Many models have built-in energy saving modes that can be enabled to save energy when the equipment is not in use. When coupled with occupant and maintenance staff awareness and actions (such as turning off monitors), these models and operational choices can result in significant energy savings.

-  Enable energy saving features on new and existing equipment, and conduct periodic checks to ensure that settings have not been changed.
-  **!** Employ power management devices on computers to reduce energy use.
-  **!** Develop guidelines for energy saving actions that occupants can easily implement, such as turning off computers, monitors, copiers and printers when done for the day, and for periods of time when occupants will be gone (weekends, holidays). These guidelines can be included in a tenant manual.
-  Provide regular reminders to occupants that “The Power Is In Their Hands.” Email “blasts,” flyers and posters can help reinforce these messages.
-  If applicable to the facility, join or investigate resources available through Green Grid, which is a global consortium dedicated to advancing energy efficiency in data centers and business computing centers.
-  Use the Electronic Product Environmental Assessment Tool to evaluate and compare electronic computing product choices.
-  Unplug equipment whenever possible or during long periods of idle time to reduce phantom loads.



## Ice Machines


Commercial ice machines that have earned the Energy Star rating are on average 15 % more energy-efficient and 10 % more water-efficient than standard models.


-  **!** Replace aging ice machines with Energy Star models
-  Encourage energy savings through occupant behavior. For example, do not automatically add ice to beverages, unless requested.
-  Always close ice machine door between uses.

## Vending Machines

Most vending machines are very energy inefficient, yet the electricity bill is typically paid by the building operators, not the vending machine supplier. The machine’s lighting system alone can account for 40% of its electricity use.


-  Request vendors to supply or replace existing machines with Energy Star qualified machines. These can save building and business owners more than 1,700 kWh/year, or \$150 annually on utility bills.
-  Install a Vending Miser. Vending Misers can save 1,000 to 1,500 kWh per year (roughly 30% of a standard vending machine’s annual energy consumption) and are installed between the line plug of the vending machine and the wall outlet. Vending Misers use an occupancy sensor to assess the presence of people, and turns off machines when they are not needed, while maintaining product temperature and being “open for business” when people come by to make a purchase.


 Disconnect vending machine lights, and inform maintenance staff of this decision (to avoid confusion of whether the machine should be plugged in or not).

 If vending manufacturer will not allow removal of lights, replace the standard T12 lamps with more energy efficient T8 lamps.

## Elevators

Elevators consume a significant fraction of the total energy used in tall buildings. The electricity-consuming elements of elevators are the drive/machine, car illumination (some elevator codes require this to be on all the time), and the controller. Marginal improvements in their efficiency translate into significant savings. Elevator energy use is less substantial in low-rise and mid-rise buildings. However, low-rise and mid-rise buildings typically use hydraulic elevators, which are the least efficient and the most problematic in terms of pollution from hydraulic fluid.

 Any time equipment needs replacing or significant maintenance, work with operations staff evaluate options for upgrading to more energy-efficient and environmentally friendly systems.

 If using a hydraulic system that is not up for replacement, switch to less toxic hydraulic fluid.

## Metering Options –

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Metering options range from very simple to complex. Choose the right equipment and monitoring plan that meets the needs of your own facility. Create a plan for processing and using the monitoring data before purchasing and installing equipment. Consider who will look at the data, what the goals of metering are, and what strategy will provide the optimal cost/benefit ratio.


Advanced metering Infrastructure (AMI) includes the integration of electronic communication into metering technology to facilitate one-way or two-way communication between utility and customer equipment. AMI systems consist of **meters, data-collection systems, data storage, and data analysis** and **presentation**. Advanced metering can provide electricity consumption data for the parts of the facility of interest. The data may be analyzed for electricity use and time of use. Advanced metering information can help:

- Manage electricity service requirements
- Determine optimum size of new electric service
- Identify savings opportunities
- Spot unusual usage trends
- Realize cost savings through specific action items.

Details on selecting the appropriate system are available in the U.S. Department of Energy Federal Energy Management Program, Advanced Utility Metering Report.

Sophisticated customer sub-metering also includes additional equipment and typically is only monitored by the property management (not the utility). This type of metering provides significant value to Operations & Maintenance but requires equipment, installation, and ongoing monitoring.

 Establish purpose and use of a metering system prior to specifying system, by working with each facility and department to identify individual interests and goals.

 Use the type of metering system that is appropriate for your facility. Metering devices should provide data at least daily and measure at least hourly consumption of electricity in your facility.

## Lighting & Electrical System Resources

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### O & M Plan Resources

- ☞ Recommended Practice for Planned Indoor Lighting Maintenance (IESNA/NALMCO RP-36-03). Available electronically or as a publication for purchase at <http://www.iesna.org>
- ☞ Federal Energy Management Program, Fact Sheet: [http://www1.eere.energy.gov/femp/pdfs/om\\_lighting.pdf](http://www1.eere.energy.gov/femp/pdfs/om_lighting.pdf)
- ☞ Energy Star's Building Upgrade Lighting Chapter: [http://www.energystar.gov/ia/business/EPA\\_BUM\\_CH6\\_Lighting.pdf](http://www.energystar.gov/ia/business/EPA_BUM_CH6_Lighting.pdf)

### Scheduling Group Relamping and Cleaning Resources

- ☞ IESNA RP-36-03 provides information on cleaning curves and equations to determine the best and most appropriate cleaning schedule. Available electronically or as a publication for purchase at <http://www.iesna.org>

### Luminaires Resources

- ☞ Lamp recyclers in King County: <http://your.kingcounty.gov/solidwaste/takeitback/fluorescent/>
- ☞ For more information on leaking used PCB Ballasts, see <http://www.epa.gov/osw/http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/ballasts.htm/tsd/pcbs/pubs/ballasts.htm> or call 1-202-554-1404 (National TSCA/PCB hotline)
- ☞ For requirements to dispose of non-PCB ballasts in the garbage, call the King County Business Waste Line at 206-296-3976.
- ☞ American National Standards Institute (ANSI) typically provides ballast designations for each HID lamp type.
- ☞ SF Approved Lighting Products - Energy Efficient, Low-Mercury Lighting: [http://www.sfenvironment.org/downloads/library/1\\_sf\\_approved\\_lamps\\_ballasts\\_fixtures\\_102109.pdf](http://www.sfenvironment.org/downloads/library/1_sf_approved_lamps_ballasts_fixtures_102109.pdf)
- ☞ ENERGY STAR compliance can provide confidence that a CFL will give reasonable performance.
- ☞ Tritium Exit Signs Present a Challenge in Handling and Disposal <http://www.crcpd.org/TritiumExitSigns/tritiumSignsAbout.aspx>
- ☞ The U.S. Department of Energy has a R&D program in place focusing on development of energy-efficient LED technology. Their plan spans 20 years, ending in 2020. Their website is a good source of additional up-to-date information of LED technology, [http://www1.eere.energy.gov/buildings/ssl/using\\_leds.html](http://www1.eere.energy.gov/buildings/ssl/using_leds.html)

### General Lighting Resources

- ☞ Management Programs, U.S. Department of Energy [http://www1.eere.energy.gov/femp/pdfs/omguide\\_complete.pdf](http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf)
- ☞ IESNA Guidelines for Upgrading Lighting in Commercial and Institutional Spaces <http://www.iesna.org>
- ☞ Energy Star's Building Upgrade Manual, Chapter 6, Lighting [http://www.energystar.gov/index.cfm?c=business.EPA\\_BUM\\_CH6\\_Lighting](http://www.energystar.gov/index.cfm?c=business.EPA_BUM_CH6_Lighting)
- ☞ Recommended Practice for Planned Indoor Lighting Maintenance. Joint publication of the Illuminating Engineering Society of North America and the International Association of Lighting Management Companies <http://www.iesna.org>
- ☞ U.S. Department of Energy Federal Energy Management Program, Advanced Utility Metering Report <http://www1.eere.energy.gov/femp/pdfs/33539.pdf>
- ☞ U.S. Department of Energy Federal Energy Management Program, Operations and Maintenance Best Practices Guide [http://www1.eere.energy.gov/femp/pdfs/omguide\\_complete.pdf](http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf)
- ☞ Greening Federal Facilities, An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers <http://www1.eere.energy.gov/femp/pdfs/29267.pdf>

## Residential Grade Appliances Resources

- ☞ U.S. Department of Energy website <http://www1.eere.energy.gov/buildings/residential/appliances.html>
- ☞ ENERGY STAR maintains lists of energy-efficient office equipment that meet thresholds of energy efficiency that are markedly improved over standard models  
[www.energystar.gov/index.cfm?c=ofc equip.pr office equipment](http://www.energystar.gov/index.cfm?c=ofc equip.pr office equipment).
- ☞ ENERGY STAR has a listing of products that are certified including copiers, fax machines, mailing machines, printers and scanners  
[http://www.energystar.gov/index.cfm?c=bulk\\_purchasing.bus\\_purchasing#off](http://www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing#off)
- ☞ Green Grid offers research, white papers, and opportunities to interact with other organizations at the forefront of reducing energy in large datacenters <http://www.thegreengrid.org/>
- ☞ Electronic Product Environmental Assessment Tool (EPEAT): EPEAT is a three-tiered rating system for electronic computing products to help the public and private sector “evaluate, compare and select desktop computers, notebooks and monitors based on their environmental attributes.” All EPEAT certified products also meet at minimum, the current Energy Star (Energy Star 4.0) criteria.
- ☞ Climate Savers Smart Computing is a non-profit group initiated by Google and Intel, comprised of a group of consumers, businesses and conservation organizations with the goal of improving computer power delivery efficiency and energy reduction. The organization has an online Smarter Computing Catalogue, which lists computing equipment with efficient power supplies, and certifications such as Energy Star or EPEAT.

## Miscellaneous Electrical Equipment

- ☞ Vending Miser: <http://www.vendingmiserstore.com/>

## Advanced Metering Resources

- ☞ Seattle City Light offers Advanced Metering that can be installed temporarily at survey locations for as little as one week or up to a three-month period. It also can be installed permanently to monitor electricity consumption of specific equipment or a part of the facility. (The permanent installation cannot be used for billing purposes.) For contact information at Seattle City Lights regarding Advanced Metering see [http://www.seattle.gov/light/products/pd5\\_am.htm](http://www.seattle.gov/light/products/pd5_am.htm).
- ☞ U.S. Department of Energy Federal Energy Management Program, Advanced Utility Metering Report (<http://www1.eere.energy.gov/femp/pdfs/33539.pdf>).

# Plumbing Fixtures and Systems

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## Introduction

Between 1950 and 2000 the national public demand for water more than tripled while the population doubled. Americans now use an average of 100 gallons of water each day. This increased demand has put additional stress on water supplies and distribution systems, threatening both human health and the environment. By using water more efficiently, we can help preserve water supplies for future generations, save money, and protect the environment. (Source: U.S. Environmental Protection Agency WaterSense website: [http://www.epa.gov/WaterSense/water\\_efficiency/](http://www.epa.gov/WaterSense/water_efficiency/))

Operations & maintenance of plumbing systems involves selecting efficient and durable systems & fixtures, repairing stoppages and leaks, and detailed maintenance of all plumbing systems including steam and gas lines, kitchen appliances, waste systems, and irrigation systems. Plumbing maintenance staff may also be in charge of maintaining water lines for HVAC equipment, such as water source heat pumps.

## Plumbing Operation & Maintenance Plan

A plumbing O&M plan usually establishes operating and performance standards for domestic water lines, sanitary lines, and gas lines, and includes information on building equipment, inspection procedures, schedules and reporting requirements for repairs and maintenance. The plan should include an assessment and timeline for the conversion of plumbing fixtures to high-performance

### Tip for LEED-EB: O&M


LEED-EB includes a prerequisite with the intent of reducing water use within buildings. When preparing your plumbing O&M plan, keep the following prerequisite requirements in mind so you could easily qualify for this if you decide to pursue LEED EB in the future:


### WE Prerequisite 1: Minimum Indoor Plumbing Fixture & Fitting Efficiency


Reduce potable water usage of indoor plumbing fixtures and fittings to a level equal to or below the LEED-EB: O&M baseline, which is calculated using the assumption that 100% of the buildings' indoor plumbing fixtures and fittings meet the Uniform Plumbing Codes (UPC) 2006 or International Plumbing Codes (IPC) 2006 fixture and fitting performance requirements. See the reference manual for additional requirement details.

plumbing fixtures and fittings as part of any future renovations, as well as a list of scheduled maintenance tasks, frequency the tasks will be performed, the personnel or level of skill required to perform the task, and the time required. A good plumbing O&M plan will ensure the expected life of equipment is extended, that pollutants do not enter the system, and that the systems are maintained for optimum performance and safety. Additional specifications to consider including in the plan are water heater storage temperatures, control of mixing valves, operating pressures, and flow rates.

**For preventive maintenance:** identify the expected life of equipment. Determine the routine maintenance required to meet or exceed the expected life of the components. The level of preventive maintenance will depend on manufacturer's recommendations, industry guidelines and facility managers' experience and district operating budgets.


-  **!** Develop a plumbing operations and maintenance plan that includes information on building equipment, inspection procedures, schedules and reporting requirements for repairs and maintenance. Fundamental elements to include in the plumbing maintenance plan are:
- System requirements for storage temperature, delivery temperature, fixture flow rates, required cleanouts and isolation valves,
  - Safety & health standards.
  - Location of reference and operations & maintenance manuals for all parts.
  - A record keeping procedure and work order process for routine maintenance and responses to calls.
  - Assessment for the conversion of plumbing fixtures to high-performance plumbing fixtures and fittings as part of any future renovations.
  - List of scheduled tasks, frequency the tasks will be performed, the personnel or level of skill required to perform the task, and the time required.
  - Establish a method to report leaks and fix them immediately.
  - Encourage cleaning or custodial crews to report problems.


-  Complete a prescreening system audit to determine the need for a full-scale system audit, using one of the following methods. Every two years:
- Determine authorized uses
  - Determine other system verifiable uses
  - Determine total supply into the system
  - Divide authorized uses plus other verifiable uses by total supply into the system. If this quantity is less than 0.9, a **full-scale system audit** is needed.

-  Once a system audit has been conducted, obtain and monitor minimum system flow. This is usually the flow rate at around 3 or 4 AM. Significant increases to this amount are likely leak-related, indicating that a full-scale leak detection survey is necessary.


## General Plumbing Fixtures and System Guidelines

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-  Water systems should be reviewed for retro-fit opportunities. Identify opportunities and develop a plan to complete these updates in the near future.

-  Periodically check safety and shutoff valves for proper operation. For faucets, clean aerators if the flow appears restricted or irregular. Inspect showerheads for deposits, debris, or build-up.

-  Maintain spare supply for valves and controls, and indicators for fire suppression systems.

-  Install additional shut-off valves to isolate problems so that sections of buildings do not have to be shut down.











-  Maintain spare supply for valves and controls, and indicators for fire suppression systems.
-  Test for pressure relief valves and checks for trapped air.
-  Check manual or automatic bleeder devices twice a year for operability.
-  Check pumps and motors for circulation pumps for leaks, noise or vibration. Test for proper pressure.
-  In areas where water quality is a problem, perform routine testing of water quality. Water quality testing is important for both public health and for the maintenance of the piping system.
-  Monitor the pH in the water system. Facility managers can use water treatment kits to treat unbalanced pH levels. Testing the water quality annually will reduce the mineral build-up that leads to scaling.
-  Check domestic hot water circulator pumps for proper operation. Periodically check the flow rate through domestic water lines.

## Fixtures













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Low flow fixtures are cost-effective in the long run; the U.S. Energy Department estimates that they can pay for themselves in less than a year. Zero-water consumption urinals have payback periods ranging from 3 months to up to 3 years and have estimated savings of \$150–\$300 annually for each unit. (Source: Collaborative for High Performance Schools, Best Practices Manual, <http://www.chps.net/dev/Drupal/node/288>)






Following are suggested operation and maintenance, retrofit, and replacement options for various fixture types. The lists are from the U.S. Department of Energy, Federal Energy Management Program “Best Management Practices for Water Conservation” [http://www.wbdg.org/design/conserve\\_water.php](http://www.wbdg.org/design/conserve_water.php).




-  Where appropriate, install expansion tanks, pressure reducing valves, and reduce water heater settings to prevent temperature and pressure relief valves from discharging water.
-  Ensure all equipment is installed and operated in accordance with the manufacturer's instructions.
-  If applicable, ensure that procedures are in place to turn off the water supply when the equipment is not in operation. Some equipment allows water to constantly run, even when the equipment is turned off.
-  For water softeners, set the softener controls to start the softening and regeneration process only when needed. Softeners with timers should be avoided. Avoid chemical and salt softeners when possible and cost effective.
-  If practical, consider metering or otherwise measuring the amount of water used in other high water using processes.
-  Post energy and water use information to raise awareness and to encourage occupants to conserve water.
-  Implement inspection procedures for all water delivery devices: drinking fountains, sinks, showerheads, emergency wash stations, water closets, urinals and kitchens. Perform routine maintenance on all terminal devices and associated piping.
-  Remove aerators to clean and ensure fixture flow is consistent.

## Toilets and Urinals












-  **!** When replacing tank-type toilets (gravity or pressure assist), specify toilets with the WaterSense label. These have an effective flush volume of 1.28 gallons or less and have been independently tested and certified for performance.
-  **!** When replacing urinals, replace with high efficiency models designed to use 0.5 gpf or less.
-  **!** Do not retrofit tank-type toilets with displacement dams or bags as these hamper overall operation of the toilet and increase maintenance costs.
-  For some commercial flushometer valve type toilets (diaphragm type only), the existing flush valve can be retrofit with a dual-flush valve capable of delivering a reduced flush or a full flush depending upon the demand (i.e., liquids only or solid and liquid waste). **Note:** this type of retrofit may require user education to be fully successful.
-  Evaluate and, when possible, update systems to use non-potable water for toilet and urinal flushing. Packaged gray water treatment systems are now available that provide water filtered and treated sufficiently for these uses.
-  Check for leaks every six months.
-  Periodically inspect flush valves and fill valves in tank-type toilets.
-  Replace worn parts and adjust mechanisms to ensure that the water consumed per flush meets manufacturers' original equipment specifications.
-  If non-water urinals are used, clean and replace the seal cartridges or material in accordance with manufacturer recommendations.
-  Correctly adjust and maintain automatic sensors to ensure proper operation.
-  Test your system pressure to make sure it is between 20 and 80 psi. If the pressure is too low, then high-efficiency devices won't work properly, if it is too high they will consume more than their rated amount of water.
-  If applicable, check flow rates to ensure they are within manufacturers' recommendations. For maximum water savings the flow rate should be near the minimum allowed by the manufacturer. This can produce significant water savings.

## Faucets and Showerheads


-  Install temporary shut-off or foot-operated valves with kitchen faucets. These valves cut off the water flow during intermittent activities like scrubbing or dishwashing. The water can be reactivated at the previous temperature without need to remix the hot and cold water.
-  Install low-flow aerators on lavatory faucets to reduce water use, or replace with code-compliant low-flow sensor faucet (preferably self-powered, e.g. hydro-powered).
-  Encourage users to take shorter showers; place clocks or timers in or near showers.
-  Replace all showerheads with high-efficiency fixtures (1.6 gpm), or install flow restrictors in existing fixtures.
-  Replace water-cooled commercial ice makers with high-efficiency air cooled commercial ice makers with the ENERGY STAR label.








-  For low to medium volume steam cooking needs, purchase high-efficiency steam cookers with the ENERGY STAR label or purchase boilerless (connectionless) commercial steam cookers. Specifically look for steamers with improved insulation, standby mode, and closed-system design.
-  Purchase high-efficiency pre-rinse spray valves that have flow rates of 1.25 gpm or less and that meet ASTM F2323-03, Standard Test Method for Performance of Pre-Rinse Spray Valves.
-  Consider steaming needs when purchasing steam kettles. Direct steam kettles may be appropriate for bulk cooking (more than 50 servings at a time). For smaller steaming needs, purchase self-contained steam kettles.

## Commercial Kitchen Equipment






-  **!** Eliminate or minimize the use of garbage disposals by installing strainers or traps that employ a mesh screen to collect food waste.
-  **!** Purchase high-efficiency commercial dishwashers with the ENERGY STAR® label. If possible, install low-temperature machines that rely on chemical sanitizing over high water temperature. If purchasing a low-temperature chemical sanitizing machine, carefully consider the cost of chemicals and verify water use with the distributor or manufacturer to ensure that the machine uses less water than an equivalent high-temperature machine.
-  Install dishwashers with rack sensors to allow water flow only when dishes are present.
-  For commercial dishwashers, check volume of service and size the dishwasher accordingly. Be sure to consider the energy tradeoff associated with increased tank heat that may be required for larger machines.
-  Educate staff about the benefits of water efficiency and the importance of hand scraping (not using water) before loading a dishwasher.
-  Ensure ice machines operate *without* single-pass cooling. To maximize water savings, eliminate single-pass cooling by modifying equipment (if possible) to operate on a closed loop that recirculates the water instead of discharging it; otherwise replace the ice-making head with an air-cooled unit.
-  Install flow restrictors in existing pre-rinse spray valves to reduce the flow rate to 1.6 gpm or less or replace with new more efficient and inexpensive pre-rinse spray valves.
-  Immediately replace any damaged dishwasher racks.
-  Check equipment's water temperatures and flow rates to ensure that they are within the manufacturer's recommendations. For maximum water savings, water flow rate should be near the minimum allowed by the manufacturer.
-  For dishwashers, observe final rinse pressure to make sure it is at the manufacturer's recommended setting, typically 20 ± 5 psi. If the pressure is too low, then the dishes may not be rinsed and sanitized properly, if it is too high they will consume more than their rated amount of water.
-  Some pre-rinse spray valves may be easily taken apart to perform routine cleaning or to clean when performance is noticeably impacted, however, because pre-rinse spray valves are relatively inexpensive, it may be more viable to replace plugged or poorly performing valves with new efficient models. If cleaning or maintenance is necessary, avoid drilling out holes to remove scale and buildup.

## Laboratory/Medical Equipment




-  Install a pressure-reducing device on equipment that does not require high-pressure where appropriate to reduce water use.

-  Set equipment to the minimum flow rates acceptable or recommended by the manufacturer and post signs nearby equipment to increase employee awareness and discourage tampering with equipment flow rate.
-  Evaluate the laboratory's requirements for high-quality water, including the total volume and the rate at which it will be needed, so that the system can be properly designed and sized.
-  In reverse osmosis treatment systems water purification systems consider reusing concentrate produced for non-potable applications, such as bathroom commodes.
-  Choose systems with a higher recovery rate - the ratio of filtered purified water to the volume of feed water. Some proprietary systems claim recovery rates up to 95%. Conventional reverse osmosis systems have recovery rates between 50 and 75%.
-  Determine the quality of water required in each application; use the lowest appropriate level of quality to guide the system design. For example, reverse osmosis units should only be used in processes that require very pure water.
-  Evaluate the quality of the water supply for a period of time before the water purification system is designed. This evaluation allows designers to accurately characterize the quality of the water supply and helps them determine the best method for attaining the quality level required.
-  Set and regularly inspect equipment to the minimum flow rates acceptable or recommended by the manufacturer and post signs nearby equipment to increase employee awareness and discourage tampering with equipment flow rate.








## Disinfection/Sterilization Systems

-  Replace older inefficient equipment with new equipment designed to re-circulate water, and/or allow flow to be turned off when the unit is not in use.
-  If purchasing new equipment is not feasible, purchase a water efficiency retrofit kit; many are now available for older units. They reduce water use by either controlling the flow of tempering water or by replacing the venturi mechanism for drawing a vacuum.
-  Install a small expansion tank instead of using water to cool steam for discharge to the sewer. Check with the manufacturer to make sure this will not interfere with the unit's normal operation.
-  Use high-quality steam for improved efficiency.
-  Use uncontaminated, noncontact steam condensate and cooling water as make-up for non-potable uses, such as in cooling towers and boilers.

## Photographic and X-Ray Equipment

-  Replace older equipment with digital x-ray and photography equipment and computerized printing. If transitioning to digital equipment is not feasible, look for models with a squeegee that removes excess chemicals from the film. The squeegee can reduce the amount of water needed for the wash cycle as well as chemical carryover.
-  If the purchase of new equipment is not feasible, adjust the film processor flow to the minimum acceptable rate. Install a control valve and flow meter in the supply line to monitor flow rate.
-  Recycle rinse bath effluent as make-up for the developer/fixer solution.

## Other Fixtures

-  Replace older inefficient glassware washers with new dishwashers that use less water. Choose models that allow the operator to select the number of rinse cycles or that can reuse final rinse water as wash water for the following load.
-  Replace water-cooled equipment with air-cooled equipment, or the best available technology for achieving energy and water efficiency.
-  Avoid single-pass or pumpless coolers. Recirculation saves water and increases the thermal efficiency.
-  New water softener models may come with water-efficient regeneration cycles.
-  For washrack cleaning facilities, choose new rollover and conveyor equipment that uses less than 35 gallons per vehicle for automobiles and light trucks and less than 75 gallons per vehicle for bus and large truck washes.
-  For large industrial or commercial type laundries, consider replacing old washers with tunnel washers. Tunnel washers, also known as continuous batch washers, are heavy-duty, multi-tank systems for use in large industrial laundries.
-  Technologies for reducing water use in laundry operations include ozone laundering. Ozone laundering is suited for lightly to moderately soiled laundry and uses no detergent, uses only cold water, and recycles water.

## Water Heaters




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Modern buildings typically require hot water at 60°C (140°F) for heating, and may use 140°F–180°F water for sanitizing or automatic dishwashers. The expected life of commercial electric water storage tanks is around 10-15 years, or less for gas tanks. Corrosion is the primary cause of premature failure of storage tanks.

The cost of maintaining water heater storage tanks is low, but standby losses may be significant. Instantaneous heaters cost more than conventional storage units; however, these costs are offset by lower operating costs (due to the elimination of standby losses) and a longer expected life (over 20 years, in comparison to the 10–15 year life of storage tank heaters). In certain areas with extensive distribution piping, electric instantaneous water heaters may be a good option, but this depends on the design needs of the building.

Instantaneous or "on-demand" water heaters can provide a continuous supply of hot water. Instantaneous water heaters are sized for maximum flow rate through the fixture. They are also used as booster devices, to raise the water temperature to that required by automatic dishwashers. A modulating control that provides a constant outlet temperature, regardless of the flow, is preferred. A minimum flow rate is also required for heating to turn on.


Automatic timers can be used to control circulation of hot water based on demand. These are inexpensive and work well where schedules are predictable. Timers will significantly decrease the distribution losses from systems.

-  **!** Evaluate each point of use in your facility for hot water needs and determine if a tankless water heating system can be employed to reduce stand-by heat losses from existing tank heaters.
-  **!** Inspect fire control sprinkler systems annually.
-  Kitchens have higher temperature requirements: install a separate water heater or point-of-use heater to increase efficiency in specific high temperature applications.

-  Perform routine flushes to remove mineral deposits and extend the life of water tanks.
-  Install timers on water heaters to turn off heating during extended unoccupied periods.
-  For retrofits, consider using instantaneous water heaters, timers on recirculation pumps, and heat-tracing on distribution piping.
  - Check thermal insulation condition periodically.
  - Check temperature set point and ensure water is being heated to this temperature. Low temperatures can increase water use.
  - Tanks should be flushed at least annually. Chemical tests should be performed after flushing to test for deposits on the tank.
  - Pressure gauges and relief valves should be checked for proper operation four times a year.
  - Temperature control: limit hot water to a maximum of about 60°C (140°F). Verify that mixing valves deliver a maximum outlet delivery temperature of 40°C–45°C (105°F– 110°F).
  - Temperature controls should be checked periodically to verify proper delivery temperature to showers, sinks and kitchens.

## Solar Thermal Systems

Solar water heating involves additional first cost but can provide savings over the life of the system. With these systems there are additional maintenance concerns, such as collector cleaning, roof penetrations for collector mounts, and periodic replacement of antifreeze fluid, for closed systems. An excellent introduction to the types of systems available is provided by the DOE's Energy Efficiency and Renewable Energy Office.






-  Adhere to the DOE Energy Efficiency and Renewable Energy Office website's maintenance requirements for solar hot water heating systems:  
[http://www.energysavers.gov/your\\_home/water\\_heating/index.cfm/mytopic=12950](http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12950)

## Waste- and Stormwater Management

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### Sanitary Systems

Kitchen plumbing should contain grease traps or interceptors, so that fats, oil and grease do not clog sewage lines. The trap may have to be cleaned weekly or more frequently, depending upon kitchen practices.




-  Check the cleanout ability of acid and sand interceptors.
-  Periodically clean out filters and replace when necessary.
-  **!** Check backflow preventers periodically for leaks, test annually for proper operation.
-  Isolate potable line from non-potable water line with backflow prevention devices. Inspect periodically, and have the devices tested and certified annually.
-  Flush exterior water mains periodically to prevent sediment build-up in distribution piping.

### Conventional Septic Systems



Septic systems are used for onsite waste disposal. First, waste solids and grease separate in a septic tank. The remaining liquid effluent is pumped through a distribution box to an absorption field ("leach field"), where it is slowly emitted from a series of pipes. Onsite waste management systems can be cost-effective but must be carefully designed to avoid contaminating the groundwater supply.

-  **!** Ensure septic tank sludge levels are checked annually, and clean effluent pump filters annually. Storm Water Systems.

## Stormwater Systems

-  **!** For storm drains that have no filters collection sumps, install a sediment filter and oil absorbing medium on the end of the drain pipe.
-  **!** Verify proper roof drainage and site drainage away from foundation.
-  **!** Inspect storm sewage lines for debris or other blockage annually. Clean accumulated debris when the debris has reached a depth of half the distance between the bottom of the drain pipe and the bottom of the sump.

## Alternative Onsite Disposal Systems







-  Constructed wetlands mimic natural wetlands and are designed to treat wastewater at the soil surface or beneath the surface. These systems also require little maintenance.
-  Ensure septic tank sludge levels are checked annually. Clean effluent pump filters annually.

## Gray Water Systems

Implementing reuse of gray water can reduce water use for landscaping and sanitation. These systems require separate piping to route the wastewater out of the building and appropriate valves to control flow to irrigation system. Retrofits for gray water systems can be expensive in some existing structures but may be feasible where drain piping can be separated easily from non-sewage purposes. The use of non-potable water is generally most cost-effective when included in the design of new facilities.

Currently the [2006 Uniform Plumbing Code](#), as enforced by King County Public Health provides guidance on rainwater and gray water harvesting. Within this document, Chapter 6, “Water Supply and Distribution” covers potable, non-potable, and reclaimed water use, including “backflow prevention.” UPC Appendix J covers reclaimed water for non-residential buildings. Currently, the Brac system is identified as an approved system that can be installed upon permit approval within King County.

The following guidelines are based on current EPA requirements related to gray water systems.

-  Facilities using alternative on-site water sources must comply with all applicable backflow prevention requirements.
-  The pathogenic organisms in sanitary gray water must not come into contact with either humans or animals. This can be accomplished by treating the water to eliminate pathogens or avoid their introduction into water by not mixing sanitary gray water with any potable water source. Human exposure can be prevented by not collecting or storing it in an open container.
-  Sanitary gray water used for irrigation should not be applied directly through a spraying device, but rather injected directly into the soil through drip irrigation.
-  Use biodegradable cleaning products that do not contain sodium, chlorine, or boron. Cleaning products that contain high chemical levels may make their way into the gray water recycling system and could poison plants or damage soil through the buildup of inorganic salts.
-  Turn off the gray water system and divert the gray water to the sanitary sewer line during rainy periods. Rain or excessive irrigation could cause ground saturation and result in pools of gray water on the surface.
-  A maintenance program for a gray water system must include the following steps, all of which must be performed regularly:

- Inspecting the system for leaks and blockages
- Cleaning and replacing the filter bimonthly
- Replacing the disinfectant
- Ensuring that controls operate properly
- Periodically flushing the entire system

## Retrofit and Replacement











For buildings with slab foundations, recoverable gray water may be limited to washing machine discharge, because most drain pipes such as for sinks are buried beneath the slab and thus not easily accessible without a significant additional expense. For buildings with perimeter foundations, gray water may be recoverable from most sources due to accessibility to piping from crawl spaces.

Current payback for gray water systems can be less than 10 years.

## Steam and Gas Lines

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Proper operation and maintenance of boilers and furnaces by trained staff is essential for occupant safety and efficiency.

-  Provide proper training for all staff that operate or maintain boilers and furnaces.
-  Establish written checklists for startup and shutdown of boilers.
-  Replace older inefficient boilers. Newer pulse combustion boilers can have efficiencies of 98%.
-  Ensure proper boiler installation. Verify air supply to ventilation and combustion openings. Keep boiler room clear of unnecessary items.
-  **!** Inspect the piping. Improper flow to the boiler can affect the operating cycle of the boiler. Inspect the pressure relief valve and verify it is plumbed to an adequate drain. Periodically test its operation.
-  **!** Check temperature and pressure controls. Although boilers will have automatic sensors and controls, periodic inspections should be performed in case of malfunctions. Flow switches and low flow cutoffs should properly shut down the boiler in the event of a sensor or control failure.
-  **!** Inspect, clean and adjust boiler according to manufacturer's specifications. Inspect the combustion chamber for cracks, deterioration or signs of incomplete combustion. Clean soot or condensate off of the exterior heat exchanger surface according to procedures recommended by the manufacturer.
-  After cleaning or maintenance of any parts, check all connections for leaks after initial firing.
-  Check steam traps for process equipment twice a year. Check steam traps for space heating annually. Use infrared thermometers or ultrasound for inspections.
-  Check all gas appliances for possible leaks.



## Plumbing Resources

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- ☞ U.S. Department of Energy - Energy Efficiency and Renewable Energy Federal Energy Management Program – Water Efficiency <http://www1.eere.energy.gov/femp/program/waterefficiency.html>
- ☞ U.S. Environmental Protection Agency. Find a WaterSense Labeled High-Efficiency Toilet [http://www.epa.gov/watersense/product\\_search.html](http://www.epa.gov/watersense/product_search.html)
- ☞ U.S. Environmental Protection Agency WaterSense website, [http://www.epa.gov/watersense/water\\_efficiency/index.html](http://www.epa.gov/watersense/water_efficiency/index.html)
- ☞ U.S. Environmental Protection Agency WaterSense website, [http://www.epa.gov/watersense/water\\_efficiency/benefits\\_of\\_water\\_efficiency.html](http://www.epa.gov/watersense/water_efficiency/benefits_of_water_efficiency.html)
- ☞ U.S. Department of Energy, Federal Energy Management Program, Best Management Practices for Water Conservation [http://www.wbdg.org/design/conserve\\_water.php](http://www.wbdg.org/design/conserve_water.php)
- ☞ Collaborative for High Performance Schools, Best Practices Manual <http://www.chps.net/dev/Drupal/node/288>
- ☞ Arizona Municipal Water Users Association. Facility Manager's Guide to Water Management [http://amwua.org/pdfs/facility\\_managers\\_guide.pdf](http://amwua.org/pdfs/facility_managers_guide.pdf)
- ☞ General Services Administration, Water Management Guide [http://www.gsa.gov/graphics/pbs/waterguide\\_new\\_R2E-c-t-r\\_0Z5RDZ-i34K-pR.pdf](http://www.gsa.gov/graphics/pbs/waterguide_new_R2E-c-t-r_0Z5RDZ-i34K-pR.pdf)
- ☞ DOE's Energy Efficiency and Renewable Energy Office: <http://www.eere.energy.gov/>
- ☞ U.S. Environmental Protection Agency, "Onsite Wastewater Treatment Systems Manual". EPA, February 2002. <http://www.epa.gov/nrmrl/pubs/625r00008/html/625R00008.htm>
- ☞ U.S. Department of Energy, Federal Energy Management Program, [http://www1.eere.energy.gov/femp/program/waterefficiency\\_bmp3.html](http://www1.eere.energy.gov/femp/program/waterefficiency_bmp3.html)
- ☞ U.S. Department of Energy - Energy Efficiency and Renewable Energy Federal Energy Management Program – Water Efficiency [http://www1.eere.energy.gov/femp/program/waterefficiency\\_bmp4.html](http://www1.eere.energy.gov/femp/program/waterefficiency_bmp4.html)
- ☞ U.S. Environmental Protection Agency. Find a WaterSense Labeled High-Efficiency Toilet [http://www.epa.gov/watersense/product\\_search.html](http://www.epa.gov/watersense/product_search.html)



# Recycling and Waste Management

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## Introduction

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The disposal of solid waste is expensive, polluting to transport, and produces greenhouse gas emissions in landfills. Reusing materials and extending equipment life can preserve natural resources while saving tight budgetary dollars for other needs. Disposal of solid waste should always be considered a last resort.

The King County Department of Natural Resources first established goals for waste prevention and the purchase of recycled products in 1998. In 2001, the scope of this effort was expanded to add recycling collection and include all of King County government. **In 2008, King County adopted a policy to work toward Zero Waste by 2030**, meaning that materials of value, whether for reuse, resale, or recycling, won't end up in the landfill and no garbage is produced that cannot be reused or recycled.

King County has an Environmental Management System (EMS) that provides recycling and waste management guidance for each County Division. An EMS consists of a series of standard procedures and practices that organizations put in place to manage their environmental obligations. Each year, King County establishes new benchmarks for recycling and waste management. These benchmarks are integrated in the King County Waste Management Plan and are revised as the county publishes new goals.

The guidelines provided in this chapter are designed to help facility O&M staff achieve the identified EMS goals, as well as the overarching 2030 zero-waste goal. Because these goals and actions are comprehensive and aggressive, they serve as the general Waste Management O&M guidelines for the Green Building Ordinance as well, and few additional guidelines were added.

## King County Waste Management Plan Goals & Actions

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As of January 1, 2008, King County waste reduction goals and recommended actions are as follows:

### Paper Reduction

- Reduce paper generation by at least 20% in ten or more paper reduction projects.
- Show overall reduction in paper use of 2% or more in targeted buildings, agencies or work groups.
- Work with clerical staff to increase double-sided copying and printing.
- Work with Information Technology (IT) staff to increase availability of double-sided printing.
- Work with various county agencies to greatly reduce the use of paper forms (replace with electronic forms).
- Eliminate or greatly reduce the use of paper phone books (replace with CD or online versions).
- Reduce the use of non-recyclable (coated) paper coffee cups by launching a reusable cup campaign.

### Packaging Reduction

- Work with Information Technology (IT) staff and [King County Procurement](#) to introduce reusable packaging (durable crate on wheels) for county computer purchases.
- For other products, ask at least five vendors to consider alternative environmentally preferable packaging methods.

### Reuse Expansion

- Set up a contract to handle reusable building materials from county renovation and demolition projects.
- Launch a county-wide internal cell phone collection program (most collected phones would be reused, and the rest recycled) that incorporates product stewardship principles.
- Expand collection of polystyrene peanuts for reuse to at least 3 additional buildings, agencies or work groups.

### Recycling Collection

- Increase paper recycling by 3% each year.
- Work directly with the vendor for paper recycling and other basic recyclables to resolve any contamination problems.
- Increase the amount of scrap metal recycled each year; increase the number of locations where scrap metal is collected.
- Increase the collection of yard waste (for off-site composting) every year.
- Begin the collection of food waste for off-site composting.

### Tips for LEED-EB: O&M

LEED-EB: O&M includes two prerequisites in the Materials and Resources Category that apply to this Chapter. King County facilities that include the following components into their facility O&M plans related to sustainable purchasing and waste should easily be able to meet these prerequisites.

#### **MR Prerequisite 1: Sustainable Purchasing**

At minimum, the sustainable purchasing policy related to the building and site be within the building owner's control and should address

- Ongoing consumables

**AND**, one of the following:

- Durable goods
- Facility alterations & additions
- Reduced mercury in lamps

#### **MR Prerequisite 2: Solid Waste Management**

At minimum, the solid waste management policy must apply to waste streams within the building owner's control as well as recycling of all mercury-containing lamps. The following types of waste should be included:

- Ongoing consumables
- Durable goods (like furniture and electronics)
- Facility alterations and additions

- Maintain or reduce costs of battery recycling, while maintaining or increasing the number of batteries collected.

### Buying Recycled Products

- Increase overall purchases of environmentally preferable products by 7% per year.
- Assist with education efforts to promote the use of higher-recycled-content paper, tree-free papers and soy-based inks.
- Conduct an informal inventory of polyvinyl chloride plastic products currently being purchased by the county; analyze the risks of these products and explore the purchase of alternative products.
- Increase the purchase of environmentally preferable products for county construction projects by 5% each year (use the Environmental Quality category in the LEED standards to define environmentally preferable products).
- Specify that all new King County buildings must have a minimum of 25% of building materials (for example, steel, gypsum, carpet, paint) that contain, in aggregate, a weighted average of 20% post-consumer content.

### Greenhouse Gas Emissions

- Show an increase of 5% each year in the reduction of greenhouse gas emissions from recycling and waste prevention (reuse and reduction)


### Outreach & Awareness


- Contact ten county divisions or agencies that the WasteWise program has not worked with previously to offer assistance in waste prevention, recycling collection and buying recycled products.
- Work directly with King County Council offices and staff to promote waste prevention, recycling and employee recognition for exemplary achievement.
- Build employee involvement through new WasteWise promotional, incentive or recognition programs.

### Waste Management Plan









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A Waste Management Plan outlines staff procedures and responsibilities and includes a list of necessary contacts and resources for effective management of garbage and recyclables. Waste and Recycling Plans focus on the 3Rs (reduce, reuse, recycle), and include goals, strategies, performance targets, and an action plan and timeline. Each division within the County must develop a Waste Management Plan and set aggressive targets and performance thresholds if the County is to achieve its Zero-Waste goal by 2030. Ideally, operation and maintenance staff should work together to produce this plan to minimize environmental impact from their organization.

 **!** Use the King County Waste Reduction Goals and Actions outlined above, in addition to the following O&M guidelines to create a custom Waste Management O&M Plan for your facility. The plan must include

 **!** Implement the actions steps and reach the benchmarks identified in the recently updated King County Waste Management Plan. These actions are developed to reach the overall King County goal of zero-waste by 2050. (For reference, the goals are also included in the Waste Management Section of this document)

Reduction of consumable goods including office supplies, fuels and mechanical/ electronic equipment is the primary strategy for preserving natural resources and keeping materials out of the landfill. Reducing overall consumption offers the most benefit for lowering carbon emissions in King County when compared with other waste management strategies, and is therefore a priority area of focus for all King County facilities.






-  Perform a waste stream audit to determine a baseline of hazardous waste, garbage and a list of chemical wastes expected by the facility each year.
-  Include record keeping requirements in the waste and recycling plan.
-  Develop a waste reduction program to reuse, recycle or compost 70% of the ongoing consumables in the facility. These materials include, but are not limited to, paper, toner cartridges, glass, plastics, cardboard and old corrugated cardboard, food waste, and metals.
-  Send office supplies and office furniture for reuse to King County Surplus. Contact the King County Personal Property Management & Surplus Line at 206-263-6263 for further information.
-  Solicit recommendations from facility staff for opportunities to streamline operations and minimize waste.
-  Identify cost savings for assets that are repaired in your facility when compared to replacement.
-  Solicit the help of personnel outside of your facility to help identify opportunities for conservation that may be overlooked.
-  For small remodels refer to the King County web page on the Cost–Effectiveness of Jobsite Diversion/ Recycling <http://your.kingcounty.gov/solidwaste/greenbuilding/construction-recycling/cost-effectiveness.asp>

## Paper Products: Cardboard, Paper

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Office paper and other paper products including cardboard packaging, newspaper, kraft paper, phone books and directories make up nearly 30% of the non-residential waste stream in King County. This means that an additional 130 tons of paper could have been recycled in 2007.




The best strategy to reduce waste paper from facilities is reducing paper use. Double-sided printing, reducing margins, and minimizing paper filing systems are key to a paper use reduction, saving office space, and lowering office supply costs. Other paper such as newspaper, phone books, kraft paper, and directories, can be recycled through commercial haulers or at County transfer stations.

-  Work with various county agencies to greatly reduce the use of paper forms (replace with electronic forms).
-  Work with occupants to increase double-sided copying and printing, and reduce paper margins.
-  Replace paper phone books with CD or online versions to eliminate or greatly reduce their use.
-  Quantify savings of consumable goods such as paper cups that have been replaced by reusable goods such as washable cups.
-  Work directly with vendors of paper products to remove any non-recyclable materials from their products and reduce or take back their packaging materials.

## Plastics


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Plastic is one of the fastest growing components of the waste stream. Plastic does not easily biodegrade in the natural environment and has historically had limited opportunities for recycling. Plastics are found in every King County facility, from water bottles and light fixtures to toner cartridges and office furniture. The most common plastic waste includes plastic film, PET bottles, polystyrene, Styrofoam™, and plastic containers from the food service and packaging industry. Most of these plastics enter the waste stream as packaging waste. With the exception of bottles, jugs and tubs, many plastics including packing peanuts, polystyrene and expanded polystyrene (EPS) blocks are not yet recyclable in King County (although re-use options exist).

-  Whenever possible, eliminate plastics from your facility, or look for products that are made of recycled plastic. Many alternative products now exist, including “plastic” products made from corn or other plant-based material.
-  Conduct an informal inventory of polyvinyl chloride plastic products currently in use in your facility, consider the risks these products pose to staff and explore the purchase of alternative products.
-  Ask vendors to use alternative environmentally preferable packaging methods.



## Toner Cartridges

Each year, millions of empty toner and inkjet cartridges used in printers, fax machines, and copiers are thrown in the trash, destined for landfills and incinerators. King County has purchased remanufactured toner cartridges for laser printers, fax machines and ink-jet printers since 1991. Typically, remanufactured cartridges save users from 30 to 50 % off the price of new cartridges and remanufacturing cartridges keeps them out of landfills.

-  Use remanufactured cartridges for any office equipment that uses a replaceable toner or inkjet cartridge (most will be compatible, but check first).

## Plastic Film




Plastic film is a thin gauge packaging medium used as a bag or a wrap. Plastic film includes dry cleaning bags, bread bags, newspaper bags, pallet wrap, and shrink wrap as well as plastic grocery bags.

-  Work with vendors to minimize the use of plastic film. Purchase in bulk whenever possible to reduce packaging materials.
-  Work with building occupants to reduce use of plastic film. Encourage occupants to bring their own food-containers whenever possible, and don't automatically offer bags unless asked.

## PET / PETE Beverage Containers



King County solid waste recycling accepts plastic bottles, jugs, jars, and tubs for recycling. This includes shampoo, juice, and soda bottles, milk and laundry detergent jugs, and round dairy tubs such as yogurt, cottage cheese and margarine tubs.

Most paper coffee cups have a protective layer on the inside that prevent them from being suitable for recycling. More paper cup products are now available that are fully compostable by commercial composting facilities.

-  Conveniently locate collection bins in your facility, and collect plastic bottles, jugs, jars, and tubs, for recycling.
-  Include signage at collection areas to increase occupant awareness of what can be recycled.
-  Work with coffee cup vendors to replace products that have plastic moisture barriers with compostable ones made of recycled paper.

## Polystyrene or Styrofoam™

Polystyrene or Styrofoam cannot be recycled and should be avoided whenever possible. This material is commonly found in packaging for food service or as packing peanuts. Packing peanuts are the small Styrofoam “peanuts” found in many packages shipped through the mail and expanded polystyrene blocks are commonly used to protect electronics during shipping. Polystyrene is highly flammable. In addition, Benzene, a known human carcinogen, is used in its production.



-  Participate in polystyrene peanuts reuse program with other agencies or work groups when applicable.
-  Source products and packaging materials that do not include styrofoam

## Electronics

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Electronic waste or “e-waste” is any broken or unwanted electrical or electronic device. Some e-waste contain materials that render them hazardous, including heavy metals and toxic chemicals such as lead, cadmium, mercury, chromium, polyvinyl chlorides. These substances are known to have toxicological effects that range from brain damage to kidney disease to mutations, and cancers.


E-waste recycling is a growing environmental and health concern due to oversees recycling markets with poor safety procedures for containing harmful substances. The “Take It Back Network” electronics recycling directory ([www.takeitbacknetwork.org](http://www.takeitbacknetwork.org)) lists more than 30 electronics recyclers in King County or call the Solid Waste Division at 206 -296-4466 for more information about recycling used electronic products.

-  Identify the toxic waste handling policy appropriate for e-waste and include disposal instructions in the waste management plan.
-  Participate in an electronics collection program (most collected electronics would be reused, and the rest recycled) that incorporates product stewardship principles.


## Bulb Disposal

The following considerations should be referred to depending on type, lamps, and lamp ballasts that are removed from service (“spent lamps”):


**Hazardous waste:** contains specific amounts or more of toxic substances and has the potential to harm human health and the environment.

-  **!** Non-leaking ballasts must be disposed as a hazardous waste, through licensed hazardous waste management firms.

**Universal waste:** contains items that are commonly thrown into the trash by households and small businesses, yet must comply with full hazardous waste requirements for final recycling, treatment or disposal.

-  **!** The following lamps should be managed as universal waste: fluorescent lamps or ballasts, compact fluorescent lamps, high intensity discharge, neon and any other lamps that are dangerous waste. Universal waste must go to either a lamp recycler, or a permitted hazardous waste disposal company. King County currently has a recycling contract with EcoLights Northwest.

**Solid waste:** can be some ‘green’ or low-mercury lamps.


-  **!** A written waste clearance must be obtained prior to disposing of such lamps as solid waste. Fluorescent light ballasts that indicate ‘contains no PCBs’ may also be disposed of at King County Solid Waste Department facilities.

## Organics and Food Scraps


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Composting is an important for “closed loop” recycling of organic residuals. By composting, “wastes” such as yard debris, food scraps, and manure can be transformed into valuable resources. Food and other organic scraps should be composted—not be wasted in the garbage.

“Yard waste” means waste resulting from maintenance or removal of vegetation, including, but not limited to, brush, branches, leaves, flowers, shrubs, and small trees. Many of these common land clearing organics can be composted or mulched yet these organics represented 11% of the non-residential waste stream in 2007. To reduce time, expense and transportation pollution, consider reusing residual organics waste on-site or contracting with a hauler for off-site composting instead of disposing in the landfill.

-  Start a compost collection system in your facility. If onsite composting is not feasible contract with a waste hauler who provides composting services.



 To save fuel and carbon emissions from transportation, compare on-site and off-site composting in places such as parks where large amount of organic debris are generated.

 Include organics disposal instructions in the waste management plan.

## Metals


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In addition to common recyclable metals in household waste, metals in the waste stream can come in the form of oil filters, appliances, wire, paint cans, metal furniture, and scrap steel. Identifying metal content in products beyond their useful life is critical to diverting those products to be recycled.

Procedures for identifying potentially recyclable metal items and how to properly dispose them should be incorporated into each facility waste management plan. Separation of metals will yield a higher recyclable value at time of recycling and will increase the cost savings compared with disposal while increasing diversion from the landfill. Recovering metal not only saves money, but also dramatically reduces energy consumption, compared to making metal from virgin materials. In turn, this reduces the amount of greenhouse gases released in to the air during processing and manufacturing metal from virgin ore.

### Wire and Scrap steel

Ferrous and nonferrous metals including electrical wiring and metal plumbing pipes are readily recyclable. Nonferrous metals are not magnetic; they include aluminum, brass, lead and copper. Ferrous metals are magnetic and contain steel, cast iron and tin. See the [2008 King County/Seattle Construction Recycling Directory](#) for local recyclers of wire and scrap metals.

 Conduct an inventory of audit common metal waste generated at each facility and create separation areas within each facility to source separate metals at time of collection.

## Oil Filters


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Used Oil Filters should be recycled in accordance with WAC 173-303-120. Filters that have been drained for 24 hours or have been crushed are accepted at KCSWD facilities. Most hazardous waste treatment, storage, or disposal (TSD) facilities will also accept used oil filters.

## Hazardous Waste


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Hazardous wastes present immediate or long-term risks to humans, animals, plants, or the environment. Hazardous waste is generated at nearly every King County facility. Many hazardous wastes can be recycled safely and effectively. Many hazardous wastes including batteries, paints, solvents, used oil, and other vehicle equipment fluids can be rendered non-hazardous through proper recycling practices. The facility maintenance plan should include a list of hazardous wastes generated at each facility and outline specific recycling guidelines.

 **!** Participate in existing County programs to properly dispose of hazardous waste. Many hazardous wastes such as paint thinner, fluorescent lights, pesticides, car batteries and electronics can be recycled.

### Batteries

Lead acid batteries, commonly used in vehicles, can create disposal problems. Disposing in the landfill presents the risk of groundwater contamination. With incineration, the risk is toxic air emissions. Given these alternative disposal options, recycling is the only safe solution. Recycling batteries not only conserves natural resources and energy, it reduces risks to the environment and human health.

 **!** Used lead acid batteries must be stored properly to prevent contamination or injury from acid spillage or leakage.

 **!** Batteries should be placed upright on pallets, stacked no more than five high, and inspected regularly.

- ! Spilled acid must be handled as a hazardous waste because it is corrosive and may contain toxic levels of lead.

## Paints and Solvents

Solvent-based paints contain oils and solvents that are toxic and flammable. These paints are also called oil-based and alkyd paints. If improperly released to the environment, solvent-based paints have the potential to contaminate drinking water supplies and groundwater, and can be toxic to plants and animals. Unusable or non-recyclable solvent-based paints are considered a hazardous waste.

Water-based paints also referred to as Latex or water-thinned paints, are made up of water, pigments and an emulsion resin (the latex). Latex paints do not have hazardous characteristics, are generally not toxic, and are not considered a hazardous waste.

- Latex paint and stains can safely be put in the garbage for disposal at a landfill, as long as the paint is dry or solidified first.

- If the paint/stain is not contaminated, old, and has not been frozen visit IMEX or call 206-263-8465 for recycling opportunities.

- Bring oil -based paints to a hazardous waste facility for proper disposal.

## Florescent Bulbs, Ballasts

Fluorescent bulbs and high-intensity discharge (HID) lamps typically contain mercury. If the ballast does not say "PCB free", you must assume that it contains PCBs.

- ! Fluorescent lights and other Universal Waste Lamps are not accepted from commercial customers. Call (206) 296-4466 for information on lamp recycling. Recycling is recommended for all commercial and residential lamps containing mercury, including low-mercury lamps that pass the federal TCLP standard. Low-mercury lamps may be accepted at KCSWD facilities when accompanied by a Waste Clearance Decision.

- ! Fluorescent light ballasts that indicate "contains no PCB's" may be disposed at KCSWD facilities. Ballasts without this information must be tested for the presence of PCB's, and are accepted only with a Waste Clearance Decision.

## Pesticides

When improperly disposed of, used pesticides can cause serious environmental and human health consequences.

- ! Follow all Washington State Department of Agriculture regulations pertaining to pesticide disposal.

## Other Waste

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All materials should be considered for reuse, recycling, and composting before disposal by other means. Garbage is the result of materials that are not valuable enough to reuse or transform into something valuable. Waste management strategies must be maximized across the King County to reach its goal of zero waste by 2030.

- Evaluate opportunities for sourcing surplus equipment such as office furniture or vehicles before purchasing new items.

- ! Consider reusable building materials from other county renovation and demolition projects in repair and renovation projects.

## Recycling and Waste Resources

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### King County Waste Management Plan Resources:

- ☞ King County Waste Management Plan:  
<http://your.kingcounty.gov/solidwaste/about/Planning/documents-planning.asp#comp>
- ☞ King County's Environmentally Preferable Purchasing Program:  
[http://www.kingcounty.gov/operations/procurement/Services/Environmental\\_Purchasing.aspx](http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing.aspx)
- ☞ King County Solid Waste Division Online Material Exchange  
<http://your.kingcounty.gov/solidwaste/exchange/index.asp>
- ☞ Industrial Materials Exchange (IMEX)  
<http://www.govlink.org/hazwaste/business/imex/>

### Waste Management Plan Resources

- ☞ EPA WasteWi\$e Tip Sheet: Facility Waste Assessments <http://www.p2pays.org/ref/01/00707.pdf>
- ☞ LEED Existing Buildings: Operations and Maintenance.  
<http://www.usgbc.org/ShowFile.aspx?DocumentID=3617>
- ☞ Myths about recycling at office buildings  
[http://your.kingcounty.gov/solidwaste/business/documents/PSBJ\\_Article.pdf](http://your.kingcounty.gov/solidwaste/business/documents/PSBJ_Article.pdf)

### Product-specific Resources

- ☞ WasteWise project List <http://your.kingcounty.gov/solidwaste/about/waste-wise/projects.asp>
- ☞ City of Seattle. Paper Cuts Program. <http://www.seattle.gov/papercuts/>
- ☞ King County Waste Characterization, 2007:  
<http://your.kingcounty.gov/solidwaste/about/documents/waste-characterization-study-2007.pdf>
- ☞ King County Waste Wise Packaging Materials  
<http://your.kingcounty.gov/solidwaste/business/packaging.asp>
- ☞ King County EcoConsumer: "Protecting yourself from plastic,"  
[http://your.kingcounty.gov/solidwaste/ecoconsumer/documents/SeattleTimes\\_11-15-2008.pdf](http://your.kingcounty.gov/solidwaste/ecoconsumer/documents/SeattleTimes_11-15-2008.pdf)
- ☞ King County has existing polystyrene peanuts reuse programs. See the King County website at <http://your.kingcounty.gov/solidwaste/business/packaging.asp> for more information or contact Tom Watson at 206-296-4481.

### Electronics Resources

- ☞ "Take It Back Network" Electronics Recycling Directory <http://www.takeitbacknetwork.org>
- ☞ Tips for Recycling Electronics  
[http://your.kingcounty.gov/solidwaste/business/documents/EastsideBusiness\\_06-06.pdf](http://your.kingcounty.gov/solidwaste/business/documents/EastsideBusiness_06-06.pdf)
- ☞ Solid Waste Division. Electronics Recycling <http://www.metrokc.gov/dnrp/swd/electronics/>

### Bulb Disposal Resources

- ☞ EcoLights Northwest is King County's current lamp recycling contractor. Contact at 1-888-214-2327 or 1-206-343-7443.
- ☞ King County's Mercury-Containing Lamp Requirements:  
<http://www.kingcounty.gov/operations/policies/aep/utilitiesaep/put73aep.aspx>
- ☞ Recommended Practice for Planned Indoor Lighting Maintenance (IESNA/NALMCO RP-36-03). Available electronically or as a publication for purchase at <http://www.iesna.org/>
- ☞ King County Business Waste Line: 206-263-8899,  
<http://www.govlink.org/hazwaste/business/phoneline.html>
- ☞ EPA's Universal Waste Handlers – Steps to Managing Your Universal Waste Lamps in an Environmentally-Safe Manner:  
<http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/recycle.htm>

- ☞ A list of lamp and ballast recyclers is available on King County's Take It Back Network Website, <http://your.kingcounty.gov/solidwaste/takeitback/fluorescent/>
- ☞ For lamp recycling information <http://www.lamprecycle.org/>
- ☞ Call 206-296-4466 for information on lamp recycling in King County.
- ☞ To obtain written clearances for solid waste disposal of green or low mercury lamps, call Public Health-Seattle & King County's Waste Characterization Program at 206-296-4633.

## Organics and Food Scraps Resources

- ☞ King County Food Scrap Recycling F.A.Q. [http://your.kingcounty.gov/solidwaste/garbage-recycling/documents/Food\\_scrap\\_recycling-FAQs.pdf](http://your.kingcounty.gov/solidwaste/garbage-recycling/documents/Food_scrap_recycling-FAQs.pdf)
- ☞ Washington Department of Ecology – Composting <http://www.ecy.wa.gov/programs/swfa/compost/>
- ☞ University of Florida Institute of Food and Agricultural Sciences, Florida's Online Composting Center <http://www.compostinfo.com/>

## Metals Resources

- ☞ United States Environmental Protection Agency. <http://www.epa.gov/osw/conservation/materials/steel.htm>
- ☞ King County Solid Waste Division Online Material Exchange <http://your.kingcounty.gov/solidwaste/exchange/index.asp>

## Hazardous Waste Resources

- ☞ King County Hazardous Waste: <http://your.kingcounty.gov/solidwaste/facilities/hazwaste.asp>
- ☞ King County Environmental Purchasing Program: Fluorescent Tube Recycling: [http://www.kingcounty.gov/operations/procurement/Services/Environmental\\_Purchasing/Products.aspx](http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing/Products.aspx)
- ☞ King County Executive Policy: Mercury-Containing Lamp Recycling PUT 7-3 (AEP): <http://www.kingcounty.gov/operations/policies/aep/utilitiesaep/put73aep.aspx>
- ☞ Washington Toxics Coalition. <http://www.watoxics.org/>
- ☞ WSU Urban IPM and Pesticide Safety Education Program. <http://pep.wsu.edu/>

## Other General Waste Management & Recycling Resources

- ☞ King County Solid Waste Division Online Material Exchange <http://your.kingcounty.gov/solidwaste/exchange/index.asp>
- ☞ King County Solid Waste Division – Goals and Reports <http://your.kingcounty.gov/solidwaste/about/waste-wise/goals.asp>
- ☞ King County Solid Waste Division – Recycling Basics for King County Employees <http://your.kingcounty.gov/solidwaste/about/waste-wise/employees.asp>
- ☞ King County Waste Wise Packaging Materials <http://your.kingcounty.gov/solidwaste/business/packaging.asp>
- ☞ Washington Department of Ecology – Composting <http://www.ecy.wa.gov/programs/swfa/compost/>
- ☞ University of Florida Institute of Food and Agricultural Sciences, Florida's Online Composting Center <http://www.compostinfo.com/>
- ☞ Source: U.S. Environmental Protection Agency – Climate Change website. <http://www.epa.gov/climatechange/wyacd/waste/generalinfo.html>
- ☞ King County Recycling <http://your.kingcounty.gov/solidwaste/garbage-recycling/recycling.asp>

# Green Cleaning Practices, Equipment and Products

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## Introduction

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Green cleaning is a holistic approach to janitorial services. It takes into account the health, safety and the environmental risks of products and processes associated with cleaning, and balances this with the needs of the facility. Green cleaning involves the use of alternative products, application of the products in different ways, and evaluation and/or behavior shifts associated with how buildings are used to reduce risks, while maintaining a satisfactory level of cleanliness and disinfection. Green cleaning practices can reduce health risks to custodial staff and building occupants, reduce costs, and increase occupant satisfaction.

The term **“green cleaning”** is synonymous with environmentally sensitive cleaning. These terms are often used interchangeably to describe cleaning and maintenance products that protect human health and the environment without sacrificing product effectiveness.


The US Department of Interior’s Sustainable Practices website lists benefits of green cleaning, including:

- Reduced health effects to building occupants and janitorial staff, such as skin, eye, and respiratory irritation or burns; allergies; multiple-chemical sensitivity; headaches; nausea or other gastrointestinal ailments; poisoning; cancer; reproductive hazards; and damage to liver, kidneys, and other internal organs.
- Reduced cost to building management, tenants, and/or the janitorial company associated with sick leave, health care, productivity loss, and litigation.
- Increased safety and increased occupant and worker satisfaction, including improved morale, productivity and efficiency, quality of life, and sense of well-being. This can result from decreased health effects and decreased annoyances such as malodor.

The above benefits can be realized by developing and implementing a green cleaning plan for your facility, using the following guidelines for green cleaning practices, equipment, and product suggestions.

These guidelines do not specify any particular products or brands; rather, they list the best practices and criteria that should be met.

## General Green Cleaning Best Practices

 **!** Follow these best green cleaning practices:

1. An effective green cleaning program is built on using best green cleaning practices along with effective products, equipment, and green cleaning methods. The following best practices apply for general green cleaning purposes across a variety of King County facilities. They have been adapted from best green cleaning practices prepared by the Collaborative for High Performance schools, the Washington State Sustainable Cleaning Standard, and the King County Transit Custodial Green Cleaning Manual.
2. **Reduce the need to clean.** Use effective entrance matting systems to prevent soil, moisture and other contaminants from entering the facility. This reduces the need to clean, eases cleaning, protects floors from damage, and makes floors safer by reducing slipping.
3. **Follow instructions and precautions provided by the manufacturer.** All products should be used following instructions or precautions provided by the manufacturer. Follow the instructions for diluting and mixing products before use, to avoid damage to surfaces being cleaned and/or leaving residues or hazardous gases.
4. **Clean first, and only use a disinfectant or germicide if needed.** A clean, residue-free surface is a top priority. Surfaces must be cleaned thoroughly, whether or not disinfectants are used. If any product claims to be a disinfectant or sanitizer, then it must be listed as a King County Facility Management Division approved antimicrobial product. If the decision is made disinfectant or sanitizer, personnel must be trained in the proper use of these products and label directions must be followed.
5. **Minimize the use of products that leave a scent in the room.** Fragrance formulations often are a complex mixture of chemical ingredients, and are often added purely for aesthetic reasons. Chemicals used in fragrance formulations can be irritating to people with hyper-responsive airways or eyes, skin allergies, or asthma. Avoid using products with fragrances, unless it is a natural fragrance used to improve cleaning performance or counter-act an objectionable odor from the product or the environment being cleaned.
6. **Purchase quality floor finishes.** A quality floor finish handles wear and tear, requires minimal burnishing, is long-lasting, and facilitates easier removal of soil by dust mopping and daily cleaning. Quality finishes prevents dust, dirt, germs, molds, and other particulate matter getting

### Tips for LEED-EB: O&M

LEED-EB: O&M includes a Green Cleaning Policy prerequisite. By including the following components in your O&M plan, your facility should easily be able to meet this prerequisite:

#### EQ Prerequisite 3: Green Cleaning Policy

This plan must include:

- Purchase of sustainable cleaning products
- Purchase of cleaning equipment that is ergonomic, quiet and meets green equipment standards
- Standard Operating Procedures that address how cleaning procedures will be managed and audited
- Strategies to promote hand hygiene
- Guidelines for the safe handling and storage of chemicals and plans to clean up spills
- Requirements for staffing, and appropriate training of personnel
- Regular collection of occupant feedback

caught in flooring or from circulating through the HVAC system, causing potential asthmatic and other health concerns. Floors should reach 5 to 10 or more years without needing to be stripped.

7. **Use cold water.** Experiment with green cleaning products that work with cold water. Products certified by Green Seal, Inc. are designed to work with cold water. The use of cold water saves money and eliminates the risk of burns from cleaning with hot water.
8. **Consider the impact and Life Cycle Costs (LCC) of maintenance in choosing floor products.** The LCC of flooring materials is important because the total cost of floor maintenance can be significantly more than the initial and/or replacement cost of the flooring materials. Over the lifespan of a floor, maintenance costs can exceed the initial installation costs by a factor of 2.5 to 25 times the initial cost of installation.
9. **Vacuum carpets frequently prior to considering the use of any carpet cleaning products.** Regular carpet vacuuming helps maintain indoor environmental quality, extends the life of a carpet, and reduces use of chemical and/or water-based shampoo extraction products. Use extraction cleaning methods when needed, but always dry vacuum before using cleaning solutions. Use cleaning methods recommended by the carpet manufacturer.
10. **Maintain vacuum cleaners and filters regularly.** A vacuum will not optimally clean if it is not maintained, the filter is clogged, or the bag is full. Follow the manufacturer recommendations carefully, use only approved filters and bags for the vacuum, and make sure they are properly installed in the equipment. Improperly seated filters and bags or ill-maintained equipment will contribute to poor air quality.
11. **Investigate the use of new cleaning technologies and equipment.** Frequently investigate availability of new cleaning tools, “no-touch” systems, reusable microfiber cloths and mops, multilevel walk-off mats, carpet extractors, floor polishing and floor stripping pads, and other advances in cleaning equipment. New products offer opportunity to conserve energy, improve safety, reduce resource use and waste, and eliminate toxics.
12. **Properly train all custodial and maintenance personnel.** Effective training and application is required to ensure optimum cleaning results and user safety. The product manufacturer, distributor, or a third party should be involved in training and offer training materials such as videos, web tutorials, or written documents. Include instructions for proper dilution, disposal and use of cleaning equipment, and apply a product-labeling system to assist non-English speaking personnel. Conduct periodic monitoring to ensure personnel are properly following established procedures.
13. **Leave virtually no residue.** Cleaning products should leave no residue when used on a daily basis, and therefore should not require a rinse step. Detergents that leave residue are unsanitary or force the need for an additional step of a fresh water rinse, which wastes time and water.
14. **Purchase universal mounted dispensing/proportioning systems.** Choose universal dispensing/proportioning systems to offer flexibility in purchase and use of cleaning products and supplies from different manufacturers and vendors. Proportioners dispense chemical concentrate diluted with the right amount of water, to provide a ready-to-use mixture to spray bottles, mop buckets, auto scrubbers or any other receptacle.
15. **Investigate the need, procurement, and use of sanitary paper products.** For tissue paper, paper towels, toilet paper, and other paper products, choose certified products that have identified post-consumer fiber content, recovered fiber content, are chlorine free, and are produced with a chlorine free manufacturing process. Good resources for available products include the [Green Seal Standards](#) and the EPA. In addition, employ strategies to eliminate or reduce the use of paper products (see Paper Products: Cardboard, Paper section for paper product strategies).

## Green Cleaning Plan


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Development of a Green Cleaning Maintenance Plan is critical to the measurable success of a green cleaning program. A green cleaning plan serves as a blue print for the building maintenance team to evaluate what they are currently doing, establish goals, and provide a way to track success.


The Green Cleaning Plan should outline goals, tasks, schedules, staff training, safety guidelines, and supply information. The Facility Manager will finalize the green cleaning plan and implement a training


program, including orientation for new employees assigned to the facility, regular tenants of the facility and crews dispatched from the facility, and contractors working at the facility.

The cleaning maintenance plans should adhere to the Washington State Cleaning Industry Professionals Group Sustainable Cleaning Standard. This Standard offers certification for cleaning programs that facility managers should strive to achieve.


 **!** Develop a Green Cleaning Plan for your facility and train custodial staff on use of new products and practices. Utilize the O&M plan in the Resources Section as a template.

 **!** Develop goals for each of the green cleaning topics identified in these guidelines, and include them in your green cleaning plan. Ensure these goals correspond with the LEED Existing Buildings: Operations & Maintenance Green Cleaning credits or the Washington Green Cleaning Manual to allow for potential certification of your green cleaning program through these programs.


 Establish an Environmental Health and Safety (EH&S) Committee for your department or building. The committee should include people affected by the green cleaning plan, including administration, custodial staff, and building occupants. The Committee will evaluate cleaning practices and products, and design an evaluation form to rate the success of the new products, practices, and equipment.


 Evaluate your current cleaning products, methods, and equipment. There are a variety of evaluation checklists available, such as the US Department of Interior's checklist:

<http://greeninginterior.doi.gov/buildings/index.html>, and the Washington Green Cleaning Standard.

 Identify which products contain hazardous substances that can be replaced by healthier alternatives. Phase-in the selected new green cleaning products after current products are depleted.

 Monitor progress and continually improve the program.

 Start the phase-in by properly disposing of any chemicals the facility has in storage but isn't using, and using up stores of some of the most common chemicals before purchasing the environmentally preferred alternatives.

 Keep a log of all cleaning chemicals used or stored on the premises, and attach Material Safety Data Sheets (MSDSs) and Technical Bulletins from the suppliers.

### Tips for LEED-EB: O&M

LEED-EB includes a credit for a high performance cleaning plan. King County facilities that include the following components into their plan should easily be able to earn a point for this credit:


#### EQ 3.1: High Performance Cleaning Program

This plan must include:

- Staffing Plan
- Training of maintenance staff in the hazards, use, maintenance, disposal and recycling of cleaning chemicals, dispensing equipment, and packaging.
- Use of concentrates with appropriate dilution to minimize chemical use
- Use of sustainable cleaning materials, products, and trash bags
- Use of sustainable cleaning and hard floor and carpet care products
- Use of sustainable cleaning equipment

## Green Cleaning Product Selection

Low impact cleaning products reduce exposure of building occupants and maintenance staff to potentially hazardous chemical, biological and particulate contaminants, which adversely impact air quality, health, building finishes, building systems, and the environment. Always follow manufacturer's instructions for cleaning equipment and materials.

 **!** The following green cleaning product characteristics were developed and adapted from Green Seal, Inc. and should be referred to as guidelines for product selection:

- The undiluted compound shall not be hazardous to humans.
- The undiluted product shall not contain any ingredients that are carcinogens or known to cause reproductive toxicity.





- The undiluted product shall not be a skin sensitizer as tested by the Organization for Economic Co-operation and Development (OECD).
- The undiluted product shall not be corrosive to the skin or eyes. Dispensing system concentrates shall be tested as used.
- The undiluted product shall not be combustible.
- The product as used shall not contain substances that contribute significantly to the production of photochemical smog, tropospheric ozone, or poor indoor air quality.
- The product as used shall not be toxic to aquatic life.
- All organic ingredients in the product as used shall exhibit ready biodegradability in accordance with OECD definition, except for a Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)-registered ingredient in a bathroom cleaner and the polymer portion of a carpet cleaner. All other ingredients in a FIFRA-registered bathroom cleaner or carpet cleaner must comply.
- The product as used shall not contain more than 0.5% by weight of total phosphorus.
- The primary packaging shall be recyclable. Alternatively, manufacturers provide for returning and refilling of their packages
- The product must be a concentrate, except for FIFRA-registered bathroom cleaners and absorbent compound carpet cleaners.
- Manufacturers shall identify any fragrances on their material safety data sheets (MSDS's). Any ingredient added to a product as a fragrance must follow the Code of Practice of the International Fragrance Association.

 **! Prohibited ingredients and ingredients to avoid** are shown in Table 2:

**Table 2: Prohibited Cleaning Ingredients**

Prohibited ingredients	Ingredients to avoid
a. Alkylphenol ethoxylates	a. Chlorinated compounds (i.e. trichloroethane or methylene chloride)
b. Dibutyl phthalates	b. Aerosols
c. Heavy metals including arsenic, lead, cadmium, cobalt, chromium, mercury, nickel or selenium.	c. Petroleum distillates)
d. Ozone-depleting compounds	d. Lye or sodium hydroxic
e. Optical brighteners	e. Phenols

 **! Avoid products that are tested on animals.** Green Seal recommendations for product selection based on testing procedures should be followed.

 **! The manufacturer's label must clearly and prominently state recommended dilution levels with cold water.** The manufacturer must also include detailed instructions for proper use and disposal, and for the use of personal protective equipment.

## All Purpose Cleaners

All Purpose Cleaners consist of a broad array of possible formulations. The following are some of the specific issues to compare and guidelines to use for this product category:

- Use cleaners with a neutral pH (closer to 7) instead of those with extreme pH (closer to 1 or 14).
- Use cleaners that are readily biodegradable. Unfortunately, many older formulations use excellent performing ingredients that have been found to have serious environmental and health concerns (see Table 2: Prohibited Cleaning Ingredients)
- Use products with no or low levels of dyes and fragrances. If dyes are necessary, use those that are approved for foods and cosmetics (F&C).
- Use products that have no or low VOCs. Consider detergent based products instead of solvents.

- **More Preferable Ingredients:** surfactants containing terms such as lauryl, amides, and glycosides.
- **Less Preferable Ingredients:** Nonyl Phenol Ethoxylates, NTA, EDTA, glycol ethers, sodium hydroxide, potassium hydroxide, sodium metasilicate, phosphates.


## Chrome Cleaners / Polish


Chrome Cleaner/Polish frequently includes petroleum distillates, which are poisonous and derived from a non-renewable resource.

 Avoid products that contain petroleum distillates, such as ammonia.


## Floor Finishes / Floor Strippers


Floor Finishes must be durable and appropriate for the prescribed maintenance method, but they typically contain heavy metals. Importantly, floor finishes must be compatible with the stripping solution. The following are some of the specific issues to consider for this product category:

 Prefer finishes that are durable and require less maintenance such as buffing, restoring and recoating. Finishes should last 5 to 10 years or more before needing to be stripped.

 Prefer products containing non-metal cross-linked polymers. A significant benefit of non-metal polymer formulas is that they can frequently be removed with less hazardous floor strippers.

Floor Strippers typically have an extreme pH, and include solvents and ammoniated compounds to remove metal cross-linked floor finishes. Floor strippers must be compatible with the floor finish.

 Use strippers with a pH close to neutral, up to the range of 10 to 12 and prefer products containing naturally derived solvents (as compared to petroleum-derived solvents).

 Choose products with d-Limonene (citrus solvent) and methyl esters and avoid products with ethylene glycol mono butyl ether (butyl cellulose), 2-butoxyethanol, ammonia, and sodium hydroxide.

## Furniture Polish


Furniture polishes frequently use petroleum distillates, which are poisonous and derived from a non-renewable resource.

 Use products containing citrus (lemon and orange) oils. Avoid products with petroleum distillates.

## General Degreasers / Disinfectants

General Degreasers are typically heavy-duty cleaners that include solvents for removing oil-based soils. Traditional solvents are typically derived from a non-renewable sources (e.g., petroleum), can be flammable, and have a high degree of VOCs. All purpose cleaners should be used for this purpose whenever feasible.

General Disinfectants are similar to all-purpose cleaners with additional ingredients to kill bacteria and other unwanted organisms. Because disinfectants kill organisms, they are toxic by definition. Some are persistent in the environment and accumulate in living tissue. Care in selection and use is important. Refer to the Bathroom Disinfectants for additional information.

 Use antimicrobial ingredients that are known to have less potential for persistence in the environment and to accumulate in living tissue.

 **More Preferable Ingredients:**

- Degreasers: Choose products with d-Limonene (derived from citrus fruits) and methyl esters from soy and corn.

- Disinfectants: Choose products containing hydrogen peroxide.



### **Less Preferable Ingredients:**

- Degreasers: Avoid glycol ethers, ethylene glycol mono butyl ether (butyl cellusolve), and sodium hydroxide.
- Disinfectants: Avoid sodium hypochlorite (chlorine bleach), quaternary ammonium compounds and phenolic compounds.

## **Glass Cleaners**

Glass cleaners include ingredients that reduce streaking and evaporate quickly, including alcohol, solvents such as glycol ethers, or ammonia. The following are some of the specific issues to compare for this product category:



Consider detergent based products compared to those containing solvents.



Prefer products that have a high flashpoint.



Prefer those with a neutral pH (closer to 7), that are readily biodegradable, and have no or low levels of dyes and fragrances. If dyes are necessary use those that are approved for foods and cosmetics (F&C).



**Ingredients:** prefer surfactants containing lauryl, amides, and glycosides. Avoid ammonia, alcohols, propylene glycol, ethylene glycol and other glycol ethers.



Use engineered cleaning cloths that require only water to clean the windows.

## **Graffiti / Gum / Solvent Spot Removers**

Graffiti Removers used to be formulated with chlorinated solvents (e.g., methylene chloride) before they were banned due to their environmental impact. Many graffiti removers are packaged in aerosol containers which often contain hydrocarbon propellants (e.g., propane, butane), which are highly flammable and can contribute to indoor air quality problems.

Gum Removers used to be formulated with chlorinated solvents (e.g., freon) before they were banned due to their environmental impact. Dry ice and carbon dioxide are preferable replacements. Degreasers can be used in some situations (see section on General Degreasers).

Solvent Spot Removers are necessary for spot removal particularly on carpets. Use detergent based spotters if possible (must be followed with extraction or other method to remove/absorb the detergent), and use all purpose cleaners whenever feasible.



Use detergent based products as opposed to those containing solvents, and prefer products that have a high flashpoint and a neutral pH (close to 7).



### **More Preferable Ingredients:**

- Graffiti remover: n-Methyl-2-Pyrrolidone, d-Limonene.
- Gum remover: dry ice, carbon dioxide.
- Solvent spot remover: d-Limonene (derived from citrus fruits) and methyl esters from soy and corn.





### **Less Preferable Ingredients:**

- Graffiti: methylene chloride, petroleum distillates, propane, butane, isobutene, and sodium hydroxide.
- Gum remover: freon, dichloro-difluoromethane, trichloro-fluoromethane.
- Solvent spot remover: mineral spirits, 2-butoxyethanol.

## Wood & Stone Floor Coatings

Wood & stone floor coatings have traditionally been solvent-based products. While extremely durable to protect flooring materials that are very expensive to replace, these coatings can be quite hazardous during the drying and curing period. The two primary issues to consider during product selection is the use of zero or low-VOC containing materials which will reduce indoor air quality concerns and the products' durability which is important to protect the flooring. One final note, many janitorial firms lack specific expertise in application for these types of finishes. Thus, supplier support (e.g., training) is very important.

 Prefer durable finishes that require less maintenance (e.g., re-coating) rather than less durable finishes that require more frequent recoating.

 Prefer products that have a high flashpoint.

 **More Preferable Ingredients:** water- or epoxy-based finishes.


 **Less Preferable Ingredients:** xylene, standard solvent.


## Bathroom Cleaners / Disinfectants / Urinal Deodorizer

Bathroom Cleaners are often acids because of the need to remove mineral deposits from sinks, bowls and urinals. Frequently they are heavily dyed and strongly fragranced.

Bathroom Disinfectants are similar to general disinfectants, but typically may have an acidic pH, closer to 1, to remove hard water deposits in sinks, bowls and urinals. The selection issues include both those under general disinfectants and bathroom cleaners. Care in selection and use is important. See Bathroom Cleaners for similar attributes.

Urinal Deodorizers are traditionally blocks placed in urinals to reduce odors. Preferably these deodorizers should be eliminated altogether through more frequent cleaning and other methods of deodorizing. However, if urinal deodorizers are still required, preference should be given to those with the safest ingredients.

 Prefer products with a more neutral pH (green bathroom cleaners may fall more in the range of pH 4 as compared to a pH below 1).


 Use products that readily biodegrade and have no or low levels of dyes and fragrances. If dyes are necessary use those that are approved for foods and cosmetics (F&C).

 **More Preferable Ingredients:**

- Bathroom cleaners: surfactants containing terms such as lauryl, amides, glycosides, citric or acetic acid.
- Bathroom disinfectants: hydrogen peroxide
- Urinal deodorizer: surfactants containing terms such as lauryl, amides, glycosides.


 **Less Preferable Ingredients:**

- Bathroom cleaners: nonyl phenol ethoxylates, NTA, EDTA, hydrochloric acid, phosphoric acid.
- Bathroom disinfectants: sodium hypochlorite (chlorine bleach), quaternary ammonium compounds, alcohols, phenolic compounds.
- Urinal deodorizer: nonyl phenol ethoxylates, paradichlorobenzene


 Prefer antimicrobial ingredients that have a lower potential for persistence in the environment and to accumulate in living tissue compared to those with a greater potential.

## Lime & Scale Remover

Lime & Scale Removers are acids because of the need to remove mineral deposits from sinks, bowls and urinals.

 Choose environmentally preferable lime and scale remover with a PH in the range of pH 4 as compared to traditional products that may have a pH below 1.

 **More Preferable Ingredients:** citric or acetic acid.


 **Less Preferable Ingredients:** hydrochloric or phosphoric acid.

## Carpet

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Poorly maintained carpets can harbor the growth of mold, mildew and bacteria. Promptly clean up spills. If wetted carpet is not dried and cleaned within 24 hours, it may have to be replaced. See All Purpose Cleaners for products that will work as carpet cleaners. Select carpet cleaners that when dry are not sticky or tacky. This minimizes re-soiling and extends the time between cleaning.

 Refer to [www.carpet-rug.com/pdf\\_word\\_docs/CarpetRug\\_Care\\_Guide.pdf](http://www.carpet-rug.com/pdf_word_docs/CarpetRug_Care_Guide.pdf) for a complete guide to carpet cleaning, produced by the Carpet and Rug Institute.

 Link to the Carpet and Rug Institute's list of approved carpet cleaning chemicals at the following website: [www.carpet-rug.com/about-cri/cri-signature-programs/cleaning-solutions-list.cfm](http://www.carpet-rug.com/about-cri/cri-signature-programs/cleaning-solutions-list.cfm).


## General Carpet Cleaning

 Guidelines for general carpet cleaning procedures include:

- Do not allow carpets to become too wet.
- Use general purpose cleaners whenever possible and reduce water use.
- Use equipment that provides maximum extraction of moisture from carpets.
- Use blowers/dehumidifiers when needed.

## Spot Cleaning

Spot removal technique is more important than the cleaning chemicals used.

 Techniques to follow include:

- Gently scrape up solids with a spoon, working from the outside of the spot toward the center to prevent spreading.
- Blot the spotted area with a dry white towel or paper towels. Continue blotting the area by pressing firmly with a clean portion of the toweling until there is no further transfer from the spot. Then begin use of spot remover if needed. NOTE: Do not scrub stains. Scrubbing can damage fabric and spread the stain. Use blotting action.
- Never soak upholstery. Over-wetting with cleaning solution or water will make effective cleaning difficult. Messy spills will spread, and soiled water will seep deep into the fabric, cushions and wood frame.
- Test for color fastness: Never pour cleaning solution directly on a spot or spill. Put solution on a white towel and in an inconspicuous area, apply with a blotting action to the upholstery before attempting to remove the spot. If color from the fabric transfers to the towel, do not attempt to remove the spot. Call a professional cleaner for help.
- Finding the color to be fast, continue blotting with the spotting solution as above.
- As long as the color of the stain is transferring to the towel, you are "moving" the spot. Keep at it patiently. If the spill will not come out at all - do not persist. Trying many different chemicals will probably make it worse, or create a permanent stain.
















## Green Cleaning Equipment, Tools, Maintenance, Storage, and Disposal

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Quality equipment results in reduced hours for maintenance personnel and fewer equipment repairs. These benefits, along with the IEQ impacts that protect occupant health and improve productivity, will save money compared to average cleaning equipment.

Many new options and choices are available in cleaning equipment. As a general rule, when making new purchases, always look for products that are made with the highest levels of recycled content, and that offer maximized reuse opportunity and minimized disposal requirements after use.








When selecting and maintaining equipment, ensure that:

-  The green cleaning equipment program ensures that records of inspections and maintenance are logged.
-  Hot water extraction equipment for deep cleaning carpets is capable of removing sufficient moisture such that carpets can dry in less than 24 hours.
-  Powered maintenance equipment including floor buffers, burnishers and automatic scrubbers are equipped with vacuums, guards and/or other devices for capturing fine particulates, and operate with a sound level less than 7bBA.
-  A log is kept for all powered housekeeping equipment to document the date of equipment purchase and all repair and maintenance activities and include vendor cut sheets for each type of equipment in use in the logbook.
-  All cords and plugs are sound and intact.
-  Cord length and gauge will be per manufacturers' specifications.
-  Vacuum cleaner bags are inspected and emptied as needed, at least once each day of use, and replace as needed.
-  Filters will be replaced according to manufacturers' specifications.
-  Floor maintenance equipment must be able to capture and collect particulates, preferably with HEPA filters.
-  All equipment is cleaned after use and maintained according to manufactures instruction and maintenance logs will be kept.
-  Worn, improperly functioning, and unsafe equipment will be taken out of service and removed from facilities.
-  Propane-powered equipment must have appropriate low-emission engines and catalytic and exhaust monitoring systems, and should only be used in well-ventilated spaces.
-  Where appropriate, active micro fiber technology shall be used to reduce cleaning chemical consumption and prolong life of disposable scrubbing pads.
-  Equipment to have rubber bumpers to reduce potential damage to building surfaces.
-  Properly dispose of all spent equipment. Consider contamination concerns based on the location and use of the equipment, and when in doubt, follow King County procedures for hazardous waste.

## Entryway Systems, Hallways, and Floors

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Many contaminants infiltrate building ventilation systems through contaminants brought into the building on occupants' and visitors' shoes. The installation and maintenance of entry systems reduces contaminants, and appropriate use and maintenance of entryway systems has the added benefits of increased longevity of flooring materials, reduced need for chemicals needed to maintain flooring materials, costs savings from reduced spending on flooring and cleaning materials, and improved indoor air quality which can in turn result in improved worker productivity.

-  Mat systems can be designed or used both outside and immediately inside entryways. Consult a local mat supplier for proper specification and recommendation on the maintenance program.
-  Vacuum entry mats daily.
-  Vacuum or dust mop floors daily.
-  Vacuum all visible soil, dirt, paper, and food (High-Spotting).
-  Vacuum walls and furniture instead of using a feather duster.
-  Damp-mop the floors weekly.
-  Pressure-wash outdoor entries monthly.

## Offices and Meeting Rooms


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### Daily Practices

-  Daily Cleaning Practices for offices and meeting rooms include:
  - Unlock and spot clean door and door glass.
  - Turn on light and wipe switch panel.
  - Dust horizontal and vertical surfaces (clocks, TVs, computers, screens, including behind the computer) with a lint-free dust cloth.
  - Empty the trash and recycling bins and wipe down the wall behind the container.
  - Wipe down touchable surfaces with a clean cloth and cleaner.
  - Wipe white boards. Make sure to leave one clean eraser.
  - Wipe down phones as needed.
  - Hand pick floors (removing large pieces of paper, cans, etc.)
  - Clean window glass.
  - Check for open windows and shut them if found.
  - Vacuum carpet and HVAC vents.
  - Check furniture and report any needing maintenance or replacement.
  - Turn off all lights, other than areas that are being cleaned, unless another custodian is following shortly.

### Periodic Practices

Periodic light carpet cleaning is necessary to maintain carpeted floors. Restorative deep carpet cleaning operations are appropriate when light carpet cleaning is insufficient to clean carpeted areas in heavy use areas. Schedule either on an as-needed basis, not on a regular schedule.

-  Remove sufficient water from the carpet and provide sufficient airflow (via blowers or other increased outdoor air exchange) so that the carpet will dry in less than 12 hours.

 Provide advanced notice to building occupants and schedule during a period of minimum occupancy.

## Kitchenettes/ and Lunch Rooms

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 Daily cleaning practices for kitchenettes and lunch rooms include:

- Wipe down all cupboards, including tops and doors.
- Wipe down all sink areas and drinking fountains.
- Clean around faucet with small blue brush.
- Clean garbage cans inside and out, replacing their liners.
- Clean walls behind garbage and recycling cans.

## Janitorial Closet

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The storage and mixing of cleaning chemicals, as well as janitorial equipment such as mops, buckets, vacuum cleaners, and floor machines can contribute to airborne contaminants. These contaminants include particles, VOCs and biological contaminants affecting the building occupants. Janitorial staff and building occupants should be protected from inadvertent exposure to hazardous materials.

 **Retrofit:** During renovation projects, consider installation of an isolated janitorial room. Install deck-to-deck partitions with separate outside exhausting and negative pressure in place. Provide hot and cold water and drains plumbed for appropriate disposal of liquid waste.

## Bathrooms

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Clean restrooms daily from “high to low” toward the doorway, with dry cleaning tasks performed before wet cleaning tasks. See Bathroom Cleaners / Disinfectants / Urinal Deodorizer for details on preferred cleaning products.

### Daily Cleaning Practices

 Complete the following daily bathroom cleaning practices:

- Remove trash, replace can liners, and disinfect trash receptacle.
- Refill soap dispensers and restock paper products.
- Clean toilets & urinals. Bowl brush all toilets and urinals and remember to use a Johnny mop on the waterless urinals. Use nothing scratchy on the waterless urinals and do not put chemicals down them!
- Clean mirrors and other glass surfaces.
- Clean touchable surfaces: walls, partitions, doors, and light switches.
- Remove graffiti.
- Disinfect touchable surfaces and fixtures.
- Vacuum floor and then wet mop with a cleaner/disinfectant. Control and remove standing moisture from floor and surfaces in a timely manner. Mop floor daily, switching between germicide and natural cleaner daily.
- Change mop solution after each restroom.
- Dust high surfaces; including vents, walls, partitions and lights, 3 times a week.
- Fill drain traps with water.
- Deep clean to remove stains inside toilet bowls and around the base of urinals.

## Quality Control

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 As part of your division’s green cleaning program, include quality control to:





- Ensure that the occupant, custodian, and program management team have a mutual understanding of the service schedule and performance expectations



- Have a method in place to correct unsatisfactory cleaning results or performance
- Have a periodic inspection and evaluation method in place
- Update the green cleaning plan every year to include new approved products and methods to use.





## Ergonomics

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-  Select power equipment that is ergonomically designed to minimize vibration, noise and user fatigue.
-  Ensure that custodial equipment that is worn by the user is properly fitted to each custodian.
-  Ensure that custodians are properly trained to correctly use equipment and tools to avoid injury.
-  Ensure that custodians understand how to lift, pull, and push in a manner that avoids injury.

## Chemical Storage and Disposal


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-  Clearly label all products, spray bottles, and other secondary containers.
-  Do not store solvents, paints and other fume-emitting materials inside or near the building.
-  Recommended disposal methods depend on the material you need to dispose.
-  Properly dispose of leftover “non-green” cleaning products and chemicals by first linking to the King County hazardous Waste Management Program.

## Trash Removal & Recycling

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The recycling and trash program must meet the guidelines of the local recycling hauler and facility. It is important to inform occupants of what can be recycled, how recyclable items need to be separated, and where the facility’s recycling collection center is located. Research recycling options for unique materials your facility uses extensively, and contact the King County Green Team for ideas and suggestions on materials that can be recycled or re-used. Hazardous materials must be disposed of properly and according to state and King County regulations.







-  General trash removal and recycling guidelines include:
  - Remove trash from bathrooms and kitchen/lunch room areas daily.
  - Post signage for items that can be recycled, composted, or reused, and provide separated bins for these three categories, alongside a general waste bin.
  - Inform occupants to rinse food waste from recyclable containers before placing them in recycling bins to avoid attracting pests.
  - Cover all trash receptacles.
  - If trash is not collected every day, make sure it is hauled away before weekend and holidays to minimize pests.
  - Use can liners that include a minimum of 10% post consumer recycled content.

## Waste, Energy & Water Reduction





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A green cleaning program should focus on the **3 R’s: reduce, reuse, recycle**. Guidelines to follow to achieve overall reduction in resource use, recycling rates, and products reuse, include:

-  Purchase chemicals in quantities and sizes that minimize container materials storage, transport, and disposal.

-  Properly recycle old and surplus equipment, light tubes and ballasts, and reuse containers and materials to avoid disposal and re-supply.
-  Purchase materials that require less packaging materials.
-  Encourage use of reusable cleaning cloths such as micro-fiber cloths and mops to facilitate reduced water use while maintaining adequate mop-water exchange.
-  Create a cleaning schedule that moves custodial staff through the facility with the least amount of lighting need.
-  Create a work process that reduces duplication of powered equipment during the cleaning shift.
-  Recycle waste materials to the greatest extent possible including product packaging materials, cardboard boxes and empty chemical containers.


A number of cost savings and waste reduction options are possible from procurement and use of sanitary paper products. The following simple strategies have been found to reduce sanitary paper product consumption between 10 and 15 %, which can be a good strategy to help offset any potential increase in cost for recycled paper.

-  Replace a single roll tissue dispenser with a dispenser that can hold multiple rolls. This will reduce the number of small rolls that get thrown away because the tissue would run-out before they were to be changed the following day or cleaning shift.
-  Consider replacing multi-fold towel dispensers with large rolls dispensed from a touch-free dispenser to reduce not only paper consumption, but possible cross-contamination (the passing of potentially harmful organisms) from touching levers and cranks.
-  Consider utilizing paper products that eliminate cores and wrappers that must be discarded.
-  Consider utilizing paper that uses a case configuration to allow more to be shipped on a truck, thus reducing transportation impacts.

**Table 3: EPA Recommended Recycled Content Level for Commercial / Industrial Products**

PAPER PRODUCT	NOTES	POST-CONSUMER RECOVERED CONTENT	TOTAL RECOVERED CONTENT
Bathroom Tissue	Used in rolls or sheets	20–60%	20–100%
Paper Towels	Used in rolls or sheets	40–60%	40–100%
Paper Napkins	Used in food service applications	30–60%	30–100%
Facial Tissue	Used for personal care	10–15%	10–100%
General-purpose Industrial Wipers	Used in cleaning and wiping applications	40%	40–100%
Plastic Trash Bags		10–100%	10–100%

## Management Controls & Accountability

-  Have tracking tools in place to allow management to understand the program requirement, costs and benefits. These tools should include:
  - Written job description and standards of performance for every cleaning custodial position within the program
  - Injury reports and hazard report logs

- Mandatory compliance logs
- Prepare assessment of scope and size of areas to be cleaned
- Written facilities information regarding areas to be cleaned
- Written established and agreed upon schedule of services
- Written job cards that provide work schedule details to ensure compliance with specifications
- Written productivity standards
- Inventory ordering/receipt logs to track supplies ordered and received into inventory
- Supply issue logs to track supplies issued to cleaning staff
- Logs to track vacuum filers and bags used
- Cleaning cloth and more head use
- Attendance absenteeism and backfill records to determine labor costs

## Green Cleaning Resources

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### Green Cleaning Standards & References

- ☞ Washington State Cleaning Industry Professionals Group - Sustainable Cleaning Standard [www.kingcounty.gov/operations/procurement/Services/Environmental\\_Purchasing/~/\\_media/operations/procurement/documents/EP\\_Bulletin\\_109\\_attachD.ashx](http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing/~/_media/operations/procurement/documents/EP_Bulletin_109_attachD.ashx)
- ☞ Green Seal: [www.greenseal.org](http://www.greenseal.org).

### Green Cleaning Product Resources

- ☞ The Pennsylvania Green Building Operations and Maintenance Manual for cleaning product selection: [http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green\\_building\\_maintenance\\_manual/254756](http://www.portal.state.pa.us/portal/server.pt/community/energy/1300/green_building_maintenance_manual/254756)
- ☞ Green Seal Standards: <http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=25> (GS-01 Tissue Paper)  
<http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=41> (GS-09 Paper Towels)
- ☞ Environmental Choice Standards <http://ws617399.websoon.com/common/assets/criterias/CCD-086.pdf> (CCD-086 Hand Towels) <http://ws617399.websoon.com/common/assets/criterias/CCD-085.pdf> (CCD-085 Kitchen Towels) <http://ws617399.websoon.com/common/assets/criterias/CCD-082.pdf> (CCD-082 Toilet Tissue)
- ☞ United States Environmental Protection Agency <http://www.epa.gov/epaoswer/non-hw/procure/products/tissue.htm>
- ☞ Organization for Economic Co-operation and Development (OECD): <http://www.oecd.org>
- ☞ Industrial & Institutional Floor Finishes and Floor Finish Strippers (GS-40): <http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=28>
- ☞ Hand Cleaners and Hand Soaps Used for Industrial & Institutional Hand Purposes (GS-41): <http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=29>

### General Green Cleaning References/Resources

- ☞ Green Seal <http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=23>
- ☞ California Air Resource Board (CARB). <http://www.arb.ca.gov> or <http://www.arb.ca.gov/consprod/regs/regs.htm>
- ☞ US EPA – Comprehensive Procurements Guidelines (CPG) <http://www.epa.gov/cpg>
- ☞ US Department of Interior <http://greeninginterior.doi.gov/buildings/index.html>
- ☞ US Green Building Council. <http://www.usgbc.org>
- ☞ INFORM.org <http://www.informinc.org/>
- ☞ Collaborative for High Performance Schools, Best Practices Manual <http://www.chps.net/dev/Drupal/node/288>
- ☞ Carpet & Rug Institute Green Label and IAQ Test Program <http://www.carpet-rug.org>
- ☞ King County environmentally preferred carpet choices: [http://www.kingcounty.gov/operations/procurement/Services/Environmental\\_Purchasing/Products.aspx](http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing/Products.aspx)
- ☞ GreenGuard: <http://www.greenguard.com>
- ☞ G/rated Tech Sheet. Low toxic solutions: Adhesives, sealants, primers, and paints. Portland office of sustainable development: <http://www.portlandonline.com>

## **Part II:**

# **Resources & Worksheets**

## Measurable Goal Identification Matrix

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Building Component	Measurable Goal	Purpose	Timeframe for Inspection/Maintenance	Actions / Notes
(example) Windows	No visible or reported water leakage at windows for 6 months	Improve durability of building, increase energy efficiency, and prevent mold & mildew growth	Weekly inspections during Summer; 3 inspections/week during rainy season.	Include inspection log and any notes in Building Envelope O&M Plan; involve occupants and other staff in the monitoring.

# O&M Plan Template

<b>TITLE</b> (Landscape O&M Plan, HVAC O&M Plan, etc):			
<p><b>Operations &amp; Maintenance Goals</b></p> <ul style="list-style-type: none"> <li>○</li> <li>○</li> <li>○</li> <li>○</li> <li>○</li> <li>○</li> </ul>			
<p><b>Responsibilities</b></p> <ul style="list-style-type: none"> <li>○</li> <li>○</li> <li>○</li> <li>○</li> <li>○</li> <li>○</li> <li>○</li> </ul>			
<p><b>System Documentation</b></p> <p>Identify which system documents are available/missing/incomplete, where they are located, and who is responsible for maintaining and updating them. Information to collect and maintain includes:</p> <ul style="list-style-type: none"> <li>○ “As built” blueprints, including system modifications to reflect current conditions.</li> <li>○ Up-to-date drawings of all tenants' build outs and interior renovations.</li> </ul>			
<b>System Documentation Required for O&amp;M</b>	<b>Location of Documentation</b>	<b>Person responsible for Documentation</b>	○ <b>Notes</b>

**OPERATIONS & MAINTENANCE PLAN TEMPLATE (cont'd)**

**Maintenance Task List and Schedule**

<p><b>Prioritize maintenance tasks and adjust schedules to fit available staff time.</b> <i>(When setting priorities, keep in mind the department goals, stated above).</i></p>	<p><b>OPERATIONS</b> Task Description (ex: inspect, measure, test, document)</p>	<p><b>MAINTENANCE</b> Appropriate corrective actions for typical problems (ex: clean, remove, repair, trim)</p>	<p>Tools required</p>	<p>Notes: why the task is important or how it helps meet the goals</p>	<p>Location of related system documentation</p>	<p>Description of what, where, and how the records resulting from this task will be stored</p>

**Evaluation Task List and Schedule**

In addition to regular inspections, include monitoring and testing in your operations and maintenance plan to ensure that all systems are meeting performance goals.

List performance characteristics (such as energy use, landscape condition, water use, etc.):

- 
- 
- 

Describe work required to evaluate performance characteristics (such as: obtain water use data, monitor energy use, and obtain occupant feedback).

- 
- 
- 
-



**OPERATIONS & MAINTENANCE PLAN TEMPLATE (cont'd)**

**Recordkeeping Process**

For each task, record actions taken and reasons. Record the name and affiliation of the person performing the work and the date of response. Create a simple worksheet to use for your facilities and include it as an Appendix to your O&M plan. Retain records for at least three years.

**Operations & Maintenance System Audit**

Include an audit process to periodically review how well your system is functioning. The audit plan should cover the following:

- Completeness of procedures and checklists
- Availability of procedures and checklists to the O&M staff
- Training for staff
- Discussion with O&M staff and occupants to find out if the procedures are being followed and comfort levels are adequately maintained.

**External Factors**

External factors can impact operations and maintenance practices. List possible external factors here:

- 
- 
- 
- 
- 
- 

Address ways of dealing with these external factors.  
Conduct a building survey to identify behavioral practices of building occupants, which may impact effective and efficient green operations and maintenance.  
Negotiate an agreement with all occupants to empower them to make behavioral choices and actions that positively affect building operations and maintenance.

# GBO Operations & Maintenance Annual Reporting Form

Year: \_\_\_\_\_

Priority Operations & Maintenance Actions Completed	Date Completed	Benefits Achieved / Comments

Additional O &M Guidelines Completed	Date Completed	Benefits Achieved / Comment
What Guidelines Are You Planning to Implement Next Year?	What Resources / Training Do You Need For Next Year?	

## Custodial Services Inspection Form

<b>Run:</b>	<b>Inspected By:</b>
<b>Date/Time:</b>	<b>Area/Room Inspected:</b>
<b>Walkways, Entrances</b>	<b>X</b>
Area is free of trash, paper and cans	<b>Notes:</b>
Lights are burning and clean. Covers are cleaned	
Walk off mats are clean	
Walkways are swept	
Trash containers are clean and empty	
<b>Lobby/ Entrance</b>	<b>Notes:</b>
Doorway thresholds/mats (cleaned and in place)	
Glass Is clean	
Lights are burning and clean. Covers are cleaned	
Main surface/ floor is clean	
Trash containers are clean and empty	<b>Notes:</b>
<b>Corridors/ Halls</b>	
Doorway thresholds/mats (cleaned and in place)	
Glass Is clean	
Lights are burning and clean. Covers are cleaned	
Main surface/ floor is clean	
Trash containers are clean and empty	
Water Fountains are clean, polished	<b>Notes:</b>
<b>Classrooms</b>	
Carpet is clean and spot free	
Glass Is clean	
Lights are burning and clean. Covers are cleaned	
Students desks are clean	
Trash containers are clean and empty	<b>Notes:</b>
<b>Stairwells</b>	
Glass Is clean	
Handrails are clean and dust free	
Lights are burning and clean. Covers are cleaned	
Steps are clean	<b>Notes:</b>
<b>Office Areas</b>	
Carpet is clean and spot free	
Dispensers are cleaned and stocked: Soap, towels	
Floors are clean	
Glass Is clean	
Horizontal surfaces are dust free	
Lights are burning and clean. Covers are cleaned	
Counter tops are clean	
Trash containers are clean and empty	<b>Notes:</b>
<b>Custodial Closet/ Storage Area</b>	
Equipment is clean and properly stored	
Floor is Clean	
Horizontal Surfaces (shelves) are clean & organized	
Supplies properly stored and maintained	
Sinks/ tub/ basins are clean, drain works, odor free	

## Custodial Services Inspection Form

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### SAMPLE LIST OF APPROVED CLEANING PRODUCTS

(provided by Denise Thompson for Black River Building)

Product Name	Manufacturer	Type	Meets Standard
United 92 Scrub Bugs Non-Abrasive Cream Cleanser	United Laboratories	Abrasive Cleaner	CA Code, Title 17, #94509
Penetrate	Buckeye International	Floor Stripper	GS 37 Green Seal
Marauder	Buckeye International	General Cleaner	GS 37 Green Seal
Verde	Buckeye International	Floor Finish	GS 37 Green Seal
Star Spray Concentrate	Buckeye International	Glass Cleaner	GS 37 Green Seal
Tenacity	Buckeye International	General Cleaner	GS 37 Green Seal
True 7	Buckeye International	Neutral Cleaner	GS 37 Green Seal
GoJo Green Certified Foam or Lotion Hand Cleaner	GoJo Industries	Hand Cleaner	GS 41 Green Seal

Product Name	Manufacturer	Type	Meets Standard
Look Non-Ammoniated (NA)	Butcher's	Glass Cleaner	GS-37 Green Seal
Raindance	Butcher's	Neutral floor cleaner	GS 37 Green Seal
#72 G-Force H <sub>2</sub> O <sub>2</sub>	Butcher's	Multi-purpose Cleaner	GS 37 Green Seal
#15 G-Force Fountainhead	Butcher's	Carpet extraction cleaner	GS 37 Green Seal
#73 G-Force	Butcher's	Floor Stripper	GS-40 Green Seal
G-Force	Butcher's	Floor Finish	GS-40 Green Seal
#11 Dimension III	Butcher's	Disinfectant	n/a

See these Resources for Additional Forms and Checklists:

EPA's IAQ Building Education and Assessment Model (I-BEAM): <http://www.epa.gov/iaq/largebldgs/i-beam/forms.html>

California Best Practices Manual: Better Building Management for a Better Tomorrow, including a Toolkit and Template: <http://www.green.ca.gov/GreenBuildings/BBBTManual.htm>.

# Guidelines Example: Chinook Building

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## GENERAL

1. Office doors shall remain closed when HVAC is operating. Ensure doors between conditioned space and non-conditioned space remain closed at all times (i.e. between hallways and office areas).
2. Proper and thorough utilization of data loggers will be initiated and maintained to monitor relative humidity, temperature, and light levels throughout the building to ensure compliance with these guidelines.
3. Non-critical or non-essential exhaust fans should be turned off every day and during unoccupied hours.
4. All office machines (copy machines, laminating equipment, etc.) shall be switched off each night and during unoccupied times. Fax machines should remain on.
5. All computers should be turned off each night. This includes the monitor, local printer, and speakers. Network or sensitive equipment is excluded.
6. All capable PC's should be programmed for the "energy saver" mode using the power management feature. If network constraints restrict this for the PC, ensure the monitor "sleeps" after 10-minutes of inactivity.

## AIR CONDITIONING EQUIPMENT

1. Occupied temperature settings shall NOT be set below 74°F unless that area is identified as a critical environment that requires cooling below 74°F.
2. The unoccupied time shall begin at 17:00 Monday/ Friday
3. During unoccupied times, the air conditioning equipment shall be off.
4. Air conditioning start times will be no sooner than 06:00 Monday-Friday.
5. Ensure outside air dampers are closed during unoccupied times.

Cooling Season Occupied Set Points:	74°F
Unoccupied Set Point:	85°F
Heating Season Occupied Set Points:	70°F
Unoccupied Set Point:	55°F

## HEATING EQUIPMENT

1. Occupied temperature settings shall NOT be above 70°F unless it is a critically controlled environment.
2. The unoccupied time shall begin at 17:00 Monday/Friday.
3. The unoccupied temperature setting shall be 55°F (i.e. setback). This may be adjusted to a 60°F setting during extreme weather.
4. During the spring and fall when there is no threat of freezing, all steam and forced air heating systems should be switched off during unoccupied times unless required to maintain a sensitive environment. Hot water heating systems should be switched off using the appropriate loop pumps.
5. Ensure all domestic hot water systems are set no higher than 120°F or 140°F.
6. Ensure all domestic hot water re-circulating pumps are switched off during unoccupied times.
7. In applicable areas with heat pumps, ensure a 6°F dead-band between heating and cooling modes.

## LIGHTING

1. All unnecessary lighting in unoccupied areas will be turned off. Tenants should make certain that lights are turned off when leaving an empty space that has lighting control (i.e.: switch). Utilize natural lighting where appropriate. Lights shall remain off in all unoccupied areas.
2. All outside lighting shall be off during daylight hours.
3. All lights will be turned off when tenants and staff leave the area. Custodians will turn on lights only in the areas in which they are working.
4. Refrain from turning lights on unless definitely needed. Remember that lights not only consume electricity, but also give off heat that places an additional load on the air conditioning equipment and thereby increases the use of electricity necessary to cool the room.

# Inspection Log Example: Black River Building Exterior



Department of Executive Services  
 Facilities Management Division  
 Building Services Section  
 500 Fourth Avenue, Room 201  
 Seattle, Washington 98104

## Annual Roof Inspection Form

Building: DDES      Superintendent: VAN PHAN      Year: 2009

General Roof Conditions	
Item	Remarks
Debris on Roof	MINIMAL
Drainage	EXCELLENT
Physical Damage	NONE
Attic Conditions	NONE
Structural Deformation	NONE
Other	
Flat / Membrane Roof	
Item	Remarks
Condition of Coating	NONE
Granular Loss	MINOR
Punctures	NONE
Cracks / Alligating	NONE
Blisters / Fishmouths	THERE ARE A FEW BLISTERS
Ponding	NONE
Other	
Sloped Roof	
Item	Remarks
Roof Material	X
Condition of Surface	
Deformed Edges	
Shingle: Buckled	
Curled	
Missing Tabs	
Granular Loss	
Metal: Corrosion	
Fasteners	
Other	
Roof Features	
Item	Remarks
Fascia	NONE
Soffit	-
Flashing	GOOD
Gutters / Drains, etc.	GOOD
Skylights	-
Chimneys / Vents	-
Fall Arrest Anchors	NONE
Control Zone Access	-
Drains / Vents	-
Other	



Department of Executive Services  
 Facilities Management Division  
 Building Services Section  
 500 Fourth Avenue, Room 201  
 Seattle, Washington 98104

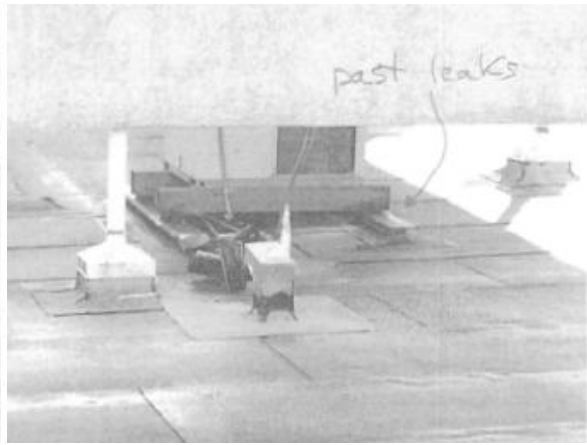
# Annual Roof Inspection Form

Building: DDES Superintendent: VAN PRAIN Year: 2009

Comment on changes from previous inspections, and overall roof condition. Indicate recommended action of roof repair and/or further assessment, and estimated remaining life expectancy of roof system. Include any photographs and thermography records in this report.

THERE HAVE BEEN A FEW LEAKS IN THE PAST CAUSED BY THE STRUCTURE THAT SURROUNDS THE HVAC EQUIPMENT.

THE STUCCO SIDING WILL LEAK AT VARIOUS LOCATIONS AROUND THE BUILDING WHEN IT RAINS WITH A HARD WIND. WATER WILL COME IN AROUND THE WINDOWS.

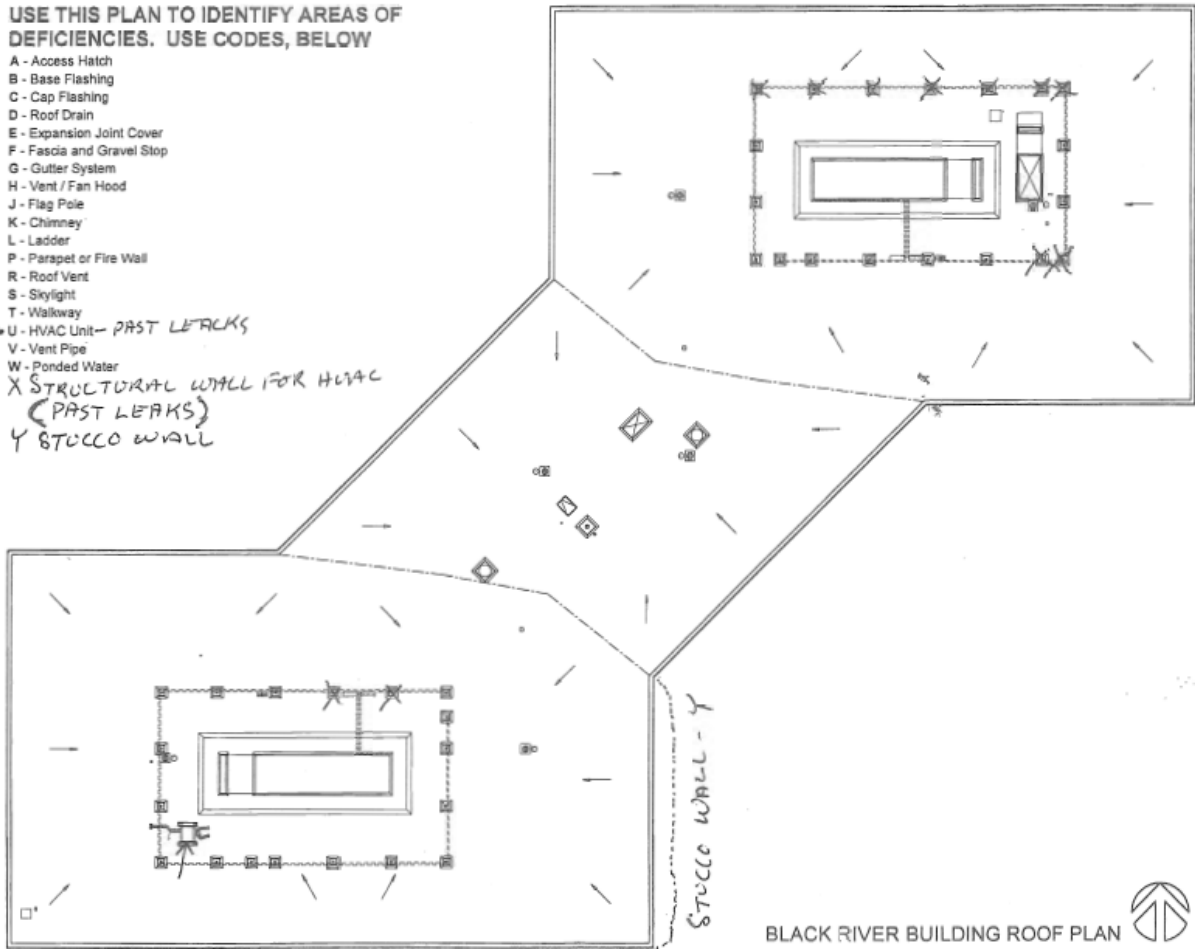


• Report rapidly deteriorating roofs and/or water damage to the PW&S Regional Superintendent.



**USE THIS PLAN TO IDENTIFY AREAS OF DEFICIENCIES. USE CODES, BELOW**

- A - Access Hatch
- B - Base Flashing
- C - Cap Flashing
- D - Roof Drain
- E - Expansion Joint Cover
- F - Fascia and Gravel Stop
- G - Gutter System
- H - Vent / Fan Hood
- J - Flag Pole
- K - Chimney
- L - Ladder
- P - Parapet or Fire Wall
- R - Roof Vent
- S - Skylight
- T - Walkway
- U - HVAC Unit - PAST LEAKS
- V - Vent Pipe
- W - Ponded Water
- X STRUCTURAL WALL FOR HVAC (PAST LEAKS)
- Y STUCCO WALL



BLACK RIVER BUILDING ROOF PLAN 

# Glossary (from Black River Building O&M Guidelines)

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## **Air Pollution**

Contaminants or substances in the air that interfere with human health or produce other harmful environmental effects.

## **Alternative Energy**

Energy produced without burning fossil fuels. Examples include wind, or solar energy.

## **Alternative Fuel**

Non-conventional fuels like natural gas, methanol, bio fuels and electricity. Conventional fuels are typically fossil fuels.

## **Biodegradable**

Able to break down naturally and be absorbed into the ecosystem.

## **Biodiversity**

The tendency in ecosystems, when undisturbed, to have a great variety of species forming a complex web of interactions. Human population pressure and resource consumption tend to reduce biodiversity dangerously; diverse communities are less subject to catastrophic disruption.

## **Biomass**

Plant material from trees, grasses, or crops that can be converted to heat energy to produce electricity.

## **Blackwater**

Wastewater generated by toilets. Some jurisdictions also consider blackwater to include wastewater from kitchen sinks, showers and bathtubs.

## **Agrifiber**

Fibrous material made from agricultural, or bio-based, products. Often made into panel products for building materials like strawboard.

## **Best Management Practices (BMPs)**

Methods that have been determined to be the most effective, practical means of management. Usually refers to environmental topics, especially stormwater and pollution.

## **Carbon dioxide (CO<sub>2</sub>)**

An atmospheric gas produced through natural processes, carbon dioxide is also released through human activities, such as the burning of fossil fuels to produce electricity. Carbon dioxide is the predominate gas contributing to the greenhouse effect, and therefore, climate change. Some carbon dioxide contaminates our water bodies, raising their acid levels and deteriorating marine wildlife.

## **Carbon dioxide (CO<sub>2</sub>) levels**

An indicator of ventilation effectiveness inside buildings. Concentrations greater than 530 ppm above outdoor carbon dioxide levels generally indicate inadequate ventilation. Absolute concentrations of CO<sub>2</sub> greater than 800 to 1,000 ppm generally indicate poor air quality for breathing.

## **Carbon footprint**

A measure of greenhouse gas emissions produced. Unit of measurement is ton of carbon dioxide equivalent.

## **Carbon monoxide**

A colorless, odorless, poisonous gas which results from incomplete combustion. Three-quarter of U.S. carbon monoxide emissions is from vehicle exhaust, contributing to smog. Exposure can cause cardiovascular and central nervous system effects and even death.

## **Carbon neutral**

Not producing carbon emissions or offsetting its use elsewhere.

## **Carcinogen**

A cancer-causing substance.

## **Chlorofluorocarbons (CFCs)**

Man-made chemical compounds containing carbon, chlorine, fluorine, and sometimes hydrogen. Often used in older refrigerators and air conditioners, CFCs can damage the ozone layer.

## **Climate Change**

A change in temperature and weather patterns due to natural causes or human activity. Also referred to as global warming.

## **Co-mingled C&D Recycling**

The process of collecting mixed recyclable materials in one container on-site. The container is taken to a material recovery facility where materials are separated for recycling. Less preferable to source-separated recycling due to lower recycling rate.

## **Composting**

A process whereby organic wastes, including food and paper, decompose naturally.

## **Construction and Demolition (C&D) Waste**

Includes all non-hazardous solid wastes resulting from construction, remodeling, alterations, repair, and demolition. This includes material that is recycled, reused, salvaged or disposed as garbage.

## **Cradle-to-Cradle**

The life cycle of a material or product starting from its manufacture (cradle), through its useful life, and to its recycle into a new product or use.

## **Cradle-to-Grave**

The full life cycle of a material or product starting from its manufacture (cradle), through its useful life, to its disposal (grave).

## **Design For Disassembly (DfD)**

A building design process that allows for the easy recovery of products, parts and materials when a building is disassembled or renovated. The process is intended to maximize economic value and minimize environmental impacts through reuse, repair, remanufacture and recycling. A DfD process involves developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal.

## **Dioxins**

A class of chemical contaminant produced as a by-product from combustion processes such as pulp paper bleaching, pesticide and herbicide manufacturing and the burning of PVC products. Exposure is typically through ingestion of foods contaminated with dioxins. Studies have shown elevated exposure to dioxins is linked to health risks including skin disease, cancer, reproductive and developmental problems, diabetes, and heart disease.

## **Durable goods**

Products that have a useful life of 2 years or more and replaced infrequently and/or may require capital program outlays. Examples include furniture, office equipment (computers, monitors, printers, copiers, scanners, fax machines), appliances (refrigerators, dishwashers, water coolers), televisions, audiovisual equipment, external power adapters.

### **Energy Star**

A joint program of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy that promotes the use of energy-efficient products and services. Energy Star labeled products meet the program's energy-efficiency guidelines and result in consumer cost savings in operation. <http://www.energystar.gov>

### **Environmentally preferable products (EPP)**

Products that have a lesser or reduced effect on human health and the environment when compared with competing products that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, or disposal of the product.

### **Electronic Product Environmental Assessment Tool (EPEAT)**

An online tool developed by the Green Electronics Council (GEC) that helps purchasers evaluate, compare and select electronic products based on their environmental attributes. The system currently covers desktop and laptop computers, thin clients, workstations and computer monitors. EPEAT-registered products must meet 23 required environmental performance criteria and are rated gold, silver and bronze if exceeding the minimum requirements. <http://www.epeat.net/>

### **Embodied Energy**

The total energy used in growing, extracting, and manufacturing a product, and the energy used to transport it to the point of use. The embodied energy of a structure or system includes the embodied energy of its components plus the energy used in construction.

### **E-waste**

Refuse created by discarded electronic equipment and components. Electronic waste.

### **FloorScore®**

Program to test and certify flooring products for compliance with indoor air quality emission requirements adopted nation-wide. Developed by the Resilient Floor Covering Institute (RFCI) in conjunction with Scientific Certification Systems (SCS). Products include vinyl, polymeric flooring, linoleum, laminate flooring, engineered hardwood flooring, ceramic flooring, rubber flooring, wall base and stair tread, and associated sundries. A flooring product bearing the FloorScore® seal has been independently certified by SCS to comply with the volatile organic compound emissions criteria of the California Section 01350 standard.

### **Forestry Stewardship Council (FSC)**

An independent, not-for-profit organization whose mission is to promote environmentally appropriate, socially beneficial, and economically viable management of the world's forests. FSC-certified products indicate that the wood is harvested from responsibly-managed forests. <http://www.fsc.org/>

### **Formaldehyde**

A colorless, pungent-smelling gas used in making building materials and household goods. It is commonly found in pressed wood products made using adhesives that contain urea-formaldehyde resins. These include products such as plywood, particleboard and MDF. Health effects include burning sensations in eyes and throat; nausea; difficulty in breathing; fatigue; skin rash; asthma attacks; severe allergic reactions. Some people can develop sensitivities to formaldehyde. It causes cancer in animals and may cause cancer in humans. Many pressed wood products are available with no added urea-formaldehyde.

## **Fossil fuel**

A nonrenewable resource commonly burned to generate electricity or heat, supplying 85% of the nation's energy. Formed hundreds of millions of years ago (hence the name fossil), the three primary forms are coal, oil and natural gas. The burning of fossil fuels creates carbon dioxide.

## **Global warming**

See **Climate change**.

## **Graywater**

Waste water that does not contain sewage and can be reused for things like irrigation and car washing after filtration. Examples include dishwashing, laundry and shower waste water.

## **Green Cleaning**

The use of cleaning products and practices that have lower environmental impacts than conventional products and practices.

## **Green collar jobs**

Career track jobs that contribute directly to preserving or enhancing environmental quality. Some examples are solar panel installer, renewable energy engineer, hybrid auto mechanic.

## **Greenhouse gases (GHG)**

Gases in the earth's atmosphere that absorb the infrared radiation coming from the planet's surface and re-emit it back to Earth, increasing the globe's average temperature. Primarily composed of carbon dioxide.

## **Greenhouse effect**

The process whereby greenhouse gases trap heat from the sun, keeping the Earth's surface warmer than it should be.

## **Green Label / Green Label Plus**

Program to test and certify carpet, adhesive and cushion products for compliance with indoor air quality emission requirements. Developed by the Carpet and Rug Institute.

## **Green Seal**

A non-profit organization that develops environmental standards and third-party certification of products and services.

## **Greenwashing**

The practice of making misleading or unsubstantiated claims about the environmental benefits of a product or service.

## **Hardscape**

The non-living parts of the landscape, such as pavement, walls, fences, pavers, decks, flat roofs, streets, sidewalks and driveways.

## **Hydroelectric power**

Energy generated by moving water, usually through dams or ocean waves. Some automatic faucets are now hydroelectrically powered.

## **Indoor Air Quality (IAQ)**

The nature of air that affects the health and well-being of building occupants.

## **Indoor Air Quality Building Education and Assessment Model (I-BEAM)**

An EPA guidance tool to regulate and improve indoor air quality in commercial buildings.

## **KCSWD**

King County Solid Waste Division

### **Life cycle assessment (LCA)**

Also known as life cycle analysis. A method to evaluate the environmental effects of a product or activity holistically, by analyzing the entire life cycle of a particular product, process, or activity.

A methodology developed to assess a product's full environmental costs, from raw material to final disposal.

<http://www.epa.gov/nrmrl/lcaccess/lca101.html>

### **Life Cycle Cost (LCC)**

The costs accruing throughout the service life of a material. Life cycle costs address the capital costs involved in production, maintenance, and disposal, and can also include other environmentally related capital and societal costs.

### **Nitrogen dioxide (NO<sub>2</sub>)**

A highly reactive gas primarily from emissions from cars, trucks and buses, power plants, and off-road equipment. Nitrogen dioxide contributes to smog ground level ozone, and can cause respiratory illness.

### **Offgas**

The evaporation of volatile chemicals from the surface of a material into the environment. Commonly associated with new flooring, paints, and car interiors (new car smell).

### **Ongoing consumables**

Products with a low cost per unit that are regularly used and replaced through the course of business.

### **Organic**

Foods and fibers that are grown and processed without the use of chemical fertilizers and pesticides. Organic livestock is reared without the use of antibiotics or hormones.

### **Ozone Layer**

A protective layer in the upper atmosphere that shields the earth from excessive ultraviolet radiation.

### **Phantom load**

Power drawn by appliances and electronics when they are switched off or not in use.

### **Photovoltaics (PVs)**

Arrays of cells that convert sunlight into electricity.

### **Polychlorinated Biphenyl (PCB)**

Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. PCBs may be present in products and materials produced before the 1979 PCB ban. Products that may contain PCBs include: transformers and capacitors; other electrical equipment including voltage regulators, switches, reclosers, bushings, and electromagnets; oil used in motors and hydraulic systems; old electrical devices or appliances containing PCB capacitors; fluorescent light ballasts; cable insulation; thermal insulation material including fiberglass, felt, foam, and cork; adhesives and tapes; oil-based paint; caulking; plastics; carbonless copy paper; floor finish.

PCBs have been demonstrated to cause cancer, as well as a variety of other adverse health effects on the immune system, reproductive system, nervous system, and endocrine system.

### **Polyvinyl chloride (PVC)**

Also known as vinyl. An inexpensive and durable material made through a highly toxic process which creates and releases dioxin. It is made softer and more flexible by adding plasticizers, commonly phthalates, which carries numerous health risks. PVC products can leak harmful chemicals during use and disposal and releases more dioxins and other chemicals when burned. Studies show some of these chemicals to be linked to cancer, kidney damage and other health concerns. PVC is difficult to recycle resulting in most of it ending up in the landfill. Since PVC is not biodegradable, an ever-growing massive amount remains in landfills, potentially leaching chemicals into the ground water.

PVC is used to make a countless amount of common items such as potable piping, flooring (vinyl), roofing membranes, window frames, cables, window blinds, car interiors, toys, binders, pens, shower curtains, cling film, and many, many more.

### **Post-consumer recycled material**

A material or finished product that has served its intended use and has been diverted or recovered from waste destined for disposal, having completed its life as a consumer item. Postconsumer materials are part of the broader category of recovered materials.

### **Post-industrial (pre-consumer) recycled material**

Industrial, or manufacturing, material waste, such as manufacturing scrap and trimmings/cuttings. Usually not as preferable as post-consumer recycled material since it may indirectly encourage manufacturing inefficiency.

### **Potable water**

Water suitable for drinking that meets or exceeds EPA drinking water standards. Supplied from wells or municipal water systems.

### **Rapidly renewable materials**

Material made from plants that harvested in less than 10 years.

Examples include bamboo, straw, cork, natural linoleum (not vinyl) products, wool, wheatboard, strawboard, and agrifiber.

### **Recovered Materials**

Waste materials and byproducts that have been recovered or diverted from solid waste, but does not include materials and byproducts generated from, and commonly reused within, an original manufacturing process.

### **Recycling**

The process of sorting, cleaning, treating, and reconstituting materials for the purpose of using the material in the manufacture of a new product.

### **Renewable**

Can be grown or naturally replenished or cleansed at a rate that exceeds human depletion of the resource.

### **Renewable Energy**

Energy from sources that are not depleted when used. Examples include energy from the sun, wind and small hydropower.

### **Retrocommissioning**

Testing and adjusting HVAC, electrical, plumbing, and other systems of an existing building to assure systems are performing the way they were designed to. Also includes the instruction of building maintenance personnel in the use of the building systems.

### **Reuse**

Making use of a material without altering its form. Materials can be reused on-site or reused on other projects off-site.

### **Salvage**

Recovery of materials for on-site reuse, or off-site sale or donation to a third party.

### **Sedimentation**

The addition of soil particles to waterbodies by natural and human-related activities. It often decreases water quality and can accelerate the aging process of lakes, rivers and streams.

### **Solar Reflectance Index (SRI):**

A measure of a surface's ability to reject solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

### **Source-Separated C&D Recycling**

The process of separating recyclable materials in separate containers as they are generated on the job-site. The separated materials are hauled directly to a recycling facility or transfer station. Preferable to co-mingled C&D recycling.

### **Stormwater runoff**

Water from rain or snowmelt that flows over land and impervious surfaces (like pavement) and does not soak into the ground. It accumulates pollutants like debris and chemicals from the surfaces as it flows to the storm drainage system which empties to water bodies like creeks and rivers.

### **Sustainable**

The condition of being able to meet the needs of present generations without compromising those needs for future generations. Achieving a balance among extraction and renewal and environmental inputs and outputs, as to cause no overall net environmental burden or deficit. To be truly sustainable, a human community must not decrease biodiversity, must not consume resources faster than they are renewed, must recycle and reuse virtually all materials, and must rely primarily on resources of its own region.

### **Third party certification**

a scientific process by which a product, process or service is reviewed by a reputable and unbiased third party to verify that a set of criteria, claims or standards are being met.

### **Vampire load**

See **Phantom load**

### **Vinyl**

See **Polyvinyl chloride**

### **Volatile organic compounds (VOCs)**

Chemical compounds that evaporate as gasses into the air and are emitted from a wide variety of products. VOCs are one type of indoor contaminant. Examples include paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions. The U.S. EPA lists these health effects: Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue, dizziness. Many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

### **Walk-off Mat**



Design strategy for reducing the amount of contaminants introduced into an interior space by providing grating or other material to remove contaminants from shoes. A significant portion of contaminants in a building are brought in this way, impacting indoor environmental quality.

### **Waste Diversion**

A management activity that disposes of waste other than through incineration or landfilling.

### **Waste Stream**

The overall flow of wastes from the building to the landfill, incinerator, recycling facility, or other disposal site.

### **Wind Turbine**

Device that converts energy from wind into kinetic energy; windmill. A type of alternative and renewable energy source.

### **Xeriscaping**

Landscaping design for conserving water that uses drought-resistant or drought-tolerant plants.