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the Kirksey

guide *to a* Green Facility

Second Edition

A working guidebook for operating your facility ***more efficiently.***

the **Kirksey** guide *to a* Green Facility

Kirksey 2nd Edition

Kirksey *Center for Sustainable Architecture*℠

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The Kirksey Center for Sustainable Architecture is a private research and consulting group whose focus is to mainstream environmentally friendly building practices. Through ongoing research and application, the Center has defined basic strategies for facilities that are easily implemented and that make sense both environmentally and economically. We share these principles with you in this volume,

the Kirksey Guide to a Green Facility.

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TX Registered Architect #5236

about this book

If you picked up this book, you are probably wondering if you can run your facility in a more sustainable way. You may be plagued by doubts: Can it be done without spending a fortune? Can someone without a PhD in environmental engineering understand it? Can it be done without completely changing your organization and culture?

In a word, ***yes!***

We wrote this book to get you started. It's a simple guide with straightforward recommendations that almost any facility can employ.

Greening your facility doesn't have to be…

costly. This book is full of ideas that will cost you nothing, or will save you money. There are even some ideas that will do both!

complicated. Much of what we suggest is just plain common sense.

disruptive. You can start with small steps and build up.

Adopting green does require commitment, a willingness to look critically at the way your facility is run, and a willingness to change. That may not be easy, but it is an effort that will pay for itself bountifully in better health, greater productivity, lower maintenance, lower energy costs, and increased goodwill.

We've done it at Kirksey, and you can, too.

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acknowledgements

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The Kirksey Guide to a Green Facility
2nd Edition

table of contents

Energy saving measures at the SpawGlass Corporate Office decrease operating costs by 30%.*

**The SpawGlass Corporate Office is the 1st LEED® Certified building in Houston, Texas, and achieved a Silver rating.*

energy at a glance

- ☑ Don't overlight your space.
- ☑ Purchase efficient light bulbs.
- ☑ Purchase low-mercury fluorescent bulbs.
- ☑ Properly maintain lighting fixtures.
- ☑ Install occupancy and lighting controls.
- ☑ Properly maintain HVAC systems.
- ☑ Have your building retro-commissioned.
- ☑ Turn off computers at the end of the day.
- ☑ Purchase flat-screen monitors.
- ☑ Install window film.
- ☑ Install CO_2 monitors.

Interior Lighting

Lighting improvements are often the most cost-effective way to conserve energy.

Perform a lighting audit to check if lighting levels in your facility are appropriate.

- Measure light levels with a light meter.
- Compare them to IESNA standards for interior lighting.

IESNA RECOMMENDED LIGHT LEVELS

Task and Area Description	Footcandles
Public spaces (where reading is rarely performed)	3
Spaces with simple signage	5
Working spaces where occasional, simple visual tasks are performed (Lobbies, Reception Areas)	10
Working spaces where visual tasks of high contrast and large size are performed. Good ambient lighting level for offices with task lighting (Photocopy Rooms, Machine Rooms)	30
Working spaces where visual tasks of either low contrast or small size are performed (Filing Areas, Typical Offices)	50
Working spaces where visual tasks of both low contrast and small size are performed (Accounting or Drafting Areas)	100
Working spaces where critical specialized tasks of very small or very low contrast elements are performed (Surgery Suites)	300

(source: IESNA Lighting Design Guide)

LAMP EFFICIENCIES

Product	Watts	Life (hours)	Color Rendering Index	Increased Efficiency	Payback
Incandescent	100	1,000	100	N/A	N/A
Compact Fluorescent	23	10,000	82-88	75% (over incandescent)	< 1 year (over incandescent)
T12	40	20,000	62	N/A	N/A
T12 (efficient)	34	20,000	62	N/A	N/A
T8	32	20,000	86	16% (over T12)	3 yrs (from T12)
T5	28	20,000	85	33% (over T12)	3-8 yrs (from T12)

(sources: EPA, California Energy Commission, Alan Whitson, United Illuminating Co., US Navy)

Replace incandescent bulbs and fixtures with fluorescent bulbs and fixtures.

- Check that the new lamp's lumen output matches the tasks performed in the space and conforms to the fixture's specifications.
- If replacing ballasts in fluorescent fixtures, purchase improved electromagnetic ballasts or electronic ballasts. They will raise the efficiency of the fixture 12% to 30%.

Compact fluorescent bulbs use 75% less energy than a standard incandescent bulb and last up to 10 times longer.[1]

LIGHT LEVELS DECREASE

over time because of aging lamps and dirt on fixtures, lamps, and room surfaces. These factors can reduce total illumination by 50% or more, while lights continue drawing full power.[2]

RULES OF THUMB

FOR OCCUPANCY SENSORS

OFFICES:
Specify wall-mounted sensors.

OPEN AREAS:
Specify ceiling-mounted sensors.

BATHROOMS AND AUXILIARY SPACES:
Specify ceiling-mounted sensors.

A STUDY by the Lighting Research Institute at Rensselaer Polytechnic Institute evaluated the National Center for Atmospheric Research's facility for lighting controls. It found that the lighting control system accounted for a 61% lighting energy savings, compared to an automatic control system with lights on 10 hours each day.[3]

Purchase fluorescent light bulbs with low mercury content, and make sure to dispose of mercury-containing lamps properly.

- All fluorescent bulbs contain mercury. They are considered Universal Waste and must be handled at an EPA-approved facility. They can either be recycled or disposed of at a hazardous waste landfill.

- Find more information and a list of lamp recyclers in your area at www.lamprecycle.org, a service of the National Electrical Manufacturers Association.

Maintain lighting fixtures properly.

- Wipe dust off fixtures, lamps, and lenses every 6 to 24 months.
- Replace lenses if they appear yellow.
- Consider group re-lamping. Incandescent and fluorescent lamps lose 20% to 30% of their light output over their service life.

Install occupancy and lighting controls.

Texas state code requires meeting or exceeding ASHRAE 90.1-2001 standards for energy efficiency, including lighting controls. These standards call for either time scheduling or occupancy sensors for all buildings 5,000 sf or more. To meet and go beyond code, we recommend the following:

- **Programmable time scheduling**
  These systems turn off or dim lights according to a schedule using digitally controlled relay or dimming systems. In areas such as cafeterias or corridors where it won't be disruptive to work, enhance this system with photocells that can turn off banks of lights near windows.
- **Occupancy sensors**
  These must turn lights off within a specified period after a space is vacated.
- **Manual on**
  For both of the above strategies, specify that the system be manual on, auto off. This means that the system will not turn on unless someone flips the light switch. Once the light switch has been turned on, the system will return to its regularly scheduled mode—turning off after a set time, or when the system senses no occupants.

Low Mercury Content Bulbs
Sylvania ECOLOGIC: www.sylvania.com
GE Ecolux: www.gelighting.com
Philips ALTO: www.lighting.philips.com

HVAC

Heating, Ventilation and Air Conditioning account for 40-60% of the energy used in US commercial buildings.

Have your building retro-commissioned to ensure that all systems are performing as they were designed.

Retro-commissioning (RCx) is a process of verifying that installed equipment is operating efficiently and is capable of providing the services necessary to meet the building occupants' needs. The RCx process addresses problems that lead to high energy and maintenance costs, occupant complaints, poor indoor environmental quality, and premature equipment failure.

- A building may be a candidate for RCx if it has:
  - An unjustified, high-energy use index (BTUs/square foot)
  - Persistent failure of building equipment, control systems or both
  - Excessive occupant complaints about comfort

- RCx is not appropriate when:
  - Most of the equipment and systems are either outdated or at the end of their life
  - Major equipment malfunctions exist such that the best remedy is replacement

RCx **costs** typically range from $0.10 to $0.50 per square foot. Costs vary depending on the complexity of systems and project goals.

QUALIFICATIONS FOR COMMISSIONING AGENTS

The California Commissioning Collaborative recommends looking for the following qualifications when selecting a building commissioner:

- Current technical knowledge and extensive recent hands-on field experience equal to that of a Professional Engineer, regarding:
  - Building System Commissioning, including design review, construction observation, system testing, and post-occupancy evaluations
  - Building system performance and interaction, with a focus on building automation control systems;
  - Common installation, maintenance and operational pitfalls for commissioned systems
  - The building design and construction process
- Experience troubleshooting commissioned systems
- Provider for at least four (4) other commissioning projects of a similar nature
- Experience in related fields, such as design, construction, and building operations
- Good written, verbal, conflict resolution and organizational skills
- Excellent references and work products from similar commissioning projects

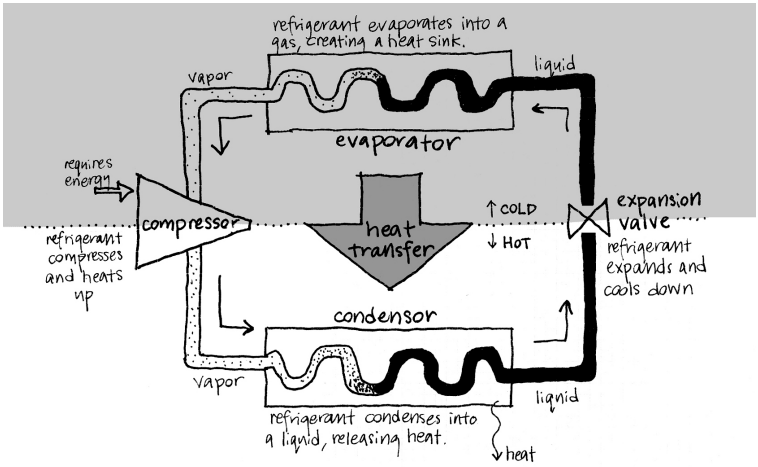
A US Department of Energy-funded study compiling data from 224 buildings concludes that retro-commissioning is cost-effective in terms of energy savings from improved equipment lifetimes, reduced maintenance, fewer contractor callbacks, and other non-energy benefits. Investigators found that existing buildings achieved median energy cost savings of 15%, with payback periods of 0.7 years.[4]

Commissioning Websites:
California Commissioning Collaborative: http://www.cacx.org
Building Commissioning Association: http://www.bcxa.org

Properly maintain HVAC systems.

There are three important benefits to having a trained technician perform regularly scheduled maintenance on your HVAC system:

- **Energy Efficiency**
  A clean and well-maintained piece of equipment will perform efficiently and be less expensive to operate.
- **Extended Equipment Life**
  A well-maintained HVAC system will normally outlast a neglected one by more than two times.
- **System Reliability**
  The cost of sending employees home for the day is staggering. A well-maintained HVAC system is less likely to experience equipment failure.



Schematic Diagram Showing Heat Transfer in a Chiller — The Vapor Compression Refrigeration Cycle

HVAC MAINTENANCE
GENERAL CONSIDERATIONS

- Maintenance schedules should be driven by the equipment application and environment, which are different for every installation. For example, an air-handler in a welding shop located next to an open grinding shop might need the return air filter changed weekly, whereas a 100% recirculation air-handler supplying an interior office might need its return air filters changed only four times per year.

- It is very important to keep heat transfer surfaces as clean as possible. In its simplest form, an HVAC system moves heat into or out of a building through media of refrigerant, water and air. Surface areas where this heat transfer takes place are of critical importance. The most common surface areas are condenser/evaporator coils and condenser/evaporator tubes. As little as 1/64 inch of dust on a coil surface may decrease system efficiency by 10% or more.

BASIC HVAC MAINTENANCE

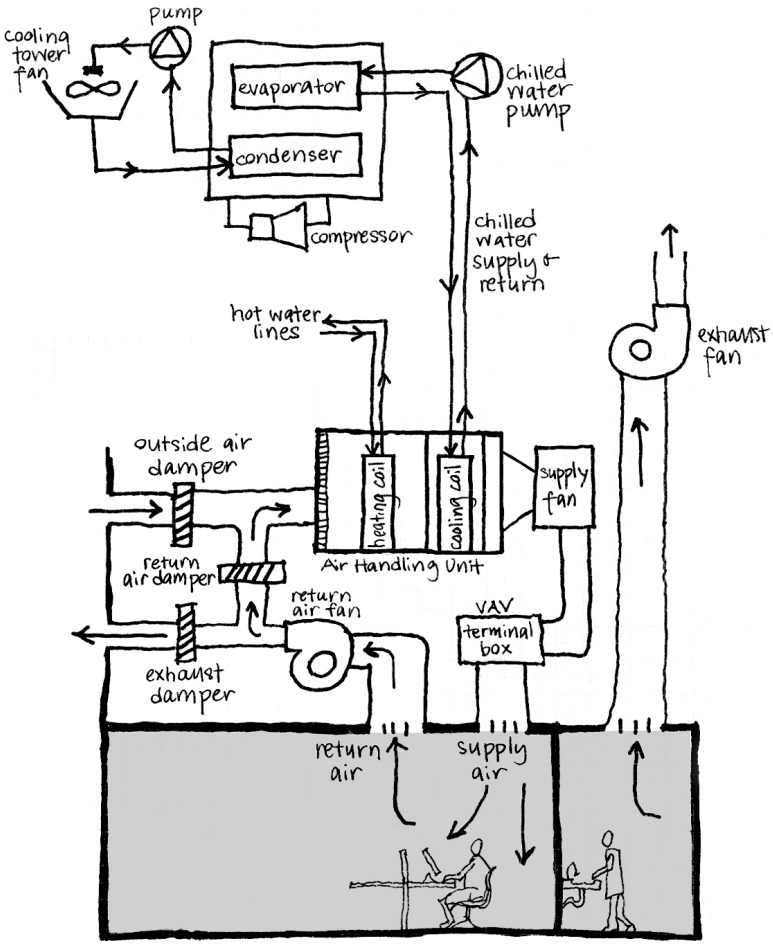
- **Filter Change**
  Use 2" pleated filters: they have a longer life and provide better filtration than fiberglass filters. Be sure to seal all areas of "air-bypass" around or between air filters. The frequency of changing filters can be set by matching the air pressure drop across the filter with manufacturer's recommendations.

- **Coils**
  Cleaning Schedule: Condenser coils are typically cleaned once or twice per year, but this can vary greatly with the environment. Plantings or construction activity nearby the coils could dictate monthly cleaning. On light commercial units, often the coil must be separated and cleaned between multiple layers. Failure to do this can result in higher than normal system pressures and temperatures, which can shorten equipment life and reduce efficiency. If filter changes are routine, evaporator coils should only be cleaned once per year. In a clean environment, the evaporator coil might need cleaning only once every two years. **Method:** Use water or a mild detergent to clean the condenser and evaporator coils. Do not use a pressure washer or acid-based cleaner. Add pan tabs to prevent slime and mold build-up. Slime can clog system drains and cause drain pan overflows, which lead to water damage and mold growth.

- **Variable Air Volume (VAV) Boxes**
  Inspect annually for proper damper position. A damper out of calibration will cause an area to overheat or overcool. A VAV with electric heat does not need a filter; however, if it has a hot water coil, it should have a return air filter. This filter is typically changed once per year.

- **Ducts and Grilles**
  Ducts are usually a zero-maintenance item. If black, dust-like particles start coming from the grilles, this indicates loose or dirty insulation. In a clean office environment, this might happen every 15 years.

ENERGY



Central HVAC System with Water-Cooled Chiller

Energy Conservation Website:
US DOE Energy Efficiency Information Page:
http://www.eere.energy.gov/EE/buildings.html

MAINTENANCE OF A LARGE COMMERCIAL HVAC SYSTEM

- Equipment for a typical water-cooled system includes reciprocating, helical rotary (screw) and centrifugal chillers cooled by an open or closed condenser water loop.
- An onsite employee should do a daily inspection as recommended by the system manufacturer.
- Thorough inspections should be performed by factory-trained technicians four times per year. These usually include three running inspections and one stop inspection. This schedule could vary depending on the age of the system or the customer's comfort level and expertise.

Annual inspection typically includes:

- Check for refrigerant leaks and clean tubes.
- Check electrical system and lubrication system.
- Analysis of oil and refrigerant for contaminants.
- Check for unusual vibrations or alignments.
- Check water and refrigerant pressures.

HVAC maintenance information provided by Scott Schomburg and Guy Gibson of Hunton Trane Services.

Other Energy Conservation Measures

The following energy efficiency strategies are cost effective for certain existing buildings.

Turn off computers at the end of the day.

- You can save 200 to 300 kilowatt-hours per year for each computer turned off versus keeping computers on all the time. This is $20-$30 per computer per year.

Purchase flat screen/LCD monitors.

- A 17" CRT monitor uses about 89 watts, while an LCD monitor uses 35.

IT'S A MYTH

that it takes more energy to start a computer than to keep it running. You will always save energy by turning your computer off when you're not using it. Turning just one computer off at the end of each work day can save up to 600 pounds of greenhouse gas emissions over the course of a year.

CHECK OUT THESE WEBSITES

if you are upgrading your facility's windows:

www.efficientwindows.org

www.nfrc.org

Install spectrally-selective film on unprotected windows to block solar gain and reduce cooling loads.

- Use Low Solar Gain, Low-e coatings in humid subtropical climates. Look for:
  - **Visible Light Transmittance (VT)—** This measures how much light is transmitted. Use 70 to 80% if the window is well-shaded, or 40 to 60% if it is not.
  - **Solar Heat Gain Coefficient (SHGC)—** This measures how well a product blocks heat caused by sunlight. SHGC should be as low as possible below 40%.
  - **The ratio of VT to SHGC** should be as high as possible over 1.0.

Install CO_2 monitors. Demand-controlled ventilation using CO_2 monitors can reduce ventilation based on actual occupancy of a space. This saves money and energy.

- CO_2 monitors measure carbon dioxide concentrations in a building, allowing you to track occupancy and the rate of outdoor air ventilation required.
- CO_2 monitoring makes sense in the following situations:[5]
  - In hot humid climates, where approximately half the energy used in the HVAC system is used to remove moisture from the air. Reducing the ventilation load in this situation will produce considerable savings.
  - Buildings with variable occupancies. These can include offices, classrooms, and assembly spaces.

The Satterfield & Pontikes headquarters building provides daylight and views to 100% of its occupants by using interior glass walls on perimeter offices and low partitions in the central work areas.*

**The Satterfield & Pontikes building is the 1st in Houston to achieve a LEED® Gold rating and a LEED® Core and Shell Certification.*

daylight & views at a glance

- ☑ Use space planning to introduce daylight.
- ☑ Bring in direct natural light at the highest window level possible.
- ☑ Use color to reflect light.
- ☑ Avoid direct sunlight at occupant level.
- ☑ Provide views over workstation partitions.
- ☑ Use vision glass at offices on the perimeter of a building.
- ☑ Provide views of trees or landscaping.

DAYLIGHT AND VIEWS

ON A PER SQUARE FOOT BASIS,

the average office spends 72 times as much money on people as on energy. Therefore, even a tiny improvement in productivity or reduction in absenteeism can boost a company's bottom line more than eliminating energy costs altogether.[6]

DAYLIGHT

has as much explanatory power in predicting sales in retail facilities as other more traditional measures of retail potential, such as parking area, number of local competitors, and neighborhood demographics.[7]

Daylight

People almost universally prefer daylit spaces to artificially-lit spaces. Studies have shown that productivity increases in daylit spaces.

Wherever possible, use good space planning to introduce daylight to the interior of your facilities.

- Keep offices and large furniture away from perimeter walls to allow natural light into the interior of buildings.
- Use open plan workstations.

Allow direct natural light to enter at the highest window level possible.

This will throw light to the rear of an interior space and help prevent glare.

- Consider top-down, bottom-up blinds or light shelves to allow direct sun in only at the top of windows where it is most useful.

Carefully consider color and material choices.

- Don't use large areas of dark color. Walls facing windows should be light-colored, with a Light Reflectance Value of 50% or above. Paint samples should list LRV.
- Ceilings should be white or off-white.
- Use light-transmitting materials like glass wherever possible.

Avoid direct sunlight at occupant level.

- It causes thermal discomfort and glare.

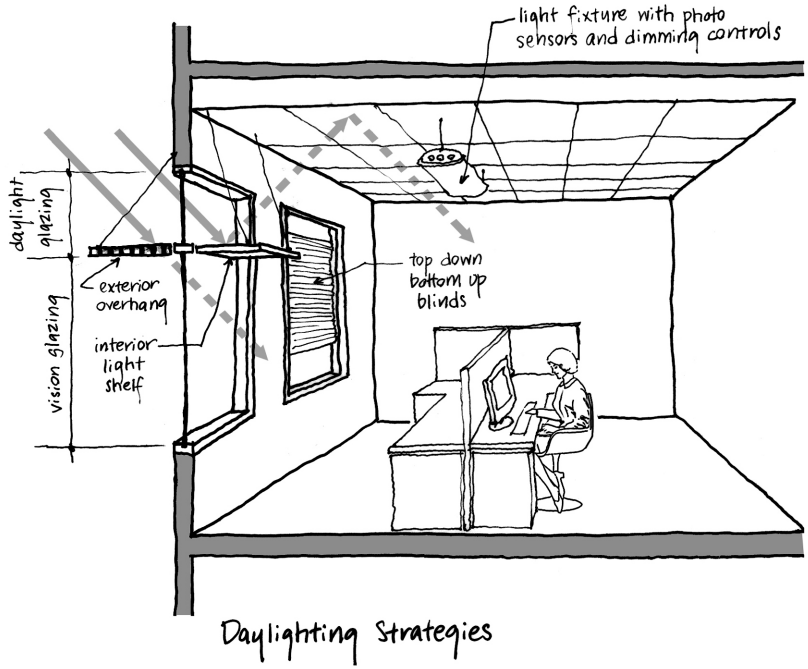


Diagram illustrating daylighting strategies for a typical office floor.

Properly designed and implemented daylighting strategies can reduce electricity use for lighting by 50 - 80%.[8]

DAYLIGHT AND VIEWS

STUDIES HAVE SHOWN

that patients in rooms with tree views have statistically shorter hospital stays and less need for pain medication compared to those with no views.[9]

WORKERS

in the Call Center at the Sacramento Municipal Utility District process calls 6% to 12% faster when they have the best possible view compared to those with no view.[10]

Where possible, use west-facing spaces for service areas. Service areas include storage rooms, janitor closets and windowless restrooms.

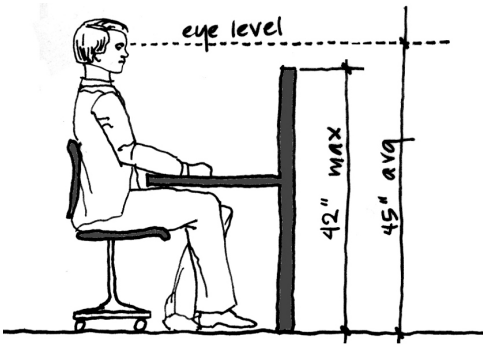
- Western exposures receive direct sunlight in the afternoon when the sun is at its hottest. This makes them thermally uncomfortable.

Views

Providing views has been shown to have a significant impact on the satisfaction, productivity, and health of building occupants.

Ensure views from regularly occupied workstations.

- Construct walls or partitions with a maximum height of 3'-6".



Use vision glass at the front of perimeter offices.

Provide views of trees or landscaping.

Efficient irrigation and the use of native and adaptive landscaping allows the SpawGlass Corporate Office to use 52% less water outdoors.*

**The SpawGlass Corporate Office is the 1st LEED® Certified building in Houston, Texas, and achieved a Silver rating.*

site & landscaping at a glance

- ☑ Plant native or well-adapted species.
- ☑ Minimize turfgrass.
- ☑ Avoid synthetic chemical fertilizers.
- ☑ Plant perennials.
- ☑ Plant shade trees.
- ☑ Maintain groundskeeping equipment properly.
- ☑ Care for turfgrass appropriately.
- ☑ Minimize stormwater runoff.
- ☑ Reduce the heat island effect.
- ☑ Use micro irrigation.
- ☑ Check irrigation timing.
- ☑ Maintain irrigation equipment.
- ☑ Install moisture sensors.
- ☑ Check exterior light levels on your property.
- ☑ Use timers on outdoor lights.
- ☑ Choose non-polluting light fixtures.

SITE AND LANDSCAPING

Vegetation

Choosing the right vegetation for your site will save money on maintenance and irrigation, and will help to create a healthy ecosystem.

Plant native or well-adapted species.

- They will use less water and be easier to maintain.

Minimize turfgrass.

- Reduce or replace areas of turfgrass with native grasses, groundcover, or shrubs.

WHAT'S WRONG WITH TURFGRASS?

Lawns occupy roughly 50 million acres in North America—that's an area 40% of the size of Texas.

Americans use 3-6 million tons of fertilizer on lawns every year. Nitrogen fertilizers are extremely energy-intensive to make, using 18,000 BTUs of energy per pound.

Watering lawns consumes 30% of municipal freshwater in the eastern US, and 60% in the western US. In urban areas of Texas, 40-60% of the water supply is used for landscape watering.[11]

The 90 million lawnmowers, weed trimmers, and other small engine lawn and garden tools in the US produce 5% of the nation's air pollution.[12] A conventional lawnmower pollutes as much in an hour as a car does driving 100 miles.[13]

US lawns receive heavier pesticide applications than agricultural land: between 3.2 and 9.8 lbs/acre vs. an average of 2.7 lbs./acre for agriculture.[14] Americans spray 70 million pounds of pesticide on lawns each year.[15]

Stormwater runoff from turf is one of North America's biggest sources of water pollution.[16]

FOR A LISTING OF NATIVE PLANTS
and nurseries in your area, see www.plantnative.com

Use mulch, organic fertilizers, and compost instead of synthetic chemical fertilizers.

Synthetic chemical pesticides are detrimental to the health of organisms in the soil. As soil organisms die over time, plants are deprived of required nutrients.

- Use only high-quality compost; it is fully decomposed and has no odor. Spread 1/6" to 1/2" thick once a year in spring or early summer. Apply manure-based composts sparingly.[17]

Perennials with staggered bloom cycles require less water and maintenance than annuals.

- Check out these books for lists of native Southeastern and Gulf State perennials and advice about landscaping with them:
  - Howard Garrett. Howard Garrett's Plants for Texas
  - Samuel Jones and Leonard Foote. Native Shrubs and Woody Vines of the Southeast
  - Sally and Andy Wasowski. Gardening with Native Plants of the South

When fertilizers wash into surface water, they stimulate the growth of algae. When the algae decays, it robs ecosystems of oxygen through a process called eutrophication, killing aquatic life.[18]

Use trees to mitigate climate conditions.

- Trees may be planted to protect the eastern and western façades of a building from sun.

RECOMMENDED TURFGRASSES FOR SOUTHEASTERN & GULF COAST STATES

	Native	Mowing Height	Sun Requirements
St. Augustine		2 1/2 - 3 1/2"	Partial shade
Buffalograss		2 1/2 - 3"	Partial sun
Seashore Papsalum		<1"	Full sun
Bermuda		1 - 1 1/2"	Full sun
Zoysia		1 - 1 1/2"	Partial shade
Centipede		1 - 2"	Partial sun

(source: Texas A&M Turfgrass Program)

- Suitable native deciduous shade trees to plant in Gulf Coast and Southeast Atlantic states:

  - Drummond Red Maple
  - River Birch
  - Pecan
  - Black Gum
  - White Oak
  - Bur Oak
  - Swamp Chestnut Oak
  - Willow Oak
  - Shumard Red Oak
  - Live Oak
  - Hackberry
  - Magnolia
  - Texas Ash
  - Cedar Elm

For more information
about the heat island effect, see the EPA Heat Island Effect website: www.epa.gov/heatisland

Groundskeeping

Check that your lawn maintenance professionals clean and sharpen groundskeeping equipment once a week.

For healthy turfgrass, take the following steps:

- No more than 1/3" of the grass blade should be removed in one mowing.
- Use a mulching lawnmower.
- Allow grass to grow a little longer; longer grass is healthier and retains moisture better.

Dull blades can tear grass and make it more vulnerable to pests and disease.

Minimize stormwater run-off.

- Eliminate unneeded paved areas.
- Use pervious paving.
  - It acts as a stormwater filtration system, removing suspended solids and phosphorus from stormwater.
  - Pervious pavement is ideal for low-traffic areas like parking lots and sidewalks.

Reduce the heat island effect.
Urban areas are paved with surfaces that tend to absorb solar radiation, raising the average temperature of the city. This is known as the heat island effect.

HOUSTON'S URBANIZED AREAS ARE HOTTER

than surrounding rural areas by 6° F to 8° F. These higher temperatures contribute to air pollution and higher energy costs. Roads, buildings, and other hard surfaces absorb and retain heat, leading to surface temperatures 50 °F to 70 °F hotter than surrounding areas.[19]

DRIP IRRIGATION

may use less than half of the water of conventional systems, and often produces faster, healthier plant growth.[20]

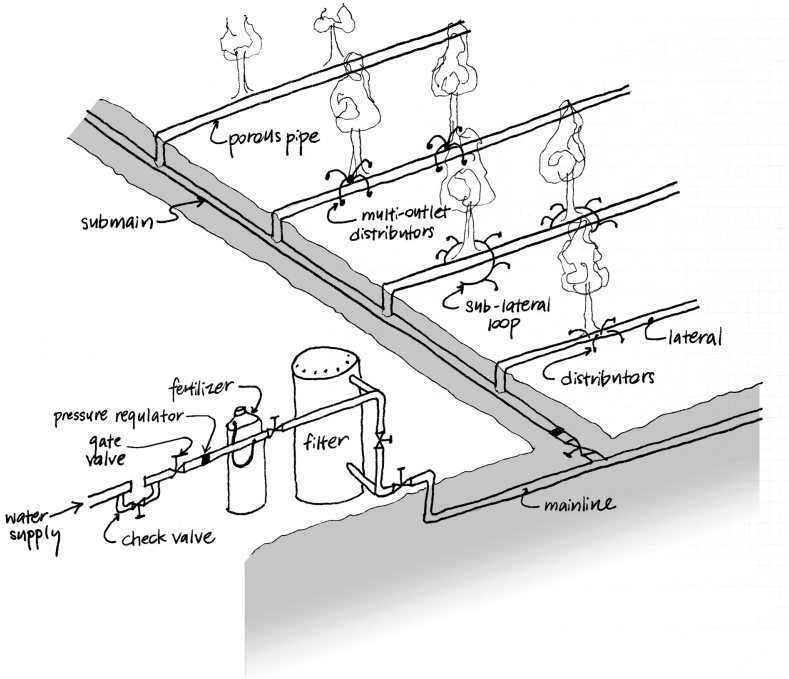
TO DETERMINE

how much irrigation is needed for your landscape, use the calculators at the Texas A&M Irrigation Technology Center website: http://texaset.tamu.edu

- Use pervious paving or pavement with 30% or greater reflectance to counter the heat island effect.
  Appropriate paving includes the following:
  - Light-colored cement concrete
  - White topping over existing concrete
  - Interlocking concrete pavers
  - Cool asphalt
  - Lattice pavers filled with gravel or turf grass

Irrigation

The following strategies will conserve water.



A Typical Drip Irrigation System

Use micro irrigation.

- Micro irrigation, such as drip and bubbler systems, releases water just where it is needed.
- Drip systems are buried a foot or more into the ground, and supply water directly to a plant's roots.
- Slow release and targeted application minimize water wasted through evaporation and runoff.
- Costs are comparable to sprinkler systems.

ANNUAL IRRIGATION CHECKLIST

- Check time and schedule operation.
- Check sprinkler system.
  - Observe the spray patterns and position of the sprinklers for clogged or misaligned heads.
  - Clean and replace filter screens if necessary.
  - Leaks and misting from sprinkler heads may indicate high water pressure problems. These may be corrected by plumbing a pressure regulator into the sprinkler system.
- Check drip system.
  - Replace clogged emitters. Add a water filter if the system does not have one.
  - Check the placement of emitters. Emitters should be at the edge of the root-ball on new plantings and at the drip line (edge of foliage) of established plants.
  - Check for emitters where tubing has popped off because of high pressure, and install a pressure regulator if needed.
  - Missing and broken emitters must be replaced to keep the system running efficiently.
- Check irrigation controller.
- Check automatic valves.
- Flush the system.
  - Remove the last sprinkler head in each line and let the water run for a few minutes to flush out any dirt and debris. Replace the sprinkler heads and turn the system on, running one valve at a time.

Schedule irrigation appropriately.

- Adjust irrigation timing at least monthly to account for seasonal weather changes.
- Deep, infrequent irrigation is best for the overall health of turfgrass. It reduces disease, helps insure good air movement down to the root system, and conserves water. Apply enough water to wet the soil to a depth of six (6) inches.
- The best time to irrigate is early morning.

Maintain irrigation equipment.

- Examine the irrigation system for damage or malfunction monthly.
- Have landscaping company perform an annual irrigation system check. (See checklist.)

Install moisture sensors.

- Make sure your system includes a rain sensor, an inexpensive device that turns off irrigation when it rains.
- The most efficient sensor is an in-ground moisture sensor. These are the most expensive, but will save the most water by preventing irrigation when the soil moisture level is adequate.

Site Lighting

The following strategies will help eliminate light pollution and trespass.

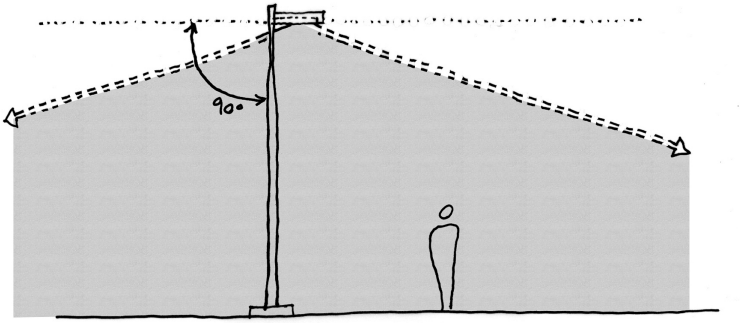
Provide the lowest light levels required to address safety, wayfinding and identification.

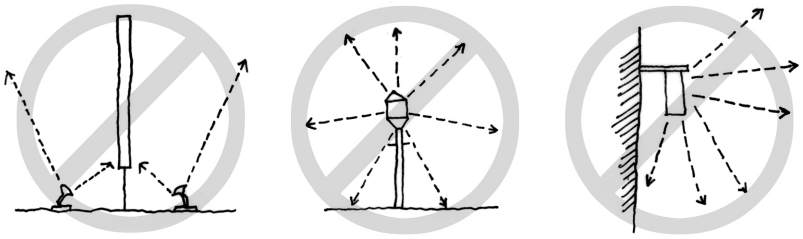
- Direct light fixtures to light only the desired surface.
- An average horizontal illuminance of 3 footcandles is an appropriate amount of light to secure a property.

Use timers to turn off outdoor lights at hours when they are not needed, where safety concerns allow.

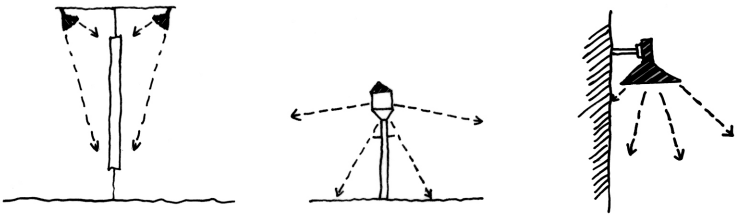
Choose light fixtures with the following qualities:

- Full cutoff fixtures that ensure that no light escapes above the plane of the horizontal.
- Opaque reflectors that direct light downwards.





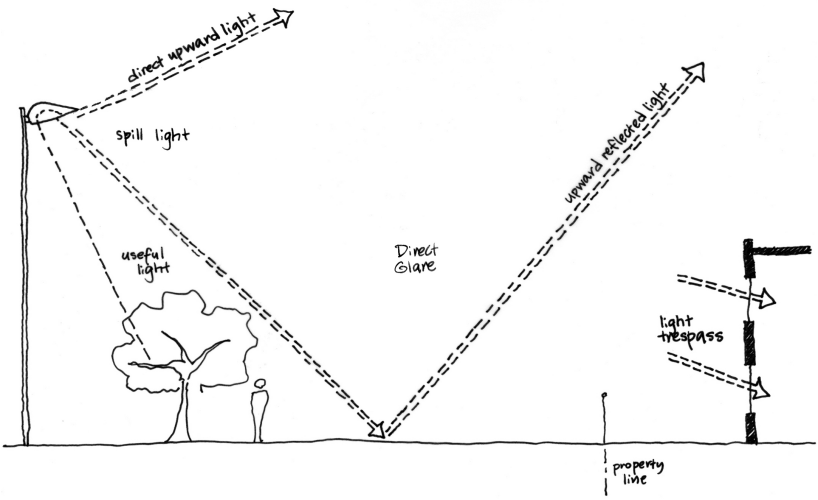
POLLUTING light fixtures



NON-POLLUTING light fixtures

What is Light Pollution?

Light pollution is caused by any electric lighting that has the potential to cause adverse effects to humans, the ecosystem, or the nighttime environment. These adverse effects include glare, compromised visibility, light trespass, visual clutter and confusion, energy waste, and sky glow.



Light pollution from a typical street lamp

Site Lighting Website:
International Dark Sky Association: www.darksky.org

WHY LIGHT POLLUTION MATTERS

Light pollution competes with the light from the stars. Even in a rural village, artificial light is likely to be twice the brightness of the night sky; in a typical suburb, light pollution may exceed the night sky brightness five-fold, and in a moderate-sized city, the difference is 20- to 25-fold.[21]

Light pollution presents a potent threat to professional astronomy. Many advances in astronomy require observations of very faint objects that must be studied with large telescopes located well away from population centers. Most of these observations of cosmological interest deal with extremely remote sources: galaxies or quasars at such great distances that their light has traveled for billions of years. This light can then be lost in the glare of our civilization in the last 1/1000 of a second of its journey.[22]

Birds are attracted to light. Lights left on at night can cause birds to become disoriented and fly into windows, or trapped by a beam of light and unable to land, birds can become exhausted and literally drop to the ground. Studies suggest that between 100 million and one billion birds die each year in the US as a result of striking windows.[23]

The International Dark Sky Association estimates one billion dollars in energy costs and 23 million barrels of oil are wasted each year in the United States due to light trespass, pollution, and glare.[24]

Image of the US at night showing areas of light pollution

Water-saving plumbing fixtures installed at the offices of Horizon Wind Energy reduce water use by 43% over conventional fixtures.*

**Horizon Wind Energy is the 1st interior space in Houston to achieve LEED® for Commercial Interiors Certification, and earned a Silver rating.*

water at a glance

- ☑ Identify and repair leaks.
- ☑ Retrofit older plumbing fixtures to reduce water use.
- ☑ Install low-flow and sensor-activated fixtures.

WATER

Interior Water Use

There are many ways to increase water efficiency in your facility. Take the following steps to save money on water bills and help recharge natural watersheds.

Identify and repair leaks.

Retrofit older plumbing fixtures to reduce water use.

- Install low-flow aerators on lavatory and sink faucets. The Bricor B15-16 DTK aerator goes down to .375 gpm. Be sure to check that water pressure is compatible with the aerator you purchase.
- Flush valve toilets may be retrofitted with dual flush valves. See below for more information.
- Replace showerheads with low-flow showerheads using 2 gallons per minute or less.
  - Bricor **1.0 or 1.5 gpm** Showerheads. 830 624 7228. Cost is $55 for the B100MAX 1.0 gpm showerhead, and $60 for the B150CH-R 1.5 gpm showerhead.
  - Delta **1.6 gpm** H_2Okinetic Showerhead. 800 345 3358. Cost is $50.

When replacing plumbing fixtures, install low-flow and sensor-activated fixtures.

- **Low-Flow Faucets**
  - The Energy Policy Act of 1992 established **2.5 gallons per minute** as the maximum flow rate for faucets.
  - Aerators are available to reduce flow to as low as .375 gpm.
  - Sensor-controlled faucets save water by automatically turning on and off only when the sensor is triggered.
  - Toto **EcoPower** sensor faucets deliver .5 gpm with a 10-second cycle time. The sensor battery is charged by the water itself. Costs are comparable to other industry sensor faucets. 888 295 8134.
  - Sloan **Optima Solis** Solar-Powered sensor faucets deliver .5 gpm. The solar cell powering the sensor battery is charged by either sunlight or fluorescent light. Costs are 15-20% more than Sloan non-solar sensor faucets. 800 982 5839.

- **Low-Flow Toilets**
  - The Energy Policy Act of 1992 established **1.6 gallons per flush** for toilets.
  - Low-flow toilets use **1.28 gpf** or less. Toilet water usage can be reduced by 30% by making this change.
  - Low-flow toilets have improved their flushing power to equal the efficacy of 1.6 gpf toilets. They are available in both floor-mounted and wall-mounted models.
  - Both tank type-toilets and flushometer valves are available in low-flow versions.

Water Use Websites:
EPA water issues site:
www.epa.gov/OW/
American Waterworks Association:
www.awwa.org

- **Flushometer Valves**
  - These valves allow a typical flush as well as one that uses 30% less water, depending on whether it is pulled up or down.
  - Sloan ECOs automatic dual flush flushometer or Sloan UpperCut manual dual flush flushometer. 800 982 5839.
  - Zurn **dual flush** flushometer. 800 997 3876.

- **Low-Flow Tank Toilets**
  - Turbo **Capizzi.** Pressure-assisted toilet using 1 gallon per flush. 866 250 8833.

LEAKS

account for almost 14% of water use in homes.[25]

AMERICANS

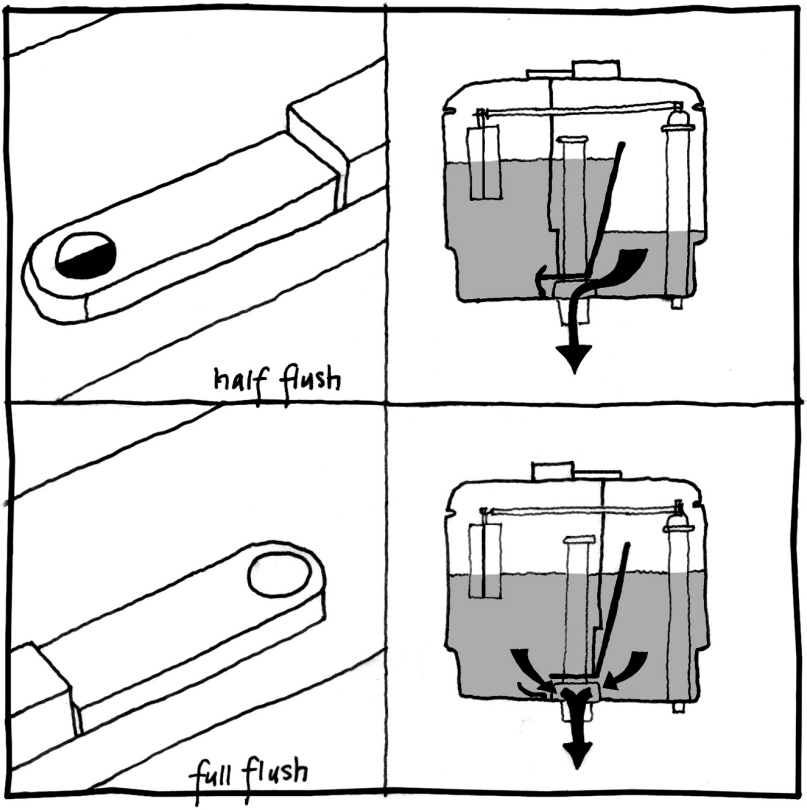
extract 3,700 billion gallons of water per year more than they return to the natural water system to recharge aquifers and other water sources.[26]

FOR TESTING

research on the flushing performance of various toilets, check out the **Maximum Performance (MaP) Testing of Popular Toilet Models** study, conducted by Veritec Consulting and Koeller and Company for American and Canadian municipal water companies.

- **American Standard Fontaine.** Pressure-assisted toilet using 1 gallon per flush. 800 442 1902.

- **Dual-Flush Tank Toilets**
  - A dual-flush toilet has one button that triggers a **1.6 gallon** flush and another button that triggers a .8 - 1.1 gallon flush.
  - Caroma **Caravelle** and **Reflections** toilets provide a choice of **.8**



Flushing mechanism for Caroma Dual-Flush toilet

and **1.1 gallon** flushes. Prices are comparable to non dual-flush toilets. 800 605 4218.
    - Toto **Aquia** has a high flush of 1.6 gpf and a low flush of .9 gpf 770 282 8686

- **Waterless Urinals**
    - Waterless urinals do not use water and have no flush valves. This can save considerable water and maintenance.
    - Models are typically available in fiberglass and vitreous china.
    - Check local code requirements, as some jurisdictions do not allow waterless urinals.
    - Cartridge-based models must have a cartridge replaced every 5,000 - 7,000 uses. Costs start at $300. Manufacturers include the following:
        - Waterless No-Flush Urinals. Cartridge replacement is $5.50 per unit plus $5 labor every 6,000 uses. 888 663 5874.

Plumbing Fixture Manufacturer Websites:
www.sloanvalve.com
www.bricor.com
www.oxygenics.com
www.totousa.com
www.americanstandard-us.com

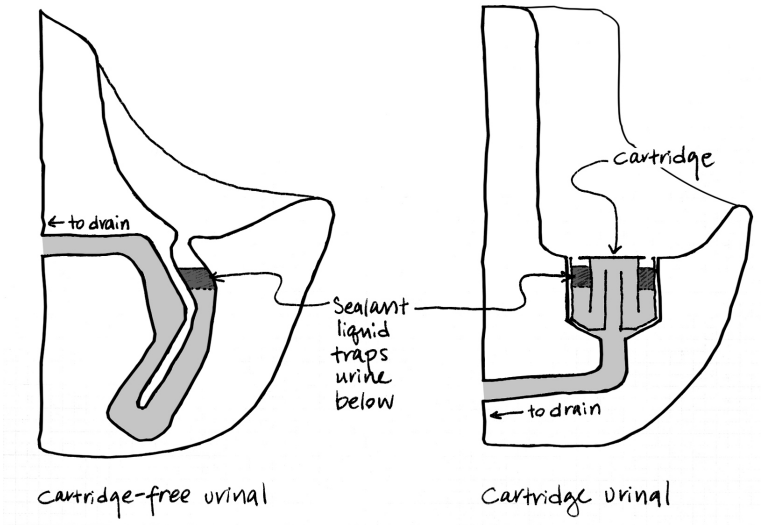
Low-Flow Toilet Manufacturer Websites:
www.capizzi.com
www.mansfieldplumbing.com

Dual-Flush Toilet Manufacturer Websites:
www.zurn.com
www.caromausa.com
www.gerberonline.com

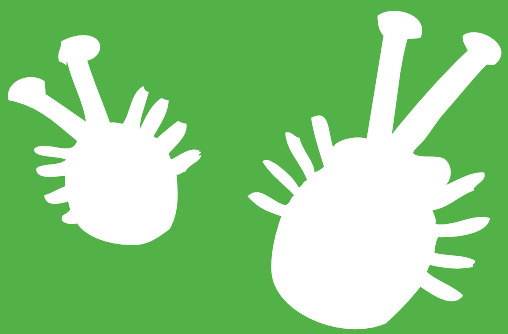
Waterless Urinal Manufacturer Websites:
www.waterless.com
www.falconwaterfree.com
www.sloanvalve.com
www.duravit.com

  - Falcon **Waterfree** Urinals. Cartridge replacement costs $35 per unit plus $5 labor, every 7,000 uses. 866 275 3718.
  - Sloan **Waterfree** Urinals. 800 982 5839.
- Non-cartridge-based models have an internal ceramic siphon that must be flushed out once a month. They can be up to 2 times as expensive as cartridge models, but will be cheaper to maintain.
  - Duravit **Dry.** 888 387 2848.
  - Kohler **Steward.** 800 456 4537.

- **Low-flow Urinals**
  - If waterless urinals can't be used, low-flow urinals are a good option.
    - Many manufacturers make urinal flush valves that will flush with 1/2 gallon or less. These include the **AEF-801 Dualflush** by AMT Corporation and the **8186-0.5** valve by Sloan.
    - Zurn One **Small Pint** Ultra Low Consumption Urinal System. This urinal and valve with automatic sensor delivers 1/8 gpf. 800 997 3876.



Types of waterless urinals



Kirksey utilizes Integrated Pest Management to control insects indoors and out.*

**Kirksey's office building is the 1st in Texas to earn LEED® Existing Building Certification.*

pest management at a glance

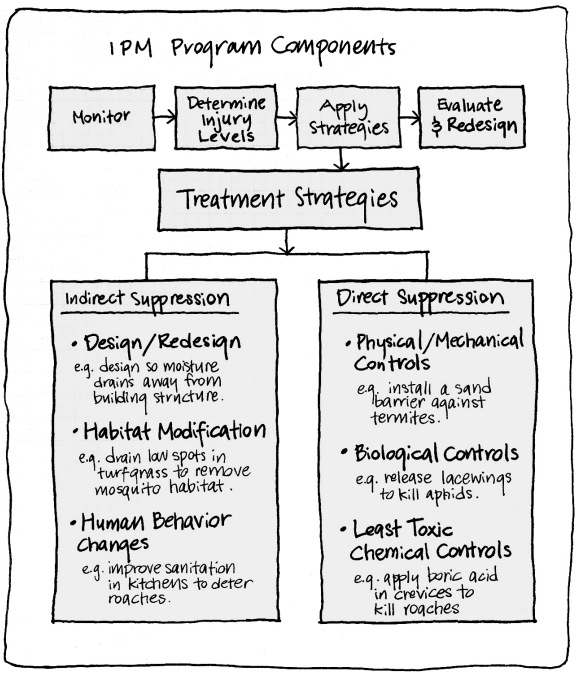
- ☑ Use Integrated Pest Management.
- ☑ Inspect for pests frequently.
- ☑ Make your building less attractive to structural insects.
- ☑ Keep the interior of the building clean and dry.
- ☑ Use the least toxic pesticides required.
- ☑ Apply pesticides with care.

PEST MANAGEMENT

Monitoring and Prevention

Pest populations can be controlled with methods that are not damaging to human health.

Use Integrated Pest Management (IPM), an alternative approach to controlling pests that emphasizes regular monitoring and prevention.



(source: Common Sense Pest Control. Olkowski, Daar, and Olkowski)

Pest populations should be monitored with frequent inspections and traps.

- Collect data on pest populations with traps. This will tell you if you have pests, where they are concentrated, and where pest management activities have succeeded.

Control structural pests such as termites, carpenter and fire ants, and woodboring beetles.

- Make sure there is no wood in contact with soil.
- Make sure soil surface slopes away from buildings to carry water away from the foundation.
- Check for damaged or poorly fitting windows, doors and sills.

Keep outdoor pests out.

- Caulk and seal building points of entry.
- Trim landscaping to keep it 18" away from the building façade.
- Dispose of food waste in rodent-proof dumpsters.

Prevent the growth of indoor pests.

- Keep work areas and garbage areas clean and dry.
- Caulk and seal cracks and crevices where roaches hide.
- Place food waste in sealed plastic bags.
- Repair leaky plumbing fixtures.
- Rinse food containers before placing them in recycling bins.

Educate building users.

- Provide information to employees about how to properly dispose of waste and store food.

REDUCING PESTICIDES

in Minnesota Schools, a two-year pilot project, showed that it is feasible to implement Integrated Pest Management without incurring additional costs.[27]

OVERUSE OF PESTICIDES

may cause problems, such as

- killing beneficial organisms that would otherwise help control pests
- promoting the development of pesticide resistance
- resurgence of pest populations
- contamination of the environment

EPA Guide to Integrated Pest Management in Schools:
www.epa.gov/pesticides/ipm

Beyond Pesticides, a National Coalition Against the Misuse of Pesticides
www.beyondpesticides.org

Treatment

If you do have a pest problem, there are safer ways to address it.

SELECTED LEAST TOXIC PESTICIDES

Pesticide	Type	Pest	Method of Action
Silica Gel	Insecticidal Dust	Cockroaches, ants drywood termites	Dehydration
Diatomaceous Earth	Insecticidal Dust	Cockroaches, ants drywood termites	Dehydration
Boron	Insecticidal Dust	Cockroaches, ants	Stomach Poison
Insecticidal Soap	Liquid (based on petroleum or natural oils)	Soft bodied plant pests; aphids, adelgids, mealybugs	Dissolves outer body of insect
Horticultural Oils	Liquid	Aphids, beetles, caterpillars	Smothering
Pyrethrum	Botanical Powder	Ants, aphids, beetles cockroaches, flies, mosquitoes	Paralysis
Limonene & Linalool	Citrus Peel Extract	Fleas, aphids, mites, fire ants	Paralysis

(source: Common Sense Pest Control. Olkowski, Daar, and Olkowski)

Use the least toxic pesticides required.

- Less toxic pesticides are listed in the chart opposite. Remember that all pesticides can be dangerous, and should be handled with gloves and eye protection.

Avoid these pesticides:

- Pesticides with ingredients labeled by the US EPA as probable, likely, or known carcinogens or endocrine disruptors.
- Mutagens, reproductive toxins, developmental neurotoxins, or immune system toxins.
- Pesticides classified by the US EPA as having a toxicity of I or II.
- Pesticides in the organophosphate or carbamate chemical family.
- Pesticides containing inert ingredients categorized as List 1: Inerts of Toxicological Concern.

Signal Word	Toxicity	Oral Lethal Dose
Danger	Highly toxic	Few drops to 1 teaspoon
Warning	Moderately toxic	1 teaspoon to 1 tablespoon
Caution	Low toxicity	1 ounce to more than 1 pint

(EPA Pesticide "Signal Words")

Apply pesticides with care.

- Inform employees in advance of pesticide applications.
- Locate areas of pest concentration, focusing treatment there and in adjacent areas.
- Avoid applying pesticides using broadcast spray, dust, tenting or fogging.
- Do not spray pesticides when using baits. Spray pesticides will repel insects, while the baits are intended to attract them.
- Take note of the label. All traditional pesticides are labeled with one of three signal words to indicate degree of toxicity. (See chart above).

BAITS & TRAPS

are preferable to sprays. Fumigants are among the most toxic pesticides.

CHILDREN

who have been exposed to household insecticides and professional extermination methods within the home are three to seven times more likely to develop non-Hodgkin's lymphoma (NHL) compared with children who have not been exposed to pesticides.[28]

Resources to use for research on pesticides:

Material Safety Data Sheets (MSDS) contain information about toxicity, including the EPA carcinogenicity rating.

The Extension Toxicology Network has pesticide information profiles, including EPA classification and detailed toxicological information. http://extoxnet.orst.edu/

EPA List of Inerts of Toxicological Concern: www.epa.gov/opprd001/inerts/fr54.htm

Kirksey's tree planting efforts have offset 200,000 pounds of carbon emissions.*

**Kirksey's office building is the 1st in Texas to earn LEED® Existing Building Certification.*

transportation at a glance

- ☑ Make it easier for employees to bicycle, walk, or jog to work.
- ☑ Support carpooling.
- ☑ Encourage use of public transportation.
- ☑ Develop an incentive program for employees to use transportation alternatives.
- ☑ Buy alternative fuel vehicles.
- ☑ Maintain vehicles adequately.
- ☑ Make your building pedestrian-friendly.

TRANSPORTATION

TRANSPORTATION

sources contribute more than half of the man-made air pollution in the United States today. Motor vehicle emissions account for approximately 77 percent of the carbon monoxide (CO), more than 36 percent of the volatile organic compounds (including hydrocarbons), and 45 percent of the nitrogen oxides (NOx) in our nation's air.[29]

OIL EXTRACTION

lays waste to many fragile ecosystems, harming tropical forests in South America and Southeast Asia, deserts and wetlands in the Middle East, mainland US coastal areas, and the fragile tundra and arctic coastal plains of Alaska.

Alternative Transportation

Follow these steps to reduce the transportation impact of your facility — this will reduce air pollution, water pollution, and consumption of fossil fuels.

Make it easier for employees to bicycle, walk or jog to work.

- Provide a bike rack in the employee parking area.
- Provide showers.

RULE OF THUMB:
Provide one shower for every 8 users.

Support carpooling.

- Post a map showing where employees live and provide incentives for them to organize carpools.
- Reserve preferred parking spaces near the building entry for carpools.

Encourage use of bus and train lines.

- Post a transit map indicating nearby transit lines and schedules.
- If free parking is provided, subsidize transit costs.

Provide an incentive program to encourage employees to find alternative transportation to work.

- For example, Kirksey provides a free lunch for every five days an employee uses alternative transportation to travel to work.

Calculate your CO_2 Emissions at these websites:
http://www.epa.gov/climatechange/emissions/ind_calculator.htm
www.earthday.net/footprint
www.nature.org/initiatives/climatechange/calculator/

Fuel Economy Websites:
US DOE and EPA website about auto fuel economy, emissions, and air pollution: www.fueleconomy.gov
Alternative Fuels Data Center: http://www.eere.energy.gov/afdc/

When purchasing cars for company business, select highly fuel-efficient or alternative fuel vehicles.

- Alternative fuel vehicles
- Hybrid gas-electric
- Electric
- Compressed natural gas
- Biodiesel

Make maintenance a priority for company vehicles.

Make the space around your building pedestrian-friendly.

- Provide well-marked and lighted walkways with awnings if possible.
- Keep parking areas to the rear.
  - If you have a complex of buildings, utilize traffic calming measures. This will make foot travel much safer. Typical measures include the illustrations on the following page:

TRANSPORTATION

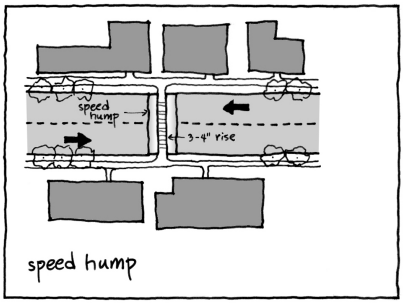
THE AVERAGE AMERICAN

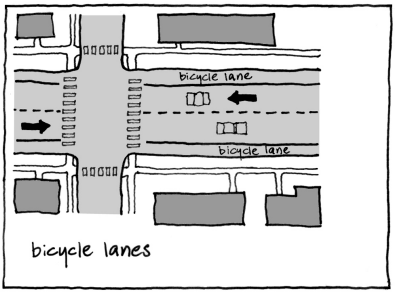
commutes 15 miles each way to work.[30]

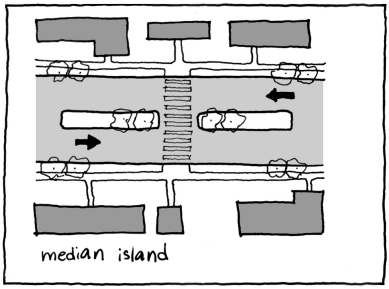
SAVE FUEL & MINIMIZE EMISSIONS

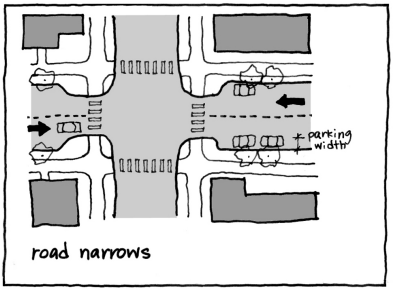
The Top 4 Things You Can Do:

- Have vehicles serviced regularly according to manufacturer recommendations.
- Properly inflate your tires.
- Don't top off the gas tank.
- Purchase low octane gas unless the manufacturer recommends otherwise.









Both Kirksey and the American Heart Association use non-toxic, Green Seal approved cleaning fluids and recycled content paper products and trash liners.

housekeeping at a glance

- ☑ Use non-toxic cleaning fluids.
- ☑ Clean carpets frequently.
- ☑ Don't strip and wax floors too often.
- ☑ Use an entryway walk-off system.
- ☑ Start a recycling program.
- ☑ Reduce waste.
- ☑ Use recycled-content products.
- ☑ Protect ductwork during renovation.
- ☑ Suppress dust.
- ☑ Prevent mold growth.
- ☑ Isolate construction areas.
- ☑ Use low-emitting materials.

Cleaning

Cleaning and maintenance supplies are a major source of indoor air pollution.

Unclean carpets capture a variety of particulate matter. Fine particles less than 2.5 microns in size are easily inhaled deeply into the lungs where they can remain embedded indefinitely.[31]

Use non-toxic cleaning solutions to protect the health of occupants and cleaning professionals.

- Use Green Seal (www.greenseal.org) certified cleaning fluids, detergents and soaps. They must meet stringent guidelines, including the following:
  - Minimal toxicity to human and aquatic life
  - Biodegradability
  - Minimal phosphates and no heavy metals

Care for carpets appropriately.

- Vacuum every 2-3 days in low- to medium-traffic areas.
- Use vacuum cleaners that meet the Carpet and Rug Institute (www.carpet-rug.org) Green Label standard, or that have HEPA

GREEN HOUSEKEEPING PRODUCTS USED BY KIRKSEY

(all of the following have Green Seal certification)

- Enviro Care, Low Foam All-Purpose Cleaner
- Enviro Care, Glass Cleaner
- Enviro Care, Neutral Disinfectant
- Enviro Care, Washroom Cleaner
- Green Solutions, Glass Cleaner
- Green Solutions, Neutral Disinfectant Cleaner
- Green Solutions, Carpet Cleaner

(High Efficiency Particulate Air) filters. They can remove smaller particles that can otherwise become airborne and enter the lungs.
- Check for spots daily and treat immediately. Start by blotting with water and cloths, and then move on to stronger chemicals only if needed.
- Perform carpet extraction regularly using equipment capable of removing enough moisture for carpets to dry in 24 hours.

Train maintenance staff to care for building finishes appropriately.

According to the US Bureau of Labor Statistics, 127 custodians were killed by cleaning products between 1993 and 2001.

- Make sure not to overuse detergent; this causes finishes to wear out prematurely.
- Follow recommended maintenance procedures for floor finishes. Many floors are stripped and waxed much more frequently than necessary; this releases toxins and is energy-intensive.

Protect occupants with an entryway walk-off system to capture dirt and particulates.

- The EPA recommends a three-part track-off entryway system, consisting

Dangerous chemicals used in cleaning solutions include:

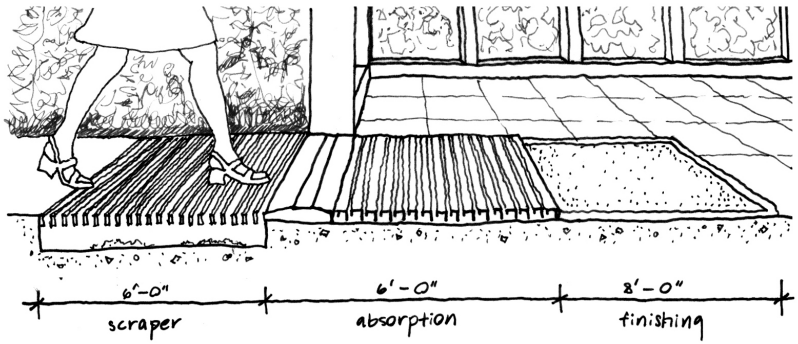
- sodium hypochlorite (in bleach): if mixed with ammonia, it releases toxic chloramine gas.
- petroleum distillates (in metal polishes): can damage the nervous system, skin, kidneys, and eyes.
- ammonia (in glass cleaner): can cause headaches and lung irritation.
- phenol and cresol (in disinfectants): can cause diarrhea, fainting, and kidney and liver damage.
- nitrobenzene (in furniture and floor polishes): can cause skin discoloration, shallow breathing, and vomiting, as well as cancer and birth defects.

of 20 feet of grating and matting. (See figure).

1. A scraper mat or grill installed outside the building.
2. A wiper/absorption mat that scrubs the shoes of people walking across. This stiff-bristled mat is typically in the entrance foyer.
3. A finishing mat installed after the wiper mat to remove residual dirt and dust.

- Provide for easy cleaning of exterior scraper mat or grate. It should be easily hosed off.
- Provide drainage for second wiper mat or grate where practical. Moisture from people's shoes can best be removed by setting the grate into a recessed floor space with drainage.
- Recycled content walk-off systems include the following:
  - Arden Architectural Specialties. **EnvIRONtread II**; http://www.ardenarch.com
  - **Milliken First Appearances** — http://www.firstappearances.com

80% of dirt is tracked into buildings on people's shoes.[32]



The amount of Volatile Organic Compounds (VOCs) emitted from a single waxing of a floor is comparable to the amount of VOCs emitted from the flooring itself over its entire life.[33]

RECOMMENDED INTERVALS FOR EXTRACTION CARPET CLEANING

Environment	Normal Interval	Special Condition	More Frequent Interval
Office	6-12 months	Ground level	3-6 months
Retail	3-6 months	Dusty Outside High Humidity	1 month 2 months
Schools	3-6 months	Dusty Outside	1-2 months
Restaurants	1 month	Dusty Outside High Humidity	1 week 2 weeks
Nursing Homes	1 month	High Humidity	1 week
Day Care	1 week	Epidemic	daily

(source: Protecting the Built Environment: Cleaning for Health), Berry

Waste

Follow these steps to reduce waste in your facility.

Start a recycling program.

- Designate well-marked collection areas for recyclables including newspaper, cardboard, glass, aluminum cans, and plastic.
- Provide office paper recycling bins at each employee's desk.

Look for ways to reduce waste and re-use resources before recycling.

- Dispose of food waste in central locations; individual desk trash-can liners can then be disposed of less frequently.
- Provide re-usable utensils and tableware in employee kitchens.

THE RECYCLING INDUSTRY

employs over 1.1 million people, generates an annual payroll of nearly $37 billion, and grosses over $236 billion in annual revenues in the US.[34]

PAPER PRODUCTS

account for 34% of the municipal waste stream.[35]

Use recycled-content disposable paper products and trash bags.

Search for recycled-content products:

www.ciwmb.ca.gov/rcp/Search.asp

The California Recycled Content Product Directory lists products from all over the country.

Minor Renovations

Take the following measures to protect indoor air quality during minor renovations.

Protect ductwork from dust while occupied spaces are being renovated.

- Follow the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) *IAQ Guidelines For Occupied Buildings Under Construction.*

Suppress dust.

- Confine indoor cutting and other dust-generating activities to one enclosed area.
- Use wetting agents or sweeping compounds to keep dust from becoming airborne.
- Clean up dust using wet rags, damp mops and vacuum cleaners with HEPA filters.

Prevent mold growth.

Mold growth will often occur when excessive moisture or water accumulates indoors. There is no practical way to eliminate all mold in the indoor environment; the way to control it is to control moisture. This is a high priority in hot, humid climates.

- Keep building materials dry. Take special care with absorptive materials like carpet, drywall, insulation, and wood.
- Do not use materials that have been damaged by moisture.

RECYCLED PRODUCTS USED BY KIRKSEY

(all of the following have Green Seal certification)

- EcoSoft Green Seal Toilet Seat Covers
  100% recycled content, 20% post-consumer, no pigments, inks, dyes or fragrance
- EcoSoft Green Seal Toilet Tissue
  100% recycled content, 20% post-consumer, chlorine-free, high capacity rolls
- EcoSoft Green Seal Towels
  100% recycled content, 40% post-consumer, non-toxic, no pigments, inks, dyes or fragrance
- PittPlastics Déjà Vu Trash Liners
  30% recycled content

Isolate construction areas from occupied areas.

- Provide a pressure differential between work areas and occupied areas. Work areas should have negative pressure, while occupied space should have positive pressure. Make sure that dropped ceilings in the construction area are not operating under negative pressure.
- Install air-tight barriers between work areas and occupied areas. Prevent foot traffic between them.
- Do not store construction materials in occupied areas.
- Temporarily seal transfer ducts, pipe chases, electrical chases and other openings with polyethylene sheeting.

Use low-emitting materials.
Low-emitting materials release minimal Volatile Organic Compounds (VOCs). VOCs are carbon compounds that readily become gas at room temperature.

GREEN SEAL REQUIREMENTS FOR LOW-VOC PAINT

	Interior	Exterior	Anti-Corrosive
Flat	50 g/L	100 g/L	250 g/L
Non-flat	150 g/L	200 g/L	250 g/L

A paint can be labeled "No VOC" if it contains less than 1 g/L, determined using EPA Reference Test Method 24.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT REQUIREMENTS FOR LOW-VOC ADHESIVES

Carpet	50 g/L
Carpet pad	50 g/L
Wood flooring	100 g/L
Ceramic tile	65 g/L
Drywall	50 g/L
Subfloor	50 g/L
Rubber flooring	60 g/L
VCT flooring	50 g/L
Cove base	50 g/L

South Coast Rule #1168, amended 7 January 2005

- **Select low-VOC paint**
  - All oil-based and most water-based paints off-gas VOCs after the paint is applied. As the paint dries, the solvent that holds the pigment and resin together evaporates. Low-VOC paints that compare well to premium paints include:
    - Benjamin Moore **Pristine EcoSpec**
    - Sherwin-Williams **Harmony**
    - PPG **Pure Performance**

Select low-VOC adhesives and sealants. (See chart).

Specify low-emitting carpets.

- Choose carpets that meet or exceed the requirements of the Carpet and Rug Institute's (www.carpet-rug.com) Green Label or Green Label Plus Indoor Air Quality Test Program. Green Label Plus is a more stringent standard.

Select low-emitting composite wood products.

Use composite wood and agrifiber products that contain no added urea-formaldehyde resins.

- **Plywood —** Urea-formaldehyde-free plywood can usually be purchased for a less than 5% premium over typical plywood.
  - Columbia Forest Products **PureBond**
  - Panel Source Plywood **Purekor**
- **MDF —** Urea-formaldehyde-free

EXPOSURE

to wood dust has long been associated with a variety of adverse health effects, including dermatitis, allergic respiratory effects, mucosal and nonallergic respiratory effects, and cancer.[36]

Mold exposure can cause stuffy nose, wheezing, and eye and skin irritation. It also may exacerbate respiratory allergies in people with asthma and cause mold infections in people with suppressed immune systems.[37]

MANUFACTURED HOMES

used to house the Gulf Coast residents after Hurricane Katrina were found to have formaldehyde concentrations 75 times the recommended maximum for US workers.[38]

MDF can be bought for a 25-30% premium over typical MDF.
  - Panel Source MDF **Purekor**
  - Sierra Pine **Medex** and **Medite II**
- **Particleboard**
  - Roseburg **Skyblend.** This is a wood-based particleboard with recycled wood fibers. The cost is approximately twice that of typical particleboard.
- **Sierra Pine Encore.**
- **Agricultural Fiberboard —** These urea-formaldehyde-free boards are made from wheat straw, a renewable material. There is a small premium for agricultural fiberboard board over traditional particleboard.
  - Environ Biocomposites **Biofiber Panels**
  - Meadowood Industries **Meadowboard**

The EPA considers formaldehyde a probable human carcinogen. Short- and long-term inhalation exposure to formaldehyde can result in respiratory symptoms, and eye, nose, and throat irritation. Studies report an association between formaldehyde exposure and lung and nasopharyngeal cancer.[39]

COMPOSITE WOOD MANUFACTURER WEBSITES:

www.choosecolumbia.com
www.panelsource.net
www.sierrapine.com
www.skyblend.com
www.environbiocomposites.com
www.meadowoodindustries.com

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