Respect Excellence
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THE ENVIRONMENTALLY RESPONSIBLE CONSTRUCTION AND RENOVATION HANDBOOK

SECOND EDITION

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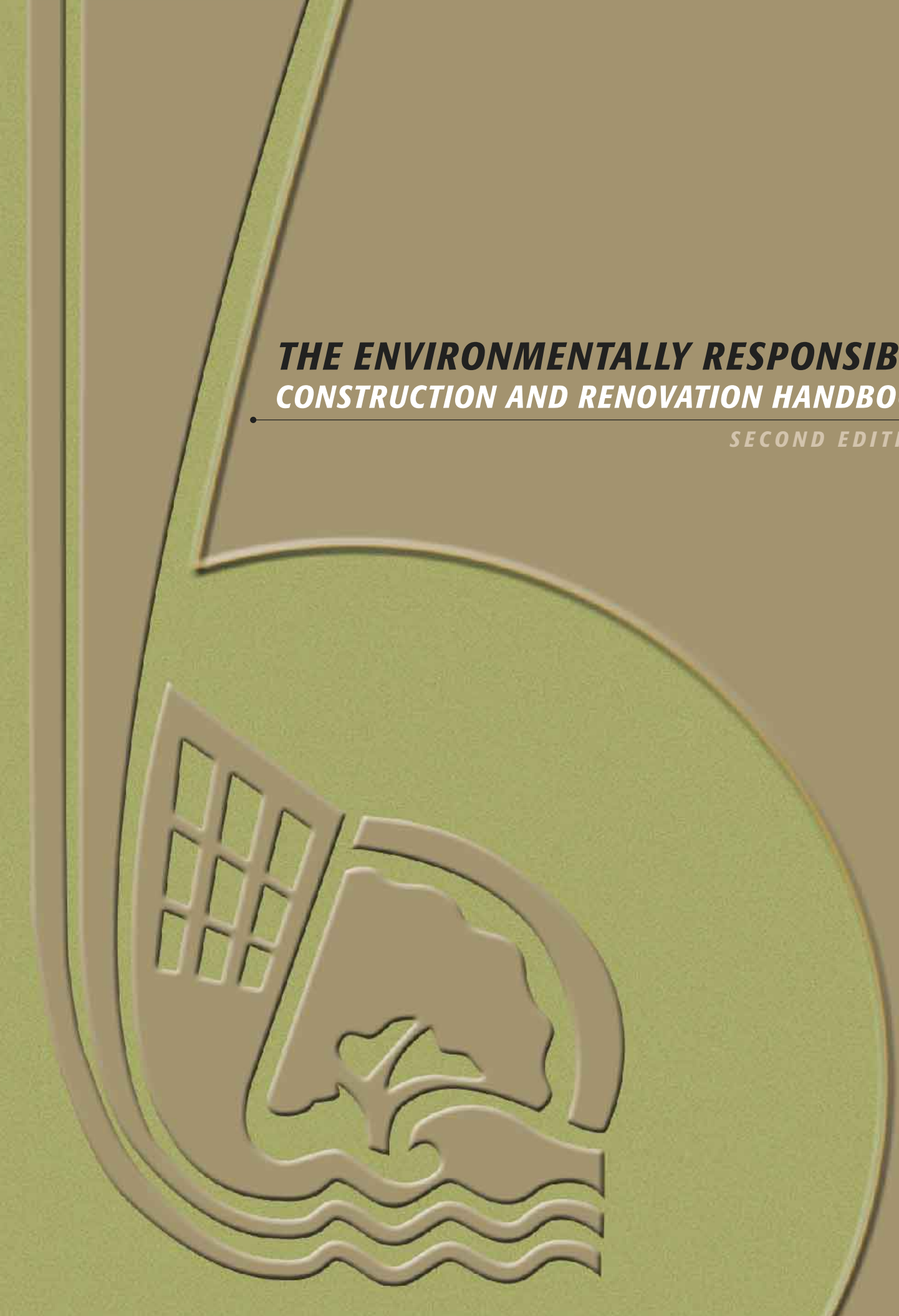

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INTRODUCTION 1.1

For many years, Canadians have been saying they are worried about the state of their environment. They have expressed concerns about pollution, about the management of resources, and about the effects of past and present decisions on future generations. In 1993, 76% of Canadians told pollsters they would pay at least 10% more for "green products" and 87% of Canadians said they would pay more to avoid harmful household products such as paint. Economic downturns removed some of the focus from environmental issues. However, a recent study, released in February 1998, suggests that the green pendulum is swinging back and Canadians are once again concerned about the environment. Canadians support actions to limit climate change and 73% put environmental protection ahead of economic progress.

These concerns are part of a major challenge facing us as we start the twenty-first century–the need to consider human activities within an ecological framework. Recognizing the links between human and environmental health requires a fundamental change in attitude. It must also be understood that technology will not by itself solve all the problems we have created. We require a commitment to working in harmony with the ecological systems that support us.

The constructed environments that Canadians inhabit are intrinsically linked to our natural environment. A significant portion of our annual resource expenditures is consumed by the construction industry, largely because of traditional material selection procedures and renovation and construction practices. Apart from structural suitability, the main criteria for selecting building materials until recently have been the up front costs and aesthetics. Environmental criteria have been all but ignored.

Waste generation and disposal constitute another important environmental issue facing the construction industry. In 1995, Canada produced more solid waste per capita than most other countries. This waste puts enormous stress on the environment. It clogs landfill sites, polluting the soil around the landfill and, in some cases, contaminating water supplies. At present, construction, renovation and demolition (CRD) waste represents about one third of the 20 million tonnes of solid waste sent to landfill in Canada each year.

Incineration of mixed solid waste requires a costly capital investment and substantial ongoing operation and maintenance. It often leads to the release of heavy metals such as mercury and cadmium into the environment. Incineration also leads to the creation of some dioxins. Specialized incineration of a controlled flow of pre-sorted waste can be less harmful, but only if proper burning temperatures are maintained and emissions are checked regularly. As a result, incineration is not a preferred option, even under controlled conditions.

Dumping or burying waste is another growing problem. Many existing municipal landfills are expected to reach capacity within the next few years, and space for additional landfill sites is at a premium. Landfill and incinerator tipping fees have risen by about 500 per cent since the mid-1980s and will continue to increase as the problem becomes more critical. These and other indicators suggest the amount and type of waste being produced is not sustainable.

Energy and water use can also create environmental impacts. Significant environmental issues such as greenhouse gas emissions, acid rain, ozone layer depletion, the flooding of lands for large hydroelectric projects, and the disposal of radioactive waste are all symptoms of our energy demands. Similarly, shortages of clean water, pollution and the impacts of energy use are symptoms of our demands for water.

If buildings are not designed and operated with energy and water efficiency in mind, large quantities of these resources can go to waste. Often, building occupants are not even aware of how inappropriate use of energy and water affects the environment. The problem is compounded when management concerns are about more immediate and more obvious problems. In turn, energy and water conservation is put "on the back burner".

Another issue, and one less often addressed, is the challenge of creating healthier building environments. Sick Building Syndrome is the term used to describe office buildings in which employees experience fatigue and other reactions to pollutants present in the air. Products and materials traditionally used in the construction trade include a multitude of hazardous chemicals, many of which can take years to 'off-gas'.

The good news is that recognition of these problems has resulted in numerous opportunities to reduce the negative impacts of traditional practices. These opportunities are multiplying all the time. Through education, federal building property and facility managers can help the federal government meet its environmental stewardship objectives.

In recognition of these factors, PWGSC in partnership with Environment Canada has initiated a process to ensure that environmental factors are taken into consideration during all project phases in the development of office space. The Green Office Building Plan (GOBP) has been developed in response to this need. The GOBP has been written to address primarily the needs of Renovation, Recapitalization and Fit-up projects, which make up the majority of the office space projects in which PWGSC is involved. When the process has been refined and tested, it will be applied to all federal office space projects in the future.

RPS classifies renovation projects in three types:
- Major renovations involve the removal and/or replacement of building structure components;
- Fit-ups and routine repair and maintenance projects involve changes within the building structure that are completed in order to meet tenant needs;
- Tenant service renovations involve modifications within the building undertaken by the tenants as opposed to RPS. RPS is usually in a position to assist the tenant in diverting the waste associated with these types of projects from landfill.

The Environmentally Responsible Construction and Renovation Handbook; Edition 2 forms Part B of the GOBP (Green Office Building Plan) and is a Technical Guidebook to address the GOBP requirements which must be taken into consideration in all renovation, recapitalization and fit-up projects.

It builds on the Environmentally Responsible Construction and Renovation Handbook, which was used extensively by many federal government staff. Some technical sections have been added to provide more complete guidance on implementation of Green Office projects.

The first version of the "The Environmentally Responsible Construction and Renovation Handbook" was a collaborative effort of the Office of Federal Environmental Stewardship, Environment Canada, and of the Real Property Branch, Public Works and Government Services Canada. The 1999 version of this document was updated to provide the staff of Public Works and Government Services Canada with direction towards meeting the goals of their Sustainable Development Strategy.

This Technical Guidebook has been prepared for portfolio and asset managers, project managers and building professionals, leasing agents, accommodation users and property managers to assist them in planning and undertaking renovations in an environmentally responsible manner, and to achieve Green Office Building Plan (GOBP) status. Building operators and property managers in the private sector will also find this document useful. Although the emphasis of the handbook is on environmentally responsible renovation, many of the principles and guidelines also apply to new construction projects.

Today's facility managers face a range of challenges associated with operating in the new century. They have to deal with downsizing and significant budget reductions, as well as a growing number of regulations, codes and standards. The information presented in this guidebook provides assistance in dealing with these challenges. It introduces a number of approaches now available for combining practical renovations and construction decisions with environmental considerations, while still remaining cost effective.

THE GLOBAL ENVIRONMENT *1.2*

Our quality of life is linked to the state of the environment. It has been generally accepted that almost every activity has an environmental impact. Buildings are a major consumer of natural resources, through both their construction and operation. Each time a resource is extracted, processed, manufactured and disposed, the environment is altered.

Many traditional building materials are directly or indirectly associated with various types of global impacts: global warming, acid rain, emissions that contribute to the depletion of the ozone layer, toxic wastes and declining landfill space. These impacts are the consequences from the extraction of raw materials, processing procedures, shipping, installation practices, use, maintenance, and disposal.

It has been acknowledged that there are foreseeable limits for many nonrenewable energy and material resources. These limits are, in part, attributed to demands for consumer and building products, which have outgrown sustainable consumption rates. Environmental depletion is evidenced through increased pricing, inferior quality raw materials, and decreased availability. Consumers usually view these situations as, market fluctuations, not as the result of an overall environmental problem.

For example, natural disasters in the southern United States in the last few years have necessitated an increased demand for cedar lumber. Cedar is a traditional building material in these regions due to its natural resistance to insect infestation. This increased demand has been evidenced by the escalating price of cedar lumber. Most consumers view this scenario as the economic fall-out of supply and demand. The truth is that consumer demand is exceeding current sustainable production that is maintained through the issuing of cutting permits and other forestry industry limitations.

Demand driven scenarios, the use of high volume, highly mechanized and energy consuming manufacturing processes and low labour requirements have a direct effect on the environment and it's inhabitants.

ENVIRONMENTAL STEWARDSHIP 1.3

Scientific research has confirmed what environmentalists proclaimed in the 60's—human's disregard for the environment has resulted in profound environmental damage.

Economic growth experienced in the 1950's and 1960's was based on unchecked exploitation of natural resources. However, costly litigation, loss of public trust, worsening environmental conditions and consumer backlash, has shifted the perspective of the business community. Many businesses and corporations are realizing that good business practices include environmental accountability.

Many construction materials are now recognized as sources of pollution. Paints, solvents and pressure-treated wood, to name only a few, threaten soil and groundwater resources, especially when disposed of improperly. Allowing unsorted CRD waste to end up in landfill is not a viable option. More stringent disposal safeguards, such as liners and leachate systems in landfill sites, are a positive step. However, the problem of land availability remains, and rising tipping fees for hazardous waste are an indication of the problem. The only real solution for the future is to reduce the presence of toxic substances in the air, soil and water altogether.

THE REGULATORY AGENDA 1.4

Legislation directly addressing issues of environmental concern has already been adopted in most developed nations. The Earth Summit, held at the United Nations Conference on the Environment and Development, in Rio de Janeiro addressed environmental issues at a global scale in 1992. One of the most notable accomplishments of this conference was the tabling of the Bruntland Report that was developed by the World Commission on Environment and Development under the auspices of the United Nations Environment Program in 1988. In this report, the term 'sustainable development' is defined as development that "allows the needs of the present to be met without compromising the ability of future generations to meet their own needs".

This 1992 Rio conference served to bring environmental issues to the forefront. As concerns for the environment have gained global recognition and support, governments are developing legislation to ensure that their exports are manufactured in accordance with the new environmental guidelines.

The Government of Canada is committed to making it's operations more environmentally friendly by integrating environmental and sustainable development considerations into the way it does business. Revisions to the Auditor General Act, passed in December 1995, allowed for the establishment of a Commissioner for the Environment and Sustainable Development, who is responsible for ensuring that the Government is following through on its environmental commitment.

The Directions on Greening Government Operations released by Environment Canada in 1995 identifies seven areas of operation where departments are expected to focus their environmental activities: procurement, waste management, water usage, energy use, motor vehicle fleets, land use management and human resource management. The document also provides examples of "best practices" for each of the seven areas.

The Greening of Government initiative presents challenges and opportunities at every level. It requires the ongoing search for solutions to environmental problems, and the active participation of all federal government employees.

The government also has ongoing commitments to improve its environmental performance in the areas of pollution prevention, waste reduction, the phase out of the use of CFCs, and reduction of greenhouse gases.

Each federal department was mandated to table a Sustainable Development Strategy (SDS) to Parliament before December 31st, 1997. Each SDS outlines the overall plan on how the department will translate its sustainable development goals and action plans into concrete policies, operations and programs. Achieving these targets will require active and continuing involvement at all levels of departmental activities. The Commissioner will evaluate each department's progress every three years.

Sustainable development requires a proactive approach to planning in which ecological objectives become a governing factor.

HEALTH CONCERNS 1.5

There are several ways building materials can impact upon human health.

- Firstly, there is human exposure during the manufacturing process.
- Secondly, there are associated health effects during installation procedures.
- Thirdly, there are health impacts during use and maintenance.
- Lastly, there is exposure during both removal and disposal.

Most people are now aware that interior environments can impact upon their health and well being. Poor indoor air quality, inferior lighting and inadequate ventilation rates are only a few of the factors that contribute to sick building syndrome, building related illness and unhealthy interior environments.

Incorporating environmental responsibility into construction activities requires the recognition of the relationship between human health and indoor air quality. More and more, people are experiencing a lower tolerance to chemical emissions. Many products and materials traditionally used in construction are known to be toxic. Some adhesives contain hazardous solvents such as xylene, toluene and acetone, solvents that remain in a highly volatile state until the materials 'cure'. Other materials, such as paints, finishes and certain types of composite wood products, may contain formaldehyde which can be toxic, or at the very least irritating.

Human health is a complex interaction of many factors, some of which are determined by heredity, diet, age, general health and exposure. Airborne pollutants, toxins, moulds and mildews, particulate, humidity levels, ions, radioactive elements, light, electromagnetic fields, temperature and noise can additionally affect human health. The problems associated with indoor air pollution can be resolved only partially by mechanical means such as exhaust ventilation, which simply redirects the pollutants elsewhere. The best strategy for reducing exposure to toxins and related health risks is to minimize or eliminate pollution at the source.

HEALTH AND TRADESPEOPLE 1.5.1

Conducting renovation and construction activities in an environmentally responsible way requires a recognition of the need for safer working conditions for tradespeople, and the need to help reduce the burden on the environment as a whole.

Since tradespeople are repeatedly exposed to toxic materials, the risk of long-term health complications, such as respiratory disease, skin problems, nervous disorders, organ damage and chemical hypersensitivity are significant. The selection of products that have been manufactured or processed using materials and practices that reduce toxicity and provide lower emission rates, allows for the creation of healthier working conditions for tradespeople.

Great care should always be exercised around clean-up procedures. Irresponsible clean-up and disposal practices can place people at risk and cause additional pollution of natural environments. Application and disposal procedures should always include the use of protective gear and proper ventilation.

EMPLOYEE HEALTH 1.5.2

Many people are becoming more concerned about the impacts of their interior environments on their health and on their ability to perform tasks effectively. Disorders such as asthma and allergies, immune system dysfunction, decreased attention spans and chemical hypersensitivity are being linked to poor indoor air quality. The chemicals emitted from building materials, office furnishings, equipment or cleaning products all contribute to unhealthy indoor environments.

By increasing the understanding of the link between human health problems and work environments, building and facility managers can ensure that renovated or retrofitted federal government office spaces are healthy places to work. The benefits include improved well being and productivity, fewer health-related complaints from employees, and reduced incidences of illness. These benefits can easily offset higher costs for materials.

RESOURCE MANAGEMENT 1.6

The availability of some raw materials has decreased significantly during recent decades due to the rate at which we consume materials—both non-renewable and renewable—and the fact that we are not creating appropriate opportunities for renewable resources to replenish themselves. As a result, we must continue looking for ways to reduce our impact on both non-renewable and renewable resources.

With any Resource Management issue, the system should be designed to minimize (reduce) as much as possible, reuse resources which can not be reduced, and finally recycle resources when all reduction and reuse options have been implemented.

Products and materials with recycled content are becoming more readily available and are a partial answer to problems of resource depletion. Recycling materials helps to create closed-loop manufacturing/purchasing cycles, significantly reducing the need to extract raw or virgin materials and reducing the amount of solid waste ending up in landfill sites.

Resource management also involves using energy and water more efficiently. Canada's total energy use is the highest per capita of any country, and some is generated from non-renewable resources such as oil and coal. The percentage of energy use from fossil fuels varies considerably by province. The construction industry can help to alleviate these serious problems by increasing the energy efficiency of office buildings and retrofitted spaces, by designing and building with water conservation in mind, and by encouraging the use of products and materials that are less resource—and energy-intensive.

GREEN OFFICE BUILDING PLAN—PART B—TECHNICAL GUIDEBOOK 1.7

Part A of the Green Office Building Plan (GOBP) contains checklists to guide the incorporation of "green" considerations at various times throughout the office space planning, design and construction phases.

This handbook (Part B to the GOBP) provides more detail on energy conservation and efficiency, water conservation and on waste management practices which maximize waste diversion.

SELECTING PRODUCTS AND MATERIAL

2.0

SELECTING PRODUCTS AND MATERIAL 2.0

INTRODUCTION 2.1

When choosing construction materials, it is important to recognize that a product's environmental impact is the sum of a number of factors, many of which may not be obvious. Determining which products are best from an environmental point of view may seem like a confusing task, however the utilization of internationally recognized criteria can simplify this task. Selecting materials that provide reduced environmental impacts requires a shift in mind set. This section is intended to introduce portfolio and asset managers, project managers and building professionals, leasing agents, accommodation users and property managers, to the environmental issues that are pertinent with respect to product selection.

PRODUCT LIFE CYCLE ASSESSMENT 2.2

A product life cycle assessment is a framework that can be used to identify environmental inputs, outputs and impacts within the life of a product. The framework considers materials types, water and energy use. The manufacturing processes or activities are inventoried for the assessment. The life cycle assessment framework used for this text is based upon the Canadian Standards Association guideline CS Z760–94. The product life cycle can be grouped in four stages:

PHASE 1: RAW MATERIAL ACQUISITION
This section addresses all of the activities required to gather or obtain a raw material or energy source. It also includes the transportation of the raw materials to the point of manufacture.

PHASE 2: MANUFACTURING
This phase can be subdivided as follows:
- Material Manufacture–the activities required to process a raw material into a form that can be used to fabricate the product.
- Product Fabrication–the process steps that use raw materials to fabricate the product.
- Filling/Packaging/Distribution–processes that prepare the final products for distribution.

PHASE 3: USE/REUSE/MAINTENANCE
This phase begins after the distribution of products for intended use and includes any activity in which the product may be reconditioned, maintained or serviced to extend its useful life.

PHASE 4: RECYCLE/ WASTE MANAGEMENT
This phase begins after the product has served its intended purpose and is scheduled for disposal into the waste stream either through recycling or via a waste management system.

ASSESSMENT CRITERIA *2.3*

PHASE 1–RAW MATERIALS ACQUISITION 2.3.1

RENEWABLE RESOURCES

Renewable resources have potentially infinite availability while non-renewable resources cannot be regenerated and are available in limited quantities. Non-renewable resources such as petroleum and old growth or tropical rain forests are created over such extended periods of time that replenishment is not measurable. Renewable resources are produced during shorter periods of time and can be managed and replenished.

Numerous organizations and programs have either finalized, or are in the process of developing certification programs that ensure resources are harvested or extracted in a manner that secures the renewal of the natural resource. Perhaps the best known of these systems is the one developed by the forestry industry. Product manufacturers and construction contractors are now able to purchase wood products that display certification stating the wood was harvested in a sustainable manner that ensured the planting of sufficient seedlings to replenish the harvested trees.

Products should be avoided that are listed on the Convention in Trade in Endangered Species (CITIES) List. Products are considered renewable when it can be verified through a certification mechanism that they are constructed with materials harvested under controlled conditions, providing for resource regeneration or when their supply is so abundant that non-regeneration provides minimal environmental impacts.

RECYCLED CONTENT

This is a quantitative figure that can be supplied by manufacturers. Industry Canada's *Principles and Guidelines for Environmental Labeling and Advertising* contain a well established and acknowledged definition of recycled content. Recycled content is defined as "the portion of a product's weight composed of reprocessed post-use materials." The materials may be reclaimed from either a post-consumer source, which is material that has served its intended purpose and is generated as waste, or waste created or left over from an industrial process. Recycled content is usually calculated as an averaged percentage. Manufacturers can be asked to provide the percentage of post consumer and/or postproduction waste included in the product and a total percentage of recycled content.

REMANUFACTURED PRODUCTS

Remanufactured products reduce the necessity to extract and process raw materials, thereby reducing the environmental impacts of the product. A product or system is considered remanufactured if it has been diverted from the waste stream and is refabricated in a manner that has permitted a complete upgrading by either the original manufacturer or a second party. See also Remanufacturing under Section 2.3.3; Use, Reuse and Maintenance

Sustainable development provides for the needs of the present without compromising the ability of future generations to meet their needs. Sustainability holistically examines a products needs, manufacture, use, disposal and indirect impacts. The level to which a material does not negatively impact long term planning best determines sustainability. For example, non-renewable resources need not be evaluated any further as their use is unsustainable. However, a renewable resource may appear to be sustainable until further scrutiny identifies subtle long-term impacts.

The issues that are related to sustainable development are far reaching and incorporate all criteria addressed in this text. The specification of building materials that provide lowered environmental impacts will contribute towards sustainable development.

PHASE 2–MANUFACTURING 2.3.2

TOXICITY

The toxicity of a product can result in health hazards and environmental problems, therefore the first approach should always be to reduce or eliminate the use of toxic material, where other options are available or viable. Solvents are often highly volatile and unstable before the curing process. Particulates produced from toxic materials during construction practices can have an adverse effect on both trades-people and building occupants. Materials that have been fabricated or treated with toxic substances often have limited disposal options. The proper disposal of leftover toxic products requires shipment to facilities designed to handle hazardous waste. The introduction of toxic materials into landfill sites contributes to land, water and air pollution. The manufacturing processes for toxic materials tend to generate greater amounts of water and air pollution than for lower toxicity materials.

Workplace Hazardous Materials Information System (WHMIS) sheets must contain details concerning the inclusion of hazardous materials in a product. However, the lack of hazardous materials on a product's WHMIS sheet should not in itself be viewed an opportunity to make an environmental claim. Numerous international eco-labeling programs such as Canada's Environmental ChoiceM Program have established acceptable toxicity levels as part of their product guidelines.

GLOBAL WARMING

Global Warming is a complex issue. However, it is commonly accepted that the release of greenhouse gases contributes to this problem. Two of the most significant greenhouse gases are carbon dioxide and methane. Carbon dioxide and methane are produced through natural processes, but humankind has contributed significantly to their production. There is some uncertainty as to the ultimate impacts of atmospheric change, but global warming is considered to be an essentially irreversible process. Our actions can be directly responsible for changes to the earth's atmosphere. If the changes continue to occur at the present rate, the effects on agriculture, forestry and weather patterns may be irreparable.

The burning of fossil fuels such as coal, oil and natural gas generates carbon dioxide. Reducing our energy requirement through the use of energy efficient products can reduce the generation of carbon dioxide.

Methane gas is released naturally from rotting plant materials, but landfill sites produce 30% of the methane gas produced by artificial sources. Diverting waste from landfill sites will reduce the generation of methane gas.

The contribution to global warming for most products occurs from the release of greenhouse gases during either the production or disposal stage of the product's life cycle. These are process-orientated steps and are difficult to control or qualify within the context of a single product. Global warming is therefore considered a non-quantifiable criterion.

OZONE DEPLETION

It is believed that cloroflorucarbons (CFCs) and other ozone depleting substances are responsible for the thinning of the ozone layer that shields the earth from the sun's harmful ultraviolet rays. Many ozone depleting substances (ODS) contribute to global warming. These gases linger in the atmosphere for 60 to 100 years. CFCs are manufactured substances that are commonly contained in some refrigerants and blowing agents when producing building products and materials.

In 1987 thirty-two countries signed the Montreal Protocol on Substances that Deplete the Ozone Layer, which calls for a halt to CFC use by the year 2000. The first step towards attaining this goal came on January 1, 1996, when the production of CFCs was banned by signatories of the Protocol. A second generation of CFCs, hydrocloroflorucarbons (HCFCs), will be banned from production in the year 2025. HCFCs are currently being used as an interim solution for mechanical systems and cooling appliances that have operated on CFC based refrigerants.

Ozone depleting substances used during the manufacturing process can be quantified. CFC use and production can be eliminated through the specification of building materials that use alternative refrigerants and blowing agents.

EMBODIED ENERGY

Operational energy is the amount of energy that is consumed by a product during its use. Embodied energy is the term used to describe the amount of energy that is used to produce a product. It includes the amount of energy required to extract or harvest raw materials, transport the raw materials to a processing site, process the feedstock, package and ship the fabricated product and finally install or consume the product.

It also includes the energy to heat the plant where the product was manufactured. Organizations like the American Institute of Architects (AIA) provide general figures for the embodied energy of many products. These figures provide a degree of reference, but cannot be used for a quantitative assessment, as each application or site requires its own individual assessment.

PHASE 3–USE / REUSE / MAINTENANCE 2.3.3

ENERGY CONSERVATION

This criterion describes the reduction of energy use or the presence of energy savings as a direct result of behavioral changes rather than technological intervention. The implementation of energy conservation practices has the same benefit to the environment as those obtained from minimizing operational energy use through products and materials. However, the success of the measures is dependent upon proper implementation and communication and is therefore not quantifiable.

Although this category is a qualitative issue, utility companies regularly promote energy conservation procedures as a recognizable means of reducing energy demands. Electrical and gas utilities are able to provide information for both residential and commercial applications. Commonly recommended energy conservation practices include turning off lights in empty rooms or the installation and use of operable windows that allows for natural cooling and ventilation.

ENERGY EFFICIENCY

Energy efficient systems or products give equivalent results for less energy. Energy efficient products enable consumers to consume less energy while maintaining present behaviors.

Acceptable energy consumption rates, such as those published by The Canadian StandardsAssociation (CSA), have been established for most products. Efficient energy consumption is established on a comparative basis. However, at present a generally accepted baseline does not exist. Current energy efficiency standards are product and program specific. Standards have developed based upon on data gathered by organizations such as The New Building Energy Code, the American

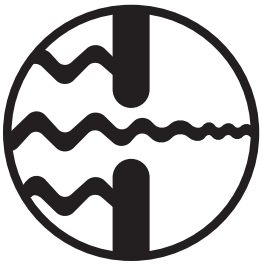
Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), the Canadian Standards Association (CSA), Ontario Power Generation, the National Research Council of Canada (NRC), the Canada Mortgage and Housing Corporation (CMHC), The Ontario Ministry of Environment (MOE), Natural Resources Canada (NRCan) and BC Hydro Power Smart Program.

Technological advances are continually increasing the efficiency of the energy consumption of appliances and fixtures. Internationally recognized eco-labelling organizations such as the Canadian Environmental Choice Program and the American Green Seal have developed energy consumption guidelines for products and provide quantifiable energy efficiency standards that are technologically attainable. The specification of products that are considered energy efficient provides reduced environmental impacts by curtailing the environmental costs that are associated with the generation of electricity. These include carbon dioxide production from the burning of fossil fuels or the flooding of lands for the building of hydro-electrical dams.

ENERGY SAVINGS

This criterion identifies materials and products that improve energy use through their intended application and that do not consume energy, such as thermal insulation. This category applies to equipment that provides effective energy use through the regulation of electricity consumption cycles and to products that offer improved illumination from energy consumed for lighting purposes. Products that allow for regulation and utilization of solar heat gain may also be covered under this criterion. While standards exist for many construction products, in most cases these ratings are performance orientated and do not provide information regarding the potential energy savings.

Most energy utilities provide literature supporting the reduction of energy loss through the use of these non-energy-consuming products. The quantitative evaluation of this criterion can be accomplished based upon this information. Many of the eco-labelling programs address building materials that provide energy savings, but the guidelines for these products concentrate on other environmental issues such as recycled content or emission rates. However, proper application of these products undeniably reduces energy loss.



REDUCED WATER CONSUMPTION

The specification and use of appliances that are rated as 'low water consumption' reduces environmental impacts by reducing the necessity for water treatment. Water pollution combined with a rapid rate of water consumption can result in damage to hydrological systems. The treatment of wastewater requires the use of hazardous compounds that impact upon ecosystems. Reducing the consumption rate of water diminishes the necessity for wastewater treatment. Appliances, fixtures and systems that have been specifically designed to fulfill their intended functions while providing reduced water consumption rates, result in a lowered environmental impact.

Eco-labeling programs have established criteria that relate to the performance of specific products and the Canadian Standards Association (CSA) has developed specific tests that determine the flow rate of water consuming products. The CSA has also established flow rates for some products that define product specific low water consumption. This criterion is based upon the same principles as energy efficiency, it uses improved performance percentage against an established baseline for evaluation.

INDOOR AIR QUALITY (IAQ)

Indoor air quality refers to the chemical, physical and biological characteristics of indoor air in interior spaces. Indoor air quality is of importance for the health and well being of the occupants. Indoor air, as well as temperature, light and sound conditions must be of a quality that sustains the health of the occupants, especially in Canada where we spend a large part of our lives indoors.

Indoor air quality can be adversely effected by chemical emissions from building materials or products. Illnesses due to inferior IAQ can be broadly divided into those that occur shortly after exposure and those that do not show up until years later. Many organizations are conducting research and testing on IAQ, however few standards have been established for individual product emission rates. Indoor air pollutants can be classified as volatile organic compounds (VOCs), formaldehyde, microbe and particulate. At the present time target objectives and action objectives are recognized for ambient air within a building. Public Works and Government Services Canada (PWGSC), Health Canada, the Canada Mortgage and Housing Corporation (CMHC), The National Research Council (NRC) and Labour Canada have all indicated that reducing emission rates from building products provides a beneficial effect on indoor air quality. At the present time there are many testing facilities that can provide documentation of specific product emission rates.

Research in this field has identified ways of establishing or reducing the emission rates of recognized volatile organic compounds (VOC's), formaldehyde and microbial matter. Therefore, each of these items has been addressed as a separate criterion.

Particulate emissions are generally controlled by the mechanical systems in a building through the use of filters and proper ventilation. The reduction of particulates is best addressed through the proper design, operation and maintenance of the HVAC components that are related to particulate control.

REDUCED VOLATILE ORGANIC COMPOUNDS (VOCS)

The term 'volatile organic compounds' represents all chemicals containing carbon and hydrogen that have a boiling point between 50–250° C. Symptoms of VOC exposure include fatigue, headaches, drowsiness, dizziness, weakness, joint pains, peripheral numbness or tingling, euphoria, tightness in the chest, unsteadiness, blurred vision and skin and eye irritations.

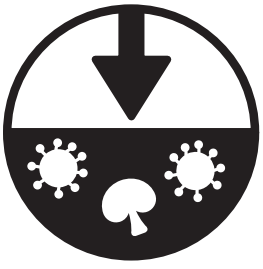
Office workers are exposed to a broad spectrum of contaminants at low concentrations for periods of 40 hours or longer per week. Hypersensitive persons may have severe reactions to a variety of VOCs at very low concentrations. These VOCs can be released by building materials, carpets and numerous consumer products including plastics and fabric dyes. These reactions can occur following exposure to a single sensitizing dose, or small series of exposures. Chronic exposure to low doses can also cause reactions. Symptoms are usually non-specific and may be insufficient to permit identification of the offending compounds.

Exposure threshold levels have not been established, as the available information on toxicology and sensory effects of VOCs are incomplete. However, product emission comparisons are an acceptable method of determining a superior product. Facilities currently exist that are able to test a product's emission rates and manufacturers can be asked to provide test results for comparison purposes. Tests should be conducted on products in their average deliverable state. As a general rule, reduction of VOCs is a desirable element to creating healthier building environments.

FORMALDEHYDE EMISSION

Formaldehyde is a colourless gas that has been associated with human health impacts. The American Conference of Government Industrial Hygienists (ACGIH) has identified formaldehyde as a "suspected human carcinogen." Exposure symptoms include dry or sore throats, nosebleeds, headaches, fatigue, memory and concentration problems, nausea, dizziness, breathlessness and burning or stinging of the eyes. Formaldehyde is present when vapours off-gas from building materials such as adhesives, particleboard, fabrics and cleaning fluids. Interior formaldehyde concentrations are dependent upon the age of the source, building ventilation rate, indoor and outdoor temperatures and humidity.

Formaldehyde is found in many resins that are used in the manufacture of building products, such as particleboard, interior grade plywood and installation adhesives. Formaldehyde can be minimized in indoor air through both source reduction and ventilation methods. As formaldehyde is present in many building products, the specification of products that have been manufactured without formaldehyde will have a beneficial effect on indoor air quality. Alternative products can be specified that have been manufactured with phenol formaldehyde. This substance contains a more stable molecular structure than urea-formaldehyde and does not react to fluctuations in interior conditions. Another solution is to specify the encapsulation of all substrate materials that contain formaldehyde.



ANTI-MICROBIAL AND FUNGICIDE TREATMENT

Microbial and fungal contamination in indoor air is a concern as it can affect human health and comfort. Although few species can directly cause disease, chronic exposure to most fungi can induce allergic or asthmatic reactions.

Microbial elevations of indoor air became a concern in the 1950's when secondary infections of patients became a major concern in many hospitals. Since that time, manufacturers of products such as carpets and wallcoverings began to produce products that were treated to reduce microbial growth. Fungicides are a common component of paints, premixed drywall compounds and other

moist products that require and extended shelf life. However, controlling microbial growth within a building can create a catch-22 situation as many fungicides and anti-microbial treatments contain chemicals which can elevate the VOC emission rates.

Although microbial and fungal problems within a building are usually associated with the mechanical components of a building, product specification can reduce the availability of suitable growth mediums and the addition of chemicals within a building. Products can be designed in a manner that naturally deters the growth of microbial matter without adding chemicals to interior environments. Paint can be specially ordered without fungicides and project specifications can call for the use of mixed-on-site drywall compound. Products manufactured from natural fibres naturally adjust to fluctuating humidity levels and often do not require topical applications of anti-microbial treatments.

REUSABLE PRODUCT

Many products are reusable by consumers. Most consumers are aware of this fact, however it is important to identify new reuse opportunities that may not be readily apparent.

Industry Canada has developed a document entitled Principles and Guidelines for Environmental Labeling and Advertising. This document provides a guideline for the term reusable. For a product to be deemed reusable an application must exist that allows the end user to directly reuse the product. Where the option is not obvious, the claim must explain how the product can be reused without extensive cleaning or restoration processes. This criterion may also be used to assess the packaging materials that are associated with a product. For example, furniture can often be shipped in reusable blankets rather than in resource intensive corrugated containers.

REFURBISHABLE PRODUCT

Refurbishable products can be reused, however they usually require cleaning or restoration to attain an as-new appearance or function. During the refurbishing procedure, the product remains the property of the consumer and the expense of the refurbishing process is the responsibility of the consumer.

The refurbishing procedure may be offered either in-house by the original manufacturer or may be a procedure easily accessible through outside sources. Information regarding refurbishing processes must be readily available to the consumer. The refurbishing of a product may require the utilization of additional energy and additional waste generation. However, the environmental impacts are considerably lower than first-time fabrication in almost all cases.

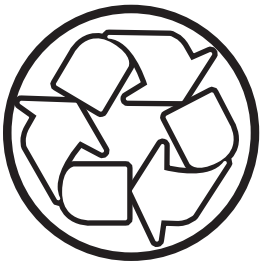
REMANUFACTURABLE PRODUCT
This criterion differs from refurbishing in that the ownership of the product becomes the original manufacturers or a second party that provides the restoration services. Products recognized under this criterion are designed in a manner that allows for complete upgrading, where products can be inspected and disassembled to their individual elements and damaged pieces can be repaired or replaced. The product is therefore restored to an as-new condition for resale by the fabricator.

DURABILITY
Durability provides reduced environmental impact by minimizing the maintenance or replacement requirements of a product. This provides an efficient use of natural resources and a diversion of material form landfill.

At present, durability is generally measured by manufacturer's warranties that are often too vague to be used as a baseline for the development of a criteria definition. Standard testing procedures and reporting requirements are currently being developed that will provide a reliable mechanism for environmental evaluation. However until this framework is developed and accepted, building practitioners can only qualitatively access a product's durability.

Maintenance requirements should be assessed to ensure that a product will maintain its aesthetic and functional value and manufacturer's warranties can be used to provide a marginal measure of a products durability. Product testimonials are another source of information by which to verify durability claims. Although this issue is marginally quantifiable, a mechanism for reliable quantitative analysis is not yet available.

PHASE 4 - RECYCLING AND WASTE REDUCTION 2.3.4



RECYCLABLE PRODUCTS
The use of recyclable products provides efficient and effective use of natural resources. The benefits are achieved by diverting the products from the waste stream and directing them to a recycling facility.

A product that is recyclable can be returned for reprocessing into new material, however a product is not considered recyclable simply because the material is technically recyclable or there are anticipated developments in the future. Recycling programs and facilities are regionally variable and a product can only be considered and recyclable when these programs and facilities exist.

In situations where products are fabricated from numerous materials, the product design should facilitate recycling options by easy disassembly and identification of material types. For example plastic components should contain plastic sorting codes. Instructions explaining disassembly and sorting requirements for inclusion in recycling systems should also be included with products.

SOURCE REDUCTION
Source reduction is the use of less material at source to produce a product in the first place. Source reduction has significant environmental benefits. These benefits are achieved through resource savings, reduced energy expenditures during collection and processing, disposal and landfill issues.

The benefits of source reduction are difficult to measure. Unless the data are available prior to the implementation of source reduction initiatives, this principle is very difficult to quantify as it can be applied in a number of ways and no standards or reporting mechanisms exist at this time. Source reduction should be viewed as superior to most other criteria, yet not quantifiable for evaluation.

However, source reduction can be incorporated into construction projects. Building architects and designers can reduce construction waste by setting floor plans to fit the dimensions of standard construction materials. Suppliers can be required to minimize packaging. Products such as paint, joint compound and caulking can be purchased in bulk. Builders can easily reuse scrap lumber for bracing and to stake concrete forms. Careful demolition can allow the reuse of doors, windows, bathrooms and systems decorative moldings. Interior furnishing can often be restored to extend their life beyond first use. Unlike many other criteria source reduction eliminates waste and other environmental impacts rather than minimizing them

DEGRADABLE PRODUCT

Degradable materials break down into materials that have less environmental impacts. Degradation may occur in air, land or water and usually occurs either through biodegradation or photodegradation.

While many materials will eventually degrade, standard disposal, at a landfill site, inhibits this process. The proper management of degradable materials through appropriate facilities reduces environmental impact by diverting waste from landfill sites. Commercial composting facilities are able to accept some building materials and interior finishes for disposal. A claim that a product is degradable should be supported by reliable scientific evidence that the entire product will break down or decompose following appropriate management methods.

WASTE GENERATION

Waste is an output that is released into air, water or land and that has no beneficial use or perceived market value. An intrinsic characteristic of waste is that it eventually requires disposal.

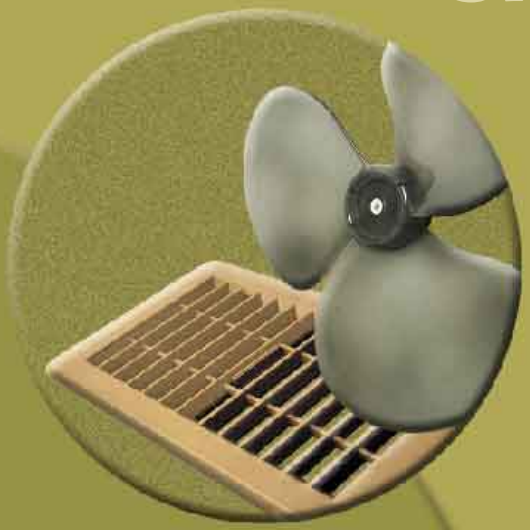
The construction industry generates waste at all levels of production, use and disposal. While waste from some products can be minimized through source reduction practices, other products generate waste in areas that are less obvious to consumers and practitioners.

Waste generated at the manufacturing level is difficult to attribute to a product or material. While current legislation aims to reduce waste generation, a standardized framework has not yet been accepted that documents procedures that exceed legislated standards. However, some manufacturers have implemented procedures that provide for reduced waste generation. Where possible construction practitioners should review the procedures used during the manufacturing processes. The specification of products that have been manufactured with minimal waste generation will encourage the industry to strive to exceed legislated standards.

Packaging materials are also waste. Many building materials are shipped with minimal packaging on pallets or skids, that are reusable. Other products, such as lighting fixtures and other interior products are often over-packaged. Packaging waste generation can be reduced by requesting that manufactures reclaim packaging of products that are shipped to the construction site. Requesting a manufacturer to accept responsibility for the packaging they use encourages the minimization and reuse of packaging. The implementation of capture procedures at the site can often divert many materials from landfill. For example, skids and pallets can be diverted for reuse and corrugated cardboard can be shipped to recycling facilities.

INDOOR AIR QUALITY & MATERIALS SELECTION

3.0



INDOOR AIR QUALITY AND MATERIALS SELECTION 3.0

The IAQ component of the Green Office Building Plan embodies the definition of acceptable indoor air quality from ASHRAE's draft revision to Standard 62. The goal is to design the office interior and ventilation system such that the occupants will be satisfied with the indoor air quality and such that there are not likely to be contaminants at concentrations leading to exposures that pose a significant health risk.

The provision of IAQ falls into two main categories;
- minimizing sources of pollutants within the office and
- providing adequate ventilation to ensure remaining pollutants are removed effectively.

Source control is always the first and most important step in mitigating contaminant levels and effects on office occupants. Ventilation strategies are then used to introduce fresh air into the space and carry out contaminants produced by both occupant activities and emissions from the materials within the building. Requirements for strategies to be used in construction, renovation, and commissioning are provided under a third section below.

The following list of requirements is a foundation for providing healthy, comfortable indoor air. For Renovation, Recapitalization and Fit-up projects, the Project Manager needs to discuss the viability of incorporating each of these measures into the design at an early stage in the Project Delivery System (PDS) as discussed in Part A of the GOBP.

SOURCE CONTROL 3.1

- **BASEMENT MOISTURE CONTROL** is required to be provided by moisture- and vapour-proof construction details on basement floors and walls and slab-on-grade floors. To prevent soil gases and moisture from entering the office building, details such as polyethylene sheeting under floor slabs and dimpled polyethylene or glass fibre or grooved polystyrene drainage layer on the walls shall be provided, where viable. Petroleum derivative water-proofing should not be used.
- **ELIMINATE OFF-GASSING FROM FINISHES** that come in contact with indoor air. Water-based (latex) finishes and adhesives should be the products of choice. Where such categories exist, products that are certified by a recognized third party for their low concentrations of hazardous chemicals or that meet the certification criteria (NAFTA) should be chosen. The Environmental Choice Program (products bearing the EcoLogo label) is one such body. Ecologo products available include paints, caulking and adhesives.
- **SPECIFY MATERIALS WITH NO/LOW FORMALDEHYDE, NO/LOW VOCS,** and/or other chemical emissions for 85% of the total interior surfaces in the building (i.e., all ceilings coatings, walls coverings and paints and floor coverings). Partitions and wall coverings made from vinyl or plastics contain a wide range of VOCs and should be replaced by products with less off-gassing potential. A wide variety of alternatives exist including textured wall coverings made from cellulose, natural fibre wall coverings such as sisal, decorative acoustical wall paneling made from fibreboard and cork, and so on.
- **CARPETING** has the potential to off-gas a variety of chemicals used in manufacturing. If carpeting is to be used it must be labeled by the Carpet and Rug Institute (CRI) certification program as a low VOC-emitting carpet. This program ensures that the emissions of the most common chemicals used in carpet manufacture meet the criteria for low emissions.
- **LIMIT CARPETING ON FLOORS:** Ideally Carpeting shall cover no more than 50% of the floor area, but this will not always be practical.
- **ADHESIVE** for affixing carpeting is to be "low-tox" or water-based. Conventional glues are very high in VOCs and off-gas for long periods of time.
- **CONDENSATION** on interior surfaces shall be prevented by ensuring all surfaces are at a minimum temperature of 100C (500F). Any individual heat-flow path through the structure should have an RSI value of not less than 0.5 (R-3) in locations with a winter design temperatures of –200C (–40F) or higher and not less that RSI 0.7 (R–4) for locations with lower design temperatures. Areas of thermal bridging that need to be considered include window frames, steel studs, flashings, fasteners or other highly conductive building components that penetrate from near the interior to near the exterior of the structure.
- **ENSURE FRESH AIR IS DRAWN FROM A CLEAN LOCATION.** Do not locate intake louvers near areas that could be contaminated by such pollutant sources as building exhausts, vehicular exhausts, cooling tower spray, combustion gases, sanitary vents, trash storage, and other hazardous air contaminants.
- **OZONE-GENERATING DEVICES** including those claiming to be air purification devices shall not be used.

VENTILATION SYSTEM DESIGN *3.2*

- **ENSURE VENTILATION AIR SYSTEM DESIGN MEETS THE REQUIREMENTS OF ASHRAE 62.** The standard provides details on calculating minimum fresh air requirements for offices and allowances for mixed air from adjoining spaces. Documentation provided with the drawings and specifications shall clearly show the design intent and calculations to verify compliance with the standard.
- **VENTILATION SUPPLY AND EXHAUST GRILLE PERFORMANCE DESIGN** (i.e., direction and throw) and locations shall be such as to avoid short circuiting of supply air directly into the return grille.
- **ALL OUTSIDE AIR LOUVERS AND DUCTS (INCLUDING ECONOMISERS)** shall be designed to limit intake air velocities to exclude rainwater entry. For most manufacturers the maximum allowable face velocity is approximately 2.54 m/s (500 ft/min).
- **AIR VELOCITIES THROUGH COOLING COILS AND HUMIDIFIERS** shall be specified to prevent wetting of downstream surfaces. For most coils the maximum face velocity would be 2.54 m/s (500 ft/min) or less.
- **NO FIBROUS DUCT-LINER OR GLASS-FIBRE DUCTING** shall be used. These materials hold moisture, are propagation sites for moulds, mildew, and bacteria and allow loose fibres to be blown into the space. Use non-porous (e.g., closed-cell polyethylene) duct-liners, exterior insulation, or acoustical baffles in strategic locations in lieu of linings. Use only metal or other hard surface ductwork.
- **VENTILATION EXHAUST AIR FROM KITCHENS, WASHROOMS, SMOKING LOUNGES, CUSTODIAL CLOSETS, CLEANING CHEMICAL STORAGE AREAS, AND DEDICATED PRINTING/COPYING** areas shall be vented directly to the outdoors with no recirculation through the HVAC system.

INDOOR AIR QUALITY DURING CONSTRUCTION AND COMMISSIONING *3.3*

There are a number of construction practices which can be harmful to construction materials and adversely affect indoor air quality as a result. To guard against these practices the following measures should be taken at all renovation, recapitalization and fit-up sites:

- **PROTECT CONSTRUCTION MATERIALS** (especially soft materials) from rain and other moisture sources.
- **ENSURE CONSTRUCTION MATERIALS SUCH AS CONCRETE ARE DRY** before they are covered with flooring or enclosed in wall cavities.
- **CONTROL FIBRE AND PARTICLE RELEASE DURING INSTALLATION OF INSULATION** and require thorough cleanup by this trade immediately after completion of this work.
- **VERIFY ALL MATERIALS ARRIVING ON SITE COMPLY** with the environmental specifications and requirements under which they were purchased.
- **COMMISSION HEATING, VENTILATING, AND AIR-CONDITIONING SYSTEMS** to ensure that the design intention and specifications have been met, and proper amounts of fresh air are delivered to each zone.

POST TESTING can be used to determine that the indoor air quality is acceptable. Table 3.1 lists major pollutants generally found in offices along with guidelines for acceptable levels of those pollutants. The guidelines or standards are currently in force either in Canada, or in other jurisdictions where a Canadian recommendation does not exist.

TABLE 3.1
ACCEPTABLE LEVELS OF AIR-BORNE CONTAMINANTS

SUBSTANCE	MAXIMUM PERMISSABLE / RECOMMENDED LEVEL
Carbon Dioxide	1,000 ppm
Carbon Monoxide	11 ppm
Formaldehyde	0.1 ppm
Particulate	.04 mg/m3 (<2.5 microns mass mean aerodynamic diameter)
Radon	2.7 pCi/L
Total VOC	0.2 mg/m3 with no individual VOC > 10% of TVOC
Nitrogen Dioxide	0.05 ppm
Sulphur Dioxide	0.019 ppm
Ozone	0.05 ppm
Microbials/ Micro-organisms	45 CFU/ m3 for a single species

ADDITIONAL IAQ IMPROVEMENT OPPORTUNITIES *3.4*

This section includes suggestions on additional measures which can be taken to improve indoor air quality above and beyond those considered essential to provide good IAQ.

SOURCE CONTROL 3.4.1

- **ELIMINATE TRIM MADE FROM MANUFACTURED WOOD (MDF) CONTAINING FORMALDEHYDE AND PLASTIC TRIM CONTAINING VOCS.** Finger jointed paintable trim should be used if it cannot be verified that other materials are free of emissions.
- **CABINETS, DESKS AND BOOKSHELVES** are usually made from particleboard using urea-formaldehyde as a binder and employ adhesives containing VOC for adhering laminates. Alternative substrates such as Medite II which contain no formaldehyde can be used for cores. Paneling for cabinetry etc. can have all surfaces coated with a high quality sealer to keep formaldehyde from off-gassing. Reconditioned furniture can be specified and aging will have reduced the off-gassing potential to a significant extent.

VENTILATION SYSTEM DESIGN 3.4.2

1. **DESIGN FOR A MINIMUM TOTAL AIR MOVEMENT OF 5.1 L/S/M2** where conventional ceiling mounted diffusers and mixed air are used. Use diffused manufacturer's velocity and throw information to avoid stagnant air in occupied spaces. Other distribution systems such as displacement ventilation and systems that provide 100% ventilation air can provide good air distribution at significantly lower air movement
2. **INSTALL DISPLACEMENT VENTILATION.** Displacement ventilation has a floor to ceiling airflow pattern. Supply air enters floor level at low velocity carries pollutants up out of the breathing space and removes stale air from near the ceiling.
3. **ISOLATE POTENTIAL POLLUTION SOURCES** through separate zoning of areas where contaminants are generated (e.g., independently-ventilated, enclosed printing/copying area),
4. **USE HIGH-EFFICIENCY FILTERS (MINIMUM 60% DUST-SPOT EFFICIENCY)** in all make-up and return air ducting. If outdoor air has high dust levels, use higher efficiency filters (80% dust spot efficiency) and include pre-filters (30% dust spot efficiency).
5. **DESIGN AIR HANDLER AND CONTROL SEQUENCE TO PROVIDE MODULATION** up to 100% of air handler capacity in outdoor air as outdoor conditions warrant. This strategy is called an Economizer Cycle (see Section 5.6).
6. **SPECIFY A NIGHT PURGE** cycle to purge the building when there are minimal comfort concerns and minimal energy penalty.
7. **EVALUATE NATURAL VENTILATION** through the use of operable windows. This can offer energy and functional advantages over mechanical ventilation. The potential for using natural ventilation in a building should be evaluated at the conceptual design phase. Considerations would also include pressurization and stack effects in buildings of six stories or higher. If appropriate the concept should be incorporated into the building design.

CASE STUDIES OF OFFICE BUILDING WITH HIGH IAQ STANDARDS 3.5

STEELCASE CORPORATE DEVELOPMENT CENTER 3.5.1

DESCRIPTION: The Steelcase Corporate Development Center (CDC) in Michigan was designed to encourage communication and creativity for 800 product-development professionals, and to help them create innovative office products, programs, and services in shorter time frames. The building, which was opened in 1989, is a seven-level pyramid-shaped building encompassing 55,740 m2 (600,000 ft2), of which 58 percent is devoted to offices and public space, and 42 percent is used for laboratories and building support services. The purpose of the building, in addition to supporting team activities and fostering interaction, is to provide a productive environment in which 800 employees can work.

FEATURES: The Steelcase CDC was designed to improve indoor air quality by controlling source emissions, proper ventilation, environmental control (temperature and humidity), and through proper maintenance. Source emissions of toxins were controlled by selecting non-toxic building materials, such as flooring, paints and finishes, and also by selecting office equipment that minimize toxin outputs when possible.

Ventilation contamination is controlled through 35 percent dust-stop efficiency pre-filters and 60 percent efficiency final filters. Large flow rates dilute any remaining contaminants thereby eliminating the use of expensive HEPA filters. The total air distribution was designed to be a minimum of 6.6 L/s per gross square metre of office (1.3cfm per gross square foot). The ventilation rate is up to 35 L/s per person of outdoor air (ASHRAE standard is 7.1 L/s). The 35 L/s represents an average air distribution for the entire building with the majority of air being distributed through the lab space with 100% outdoor air.

Both temperature and humidity are controlled for optimum comfort. The temperature is held constant at 23°C (77°F). The humidity is adjusted depending on the season to prevent accumulation of moisture that can be destructive to building materials, and can cause the formation of bacteria and mold.

A comprehensive computerized scheduling program of preventive maintenance for all building systems is used. Monthly inspections are made of key equipment; filters are checked monthly and replaced when required; and heating and cooling coils are cleaned annually. Proper housekeeping is essential in maintaining a dust and microorganisms free environment. Carpets are shampooed on a continuous basis with a complete cleaning cycle taking approximately two months. Carpet in high traffic areas is shampooed every other day and on an as-needed basis.

RESULTS: The concentration of key toxins is significantly lower than prescribed by ASHRAE standard 62-89. Measured toxin concentrations with ASHRAE standard in brackets; carbon monoxide 0ppm (9ppm), carbon dioxide 531ppm (1000ppm), respirable suspended particulates 19 ug/m3 (50 ug/m3), and formaldehyde 0.021ppm (0.1ppm).

RIDGEHAVEN OFFICE BUILDING 3.5.2

DESCRIPTION: The 73,000 ft2 building originally built in 1981, which houses the City of San Diego Environmental Services Department (ESD), showcases effective energy efficient renovations at a reasonable cost. Healthy indoor air quality was a primary goal. The ESD wanted to avoid sick building syndrome and create a healthy building environment for all of its employees.

FEATURES: Improved indoor air quality was achieved through careful material selection, a new mechanical system design, environmental construction methods, and a healthful building maintenance plan.

Environmental criteria for materials included selecting materials with minimal chemical emissions, and minimizing volatile organic compounds (VOC's) during installation. Additional considerations included building products that inhibit the growth of biological contaminants. Careful specification of low-VOC materials based on the environmental criteria included the Low-VOC Paints, Sealers, and Stains: met South Coast Air Quality Management District (SCAQMD) requirements for low-VOC coatings, and contained no formaldehyde, petroleum-based solvents or other toxins. Carpet tiles met State of Washington Indoor Air Quality Specification criteria for low-VOC product, backing had anti-microbial properties, and were installed with minimal use of low-VOC adhesive.

Linoleum sheet flooring consisted of natural material components with minimal VOC's and natural anti-microbial characteristics. Ceramic tile included glass and clay content, are inherently inert, and have no VOC emissions. Gypsum wallboard caused no VOC emissions. Steel framing is inherently inert with no VOC emissions

An entirely new mechanical system, ducting, and cooling tower were installed. The metal ducting was insulated on the exterior with a foil-faced batt to prevent man-made mineral fibers from becoming air-borne within the HVAC system. The new ventilation system was designed to the ASHRAE 62-89 standard.

Cleaning for occupant health and worker safety was the main priority for building maintenance. This included the use of non-toxic cleaning products that were water-based and contained minimal chemical emissions. In addition, a least-toxic pest control plan using no pesticides was also important in maintaining healthy indoor air quality.

RESULTS: Approximately two weeks after occupancy, the building had no noticeable "new building" smell or odor that would typically be caused by chemical emissions from new materials and furnishings. Anecdotal evidence from chemically sensitive employees indicates a healthier indoor ecology for this green office building. The city experienced lower absenteeism and higher employee productivity in this healthy "green" building demonstration project.

REDUCING ENERGY USE

4.0

REDUCING ENERGY USE 4.0

INTRODUCTION 4.1

Buildings require energy to provide services such as heating, cooling, ventilation and lighting. Energy reduction means providing the same level or quality of energy service while using less energy. Few Canadians realise that much of our electricity is generated in power plants that burn fossil fuels such as coal, oil and natural gas. These power plants discharge pollution into our atmosphere every year, which contributes to global warming.

Energy is essential to our way of life, but the provision of energy services can have a negative impact on our environment. The combustion of fossil fuels for the generation of energy is a major source of greenhouse gases that have been recognized as contributing to global warming. This process also produces ground level ozone that is a significant component of 'smog'. The emissions from coal-fired thermal electric plants combine with water vapour in the atmosphere to create 'acid rain' and other toxic emissions. Other energy-related environmental problems include the impacts on ecosystems and land-use from hydroelectric dams; the management of radioactive wastes from nuclear power plants; and the risks of spillage from transporting oil.

The Federal government has committed Canada to a range of measures aimed at reducing air emissions. Reduced energy use is the most effective and immediate means of meeting these commitments. The following section provides an overview of the environmental impacts associated with energy use and explores initiatives that can be taken to reduce energy consumption. Section 5 provides more technical details on specific measures which can be taken to reduce energy use within an office building.

GLOBAL WARMING AND CLIMATE CHANGE 4.2

United States Vice President, Al Gore has called global warming "the greatest environmental challenge of the 21st century." The term 'global warming' can be misleading as it suggests the primary concern is average temperature. However, temperature is the least significant aspect of the multitude of consequences of world-wide warming. Several current trends demonstrate that global warming is having a direct impact upon rising sea levels, the melting of icecaps and other significant world wide climate changes.

Global warming has significant effects on crops and weather conditions around the world. The Northern Hemisphere contains more land area than the Southern Hemisphere and conversely, a lower percentage of the world's ocean. Since water absorbs more heat than land areas, most climate models predict faster heating over the Northern Hemisphere than the global average. Most of the increase is expected to occur between 40 degrees north, the latitude of Philadelphia and 70 degrees north which are the northern most extremes of Canada and Siberia.

If global warming trends continue, higher temperatures in North America may reduce agricultural productivity. Northern continental areas are projected to have drier summers soils due to earlier snow melts in the spring and warmer and more cloudless summers causing extensive evaporation of ground moisture. Also, the inland areas of the Northern Hemisphere are expected to receive less moisture, resulting in lower water levels in lakes and rivers. Some reports predict the levels of the Great Lakes will drop between 0.6 and 1.2 metres by the middle of the 21st century.

Many people associate global warming with the melting of the polar icecaps. This is a significant problem as a large number of the world's cities are built in coastal areas. There are two major causes of rising sea levels. Firstly, additional water is produced when ice melts; and secondly, the natural expansion of seawater as it becomes warmer. It has been estimated that even with the level of greenhouse gases present today, the earth may warm enough in the next 50 years to melt the ice located at the poles.

Changes associated with rising sea levels are very diverse. Warmer oceans cause more intense storms and experts believe that global warming could increase the intensity of hurricanes by over 50 percent. Hurricane Andrew's devastation in 1992 set new destruction records and the intensity of Hurricane Mitch in 1998 surpassed Andrew. Damage caused by future hurricanes to populated areas will be more severe since higher sea levels are predicted in the next century. In addition, as the oceans rise coastal erosion is evidenced, particularly on steep banks. Wetlands are lost as sea levels rise. Also, there is a serious problem with the threat of salt water intruding into underground fresh water reserves in coastal areas.

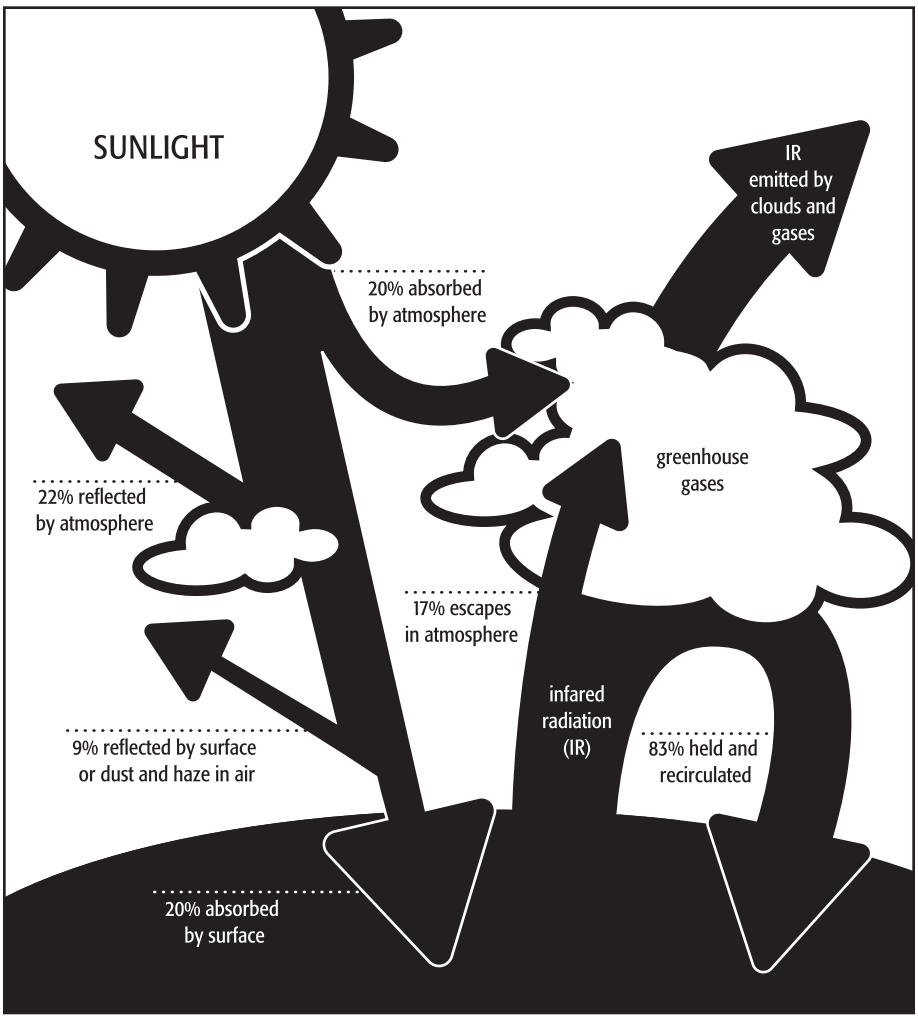
A report published by the United Nations in 1992, predicts that if CO2 and other greenhouse gases continue to be emitted at present rates, sea levels will rise by 0.6 metres by the year 2100. This would result in flooding of the coastal plains of Bangladesh and the Netherlands, and the islands of the Maldives will completely disappear.

THE GREENHOUSE EFFECT 4.3

It has been estimated that the operation of federal government facilities and vehicles accounts for about 2.6 million tonnes of carbon dioxide emissions annually. Carbon dioxide has been recognised as a greenhouse gas. While CO2 is generated by many sources, one of the principle causes is the burning of fossil fuels used for heating purposes and hydro generation.

The term 'greenhouse effect' refers to the way certain gases trap heat in the atmosphere the same way the glass in a greenhouse structure is transparent to short wave radiation but prevents long wave radiation from escaping. This is a naturally occurring phenomenon that heats the planet. Earth is 93 million miles away from its energy source, the sun. Without the greenhouse effect our atmosphere would be approximately 150 C colder.

Half of the sunlight that strikes the planet's atmosphere is in the form of electromagnetic radiation that is visible light. The remainder is infrared radiation (IR), the invisible warmth-inducing longer light waves. Incoming sunlight contains very little ultraviolet light and a few X-rays or gamma rays. Most of these are filtered by absorption in the upper atmosphere.



SOURCE: The Wasington Post Scientific American, NASA, NOAA Geophysical Fluid Dynamics Labratory.
Too much of a good thing! The greenhouse effect keeps the earth habitable, but it can also trap too much heat in the atmosphere. Here is how it works.

Approximately half of the sunlight that reaches the earth's outer atmosphere gets to the surface where it transfers energy to land and water. The surface then sheds the energy as heat, largely infrared radiation. If the air contained nothing but its main components of oxygen and nitrogen, almost all of the energy emitted at the surface would radiate uninterrupted back into space. However, nearly 90% of the infrared radiation is caught by clouds and gases and sent back to the earth's surface. The effect is that the earth's surface is subjected to twice as much infrared radiation from the atmosphere as from incoming sunlight. This is because the molecules of some gases present known collectively as 'greenhouse gases' are just the right size and configuration to trap infrared radiation and re-radiate it. Most of these gases stay in the atmosphere for decades or centuries and continually contribute to global warming.

The average surface temperature of the globe has risen between 0.3 to 0.60C since about 1860. Most climate scientists attribute global warming to the increase of greenhouse gas pollution in the air. One source of this pollution has been the surge in fossil fuel burning since the post-war development years. The burning of fossil fuels and forests generates CO2, which is responsible for about half the greenhouse effects. Other gases like halocarbons, (such as CFCs and HCFCs), methane, nitrous oxide, and tropospheric ozone are responsible for the rest.

THE KYOTO PROTOCOL 4.4

The Third Conference of the Parties to the United Nations Framework Convention on Climate Change was held in December 1997 in Kyoto, Japan. Countries participating in the conference agreed to limit greenhouse gas emissions relative to 1990 levels by the period 2008 to 2012. Canada pledged to reduce its emissions by 6 percent, measured from a 1990 baseline.

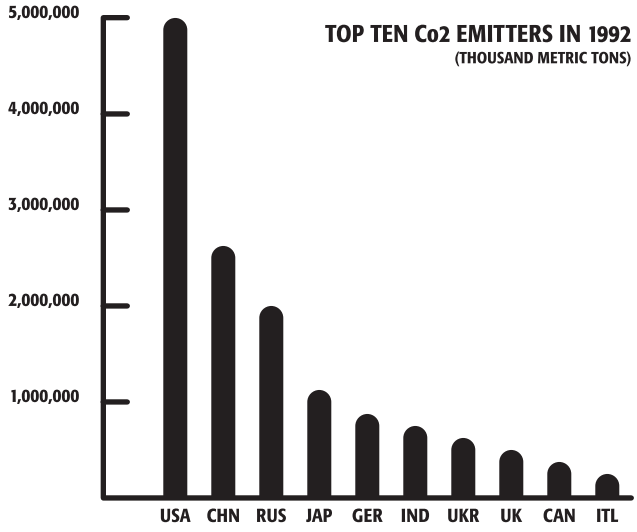
The Kyoto Protocol deals with six major greenhouse gases. Reducing carbon dioxide emissions is particularly important because this gas accounts for 80 percent of Canada's greenhouse gas emissions. Approximately 64 percent of greenhouse gas emissions are a direct result of electrical power generation required to meet the energy requirements of the agricultural, residential, commercial, industrial and transportation sectors. Reducing energy use and switching to less carbon intensive energy sources will reduce carbon dioxide emissions.

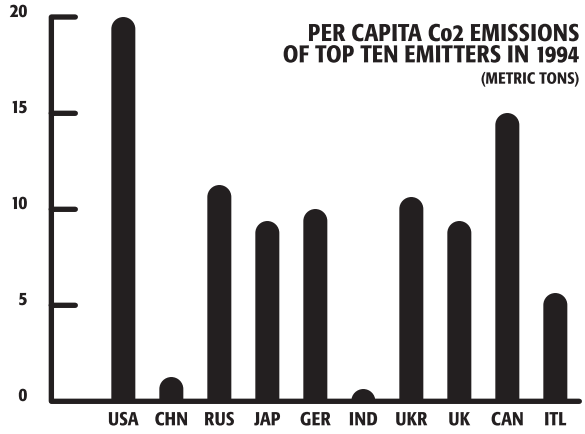
CANADA'S CO2 EMISSION LEVELS 4.5

Meeting the demands of the Kyoto Protocol will present a significant challenge to Canadians. A Natural Resources Canada publication entitled Canada's Energy Supply and Demand Outlook, 1996 – 2020, forecasts that by 2010 carbon dioxide emissions will increase by 16 percent over 1990 levels. To meet Canada's commitment at Kyoto, Canadians will have to reduce their energy consumption by 19 percent from anticipated 2010 levels.

Between 1990 and 1996, Canada's energy consumption rates were expected to increase by 15 percent, however due to the implementation of energy efficient measures the increase was 11.4 percent. In the same period Canada's carbon dioxide emission levels increased by 7.2 percent. However the decrease in energy use translated into a reduction in carbon dioxide emissions of 3.8 percent in 1996 alone. This slower growth in emission levels is the result of the implementation of energy reduction measures and a switch by consumers and the electrical power generation industry to fuels that contain less carbon.

As we move towards cleaner methods of producing energy, we can make enormous advancements in using energy more efficiently. We can make a number of improvements to save energy and curb global warming. During the last two decades, energy efficiency has improved at a rate faster than it has been adopted. It is now possible to displace about one half of all energy consumption for less money than we currently spend to use it. Some products such as fluorescent lights, have been improved to meet compliance with energy efficiency standards. In many areas, buildings and lifestyles waste enormous amounts of energy. Replacing standard fluorescent lighting with efficient fluorescent lighting can save about 80 kWh of energy per fixture per year. This translates into a decrease in greenhouse gas emissions of 17 kg per fixture per year.





ENERGY REDUCTION IS A SOUND BUSINESS PRACTICE 4.6

Energy reduction is a valuable tool for environmental protection. Integrating energy efficiency into construction projects also makes good business sense. A one-time investment in energy efficiency today will achieve ongoing financial benefits for many years. Some energy efficiency projects are known to have generated savings that translate into returns on investment of 25% and greater.

The cost-effectiveness of an energy reducing investment may be calculated in several ways. Many practitioners rely on the 'simple payback' method, which calculates the expenditures against costs to determine the length of time in which the initiatives will be paid for The simple payback method is a useful starting point but tends to under-estimate the financial benefits. A better approach is to carry out a 'life cycle costing' (LCC), which takes into account all the costs and benefits associated with the energy efficiency investment including the value of the savings over the lifetime of the measure. Costs to be considered include the costs of initial purchase, operating and maintenance costs, fuel costs, the costs of inflation and disposal, and the cost of money over time. Using the LCC approach enables practitioners to assess the feasibility of the investment from several perspectives such as returns on investment, discounted payback and net benefits.

REGULATIONS 4.7

All construction and renovation projects should ensure that they are in compliance with applicable regulations at the municipal, provincial and federal levels. The following regulations for energy reducing initiatives can affect decisions during a project:

- The National Energy Code for Buildings (NECB);
- National Building Code;
- National Plumbing Code;
- The National Energy Efficiency Act;
- Regulations calling for the phase-out of CFC based refrigerants and other CFC based products; and,
- Regulations covering the disposal of PCBs.

THE FEDERAL BUILDINGS INITIATIVE 4.8

Planning and implementing energy reduction upgrades can be a considerable challenge for most facility managers. These projects require time, expertise, and capital. The Federal Buildings Initiative (FBI) program, created by Natural Resources Canada, can help remove these barriers.

The Federal Building Initiative is a comprehensive program designed to provide federal facility managers with an opportunity to realise the benefits of improved energy efficiency. The FBI program can help an organization cut energy costs while making facilities more comfortable. The program offers:

- **ENERGY PERFORMANCE CONTRACTING:** an approved mechanism to retrofit buildings without using capital funds through private contractors called Energy Service Companies (ESCos). The ESCos finance the project, guarantee the energy savings from the retrofit, and are paid for their services from the energy savings. When the contract period is over, the custodian department realizes the savings. Any shortcomings in the expected savings are reflected in the ESCos payment.
- **TAILORED EXECUTIVE AND MANAGERIAL SUPPORT:** a complete package comprising all technical, planning and contractual support needed to implement an energy saving project on a turnkey basis. The FBI also offers access to tools and services to assist in mounting a strategy for federal buildings.

Energy efficiency in retrofit projects involving an estimated 4500 buildings have been initiated under and registered with the Federal Buildings Initiative (FBI). Table 4.1 summarizes the investment commitment and associated energy savings for FBI projects to August 1998.

TABLE 4.1
INVESTMENT AND ENERGY SAVINGS OF FBI PROJECT COMMITMENTS TO AUGUST 1998

	($ MILLION)
Total annual federal energy cost	800
Estimated total potential annual energy savings	160
Total FBI project commitments	
• Investments (cumulative to date)	154
• Estimated annual energy savings	22

DEPARTMENTAL BREAKDOWN OF FBI INVESTMENT COMMITMENTS – FIVE LARGEST SPENDERS:

	INVESTMENT COMMITMENT (CUMULATIVE TO DATE) ($ MILLION)	ESTIMATED ANNUAL ENERGY SAVINGS ($ MILLION)
National Defence	70.0	8.3
Public Works & Government Services	33.0	5.2
Industry Canada	13.1	2.3
Environment Canada	8.7	1.1
Natural Resources Canada	7.6	1.0
TOTAL	**132.4**	**17.9**

In July 1998, NRCan commissioned a study of six energy service companies (ESCOs) who undertook 24 retrofit projects in federal government buildings since April 1, 1997. Survey results were obtained for 16 of the projects representing retrofits of 450,000 square metres of floor space with expected energy savings of $1.4 million per year. The results indicate that over three-quarter of the expenditures were made on lighting and control systems.

FBI REPRESENTATIVE PROJECTS 4.8.1

NATIONAL DEFENCE

National Defence continues to be the most active department in terms of initiating FBI projects. About $68 million will be invested by the private sector in National Defence facilities for energy efficiency improvements, with estimated energy savings of over $8 million per year. Fourteen Canadian Forces Bases (CFBs) have signed FBI contracts or are in various stages of the tendering process. These include:

- CFB Halifax, NS
- CFB Gagetown, NB
- CFB Montréal, QC
- CFB Petawawa, ON
- 17 Wing Winnipeg, MB
- 7 CFSD Edmonton, AB
- 4 Wing Cold Lake, AB
- 14 Wing Greenwood, NS
- CFB Valcartier, QC
- 8 Wing Trenton, ON
- CFB Borden, ON
- CFB Shilo, MB
- CFB Suffield, AB
- 19 Wing Comox, BC

At ***17 Wing Winnipeg***, more than $3.6 million in energy efficiency measures will be implemented to reduce the $3 million annual utility bill. The project will be paid for out of the $560,000 in energy savings that will be generated annually. The program will include approximately 80 buildings, such as hangars, warehouses, garages, training facilities, offices and armouries, in five different locations. Planned energy efficiency measures include a lighting retrofit/redesign, central heating plant upgrades, mechanical modifications, centralized computerized control systems, weatherstripping and consumption metering.

About $1.1 million is being invested at ***7 CFSD Edmonton*** to improve the energy efficiency of the supply depot, with expected saving of $150,000 per year. About two-thirds of the investment will be for lighting fixture retrofits.

At ***CFB Shilo***, $1.8 million in improvements were made to over 40 buildings to upgrade the facilities and reduce utility costs (primarily energy) by 19 percent, from $1.5 million to $1.22 million per year. The changes included in lighting retrofits, controls installation, building envelope improvements, steam trap replacement, central heating plant modifications, solar wall installation and radiant heat conversions.

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

The energy management industry has retrofitted 1.2 million square metres of federally occupied floor space for energy efficiency improvements to date. Public Works and Government Services Canada (PWGSC) has signed 29 contracts representing over $31 million in private sector investment. Almost $5.2 million in annual energy savings will be generated from these projects.

ENVIRONMENT CANADA

Environment Canada launched the first FBI project in facilities leased by the federal government in 1998 for a retrofit of departmental offices in the Place Vincent Massey complex in Hull, Quebec. The project was developed in partnership with the landlord, Duroc Enterprises Ltd., NRCan and PWGSC. The private sector ESCO will invest $1.8 million to upgrade the lighting, heating and ventilation systems in order to reduce energy costs by over $200,000 per year. The pilot project helps extend the reach of the FBI program, where practical, beyond federally owned facilities to all facilities accommodating federal employees.

At the Atmospheric Environment Services Building in Downsview, Ontario, the private sector will invest $2.1 million to reduce energy costs by $330,000 per year. Key features of the project are the replacement of the outdated lighting system with energy-efficient fixtures, electronic ballasts and a computerized control system, and the installation of a sophisticated building management system to regulate the heating, cooling and ventilation system.

STATISTICS CANADA AND HEALTH CANADA

PWGSC has begun a project to retrofit the R.H. Coates Building in Ottawa, where Statistics Canada is the main tenant. The private sector is investing more than $2.6 million in this project, which will cut energy costs by $315,000 annually. The measures to be implemented include state-of-the-art lighting, variable speed drives on fan motors for HVAC systems and computerized energy management controls. Similar energy-saving technologies are being installed in the Main Building, an office building shared by Statistics Canada and Health Canada in Ottawa. The private sector is investing $2.5 million in this facility, which will generate about $330,000 in annual energy savings.

NATURAL RESOURCES CANADA

NRCan's national FBI retrofit of its custodial sites was completed in 1998, with $7.6 million invested. Annual energy savings are about $1 million, and 4,000 tonnes of GHG emissions per year will be avoided.

In consultation with NRCan's science sectors, innovative energy use measures have been implemented, including a Solarwall and solar screens. The installation of a wind turbine is currently being explored. The flexibility of the energy performance contract has allowed for customized retrofit plans to be revised at several sites. Workshops and training programs were also established for NRCan employees as part of the project to help maximize the benefits of the retrofits. A communications plan informs employees on project progress, and a Web site provides more detailed information on individual retrofit projects and the measures being implemented.

REDUCING ENERGY USE *4.9*

There are three components to the efficient use of energy. Incorporating 'a systems approach' into the building design and occupancy approach can optimize the integration of efficient energy use. This approach reflects the idea that a building and its occupants are a system with interconnected components. Making changes to one component will affect others in the system – it has 'synergistic 'effects.

Applying an integrated approach ensures that synergistic effects are anticipated and planned for accordingly. Another benefit is that overall incremental costs can be reduced because of the potential for equipment downsizing. The principle behind an integrated approach (also known as Whole Building Design) is to integrate the project's steps into a single comprehensive design. This approach recognizes that the project's stages are interactive; as opposed to 'stand alone' activities. It requires active participation from all the experts involved in the renovation, recapitalization or fit-up project.

ENERGY CONSERVATION

Energy conservation can accomplish the reduction of energy use as a direct result of behavioral changes as well as technological intervention. The implementation of energy conservation practices has the same benefit to the environment as those obtained from minimizing energy use through the use of energy efficient products and materials.

Utility companies regularly promote energy conservation procedures as a recognizable means of reducing energy demands. Electrical and gas utilities are able to provide information that is applicable to both residential and commercial applications. Commonly recommended energy conservation practices include timing controls that turn off lights during unoccupied hours and set-back thermostats to reduce heating and cooling set points during unoccupied periods.

ENERGY EFFICIENCY

Energy efficiency refers to technological changes that allow us to pursue present behaviors while consuming less energy. Most appliances or fixtures consume energy through their operation. Except for some solar-powered appliances, this equipment is connected to a direct energy source. Energy efficient systems or products give equivalent performance while consuming less energy. Acceptable low energy consumption rates, such as those published by the Canadian Standards Association (CSA) have been established for most products. Efficient energy consumption is established on a comparative basis. However, at present a generally accepted baseline does not exist as current energy efficiency standards are product and program specific. Standards have been developed based on data gathered by organizations such as the New Building Energy Code, the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), Ontario Power Generation, the National Research Council of Canada (NRC), the Canada Mortgage and Housing Corporation (CMHC), the Ontario Ministry of Environment (MOE), Natural Resources Canada (NRCan), the CSA and BC Hydro Power Smart.

Technological advances are continually improving efficient energy consumption by appliances and fixtures. Internationally recognized eco-labelling organizations such as the Canadian Environmental ChoiceM program or the American Green Seal program have developed energy consumption guidelines for specific product types that provide a quantifiable definition for energy efficiency standards of environmental merit that are technologically attainable. The specification or selection of products that are considered energy efficient provides reduced environmental impacts by curtailing the environmental costs that are associated with the generation of electricity, such as carbon dioxide production from the burning of fossil fuels or the flooding of lands by building hydro-electrical dams.

ENERGY SAVINGS

Energy savings identify materials and products that are non-energy consuming, but contribute to improved energy consumption through their intended use. While performance standards exist for many construction products in most cases these ratings do not provide information regarding potential energy savings. For example, formulas are in existence that calculate the R-value or thermal rating for many thermal-building products, but this information does not indicate how much energy will be saved as a direct result of the product's application or use.

Most energy utilities provide literature supporting the reduction of energy use through the use of these non-energy-consuming products. Many of the eco-labelling programs like the Environmental ChoiceM program address building materials that provide energy savings. The guidelines for these products also address other environmental issues such as recycled content and emission rates. The savings realized from the application of energy saving products are very specific.

ENERGY MANAGEMENT *4.10*

Increased economic development can be achieved through proper management of resources while minimizing environmental impacts. Renovation projects or new construction proposals provide opportunities for the incorporation of energy reducing measures. When dealing with renovation, recapitalization and fit-up projects, the greater the scope and the more complex the proposed renovations, the more opportunities there are for energy efficiency improvements. For new construction projects there are numerous opportunities to incorporate energy reducing measures.

Facility managers should remember to look beyond the immediate scope of the project for opportunities to minimize energy use. When an energy reducing measure is implemented, the goal should be to ensure that the estimated savings are optimized and maintained during the useful life of the initiative and beyond. It is not uncommon for savings to fall off due to poor operational and maintenance practices. For example, energy efficient products installed during a retrofit are sometimes replaced by less efficient products when they reach the end of their useful lives. One of the ways to prevent this from happening is to develop an energy management plan that includes guidelines to ensure that energy reduction is an ongoing activity.

A long-term energy management plan helps facility management to identify and include energy reducing measurements into their ongoing planning and to integrate energy efficiency into the day-to-day operation of the organization. Bundling energy efficiency projects to maximize cost-effectiveness is one of the elements of an effective energy management plan.

Three elements are essential to the effective management of a project's energy reducing components.

1. ASSEMBLE AN IN-HOUSE TEAM

Implementing energy reducing measures is a complex process entailing many activities. A competent Energy Reducing Management Team is essential to the success of the project. The team should be assembled very early on in the project process and should meet frequently to review progress. The team should include both technical and non-technical expertise and should reflect both management and operational perspectives.

2. ACCESSING THE EXPERTS

When integrating energy reduction into a project, the range of technical expertise required is diverse and different capabilities may be required at various stages. One particular area of importance is Indoor Air Quality (IAQ). In the event that the energy reducing measures will include upgrading the building envelope to reduce heat transference through air infiltration the actions may containerize interior pollutants that will negatively impact upon the health and comfort of the building occupants. This issue should be specifically addressed throughout the project.

Depending on the size and complexity of the project, a facility manager may need to look to outside resources for assistance in the following areas:

- Energy auditing,
- Costing and economic analysis,
- Architectural and systems design,
- Engineering,
- Indoor air quality analysis,
- Construction procedures,
- Commissioning,
- Staff training,
- Maintenance and monitoring, and
- Co-ordination of activities.

3. ENERGY PERFORMANCE CONTRACTING

Energy Service Companies are private sector companies that provide energy performance contracting (EPC). These companies provide technical expertise during the planning and implementation stages of a project and can also help to manage the financial aspects of the project and minimize risk. EPC is a means of implementing energy efficiency into projects and reducing operating costs with minimal up-front financial expenditures. ESCos provide a full range of project expertise, as well as the procurement of capital resources needed to implement the project. Payment is based solely on the energy cost savings realized through the building improvements. Most of the technical, financial and maintenance risk are the responsibility of the energy management services supplier. The FBI program provides assistance in using the energy performance contracting approach.

Regardless of the extent to which energy service professionals are used in a project, facility managers should be aware of basic energy efficiency principles and options. This awareness will be an important element in the development and implementation of a long-term energy management plan.

INTEGRATING ENERGY REDUCTION *4.11*

Listed below is a framework for the activities that may be required for the implementation of energy reducing measures. The sequence and scope of the phases may vary between projects.

DEFINE THE SCOPE OF THE PROJECT
Understanding the project objectives and budget will help to determine whether or not the project appears to offer opportunities for incorporating energy reduction measures. Acceptable financial payback periods and project timelines must also be determined. More detailed technical information is provided in Section 5.

RESEARCH
This stage involves a preliminary assessment of the financial benefits that can be achieved by implementing energy reducing systems and measures into the design. The research phase should involve an estimate of approximately how much energy can realistically be saved and what costs are associated with implementation.

In the case of an existing facility, reviewing records and conducting an energy audit will provide valuable baseline data. This activity allows the project team to understand the facility's present energy costs and establishes a pattern of energy use. The audit will also identify the areas of high energy consumption and the sectors where the greatest energy savings can be achieved. Engineering studies should be able to provide projected energy costs and patterns for new construction projects.

THE ENERGY AUDIT
An energy audit identifies the specific pattern of energy use. It will indicate where proposed refits will affect energy uses in the facility, and what types of energy reduction measures will provide the greatest benefits. An extensive audit will address aspects of energy conservation, energy efficiency and energy savings. For example, if occupants leave lights on at the end of the day, the audit may suggest that refits include occupancy sensors and lighting controls that automatically turn off lights when rooms are unoccupied.

The energy audit can be a brief walk-through exercise, or it can be a detailed full energy audit. The level of effort for the audit should be consistent with the scope of the proposed refits.

An energy audit is a systematic approach for gathering information about the energy use of a facility, including HVAC, water heating, lighting, office equipment and other energy consuming equipment. It covers all equipment types, usage, and activity levels, and provides answers to the following critical questions:

WHO: the audit will determine which tenants or human activities of the facility consume the greatest amount of energy.
WHEN: the audit will determine a pattern for energy use, that will identify times or activities of highest energy consumption.
WHERE: the audit will gather data on the energy consumption of the equipment such as HVAC and water heating appliances.
WHAT: the audit will identify areas that should be targeted to reduce energy consumption.

TABLE 4.2
APPROXIMATE ENERGY CONSUMPTION BY END USE IN A TYPICAL OFFICE BUILDING

Space Heating	40% of Total
Lighting	30% of Total
Office Equipment	10% of Total
Fans and Pumps	10% of Total
Other	10% of Total

**Table 4.1 below indicates typical energy use within an office building.*

REVIEW EXISTING ENERGY RECORDS

Energy use peaks can be identified by looking at the building's history of energy use over the course of a year (from meter reading data taken from utility bills) and graphing and tabulations of monthly energy bills for at least two years.

DEFINE THE PROJECT'S ENERGY REDUCTION PLAN

This stage defines the scope, costs and estimated benefits of the project's energy reduction plans. This task should build on the results of the energy audit and the record analysis. Several factors will guide the development of the energy reduction plan.

Three areas that should be examined are:

- Interest in working with the FBI Program: any concerns that the project team might have about financial and management constraints can potentially be addressed through the FBI Program and the provision of energy management services from ESCos. The FBI Program should be contacted for an initial consultation.
- Investment threshold: the department or individual operation within the department, may have a specific threshold for this type of investment
- Other needs and priorities: clearly, the energy reduction investments need to be examined in light of other considerations such as timing. Sometimes the renovation has to be implemented too quickly to allow enough time for energy reduction upgrades.

IMPLEMENT THE ENERGY REDUCTION PLAN

During this stage the energy reduction plan is put into action. Implementation takes place once the design is finalized and the budget is set and approved. In occupied facilities, occupants should be inconvenienced as little as possible during this step. Implementation includes a number of activities that will be co-ordinated with the overall renovation project. For example:

- Prepare project specifications consistent with meeting the energy reduction goals.
- nitiate a tendering process. This should include a site visit and meeting with potential energy subcontractors to share project objectives and to communicate the mandatory requirements.
- Review the tenders and award contracts as required.
- Acquire the required energy efficient equipment.
- Manage the project during the construction phase.
- Work in partnership with all others involved in the renovation.

The Energy Reduction Management Team members should be briefed and have their implementation responsibilities assigned to them. A timetable and list of milestones should be established. The team should also monitor the on going implementation process.

COMMISSIONING AND TRAINING

Commissioning of the energy reducing components of the project has two important objectives, both directed at achieving the targeted energy savings. They are:

- to ensure that the specified equipment is installed and working properly, and
- to ensure that the targeted energy reduction levels will be sustained throughout the lifetime of the specified measure.

Commissioning usually has both a technical and training component. The technical component involves testing the installed equipment, making adjustments as necessary and developing operation manuals when required. The training component focuses on instructing staff and occupants on how the new equipment should be properly operated and maintained. Cleaning staff should also be included in the training programs. They are on-site long after other occupants have left and often have to shut down equipment that is left on unnecessarily after hours.

Information sheets can make training easier. They provide brief, user-friendly and site-specific information about the equipment that has been installed. They are particularly useful in cases where the manufacturers' manuals are complex.

After commissioning, all systems should be working properly and building staff and occupants should know how to use the new equipment. The commissioning should ensure that occupants get the service they expect with the new equipment. In turn, they will not be tempted to turn off or disable equipment that does not provide adequate service.

PROMOTE ENERGY AWARENESS

Building occupants should be made aware of energy reduction issues. Awareness of the issues surrounding energy use promotes a better understanding of the energy reduction improvements that have been made in the facility. It encourages occupants to use all new features and products properly. Experience has shown that 'aware' occupants and staff are more motivated to do their part to save energy than those that are 'unaware'. They make greater efforts to operate new equipment correctly, rather than disregarding it or simply turning it off.

Communications professionals who specialize in energy programs can make the difference between a routine energy awareness program and an excellent program that brings concrete results. Promoting energy awareness should be part of any long-term energy management plan.

MAINTAIN THE SYSTEM

Routine preventative maintenance of new equipment and systems brings a number of benefits. They are:

- ensuring that the energy savings are maintained, or increased, long after the renovation is completed,
- prolonging the life of the equipment, and
- reducing disruptions from unscheduled equipment breakdowns.

Scheduled preventative maintenance programs sometimes mean higher up front costs, but they make good business sense. In the long term, the reduced energy costs, reduced replacement costs, longer equipment life and increased productivity will save money.

Maintenance usually involves a number of tasks. The first is to review manufacturer's recommendations and use these as a basis for establishing a maintenance program. The maintenance program should include a schedule of activities and an assignment of responsibilities. A thorough commissioning procedure will include a recommended preventative maintenance program.

MONITORING THE SYSTEM *4.12*

Management should review monitoring data on a regular basis. The results should be compared against the energy savings potential calculated during the research phase and used to track and update energy reduction goals. A regular monitoring program lets management know if the projected energy savings are on target. It keeps track of energy use and allows ongoing evaluation of the energy reduction measures.

Monitoring can be a simple or a complex activity. At the most basic level, monitoring means reviewing utility bills–but this provides only financial information and can be deceptive due to increasing electrical costs. At the most complex level, monitoring involves submetering of parts of a building or of specific equipment. While costs are associated to establish this process the information it produces is more accurate and useful when evaluating the effectiveness of the energy reduction program.

IMPLEMENTING ENERGY EFFICIENCY MEASURES

5.0

IMPLEMENTING ENERGY EFFICIENCY MEASURES 5.0

The energy-related goals of the Green Office Building Plan are intended to support the overall goal of minimizing the impact of federal buildings on the environment. The Federal government is committed to reducing greenhouse gas emissions, and energy efficiency contributes to this goal. The four principles behind the activities described in this section are therefore:

1. Create healthy environments for office workers: air, light, noise, temperature, humidity.
2. Reduce energy waste.
3. Reduce energy consumption.
4. Increase equipment and system efficiency.

The focus is on measures that are practical and cost-effective for major retrofits of existing buildings. There is even more scope for improvement in new construction.

The base level of energy performance is the Model National Energy Code for Buildings (MNECB). A Green Office Building should incorporate, as a minimum, where viable the mandatory and prescriptive requirements of the MNECB. In addition, certain requirements of the Commercial Buildings Incentive Program (CBIP) Prescriptive Path for Offices have also been incorporated, such as high efficiency lighting design.

Projects intended to achieve higher levels of energy efficiency are encouraged to comply with the full requirements of the CBIP and establish an energy use target that is 25% lower than a building designed to the NECB requirements. The Natural Resources Canada C2000 program sets an even more stringent target of 50% below ASHRAE 90.1 requirements and is recommended for new construction projects with aggressive energy reduction targets.

The Model National Energy Code for Buildings is available from the Institute for Research in Construction at the National Research Council Canada. Tel 1-800-672-7990 or (613) 993-2462, fax (613) 952-7673.

Most of the publications on the NECB (other than the codes themselves) are online at Canada's Energy Efficiency Homepage (http:/eb-dee.nrcan.gc.ca) .

BUILDING ENVELOPE INSULATION 5.1

The insulation of the building envelope is the key method of limiting the greatest energy use in office buildings in Canada – space heating. The intent of this section is to bring renovated buildings up to the modest insulation levels required in the NECB, and not to impose criteria that would be difficult to justify in a renovation project. Should the opportunities arise, however, higher insulation levels should be considered, for example, when new exterior walls or new roofing are installed. In the renovation, attention must be focused on insulating the thermal bridges which degrade the overall insulation value below the nominal rating of the assembly.

- **INSULATION:** Overall thermal transmittance (U-value) of walls, roofs and floors-on-ground must not exceed the values in Appendix A of the MNECB. Solid masonry exterior walls are not exempt and must also be insulated to this level.
- **THERMAL BRIDGING:** Determination of an assembly's U-value must account for thermal bridging due to framing members and other conduction paths.
- **CONCRETE ROOF AND FLOOR PENETRATIONS OF ENVELOPE:** The U-value of a wall at a concrete floor or roof intersection shall not be more than twice that of the associated wall.
- **PARTIAL PENETRATION OF ENVELOPE BY SERVICES:** Recessed heaters, pipes and ducts that partly penetrate the building envelope, must be located on the conditioned side of the insulation and must not increase the overall U-value of the building envelope assembly at the partial penetration to more than the U-value of the overall wall.
- **RADIANT HEATING:** If radiant heating sources are embedded in floors-on-ground or in walls, the assembly must be insulated to a level 20% better than the maximum overall U-value allowed by the MNECB tables.
- **ATTIC/ EXTERIOR WALL JOINT:** Attic insulation must be continuous over the top plate of the wall bearing the roof, and must have a U-value not more than that of the associated wall.
- **INSULATION OVERLAP:** At envelope locations where two planes of insulation do not physically join, the two continuous insulations shall overlap for a length of at least 4 times the distance separating the two insulations.
- **FULL ENVELOPE PENETRATION BY WALLS:** Where a concrete or masonry foundation wall, firewall or party wall penetrates an exterior wall or roof, it shall be insulated on both sides to a distance at least 4 times the wall thickness and to the same U-value as the exterior envelope assembly.
- **BELOW-GRADE WALLS** requiring insulation shall be insulated over their full height to the U-value in the NECB tables.

FENESTRATION AND DOORS 5.2

Windows are the weak link in the insulation and airtightness of most office buildings. Windows have also experienced the greatest technical advance of any building components in Canada in the last decade. In small office buildings, the thermal performance of windows to reduce heat loss will be most important. In large office buildings, concerns about solar heat gain, glare and condensation will dominate. High performance windows offer solutions for both sizes of building, compared to conventional, double-glazed, aluminum-frame windows, and must be evaluated in any project where existing windows are being replaced. Otherwise, in a renovation where the intent is to keep the existing windows, the minimum requirement for a Green Office is that windows at least meet the NECB requirements.

- **OVERALL THERMAL TRANSMITTANCE** (U-value) of windows shall not exceed the U-value in the NECB Appendix A. Airtightness rating shall be A2 or better.
- **THE SPACE BETWEEN THE WINDOW FRAME AND THE ROUGH WALL OPENING** shall be insulated and air-sealed for continuity of the air barrier.
- **SKYLIGHTS:** The U-value of skylights shall not exceed the U-value for fenestration in the NECB Appendix A.
- **DOORS:** Overall U-value of swinging doors shall not exceed the values in NECB Table 3.3.1.3. Airtightness must comply with NECB article 3.2.4.3.
- **VESTIBULES:** Vestibules are required for all doors that separate conditioned space from the outdoors, except where exempted in NECB article 3.2.2.3.

ENVELOPE AIRTIGHTNESS 5.3

Improving the airtightness of office building envelopes has several benefits:

- Reduced outside air infiltration and resulting heating and cooling loads
- Reduced structural deterioration resulting from pressure-driven moisture movement through the walls and roof assemblies
- Fewer drafts and improved worker comfort
- Reduced stack effect and better control of building pressurization

Building air-tightness is an area of active development in Canadian building science, and objective, measurable targets for the airtightness are still evolving. However, the indications are that there are multiple benefits to improved airtightness and all efforts should be made to achieve the tightest envelope possible. However, it should also be noted that the tighter the envelope the greater care must be taken to provide sufficient air exchange for worker comfort and health.

- **AIR BARRIER SYSTEMS** shall be designed and installed in accordance with Part 5 of the National Building Code of Canada (NBC). Sheet and panel type materials intended to act as an air barrier shall have an air leakage rate of no more than 0.02 L/s-m2 at 75 Pa.

LIGHTING 5.4

Lighting can be the single greatest load for electricity in many offices, and cost as much as space heating over the year. With the recent advances in lighting technology, lighting energy can be reduced significantly, even below NECB levels, and still provide required levels of illumination. In this area, the Green Office Building Plan exceeds the NECB. The CBIP Prescriptive Path for Offices has shown that lower Lighting Power Densities are cost-effective and are the single most important way to reduce electrical use in offices.

- **EXTERIOR LIGHTING EFFICACY:** All exterior lamps must provide at least 60 lm/W.
- **EXTERIOR LIGHTING CONTROLS:** Exterior lighting shall be controlled by schedule controllers and/or photocells.
- **FAÇADE LIGHTING:** Façade lighting must be less than 1.2 W/m2 of face.
- **INTERIOR LIGHTING:** Overall building Lighting Power Density (LPD) shall not exceed 11.5 W/m2.
- **CONTROLS:** There must be one control per circuit, next to an entrance, in clear line of site, readily accessible and identified, unless centralized and identified in accordance with MNECB 4.2.4.3 (2). There shall be one control for each office.
- **OCCUPANCY CONTROLS:** Lighting in spaces which are not continuously occupied, eg. washrooms, utility rooms, shall be controlled by occupancy sensors.
- **DAYLIGHTING:** Photoelectric and/or dimming controls shall be provided for lighting of common use areas greater than 40m2 and within 6 m of the building perimeter. Apply recognized daylighting design techniques to improve daylight levels, increase daylight penetration while minimizing adverse effects such as glare. (see Annotated Bibliography for references)
- **TASK LIGHTING:** Task lighting (not in the ceiling) shall have a switch near the workstation.
- **EXIT SIGNS:** Exit fixtures shall be rated less than 12 W each.
- **BALLASTS:** Fluorescent lamp ballasts shall comply with MECB 4.2.5.
- **DOCUMENTATION:** A statement of design intent and operational recommendations must be provided for lighting systems and shall include
  ⇨ single-line diagram of the lighting control systems showing the location of each zone and associated switches
  ⇨ A luminaire schedule indicating lamp ballast replacement specification
  ⇨ Manufacturers' operation and maintenance instructions for installed automatic lighting controls.

ELECTRICAL POWER *5.5*

Electricity is the largest energy cost in most offices. Electric utility bills include both energy charges in kilowatt-hours and power demand charges in kilowatts. In addition, utilities penalize large facilities with low power factors that require the utility to provide power factor compensation. Opportunities exist in major renovations for improving efficiencies of electrical power systems. As a minimum, renovation projects should add the capability to install meters to measure the performance of the electrical system and to enable users to be aware and responsible for the electricity they consume. The system design should also include adequate controls to discourage waste of electricity. The best way to save electricity is to turn equipment off.

The efficiency of office equipment is also a key element in reducing electrical use.

- **METERS:** In new construction and additions, suites having all electrical loads supplied by a feeder to only that suite shall be individually metered.
- **ENERGY MONITORING:** Systems with capacity greater than 250 kVA shall be designed to facilitate the future installation of a system to monitor current and voltage of certain spaces and loads as per NECB 7.2.1.2.
- **POWER RECEPTACLES:** Where exterior power receptacles are provided, all intended for intermitant use shall be controlled by a switch or timer from within the building and labelled accordingly.
- Where **EXTERIOR POWER RECEPTACLES** are provided for indoor/outdoor parking and are supplied through a panel board serving a suite, they shall be controlled by switches or timers accessible only to the tenants of that suite.
- **TRANSFORMERS:** Transformers and their power loss characteristics shall comply with NECB 7.2.3.1.
- **MOTORS:** Three-phase motors and their efficiency must comply with NECB 7.2.4.
- **POWER QUALITY:** Evaluate and correct voltage imbalances, voltage deviations, poor connections, undersized conductors, poor power factors, insulation leakage, and harmonics.
- **DOCUMENTATION:** Documentation of the electrical power system shall be provided and shall include:
  ⇨ A single-line diagram of the building electrical distribution systems showing the location and means to monitor energy consumption
  ⇨ Schematic diagrams of electrical control systems controlling systems other than HVAC
  ⇨ Manufacturers' operation and maintenance instructions for electrical equipment.

HEATING VENTILATING AND AIR CONDITIONING (HVAC) SYSTEMS *5.6*

HVAC systems improvements offer the greatest potential for energy savings in most buildings. The first step for reducing HVAC operating costs in large buildings is to reduce HVAC loads, through such measures as described above. "Greening" an existing building may also include replacing equipment with more efficient models, improving controls and operating procedures, and retrofitting existing equipment to operate more efficiently. It must be realized, however, that central plants contain many interrelated components, and upgrading them takes careful planning, professional engineering design, and careful implementation. Properly designed, installed and maintained HVAC systems are efficient, provide comfort to the occupants, and inhibit the growth of moulds and fungi.
Energy efficiency measures for HVAC systems required of a green office building are listed below.

EQUIPMENT 5.6.1

Buildings usually operate under less than full-load heating and cooling conditions. Therefore, the greatest overall annual efficiency improvements will result from giving special consideration to part-load conditions and selecting equipment accordingly. Chiller manufacturers now provide a standard ratings for part-load efficiency, reflecting the fact that chillers operate at less than full load 99% of the time. Staging multiple chillers or boilers to meet varying demand also greatly improves efficiencies at low and moderate building loads. Pairing different-sized chillers or boilers in parallel offers greater flexibility to central plant equipment. Units should be staged with microprocessor controls to optimize system performance.

EQUIPMENT EFFICIENCY

- HVAC equipment must comply with efficiency requirements in NECB 5.2.13.
- Field-assembled equipment must meet overall efficiency requirements in NECB 5.2.13.
- Service water equipment used for space heating must comply with the efficiency requirements of NECB 6.2.2.1.

HVAC DESIGN

- HVAC systems must be sized to meet the needs of conditioned spaces and designed in accordance with good engineering practice as described in ASHRAE 90.1.
- Equipment installed outdoors or in an unconditioned space must be designated by the manufacturer for such installation.

ICE AND SNOW MELTING

Sidewalks and driveways should be designed so they can be manually cleared of ice and snow and should not rely on ice- and snow-melting heaters. Where ice- and snow-melting heaters are required, they must have automatic or accessible manual on/off controls. The controls are to be clearly labelled and provided with an indicator light.

COOLING WITH OUTDOOR AIR (AIR ECONOMIZER)

- "Air economizer" systems that reduce mechanical cooling energy by direct use of outdoor air must be able to provide outdoor air volumes from 100% of design supply air (S/A) down to the minimum outdoor air flow required for acceptable indoor air quality. These systems must mix outdoor air and return air to a temperature as near as possible to the S/A temperature required to condition the space, except when on-coil temperatures for D/X systems must be higher to prevent coil freeze-up.
- Air economizer systems are required on systems of more than 1500 L/s supply air or 20 kW cooling capacity.

WATER ECONOMIZER (ALTERNATE TO AIR ECONOMIZER)

"Water economizer" systems that reduce mechanical cooling energy use by using outdoor air to chill cooling distribution fluid must be capable of cooling supply air to provide 100% of the cooling load when:

- outdoor air wet bulb temperature is 7 (C or below, if distribution fluid is cooled by direct or indirect evaporation, or both;
- outdoor air dry bulb temperature is 10 (C or below, if distribution fluid is cooled by sensible heat transfer only.

FAN POWER OF CONSTANT VOLUME SYSTEMS

Constant-volume fan systems with 10kW or more of combined nameplate supply return and relief fan power must not exceed 1.6 W per L/s of supply air delivered to the conditioned spaces (as calculated according to NECB Sentence 5.3.12[2]).

This requirement does not apply to fans that are included in the performance ratings cited in NECB Subsection 5.2.13.

CONTROL OF HVAC SYSTEMS

A supply air handler shall be able to achieve supply air temperature without:

- heating previously cooled air (unless for process humidity control for areas such as computer rooms, or when the reheat energy is not from electricity or fossil fuels)
- cooling previously heated air
- heating outdoor air, alone or in mixed air, which is in excess of the minimum required for ventilation

Except for systems with a minimum S/A of 2 L/s per m2 of floor area, systems that control temperature of a space by heating or cooling previously cooled or heated air, respectively, must be equipped with S/A reset controls that will automatically adjust the temperature of:

⇨ the cool air supply to the highest temperature that will satisfy the temperature control zone requiring the coolest air, and/or

⇨ the warm air supply to the lowest temperature that will satisfy the temperature control zone requiring the warmest air.

TABLE 5.1
REQUIREMENTS FOR STAGING MECHANICAL COOLING IN SYSTEMS WITH AIR ECONOMIZERS

DESIGN COOLING CAPACITY	MAX. FIRST STAGE COOLING CAPACITY
25 to 70 kW	50%
>70 kW	25%

MULTIPLE BOILERS AND CHILLERS

Multiple boiler systems must prevent heat loss through boilers when they are not in operation through the use of such items as vent dampers or water shut-off valves interlocked with the burners. In parallel systems, off-line equipment should be isolated from cooling towers and distribution loops. With reduced pumping needs, circulation pumps can be shut off or modulated with variable speed drives.

AIR DISTRIBUTION 5.6.2

DAMPERS

Every duct or opening intended to discharge air from a conditioned space to the outdoors or to an unconditioned space and every outdoor air intake duct or opening must be equipped with a motorized damper. Exceptions include: combustion air intakes, kitchen exhausts, continuously operated systems, and very small ducts (see NECB 5.2.3.1 [2] to [4]). The dampers described above are to have these characteristics:

- located as closely as possible to the plane of the building envelope;
- designed to close automatically when the system is not in operation;
- air leakage through closed dampers to be less than 15 L/s per m2 of cross-sectional area at a pressure difference of 250 Pa;
- may be located inside the building envelope if the duct between the damper and building is insulated to the level prescribed for the walls;
- dampers in air intakes/outlets serving air-heating/cooling equipment located outside the building envelope can be located within the equipment.

AIR FLOW CONTROL AREAS

Each air distribution system, serving multiple temperature control zones, and having combined conditioned floor area more than 2500 m2,,must be divided into air flow control areas of not more than 2500m2, or one storey, such that the supply of air to each air flow control area can be reduced or stopped independently of other air flow control areas. Areas requiring full flow continuously are exempt. The zones within a given air flow area must be on the same occupancy schedule and have off-hours setback or on/off controls. Where air flow control areas are served by VAV boxes, the central system must have at least a 50% reduction in fan power for a 50% reduction in air flow. All central HVAC equipment must operate properly when serving only one air flow area.

FAN POWER FOR VAV SYSTEMS

- Variable-air-volume (VAV) systems with 10 kW or more of combined nameplate supply, return and relief fan power must not exceed 2.65 W per L/s of design supply air delivered to the conditioned space (as calculated according to NECB Sentence 5.3.1.2[2]).
- Any individual supply, relief or return fan in a VAV system must be capable of meeting the power reduction requirements shown in Table 2.4

TABLE 5.2
FAN POWER REDUCTION REQUIREMENTS

FAN POWER DEMAND	AIR VOLUME	% OF FULL DESIGN POWER
7.5 to 25 kW	50%	no more than 55%
>25 kW	50%	no more than 30%

SYSTEM DESIGN

- All duct systems must be designed so that they can be balanced.
- HVAC ducts and plenums must be sealed as per the SMACNA HVAC Duct Construction Standard and NECB Table 5.2.2.3 unless:
  - ⇨ they are return air (R/A) ducts in conditioned spaces or in R/A plenums, or
  - ⇨ they are S/A ducts in conditioned spaces and are downstream of coils/boxes, or
  - ⇨ they are tested and proven to leak less than allowed by NECB 5.2.2.4(2).
- Special Temperature and Humidity Requirements:
  Spaces with special process temperature requirements, humidity requirements or both must be served by air distribution systems that are separate from those serving spaces requiring only comfort conditions. Exceptions to this requirement include when the "comfort" air is 10% or less of the total; or the total design air flow does not exceed 3000 L/s.

PIPING FOR HEATING AND COOLING SYSTEMS 5.6.3

Piping for heating/cooling systems shall have the following characteristics:

- All hydronic systems to be designed so that they can be balanced
- Pipes containing fluid with design operating temperatures outside a range of 13 (C to 40 (C must be insulated as per NECB Table 5.2.4.3, unless exempted as per NECB Sentences 5.2.4.3(2) to (6). Insulation must be protected where it may be subject to mechanical damage, weathering or condensation.

PUMPING SYSTEM DESIGN

For HVAC systems with a minimum total pump system motor power of 7.5 kW, variable flow pumping systems must be capable of reducing system flow to 50% of design flow or less. Exceptions to this requirement include equipment with higher minimum flow requirements, and single-valve and resetting systems.

INSULATION OF "OUTDOOR" PIPING

HVAC piping outside the building envelope must be insulated to the maximum requirement of NECB Table 5.2.4.3

CONTROLS 5.6.4.

Controls systems can be added or upgraded to improve the overall performance of the building, including the HVAC equipment. The simplest measure is to turn equipment off or otherwise ensure that it is in setback mode during unoccupied times.

TEMPERATURE CONTROLS

- Each system intended to provide comfort heating/cooling must have at least one automatic space temperature control device
- Thermostatic controls for comfort shall have the following characteristics:
  - ⇨ heating controls must be capable of adjusting the temperature of the space they serve down to at least 13 (C
  - ⇨ cooling controls must be capable of adjusting the temperature of the space up to at least 29 (C
- The sensors of wall-mounted thermostats must be installed in accordance with manufacturer's instructions and are to be located as per NECB 5.2.10.4.
- Heat pumps having supplementary heaters must be controlled to prevent supplementary heater operation when the heating load can be met by the heat pump alone, except during defrost cycles.
- If separate space-heating- and-cooling controls are used, simultaneous provision of heating and cooling must be prevented.
- The heating/cooling of a zone must be regulated by individual thermostatic controls located in the zone unless a perimeter system is used, in which case there must be at least one space thermostatic control per orientation (provided that the orientation is at least 15m long).

SEASONAL HYDRONIC SHUTDOWN

Seasonal pumping systems, such as heating and chilled water pumping systems, must have automatic controls or readily accessible and clearly labelled manual controls to shut down the pumps when they are not required.

ELECTRIC HEATING SYSTEMS

Electric baseboard heaters must be controlled by remotely mounted thermostats. If line-voltage thermostats are used to control electrical resistance heater units, they must conform to CSA Standard C273.4.

SHUT-OFF AND SETBACK

- Each HVAC system with a heating or cooling capacity of 2 kW or more must have automatic equipment shut-off or temperature set-back controls for periods of non-use, unless the system is intended to operate continuously. Unoccupied setback of heating setpoint shall not enable cooling, and unoccupied setup of cooling setpoint shall not enable heating.
- Heating or cooling equipment with capacities below 2 kW may be controlled by accessible, manual controls.

HUMIDIFICATION

Humidifiers and dehumidifiers must be provided with an automatic humidity control device. If the purpose of the humidity control is comfort, the controller must be able to prevent the use of energy to increase relative humidity above 30% or to decrease it below 60%.

SERVICE WATER 5.6.5

STORAGE VESSELS AND HEATING EQUIPMENT

- If service water heaters, boilers, storage tanks and pool heater included in the scope of NECB Table 6.2.2.1 are not covered by local efficiency regulations, they must comply with the relevant standard of NECB Table 6.2.2.1
- Service hot water storage tanks located outside or in unconditioned spaces must be covered with insulation having a maximum U-value of 0.55 W/m2. (C.
- Hot service water storage tanks within conditioned spaces must be covered with insulation having a maximum U-value of 0.8 W/m2. (C.
- Tank insulation located where it may be damaged must be protected
- Service water heating equipment, other than hot water storage tanks, must be installed in a conditioned space.

PIPING

All hot service water piping in circulating systems, non-circulating systems without heat traps, and non-circulating systems with electric heat-tracing elements along the pipes must be insulated in accordance with NECB Table 6.2.3.1 and NECB Sentences 6.2.3.1(2) to (4).

SYSTEMS WITH MORE THAN ONE END-USE DESIGN TEMPERATURE

When less than 50% of the total design flow of service water heating system has a design discharge temperature higher than 60 (C, separate remote heaters are required for those portions of the system with a design temperature higher than 60 (C.

CONTROLS

Service water heating systems with storage tanks must have automatic temperature controls capable of setting temperatures between the lowest and highest acceptable settings for intended use.

- Except for systems in which the storage capacity is less than 100L, each service water heating system must have a readily accessible and clearly labelled device to allow shutdown, including any electric heat trace elements installed along the pipes.
- Electric heat trace elements installed along service water pipes must have automatic controls that maintain hot water temperature within the required range.

ADDITIONAL ENERGY CONSERVATION MEASURES *5.7*

Any green office building must be designed to meet or exceed the requirements of the NECB using whichever approaches are appropriate and feasible. Compliance would be demonstrated by simulating the energy performance of the proposed building using the NRCan COMPLY software. The following measures supplement the measures listed above and will help the designer to meet or exceed NECB minimum energy standards.

BOILERS 5.7.1

Most medium to large offices use boilers to generate hot water or steam for space heating. Recent trends in boiler systems include installing multiple small boiler units, lowering system steam pressures, decentralizing systems, and installing direct digital control systems (DDC). Gas-fired boilers having rated steady-state efficiencies over 90% are available. For boilers to run at peak efficiency, operators must tend to a number of operation and maintenance needs, described in the Operation & Maintenance section of this document. The following modifications can be evaluated for implementation as part of renovations or retrofits.

- Add radiator controls to each radiator or group, to allow occupants to maintain winter comfort without opening windows. Radiators that operate "wild" at full output are common in older office buildings;
- Replace inefficient boilers;
- Decentralize systems. Several smaller units strategically located around a large facility reduce distribution losses and offer flexibility in meeting the demands of differing schedules and loads. Estimate stand-by losses by monitoring fuel consumption during no-load periods;
- Downsize. Work to lower overall heating loads through prudent application of energy conservation measures. Small boilers may be staged to meet loads less expensively than large central plants;
- Modernize boiler controls with DDC devices, which allow logic-intense functions such as optimizing fuel/air mixture based on continuous flue gas sampling, managing combustion, controlling feed drum levels, and controlling steam header pressure;
- Install an economizer in the flue to preheat boiler feedwater. Efficiency increases about 1% for every 5.5 C° increase in feedwater temperature. Ensure that stack temperature remains above the acid dew point and that excess stack temperature is not due to a maintenance problem such as scaling;
- Install an oxygen trim system to optimize fuel/ air ratio;
- Install automatic flue dampers to reduce heat loss through the flue during the boiler off cycle;
- Retrofit standing gas pilots with electronic ignition;
- Add automatic blowdown controls to reduce waste from uncontrolled continuous blowdown;
- Add waste heat recovery to blowdowns. Use recovery tanks and heat exchangers to preheat feedwater;
- Consider retrofitting boiler fire tubes with turbulators when retubing;
- Ensure boiler casing and boiler piping are insulated with at least 25mm insulation.

AIR DISTRIBUTION SYSTEMS 5.7.2

Fan motors in air handlers can account for 20% or more of electricity used in an office building. Energy costs can be significantly reduced by converting constant-volume (CV) systems to variable-air-volume (VAV) or increasing the efficiency of existing VAV systems. Good candidates for VAV conversion are CV systems with dual ducts or terminal reheat that use backward-inclined or airfoil fans. On existing VAV systems, convert airflow controls from inlet vanes or outlet dampers to variable frequency drives (VFDs).

- Convert constant volume systems to variable-air-volume. In CV systems, a constant volume of air is moved and heated or cooled regardless of the temperature and humidity needs of the space. The inefficiencies of dual-duct and terminal reheat CV systems can be virtually eliminated by converting the system to deliver only the volume of air needed to meet the actual load;
- Install a variable frequency drive (VFD) on fan motors to continually match fan speed and torque to changing building load conditions. The power requirement drops significantly as a function of this motor speed;
- Match fan speed to reduced building loads. Assess fan performance by measuring the fan on a peak cooling day. Reduce the fan RPM if vanes or dampers are closed more than 20% on a peak day. Lower the fan speed by changing pulley sizes;
- Evaluate changing fan belts to timing belt type drives. "Cogged" drive belts experience less energy loss than ordinary V-belts, are much more durable, and require less maintenance;
- Replace existing motors with properly-sized energy-efficient motors whenever the motor is due for rewinding or replacement, the motor runs a significant number of hours per year, and/or is significantly below current efficiency standards. High efficiency motors run at a higher speed than standard efficiency motors. The drives must be adjusted to account for this difference;

VENTILATION AND HEAT RECOVERY 5.7.3

Heating or cooling the relatively large amounts of outside air required by ASHRAE 62 and the NECB requires a significant amount of energy. Existing office buildings usually do not have the capacity to provide this amount of conditioned outside air. Heat recovery applied between the building general exhaust (typically washroom exhaust) reduces the ventilation energy load by about 60 % and reduces the required capacity and cost of heating and cooling equipment by a corresponding amount. Heat recovery can also make it feasible to deliver ventilation at greater than minimum rates required by Code. Energy recovery techniques include plate heat exchangers, rotary wheel heat exchangers (with or without desiccant coating for moisture and latent energy transfer), heat pipes, or run-around coils.

CONTINUOUS IMPROVEMENT 5.7.4

As part of an ongoing continuous improvement process an energy use monitoring and efficiency improvement team should be established. The team should be charged with ongoing monitoring and analysis of energy use in the building or suite (as appropriate), investigation and cataloguing of new trends and technologies in energy efficiency and recommending improvements for additional reductions in energy consumption in the building. The team should investigate wasteful practices that may be part of building operation or employee habits. Investigation of concerns and suggestions, providing feedback to employees on successes and providing constructive comment on potential areas for improvements are all essential components of the team's work.

CASE STUDIES OF ENERGY EFFICIENT OFFICE BUILDINGS 5.8

FIRST HERITAGE SAVINGS, TOWN CENTRE BRANCH, ABBOTSFORD, BRITISH COLUMBIA 5.8.1

PROJECT OVERVIEW

The First Heritage Savings Credit Union deigned the branch at 32711 South Fraser Way to serve as their 'flagship' branch. The branch was designed to provide the latest in banking services while maintaining the credit union image of efficiency and stability. The building is a two-storey 1021.9 m2 (11,000 ft2), structure that incorporates state-of-the-art building techniques and materials to improve the overall quality of the building.

The design team for the project instituted energy efficient products, systems and controls in the building design to achieve maximum energy efficiency. However, the owners also wanted to create a building that would provide a comfortable environment for both customers and staff.

ENVIRONMENTAL ACHIEVEMENTS

Energy Savings

- The steel building is constructed with curtain wall glazing, insulated metal wall panels and stone veneer walls.
- A large skylight located over the center of the building allows for utilization of natural daylight.
- Perimeter glazing consists of a thermally broken curtain wall frame system, double-glazed with low-e, gray tinted glass.
- Interior glazed partitions allow for utilization of day light from both the perimeter walls and the skylight.
- The metal clad and veneer walls contain R20 insulation.
- The roof has been insulated to R24.
- An entrance vestibule limits infiltration of outside unclimatized air.
- Sheer-woven fabric solar blinds have been installed to reduce the solar gain from the west orientated windows.
- Reducing the number of lamps resulted in a lower electrical load and lower air-conditioning requirements.

Energy Efficiency

- Luminaries contain reflectors to direct light downward onto work surfaces. This feature reduced the number of luminaries required to provide the desired level of illumination.
- Luminaries were fitted with electronic ballasts to provide for efficient energy use.
- The recessed down-lighting and exit signs are 70% more efficient than standard incandescent lamps.
- Photoelectric day-lighting controls were installed in the areas affected by the skylight and in the areas that receive daylight from the exterior perimeter glazing.
- All lighting is locally switched or photo-electrically controlled.

ECONOMIC FACTORS

As a result of the energy efficiency efforts during the design of this building, the building was awarded the 1993 Power Smart Design Excellence Award in the under 4645 m2 (50,000 ft2) category for Commercial buildings. The following tables provides a summary of the energy saved by the incorporated features:

TABLE 5.3
SAVINGS: ENERGY EFFICIENT VERSUS STANDARD FIXTURE INSTALLATION

FEATURE	INSTALLED ENERGY EFFICIENT MEASURES	ENERGY USE REDUCTION BY %
Building Envelope	R24 Roof & R20 Walls	Reduces heat loss 10–30%
Glazing Insulation	Low-e glazing	Reduces heat loss 10–30%
Lighting System	Fluorescent Lighting /Electronic Ballast's	15–70%
General Lighting	Re-electrolyzed Luminaries Compact Fluorescent Photo-electric day-lighting controls	Up to 15% 70% Up to 30%
Exit Signs Controls	Localized lighting switches and photo-electric control monitored by programmable time clock	Up to 15%
HVAC System	Water-source heat pump system	Up to 10%
Heat Pump Controls	Programmable thermostats throughout	10%
Total Estimated Savings		57,000 kWh

** Savings listed are given as a percentage of technology energy use when compared to standard building practices*

ONTARIO HYDRO'S THUNDER BAY BUILDING, THUNDER BAY, ONTARIO 5.8.2

PROJECT OVERVIEW

Ontario Hydro adopted the principles of sustainable development and seeks to incorporate these ideals into their business practices. The Hydroelectric business needed a new centralized Service Centre to house both office and industrial workspace. The recommendation was to amalgamate both its operations and office staff into one facility to improve productivity. Several alternatives to building a new facility were considered. However, the studies on each alternative determined that significant expenditures were required in order to adapt existing facilities to meet the established needs. Therefore, a decision was made to build a new facility on Ontario Hydro's property in Thunder Bay.

The building is a 13,000 square foot facility bordering a wetland site. Two work areas are clearly defined – an office area and a workshop. The office area was designed to maximize the comfort of the people that would spend most of their time indoors. To maximize the total sun exposure, the office area was orientated to the southern direction. The shop area is used on an as needed basis. Daylighting was identified as a high priority since intricate and detailed work would be done on the shop floor.

ENVIRONMENTAL ACHIEVEMENTS

Energy Savings

- Summer breezes from the south and west blow across the wetland bathing the building in cool air to take advantage of the local microclimate zone.
- Trees protect the building from prevailing northwest winds in the winter.
- A low retaining wall with a raised planting bed wraps around the building to reduce heat loss during the winter.
- Awnings were installed above each window to control the incoming sun.
- The office area of the building envelope includes a masonry cavity wall to act as a thermal mass and help regulate internal temperatures.
- To maximize daylighting in the office area a light shelf was installed at each window. The light bounces off reflective surfaces on the light shelf and the ceiling, reducing the need for artificial lighting.
- Solar light tubes provide daylight throughout the day to brighten dark windowless areas.
- The windows are high performance, triple glazed argon filled units with fibreglass frames. The glass is separated with silicone edge spacers and coated with a spectrally-selective low E-coating.
- The building was equipped with an evacuated solar water heating tube system to provide the hot water for the building.
- A south facing wall is covered with a dark coloured perforated metal siding system that captures the solar energy falling on it and raises the temperature of ventilation drawn through it, 15–20 degrees Celsius depending on the solar intensity.

Energy Efficiency

- The building was designed to exceed the requirements of the ASHRAE 90.1 standards. Annual energy savings achieved an additional 140,000 kWh compared to a conventional building.
- The heating, ventilation and air conditioning system is a water loop heat pump system capable of using alternative energy. The heating system was built to permit dual energy in the future with the flexibility to use gas, electricity or biomass.
- The offices are heated and air-conditioned with individual heat pumps.
- There are seven zones in the building featuring a separate mechanical ventilation system with automatic balanced heat recovery.
- Most spaces have separate controls to allow for individual adjustments.
- Motion sensors have been installed in areas of occasional use such as washrooms and meeting rooms.
- During the heating season, ventilation air is drawn from the 'Solarwall' into a heat recovery ventilator. This provides the two stage of ventilation pre-heat.
- Air exhausted from the building is passed through the ventilation air heat recovery units where 60% of the energy is recovered and transferred to the incoming ventilation air as the second stage of pre-heat.
- The ventilation air is reheated by a hydronic coil and supplied to each heat pump and to the shop area at 18 degrees Celsius.

ECONOMIC FACTORS

The initial capital costs of sustainable buildings are higher than those of traditional buildings, but the overall life cycle costs (from construction to operation and maintenance) are significantly less. A comparison of the Thunder Bay building to a similarly sized conventional building showed a saving of almost $300,000 in life cycle costs. In addition to long term cost savings, benefits on daylight, indoor air quality and aesthetic appeal/comfort, make sustainable buildings very cost effective.

OTHER CASE STUDIES 5.8.3

Details on four energy efficient buildings in Canada are presented below.

BENTALL 8, RICHMOND BC

TYPE:	Speculative office, completed
GROSS AREA & FLOORS:	7,435 m2, 3 floors
ENERGY CONSUMPTION:	92 ekWh/ m2 per year, 51% of NECB reference bldg
ADDED CAPITAL COST:	7% actual
STRUCTURE & BLDG ENVELOPE TYPE:	tilt-up concrete wall, steel frame, steel deck, concrete topping
WINDOWS:	Double-glazed, spectrally selective, low-e, thermally broken aluminum frames
MECHANICAL SYSTEMS:	Condensing gas boilers, air-cooled 110 ton chiller, 4 pipe fan coils, small zones
LIGHTING:	T8 direct, maximum daylighting
OTHER:	Low emission materials, leases written to encourage energy efficient use of building

BC GOVERNMENT OFFICES, KAMLOOPS BC

TYPE:	Government office, completed
GROSS AREA & FLOORS:	4,182 m2, 3 floors
ENERGY CONSUMPTION:	124 ekWh/ m2 per year, and as 45% of NECB reference bldg
IMPACT CAPITAL COST:	4% est. saving
STRUCTURE & BLDG ENVELOPE TYPE:	manufactured wood frame, rainscreen wall, ADA air barrier
WINDOWS:	Double-glazed, spectrally selective, low-e, fiberglass frames, insulating spacers
MECHANICAL SYSTEMS:	Gas boilers, 55-ton ton chiller, heat recovery chiller, 4 pipe fan coils, small zones
LIGHTING:	T8 direct/ indirect, maximum daylighting
OTHER:	ow emission materials, capture of rain water

GREEN ON THE GRAND OFFICE BUILDING, KITCHENER,ONTARIO

TYPE:	Speculative office, completed
GROSS AREA & FLOORS:	2,174 m2, 2 floors
ENERGY CONSUMPTION:	106 ekWh/ m2 per year (as built), 58% of ASHRAE 90.1 reference bldg
ADDED CAPITAL COST:	7% actual
STRUCTURE & BLDG ENVELOPE TYPE:	manufactured wood frame, double stud walls
WINDOWS:	Triple-glazed, spectrally selective, double low-e, argon, fiberglass frames, insulating spacers
MECHANICAL SYSTEMS:	30 T gas absorption chiller/boiler, latent/sensible heat recovery, radiant htg/clg, displacement ventilation
LIGHTING:	T8 direct/ indirect, dimmable electronic ballasts, photoelectric & occupancy sensors, maximum daylighting
OTHER:	Low emission materials, storm water retention pond used as cooling pond for chiller

YUKON POWER HEADQUARTERS, WHITEHORSE YUKON

TYPE:	Office and control centre, under construction
GROSS AREA & FLOORS:	1,200 m2, 2 floors + partial 3rd
ENERGY CONSUMPTION:	249 ekWh/ m2 per year measured, 28 % of NECB reference bldg
ADDED CAPITAL COST:	(12% under budget)
STRUCTURE & BLDG ENVELOPE TYPE:	wood frame, slab-on-grade
WINDOWS:	Triple-glazed, spectrally selective, low-e, argon, fiberglass or vinyl frames
MECHANICAL SYSTEMS:	Combination oil and off-peak electric boilers, groundwater cooling, 4-pipe fan coils
LIGHTING:	T8 direct/ indirect, electronic ballasts, single-step daylight control, occupancy sensors

WATER CONSERVATION

6.0

WATER CONSERVATION 6.0

INTRODUCTION 6.1

Canada is in the envious situation of having one-fifth of the world's fresh water supply. Canadian water usage per capita is the second highest in the world at approximately 326 litres per day. To put this in perspective, this is double the per capita usage of France and Germany. This level of water consumption places an ever-increasing strain on our fresh water resources and requires energy and monetary expenditures to provide clean water for our everyday use. A 10% improvement in water efficiency would reduce our consumption to about 293 litres per person per day. With a population of 30 million and an average water rate of $1.03 per cubic metre, this improvement would save Canadians over 1.00 million per day or $368 million per year. Already, many large metropolitan centres are experiencing problems because their water treatment facilities cannot keep up with the demands placed on them.

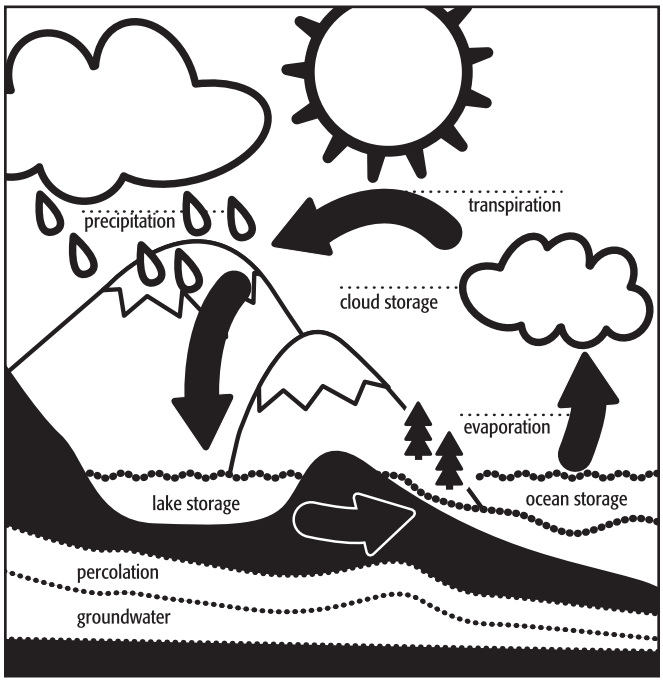
The quality, quantity and economic considerations associated with the use of our water supply are complicated but we are able to minimize impacts by the way that we manage water or practise water conservation which simply means doing the same with less. Using water more efficiently reduces pollution and health risks, lowers water costs and extends the useful life of existing supply and waste treatment facilities. The terms water efficiency and water conservation are often used interchangeably, but in fact, they mean different things. Water conservation proposes using less water and reducing waste. It can also imply a lifestyle change or technological intervention. Water efficiency is implemented through the application of appliances, practices and processes that provide the same level of service while using less water. Water efficiency reduces our demand for water. This has multiple environmental and economic benefits. Because less water is being used, the energy required for water treatment and the pollution caused by water treatment processes are also reduced. The cost of providing primary services for the community is lower and our individual water bills can decrease.

The following section provides an overview of the environmental impacts associated with water use and explores initiatives that can be taken to reduce water consumption.

THE HYDROLOGIC CYCLE 6.2

Through the process of evaporation water travels into the air, becomes part of a cloud and then returns to the earth as precipitation. This process repeats itself over and over again, in a process referred to as the hydrologic cycle.

Precipitation creates run-off that travels over the ground surface and helps fill lakes and rivers. It also percolates or moves downward through openings in the soil to replenish aquifers under the ground. Water dissolves minerals, chemicals and other substances from the ground. Some places receive more precipitation than others due to their proximity to large bodies of water, which allows more water to evaporate and form clouds. As clouds move up and over higher landmasses such as mountains, the water vapour condenses to form precipitation.



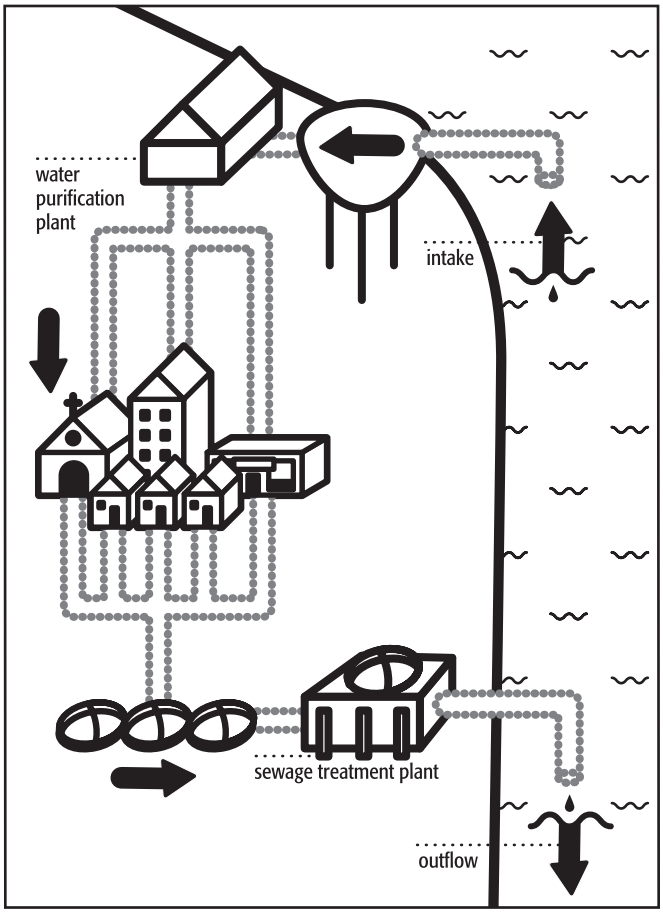
WATER QUALITY 6.3

Water quality is a problem in many Canadian cities. The decline in water quality is associated with the way that we use water. All wastewater is contaminated to some degree. Once contaminated water enters the sewer system, it is treated in a sewage treatment plant. However, this process is never 100% effective, which translates into water quality deterioration.

Poor water quality can also be caused by agricultural run-off containing residual pesticides and fertilizers, industrial pollution, chemical leaching from landfills and improperly treated sewage from both municipal facilities and private septic systems. The improper handling of wastewater can have a strong impact on water quality. In Canada, only 57% of the population is serviced by waste treatment facilities compared with 74% of Americans, 86.5% of Germans and 99% of Swedes.

Groundwater can be contaminated by agricultural activities, underground storage tanks, leachate from landfill and other forms of human intervention. Contaminated groundwater eventually finds its way into our water supply, either from wells or municipal water sources.

In Canada, the government has implemented various guidelines and objectives to protect water quality. Water quality guidelines are scientifically determined and establish allowable chemical or substance concentrations for a particular purpose such as drinking, swimming or livestock husbandry. These national guidelines provide targets for environmental protection.



Water quality objectives specify the concentrations of chemicals or substances allowable for all intended water uses at a specific location on a body of water. The objectives are based on the water quality guidelines for intended uses at the location, public input and socio-economic considerations. Water quality guidelines and objectives not only protect water users and the environment, they also encourage sustainable water management procedures.

WATER CONSERVATION IS A SOUND BUSINESS PRACTICE 6.4

Water conservation not only benefits the environment but also is a sound business practice. In many cases, application of even simple, common sense conservation techniques can yield payback periods of one year or less.

Use of the payback method for assessing the feasibility of upgrading water efficiency does not always tell the whole story. It often underestimates the benefits of water efficiency over the lifetime of a measure, particularly when taking into account potential energy cost reductions and reduced maintenance costs from not having to heat as much water for certain applications. Lower wear and tear due to water efficiency may also extend the life of equipment such as boilers, heat exchangers and pumps.

The economic benefit of efficient water use is apparent when a lifecycle costing (LCC) exercise is carried out. LCC allows a potential renovator to estimate the net benefits of an efficiency investment, over the lifetime of the measure or product. It includes the costs of initial equipment purchase, operating and maintenance costs, fuel costs, the costs of inflation and disposal, and the cost of money over time.

The integration of water efficiency into renovation projects takes into account the 'true costs' of water. The true cost of water refers to all the costs that go into producing the clean water we use. It includes the capital and operational costs of potable water treatment plants, sewage treatment plants and the entire infrastructure required for delivery and disposal of water and its waste products. It excludes government funding and subsidies.

Up front costs are often seen as a barrier to implementing water efficiency improvements. What some managers fail to realize is that often the additional cost of upgrading to a water efficient fixture is not significant (often less than 30%) when savings in operating costs are considered. Applying water efficiency measures can quickly offset costs that seem to be prohibitive.

REGULATIONS 6.5

All construction and renovation projects should be in compliance with applicable regulations at the municipal, provincial and federal levels. The following regulations can affect water reduction decisions during a project:

- national building codes
- Provincial building codes
- plumbing codes
- the Canadian Environmental Protection Act [CEPA].

THE INTERDEPARTMENTAL ADVISORY GROUP ON WATER CONSERVATION AT FEDERAL FACILITIES 6.6

The Interdepartmental Advisory Group on Water Conservation at Federal Facilities (WCFF) was formed in 1990 to help implement the water conservation aspects of the Green Plan and the Code of Environmental Stewardship. The WCFF has approximately 30 members that represent sixteen departments and agencies and is chaired by Environment Canada.

In 1994, the Canadian Council of Ministers of the Environment endorsed a National Action Plan to Encourage Municipal Water Use Efficiency. This action plan calls for federal and provincial levels of government to demonstrate leadership by reducing water use in their facilities and to adopt polices, regulations and codes concerning water efficiency.

The Guide to Greening Government Operations was signed by all federal Ministers, committing federal government departments to lower the environmental impacts of their operations, policies and programs. The Commissioner of the Environment and Sustainable Development will audit the departmental performance. The guide provides the framework for the greening of operations and one of the specific areas referenced is water usage. The document also promotes environmental management systems (EMS) as a procedure for ensuring those environmental objectives are properly considered and implemented.

The WCFF helps federal government departments meet objectives and obligations relating to these initiatives. The Advisory Group has been responsible for the development of the Water Conservation Plan for Federal Government Facilities and the accompanying Manual for Conducting Water Audits and Developing Water Efficiency Programs for Federal Facilities. The WCFF serves as a forum for sharing experiences and developing joint tools. The WCFF uses a mail list server as a quick, electronic way of asking each other questions and sharing information and ideas.

THE FEDERAL BUILDINGS INITIATIVE 6.7

The Federal Building Initiative (FBI) is a comprehensive program created by Natural Resources Canada to provide federal facility managers with an opportunity to realize the benefits of improved energy efficiency. The program also assists in the incorporation of water saving initiatives when considered in conjunction with energy refits.

REDUCING WATER USE *6.8*

Changes in staffing arrangements often require renovations to existing buildings, or sometimes even the construction of a new facility. Most renovations and new construction projects can provide opportunities to reduce water consumption. For example:

- if the planned renovations include washroom facilities, this is an opportunity to upgrade plumbing fixtures to water efficient faucets, urinals, showerheads and toilets Refer to NMS. The plumbing fixtures and trim section of the NMS has been "greened" and now recommends using the ultra low water conserving options.;
- if occupant densities increase in a particular facility, changes to system capacities are probably required. This could be an opportunity for water efficiency improvements such as connecting water-cooled refrigeration of air conditioning equipment to a closed loop system;
- in some facilities, designers can incorporate the use of ground water or surface water for heating or cooling requirements.
- Install a separate "grey water" system to allow reuse

As with energy efficiency, the extent of the opportunities to incorporate water consumption initiatives depends on the scope of the project. Generally speaking, the greater the scope and the more complex the proposed project, the more opportunities there are for water reduction improvements.

The 'systems approach' to building design recognizes that the building and its occupants are a system with interconnected components. When changes are made to one component it will affect other aspects of the system, or have a synergistic effect. This concept applies to water use as well as energy consumption. Applying an integrated approach ensures that synergistic effects are anticipated and planned for accordingly. In addition, overall incremental costs can be reduced because of the potential for equipment downsizing. The principle behind an integrated approach (also known as whole building design) is to integrate the project's steps into a single comprehensive design. This approach recognizes that the project's stages are interactive as opposed to stand alone activities. It requires a team effort from all the experts involved in the project. The project team should remember to look at the long-term effects during project planning and when addressing issues that will affect water consumption.

REDUCED WATER CONSUMPTION

The specification and use of appliances that are rated as low water consumption reduces environmental impacts by reducing the necessity for water treatment. Water pollution combined with a rapid rate of water consumption can result in damage to hydrological systems. The treatment of wastewater requires the use of chemicals that impact ecosystems. Reducing the consumption rate of water diminishes the necessity for wastewater treatment. Appliances, fixtures and systems that have been specifically designed to fulfil their intended functions while providing reduced water flow rates compared to standard appliances, can claim to provide a lowered environmental impact.

Eco-labeling programs (EcoLogo website: HYPERLINK http://www.environmentalchoice http://www.environmentalchoice.com) have established criteria that relate to the performance of specific products. The Canadian Standards Association (CSA) has developed specific tests that determine the flow rate of water consuming products. The CSA has also established flow rates for some products that define product specific low water consumption. This criterion is based upon the same principles as energy efficiency. It uses improved performance percentages against an established baseline for evaluation.

WATER MANAGEMENT *6.9*

It is estimated that the federal government's water costs for 1990 were $12 million for the National Capital area, and $100 million across Canada. Improved water management can have a significant financial impact on federal operations. Ongoing consultation with all members of the project team is an essential part of a renovation or construction plan. The sharing of experiences and ideas will ultimately result in a more co-ordinated and streamlined process. A water efficiency expert is a key resource.

Two elements are essential to the effective management of a project's water reducing components.

1. ASSEMBLE AN IN-HOUSE TEAM
Implementing water reduction measures is a complex process, entailing many activities. For a project to succeed, all levels of the organisation need to be involved. Senior management must support the program financially, and a commitment from other management levels will ensure the program works. A competent water management team (which can be part of the Green Office Building Plan team) is essential to the success of the project. The team should be assembled very early in the project process and should meet frequently to review progress. The team should include both technical and non-technical expertise and should reflect design management and operational perspectives.

2. ACCESSING THE EXPERTS
The range of technical expertise required is diverse and different capabilities may be required at various stages. Depending on the size and complexity of the project, the team may need to draw upon outside resources for assistance in the following areas:

- staff training;
- water auditing;
- costing and economic analysis;
- design;
- engineering;
- construction;
- commissioning, and
- maintenance and monitoring.

INTEGRATING WATER MANAGEMENT *6.10*

The following information provides a framework for the activities that may be required for the implementation of water reduction measures. The sequence and scope of the phases may vary between projects. The documents developed by the WCFF, Water Conservation Plans for Federal Government Facilities and the accompanying Manual for Conducting Water Audits and Developing Water Efficiency Programs for Federal Facilities, will provide a more comprehensive guideline for this process.

DEFINE THE SCOPE OF THE PROJECT
Understanding the project objectives, budget and timing will help determine whether the proposed improvements offer opportunities for water reduction improvements. As stated earlier, the larger the scope and more complex the project, the greater the likelihood that water reduction can be included as a project objective. Consulting with members of the project team will provide initial guidance.

INITIAL EVALUATION
This stage requires a preliminary assessment of the financial benefits of including water reduction as an element of the overall project. To do so, the project team needs to know how much water can realistically be saved and at what cost. Taking an inventory of the present or anticipated water use and costs and calculating potential savings that will result from the improvements of an upgrade will provide a fair measure of the financial feasibility. Water use can be determined by conducting a water audit.

THE WATER AUDIT
A water audit is a systematic approach for gathering information about the water use of a facility. This includes both domestic uses by washroom fixtures, showers, kitchen areas and workshops and mechanical uses such as boilers, cooling towers and irrigation systems. It addresses all equipment types, usage and activity levels and provides answers to the following critical questions:

WHO: the audit will determine which tenants or human activities of the facility consume the greatest amount of water;
WHEN: the audit will determine a pattern for water use that will identify times or activities of highest consumption levels;
WHERE: the audit will gather data on the water consumption of specific activities or equipment;
WHAT: the audit will identify areas that should be targeted to reduce water consumption.

A full technical description of a water audit can be found in the Manual for Conducting Water Audits developed by the WCFF. The following provides a brief synopsis of the elements of a water audit, and to the RPSB 5 Phase Water Audit and Workbook.

TABLE 6.1
WATER CONSUMPTION IN FEDERAL OFFICE FACILITIES

**Table 6-1 below indicates the typical uses of water within an office building.*

WATER USE	% OF TOTAL CONSUMPTION
Domestic	34.3%
Water-cooled AC Units	51.0%
Humidification	2.8%
Drinking Fountain Chillers	2.3%
Kitchen	8.6%
Pump Leakage	1.0%

Source: PWGSC (1994).

REVIEW WATER CONSUMPTION RECORDS

Looking at the building's history of water use over the course of twelve months gathered from meter reading data taken from utility bills and graphing and tabulating monthly water bills for at least two years will establish water use peaks. It is very simple to do as long as utility bills are accessible and water is metered.

Fluctuations in consumption and possible reasons should be noted during this process. Unexplained fluctuations should be noted and reviewed with the maintenance personnel to identify any unusual circumstances, such as mechanical failures or extensive maintenance work on boiler systems.

If metered readings are available for individual areas, these readings should be reviewed for the last twelve months and variances in consumption noted. The process should consist of a walk-through during which all areas of the facility that use water are noted and inventoried, including plumbing fixtures in washrooms, kitchens, workshops and other domestic uses. Mechanical systems, such as boilers, cooling towers and irrigation systems should also be inventoried. Such detail may also be acquired through the use of temporary water meters over a specified typical use cycle and extrapolated over a yearly basis.

Once the water use locations have been inventoried, the audit will then consist of the development of a building water balance. This calculation will identify the water consumption for each component of the building. The total of the water balance should equal the total water consumption of the building. A significant variance could indicate an area that has been overlooked or under-estimated during the audit. For new facilities, this information may be estimated through the use of engineering studies.

DEFINE THE PROJECT'S WATER REDUCTION PLAN

This stage defines the scope, costs and estimated benefits of the project's water reduction plans. This task should build on the results of the water audit and the record analysis. If it is decided that the proposed improvements will be part of a long-term project it is imperative that initial improvements ensure the possibility of later improvements.

Several factors will guide the development of the Water Reduction Plan.

- **INTEREST IN WORKING WITH THE FBI PROGRAM:** If the project includes energy reducing measures, the option may exist to utilize the services of the Federal Building Initiative. If this option is available, any concerns that the project team might have about financial and management constraints can potentially be addressed through the FBI Program and the provision of water management services from ESCOs.
- **INVESTMENT THRESHOLD:** The department may have a specific financial threshold for this type of investment.
- **OTHER NEEDS AND PRIORITIES:** The water reduction investments need to be examined in light of other considerations such as project timelines.
- **REALISTIC WATER REDUCTION GOALS:** The goals can be determined using information from the water audit and the record review.

IMPLEMENT THE WATER REDUCTION PLAN

During this stage, the water reduction plan is implemented. Execution takes place once the design is finalized and the budget is set and approved. Occupants of buildings should be inconvenienced as little as possible during this stage. Implementation includes a number of activities that will be co-ordinated with the overall renovation project. For example:

- **PREPARE PROJECT SPECIFICATIONS CONSISTENT WITH MEETING THE WATER REDUCTION GOALS.** Water efficient devices should be clearly specified and meet the project criteria. Reliability and ease of operation will ensure that devices will not be by-passed or removed after the project is complete;
- **ESTABLISH A REALISTIC IMPLEMENTATION SCHEDULE;**
- **RECRUIT AND BRIEF THE WATER MANAGEMENT TEAM**. These people are the key players in a water efficiency project and will be critical to its success. Team members should include facility personnel who represent technical operations, contracts and financial management;
- **PREPARE THE BUDGET ALONG WITH PAYBACK CALCULATIONS.** Make sure that you have considered all associated cost savings;
- **ASSIGN SPECIFIC RESPONSIBILITIES TO THE MEMBERS OF THE WATER MANAGEMENT TEAM.** Provide them with reference material and expert advice, as required. The team should also monitor the ongoing renovation;
- **INITIATE A TENDERING PROCESS.** This should include a site visit and meeting with potential plumbing subcontractors to share project objectives and to communicate the mandatory requirements, and
- **REVIEW THE TENDERS AND AWARD CONTRACTS AS REQUIRED.**

COMMISSIONING AND TRAINING

Commissioning of the water reducing components of the project has two important objectives, both directed at achieving the targeted water savings. They are:

- to ensure that the specified equipment is installed and working properly, and
- to ensure that the targeted water reduction levels will be sustained throughout the lifetime of the specified measure.

Commissioning usually has both a technical and training component. The technical component involves testing the installed equipment and making adjustments as necessary. The training component focuses on producing operation manuals and on instructing staff and occupants on how the new equipment should be properly operated and maintained. Information sheets can make training easier. They provide brief, user-friendly and site-specific information about the equipment that has been installed and how to use it. They are particularly useful in cases where the manufacturers' manuals are complex.

After commissioning, all systems should be working properly and building staff and occupants should know how to use the new equipment. The commissioning should ensure that occupants get the service they expect with the new equipment.

PROMOTE WATER AWARENESS

Water dripping at the rate of one drop per second wastes 10,000 litres of water a year. The long-term success of any water efficiency program will depend on the way in which building occupants use water. They need to be educated on how to use water wisely. This will also encourage occupants to accept the water efficiency measures introduced during the project.

Use communications professionals to develop promotional materials, such as monthly water saving tips sheets. Showing occupants how to use water efficiently both at work and at home will demonstrate the cost implications of wasting water. Encourage occupants to identify water wasteage and to report it to building maintenance. Maintenance personnel should be instructed to respond to the report promptly and efficiently.

The Internet based Water Efficiency Experience Database is designed to encourage the exchange of information on both the successes and difficulties encountered in the rapidly growing field of water use efficiency. Currently there are over 125 experiences described on the site, from all levels of government, educational institutions and the private sector. Each case study provides a brief description of the water efficiency project, a contact person for more information, and, where available, details on costs and savings. You can make use of and contribute to the database regardless of the sector you represent. The site can be reached at http://www.cwwa.ca/wed/html

Develop ongoing water efficiency strategies for the building. Some suggestions are listed below:

- establish a policy for purchasing only water efficient fixtures for repair or replacement purposes;
- ensure that shut-off and isolation valves are appropriately located to facilitate repairs and to minimize system drain downs;
- maximize operational efficiencies through annual audits and reviews of water consumption and operational procedures,
- collect and reuse water wherever possible. Possibilities include collecting rainwater or using other wastewater "grey water" for irrigation purposes.
- WCFF has a washroom decal that is placed on the washroom mirror and along with a short efficiency message, asks users to "report leaks or other water problems at this or other locations promptly to …". The blank is filled in with the appropriate phone number.

MAINTAIN THE SYSTEM

As with energy efficiency, scheduled preventative maintenance of new water efficient equipment and systems brings a number of benefits. It ensures that water savings are maintained, or increased, long after the renovation is completed. It prolongs the life of the equipment. It reduces disruptions from unscheduled equipment breakdowns and it reduces equipment replacement costs.
Maintenance usually involves a number of tasks and the schedule should be developed based on the manufacturer's recommendations.

MONITORING THE SYSTEM

A monitoring program tracks water use and provides the information that allows management to determine if the anticipated water savings are on target. As with energy efficiency, the way in which buildings are metered can make monitoring a simple or complex activity. At the most basic level, monitoring means reviewing utility bills, but this provides only very general information. At the most complex level, monitoring involves sub-metering of parts of a building or of specific equipment. It is expensive to establish this process, but the information it produces is very specific and useful. Building monitoring can provide more information than a review of the utility bills, but it does not give a detailed picture of how the water is being used.

Typical monitoring activities include:

- **SET-UP OF A REGULAR MONITORING PROGRAM.** If meter readings are required, set-up a meter-log and specify who is responsible for the readings. Consider automating the metering if practical. Install water meters if they are not already in place. Meters play an important role in water conservation by providing the data on which to justify actions, measure progress and pay for water.;
- **METERING OF HIGH WATER USAGE OPERATIONS.** Specified operations will vary from facility to facility. They would normally include kitchens, laundries, cooling towers and boiler rooms;
- **REVIEW THE MONITORING DATA ON A REGULAR BASIS.** Compare results against the efficiency performance goals set for the facility. Use the data collected to develop seasonal averages and historical trends. Use this information to track and update efficiency goals;
- **INVESTIGATE ANY VARIANCES IN CONSUMPTION** and correct problems immediately, and
- **RECONCILE A BUILDING WATER BALANCE** on an annual basis.

IMPLEMENTING WATER CONSERVATION

7.0

IMPLEMENTING WATER CONSERVATION 7.0

Water consumption in a green office building should be significantly less than a similar building typical of current renovation practices. The goal of 30% reduction in water use in renovated and fit-up buildings relative to a conventional office building with similar features and systems is considered achievable in many cases. Life cycle cost analysis was used to ensure that the systems prescribed are cost effective. The methodology used to assess the economic viability of retrofitting water conservation measure for any particular technology is given in RPSB 5 Phase Water Audit Protocol Workbook. The same methodology can be used by the designer to assess technologies that have not undergone economic analysis elsewhere, or it can be used to verify the economic viability of previously assessed measures if it is believed that the given analysis is not representative of a particular situation.

Requirements for extension, alteration, renewal or repair of plumbing systems are set out in the National Building Code of Canada. The NBC requires that every plumbing system shall be designed and installed in accordance with appropriate municipal, territorial, or provincial regulations or, in the absence of such regulations, in conformance with the National Plumbing Code of Canada. Specific requirements for meeting the GOP are incremental to the National Plumbing Code, and are generally cost effective.

Water conserving measures are divided into three categories; domestic water, HVAC, and landscaping, and are discussed in the following sections.

DOMESTIC WATER 7.1

Domestic water consumption is a significant component of water usage in an office building. There are a growing number of products available to help reduce domestic water use in any building. Installation of water conserving equipment and implementation of water efficient procedures are capable of providing considerable cost-effective savings, particularly in areas where water is metered and costs are directly proportional to usage.

These have been written in language which is easily incorporated into project specifications, or is clear for discussion with material suppliers.

- **ALL FAUCET AERATORS** to have a flow rate of not more than 4 L/min @ 413 kPa
- **SHOWER HEADS** to have a flow rate of not more than 7.6 L/min @50 kPa. Shower heads shall have a manual or automatic shut-off feature. Clear, understandable signage shall be posted explaining its use and requesting diligence in it's use.
- **WATER CLOSETS** to have a water consumption of not more than 6.0 L/flush
- **URINALS** to have a water consumption of not more than 3.8 L/flush
- **DISHWASHERS** – If dishwashers are to be installed or replaced chose water efficient dishwashers. Residential type models shall use no more that 24 L/cycle. Commercial load type washers shall use no more than 5.3 L/rack. Commercial conveyor type washers shall use no more than 21 L/m. This rating is based on a conveyor speed of 1.5 m2 per min (feed rate times width). Water consumption for other speeds and sizes will be pro-rated to this value.
- **WATER SOFTENER** – If a water softener is to be installed or replaced chose a water conserving (counterflow) softener. Use electronic demand regeneration control to ensure regeneration is initiated only as required. Connect water softener to the hot water circuit in the building only.
- **BATHROOM FIXTURES** – All bathroom faucets, and all urinals shall have automatic shut-off feature. This can be either a spring loaded feature or infrared sensor technology.

Some of these measurements may be less economically viable sense in some parts of Canada. It will depend on water availability and cost, among other factors. To confirm economic viability of these options, get a quote for replacement of existing fixtures with those listed above and carry out a Life Cycle Assessment as shown in the RPS National 5 Phase Water Audit Protocol Workbook.

HVAC MEASURES 7.2

Heating, Ventilation, and Air Conditioning (HVAC) equipment can, by design, use a considerable amount of water. There are often opportunities for water conservation with HVAC equipment. The Project Manager should tour the building with the maintenance supervisor to ascertain the viability of each of the measures described below. Where viable, within the constraints of the existing building and the renovation project, the viability of the following measures should be assessed:

- **NO OPEN LOOP EQUIPMENT** of any kind is to be installed. Any existing cooling equipment that releases water directly to drain should be replaced.
- **USE A DEMAND CONTROL TO MANAGE BLOW-DOWN FREQUENCY IN COOLING TOWERS.** Water evaporating from cooling towers leaves behind the minerals and other particles commonly found in fresh water. As make-up water is introduced, the concentrations of these materials rise. Eventually, the cooling water must be purged in a blow-down cycle to avoid excessive accumulation of mineral and biological matter. These blow-down cycles are usually on timers that drain the entire system on a fixed frequency. Water quality sampling is to be done on a regular basis after system commissioning to ensure blow-down cycles are tuned to the local water and weather conditions.
- **USE COUNTER-FLOW EVAPORATIVE COOLING TOWER SYSTEM WITH LOW DRIFT LOSS SPECIFICATION** – In larger commercial buildings, evaporative cooling towers use significant amounts of water. Water use reductions are achieved through good design. Counter-flow cooling towers are generally more water efficient than cross-flow types. Drift loss should be specified at no more than .002% of the total water flow.

LANDSCAPING *7.3*

Landscaping practices are an important target for water conservation measures. There are many alternative ways to reduce or eliminate water consumption in outdoor areas around a building without detracting from the practical and aesthetic aspects of the green space. Kentucky Bluegrass turf is a very water intensive ground cover and should be avoided as much as possible. Hearty native grass species such as rye fescues are readily available. Fescue sod is available from some sports field suppliers. Again, the viability and cost of these measures should be discussed with the Maintenance Supervisor for the building, and a schedule developed for incremental implementation of significant changes.

The following measures are required by the GOP for landscaping around buildings:

- **AUTOMATIC IRRIGATION SYSTEMS** will be set for maximum 15 mm/wk watering.
- **SPRINKLERS** will be adjusted to avoid overspray onto parking and other areas not requiring irrigation.
- **DROUGHT-RESISTANT NATIVE PLANT SPECIES** to be specified to cover a minimum of 70% of landscaped areas. Choose plants that are native to the area and that are well-adapted to the growing conditions at the site. A good variety of plants should be chosen with attention paid to growth rate, life span, and hardiness. Soil pH, light, and water requirements should be considered. Plants with similar needs should be placed together. Well-situated trees and shrubs can also help reduce cooling energy by providing summer shading on windows.
- **DESIGN TO AVOID OVER-WATERING.** Automatic irrigation systems will be equipped with timers and electronic controllers to avoid watering during the day when evaporation losses are highest. A soil moisture sensor will be used to ensure watering cycles are initiated only on an as-needed basis. Most excessive water consumption in landscaping comes from overwatering of plants. Low volume distribution devices will be specified and operation verified to reduce water wastage.

Further information is readily available from many sources on water conserving landscaping. Techniques such as xericulture and enviroscaping can create attractive, low cost, low maintenance landscapes with a minimum environmental impact.

DOCUMENTATION *7.4*

A statement of the design intent and operational recommendations shall be provided and shall include:

- descriptive information about each system, detailing its function, design capability, performance characteristics and distribution arrangement;
- schematic and control diagrams and sequence of operation; start/stop adjustment procedures, and changeover, startup and shutdown sequences.

ADDITIONAL WATER CONSERVATION OPPORTUNITIES 7.5

There are a number of additional measures which should be considered for reducing water consumption. Renovating or refitting a building in line with the basic requirements of this Green Office Plan is a good start toward sustainable development in the commercial building sector. But, it is just the beginning. Additional features will reduce the impact the building has on water resources even further.

An on-going program of monitoring and continuous improvement needs to developed whereby additional conservation features can also be added as future renovation is carried on. It is important to ensure that the sustainable development principals initially implemented become a starting point for an ongoing process of continually developing sustainability. The measures listed below may not be feasible in every situation, but should be considered to go beyond the basic recommendations of the GOP.

The Project Manager should discuss the practicality and viability of these measures with the maintenance supervisor, and a timetable for implementation should be included in the GOP Documentation Report.

DOMESTIC WATER 7.5.1

- Locate water heater centrally to ensure short piping runs and insulate water pipes. Short, insulated piping runs ensure the user does not run excessive quantities of water waiting for the desired temperature of water.
- Use pedal switch on kitchen sinks. Pedal switches encourage the use of water only as it is needed. Leaving both hands free to perform the task required ensures water can be turned on and off as needed instead of allowing it to run unnecessarily.
- Consider evaluating a waterless urinal. Waterless urinals are now on the market and could bring water use for this fixture down to zero.

HVAC MEASURES 7.5.2

- Check and calibrate humidifier controls annually to ensure humidifier operation is maintained at the minimum possible.
- Consider the use of catalytic chemical treatments that maintain minerals in suspension to minimise the need for cooling tower blow-down (however, the environmental impacts of these chemicals must also be taken into consideration).
- Consider the use of rain water for cooling tower make-up.

LANDSCAPING 7.5.3

- Reclaim rainwater. Landscaping water does not need to come from the municipal supply. Roof drainage systems can often be modified to direct rainwater to a cistern. Not only does this provide a good source of free irrigation water to be used when the weather is dry, it eases the load on the storm water system during heavy rainstorms.
- Select soils and mulches appropriately. Give consideration to soil type and its ability to hold moisture. Loose, rocky soil promotes drainage and will require more water. Mulches hold moisture well and can help provide a nourishing environment for plants.
- Install landscaping, porous paving surfaces and grass paving surfaces to ensure maximum rainwater retention and minimum run-off,
- Use an on-site storm water retention pond for collecting rain water and minimise loading on municipal storm water systems
- Install “grey water” system to provide water for irrigation and sanitary flushing.

CONTINUOUS IMPROVEMENT 7.5.4

As part of an ongoing continuous improvement process a water use monitoring and conservation improvement team should be established. The team should be charged with ongoing monitoring and analysis of water use in the building or suite (as appropriate), investigation and cataloguing of new trends and technologies in water conservation and recommending improvements for additional reductions in water use in the building. The team should investigate wasteful practices that may be part of building operation or employee habits. Investigation of concerns and suggestions, providing feedback to employees on successes and providing constructive comment on potential areas for improvements are all essential components of the team’s work.

WATER CONSERVATION CASE STUDIES 7.6

PURDY'S WHARF OFFICE COMPLEX, HALIFAX, NOVA SCOTIA 7.6.1

PROJECT OVERVIEW

The Purdy's Wharf facility is a new 350,000 square foot mixed-use complex located on the waterfront in Halifax. The project objective was to build a modern facility that would be capable of offering competitive rental rates by minimizing operating costs. As Purdy's Wharf was to be built adjacent to an unlimited supply of seawater, the developers decided to use this natural resource to reduce water costs.

ENVIRONMENTAL ACHIEVEMENTS

Water Savings

- The complex uses seawater as its primary cooling source by using two isolated water loops. The first loop draws the seawater into the building, circulates it through a titanium heat exchanger and pumps the water back to the ocean floor. The second loop is closed. It circulates the chilled water from the heat exchanger into the buildings cooling coils. Fans deliver cooled air through the ventilation system.
- All faucets have been equipped with low-flow aerators.
- Low-water consumption toilets were specified.
- Showers are equipped with low-flow showerheads.
- An education program was developed and implemented to promote water conservation.

ECONOMIC FACTORS

The seawater cooling system was a $200,000 upgrade over a conventional cooling system, but it has proven to be very economical. In the first year, the system provided a $113,500 savings in operational costs by reducing water consumption by 8,400,000 litres. Furthermore energy costs were reduced by $50,000 to $60,000 annually and maintenance and chemical costs by $51,000.

CANADIAN CENTRE FOR INLAND WATERS, BURLINGTON, ONTARIO 7.6.2

PROJECT OVERVIEW

The Canadian Centre for Inland Waters (CCIW) was originally opened in 1967 and was fully completed in the early 1970's. The complex is located on Hamilton Harbour and contains over 49,000 square metres of space, including 200 laboratories ranging in size from one room to a 100 metre long wide-wave flume. The complex provides office and research space for 700 employees that research the effects of water pollution on aquatic ecosystems. Between 1985 and 1991, this site was renovated with assistance from the Federal Buildings Initiative. In addition to energy conservation refits, the building was upgraded to maximize water conservation.

ENVIRONMENTAL ACHIEVEMENTS

Water Savings

- Drawing water from the harbour instead of the municipal water system reduced cooling water requirements.
- The water requirements of the fish tanks were reduced by controlling algae growth, thereby reducing the need to continually add municipal water.
- Low-flow adapters and aerators were installed on all faucets.
- Automatic flushing urinals were replaced with manual flush models.
- Water required for landscaping purposes is drawn from the harbour.
- Uncontaminated water from the complex is diverted from the storm sewers by pumping it directly into Hamilton Harbour.

ECONOMIC FACTORS

The greatest cost incurred in this project was refitting the cooling system. This procedure involved a capital outlay of $101,000. In turn, this initiative resulted in annual savings of $53,000 annually. Paybacks were realized in two years. The rerouting of the water flow for the fish tanks required an outlay of $32,350, but resulted in annual savings of $22,600. The costs of the other water saving measures were included in regular maintenance costs and were therefore not calculated.

GREEN ON THE GRAND – COMMERCIAL OFFICE BUILDING 7.6.3

DESCRIPTION: This 2,000 m2 office is Canada's first C-2000 office. It is located on the Grand River in Kitchener, Ontario. The building was designed to showcase leading edge environmentally responsible building features and technologies. Paramount was the provision of a comfortable and healthy environment for occupants. Among the numerous and rigorous environmental goals was a water use reduction target of 70% less water use than comparable typical office building.

FEATURES: All areas where water is used were carefully considered. Toilets had to use a maximum of 6 litres per flush but also required a high efficacy flush. Therefore pressurised-tank type toilets were installed. Ultra-low water use urinals with infra-red occupancy flush valves were used. As were water-saver lavatory faucets with infra-red sensors. Similar faucets were also used in tenant kitchenettes. The showers also have low water use shower heads and infrared occupancy sensors.

The cooling tower is a storm water retention / decorative pond located in front of the building and fed from the building's rain water leaders. Rain water provides much of the replacement water.

Over 75% of the landscaped area is covered in native species of trees, shrubs and flowers that require minimal watering. Bark mulch is used to ensure that moisture is retained in the soil and to keep weeds from flourishing. Grass is limited to the boulevards as required by the city and a small area that has a picnic table for a social gathering spot.

RESULTS: An annual city water use reduction of 72% less than a typical office (or a use of 26 L/p/d) was predicted. Monitoring showed the expected consumption target had been met with an actual consumption of 73% less than a typical building.

Two issues have the potential to increase water consumption. First, after the building was completed the owner had a significantly oversized water softener with timed regeneration installed. Second, the city insisted on installing Kentucky Bluegrass on the boulevards and required automatic irrigation installed to ensure that it would not die and require replacement.

CONSTRUCTION, RENOVATION & DEMOLITION WASTE

8.0

CONSTRUCTION, RENOVATION AND DEMOLITION WASTE 8.0

INTRODUCTION 8.1

The diversion of construction, renovation and demolition (CRD) waste from landfill sites is an issue that has been gaining attention within both the public and private sectors. Surveys have indicated that as much as one third of the 20 million tonnes of solid waste of municipal waste streams is generated by construction, renovation and demolition activities. Many of our landfill sites are reaching capacity. In addition, CRD waste is sometimes illegally dumped or burned, causing land, air and water pollution. The increasing costs of disposal are ultimately reflected in project costs, as contractors must incorporate anticipated disposal costs in their bid costing. Realities such as these emphasize the need for initiatives that focus on reducing and diverting as much waste as possible from CRD activities.

Incorporating the 3Rs (reduce, reuse and recycle) into construction, renovation and demolition waste management creates a closed-loop manufacturing and purchasing cycle. This significantly reduces the need to extract raw materials, reduces the amount of materials going to landfill sites and reduces the life-cycle costs of buildings and building materials

Project managers and construction contractors have long recognized the importance of reducing waste and salvaging high value construction and demolition materials such as copper and other metals. Contractors are usually careful about the quantity of materials ordered, how materials are used and how to carefully deconstruct valuable materials. In most cases however, materials that are more difficult to separate and that are worth less per unit weight are still going to landfill, even when they are present in large quantities. This represents an inefficient use of natural resources and uses up landfill capacity unnecessarily.

Unfortunately, some contractors do not realize that there are new opportunities for waste minimization, while others are reluctant to implement environmental practices because they believe these practices will increase their project costs. Most contractors are concerned about the cost of the labour that is needed to deconstruct materials for reuse or recycling. However, it has been shown that effective waste management during CRD projects not only helps protect the environment, but can also generate significant economic savings. Demonstration projects have shown that the diversion of waste from landfill can reduce waste disposal costs by up to 30%. This is accomplished through reduced tipping and haulage fees and the sale of reusable and recyclable materials.

LANDFILL SITES 8.2

It is becoming more difficult to find suitable locations for new landfill sites, as people are increasingly opposed to the development of them in their neighbourhoods due to odours, increased traffic, and potential problems with ground and surface water contamination. Diverting CRD waste from landfill will substantially extend the useful function of existing sites.

In order to understand some of the environmental impacts that are associated with the disposal of large quantities of CRD waste, it is necessary to understand how a landfill site functions. Biodegradable waste decomposes in a landfill water and appropriate bacteria are present. Decomposition refers to the disintegration of the chemical bonds that hold material together, causing the material to break down into simpler substances. Biological decomposition can be hastened or delayed by varying conditions, including, temperature and moisture.

During the degradation process, four actions occur:
- organic matter is stabilized,
- leachate is produced,
- landfill gas is generated, and
- settlement occurs.

A complex combination of landfill liners, monitoring wells, piping, pumps and capping of landfills controls leachate flow. However, these systems are not always successful and if leachate escapes from landfill sites, it can pollute groundwater, rivers, streams and surrounding land areas.

RESOURCE MANAGEMENT 8.3

The reuse, refurbishment and remanufacturing of products also diverts materials from landfill and are always preferred to disposal.

Environmental impacts due to the extraction and transformation of materials are significant. This includes habitat destruction, resource depletion, energy use, air pollution, water pollution and solid waste problems. The availability of some raw materials has decreased significantly during recent decades due to the rate at which we consume materials – both non-renewable and renewable – and the fact that we are not creating appropriate opportunities for renewable resources to replenish themselves. As a result, we must increasingly look for ways to reduce our impact on both non-renewable and renewable resources.

Products and materials with recycled content are more readily available and are a partial answer to problems of resource depletion. Recycling materials helps to create closed-loop manufacturing and purchasing cycles and significantly reduces the need to extract raw or virgin materials.

PROVINCIAL AND MUNICIPAL REGULATIONS 8.4

The construction waste management field is regulated by provincial and municipal legislation. In acknowledgement that construction and demolition materials make up such a large percentage of the waste stream, regulations exist in some parts of Canada to divert these materials from landfills or prevent them from being dumped illegally. Municipalities often manage or control CRD waste management practices at the local level. Many municipalities throughout Canada have by-laws in place banning the landfilling of specific CRD material (e.g. drywall etc). The Province of Ontario has regulations in place which require detailed waste audits for construction contracts above a certain size. These are described below.

These requirements vary by location across the country. The following is a partial list of provincial and municipal legislation to be consulted prior to the handling or disposing of any CRD waste material.

ONTARIO'S 3RS REGULATIONS

In 1994, the Ontario Ministry of the Environment (MOE) passed the 3Rs Regulations. Regulations 102/94 and 103/94 are applicable to construction and demolition projects consisting of one or more buildings with a floor area greater than 2,000 m2.

Regulation 102/94 requires the following:

- the completion of an on site waste audit that identifies the amount and nature of the waste that will be generated;
- the development of a waste reduction workplan that outlines specific achievable diversion options for reduction, reuse, and recycling;
- the implementation of the waste reduction workplan;
- the documentation of the waste audit and workplan results on forms provided by the MOE or forms that have been designed in the same general format; and
- the retention of a copy of the audit and workplan documents on file for five years from completion of the project.

Regulation 102/94 requires that the waste audit be conducted and the workplan completed before the beginning of the CRD project.

Regulation 103/94 requires the following:

- the implementation of a source separation program for the reusable and recyclable materials listed in Regulation 102/94;
- the specification of facilities that are sufficient for the collection, sorting, handling and storage of these materials;
- the communication of the source separation program and its successes to employees, patrons, and tenants; and
- reasonable effort in ensuring that the separated waste is reused or recycled.

The project team should check with provincial environment departments to identify all relevant environmental regulations. The federal government adheres to the Ontario 3Rs Regulations as they represent best practices in the industry.

MUNICIPAL BY-LAWS

Municipalities who own and operate municipal landfills are the decision-makers when it comes to what materials can be landfilled and what by-laws and regulations are enforced. Local requirements regarding landfill bans should be checked prior to each CRD project.

The project team should ensure that contracts made with disposal companies, state that all removed materials will go to permitted facilities.

REDUCING CRD WASTE 8.5

The traditional handling of CRD waste represents a lost opportunity. Most of this material is not waste, but a valuable resource. As the cost of construction materials escalates due to dwindling virgin resource availability (especially lumber), many of the materials that we throw away are becoming increasingly valuable. Almost everything–from concrete and lumber, to electrical wiring and plumbing fixtures–can be reused or recycled.

To take advantage of the value of waste materials as a resource, salvageable materials must be separated from other materials. The purpose of separating CRD waste is that there will often be markets for certain items, but once mixed or contaminated, these materials have lost their value. By separating materials, a higher value can be given to those materials that can be salvaged, thereby reducing tipping fees at landfill. In short, recovering waste and keeping it separated reduces project costs in two ways:

- it minimizes the transportation and disposal costs for landfilling this material, and/or
- the materials acquire economic value, either by selling them to a recycler or by incorporation into future projects.

DESIGN CONSIDERATIONS 8.6

During the planning phase of a project, consideration should also be given to future waste diversion techniques. The construction industry has traditionally relied upon standard assembly methods, products and routines. Unfortunately, during a renovation or demolition project materials are often not easily salvaged for reuse or recycling. The result is a high percentage of waste generation. In order to combat this problem, steps can be taken early in a project to decrease waste generation during future demolition activities. Future disassembly should always be a consideration during the design phase.

By designing for disassembly, a greater percentage of materials and products may be reused or recycled with little effort, resulting in less waste generation and reduced quantities of materials entering landfills. In order to employ successful design for disassembly techniques, attention must be given to the specifics of material assemblies, product selection and connection details.

The use of reversible connections instead of nails to fasten wood framing and other materials allows for easy disassembly. Not only can the material be used again, but the screws and bolts can also be reused. In addition, by making the connections more easily accessible, disassembly will be facilitated and less waste will be generated.

Other methods of disassembly include selecting materials that are fastened by a tongue and groove connection rather than the need for an adhesive compound. Adhesive compounds produce a permanent connection that contaminates the material and affects its recyclability. Consider the use of materials that are classic and timeless so that they will endure for the life of the building and not be removed during a renovation. Material such as linoleum flooring is often left in place for the entire life cycle of a building, while carpeting is traditionally changed on a five to seven year cycle. It is also environmentally beneficial to determine from suppliers which materials and products have well-established recycling and reuse markets. Designing for disassembly results in substantially lower amounts of waste being produced during a renovation or demolition project.

Section 2 of this document identifies criteria that can be used for the environmental assessment of products and materials. The following criteria are relevant to the selection of products that will facilitate future waste diversion practices.

REUSABLE PRODUCTS

Many products are reusable by consumers. Most consumers are aware of this fact, however, it is important to identify new reuse opportunities that may not be readily apparent.

Industry Canada has developed a document entitled Principles and Guidelines for Environmental Labelling and Advertising. This document provides a guideline for the term reusable. For a product to be deemed reusable, an application must exist that allows the end user to directly reuse the product. Where the option is not obvious, the claim must explain how the product can be reused without extensive cleaning or restoration processes. This criterion may also be used to assess the packaging materials that are associated with a product. For example, furniture can often be shipped in reusable blankets rather than in resource intensive corrugated containers.

REFURBISHABLE PRODUCTS

Refurbishable products can often be reused. However, they usually require cleaning or restoration. During the refurbishing procedure, the product remains the property of the consumer. Hence, the expense of the refurbishing process is the responsibility of the consumer.

The refurbishing procedure may be offered either in-house by the original manufacturer or may be a procedure easily accessible through outside sources. Information regarding refurbishing processes must be readily available to the consumer. The refurbishing of a product may require the utilization of additional energy and additional waste generation. However, the environmental impacts are considerably lower than first-time fabrication in almost all cases.

REMANUFACTURABLE PRODUCTS

This criterion differs from refurbishing in that the ownership of the product reverts to the original manufacturers or a third party that provides the restoration services. Products recognized under this criterion are designed in a manner that allows for complete upgrading, where products can be inspected and disassembled to their individual elements and damaged pieces can be repaired or replaced. The product is therefore restored to an as new condition for resale by the fabricator.

DURABILITY

Durability provides reduced environmental impact by minimizing the maintenance or replacement requirements of a product. This provides an efficient use of natural resources and a diversion of material from landfill.

At present, durability is generally measured by manufacturer's warranties. However, typical manufacturer warranties are generally too vague to be used as a baseline for the development of a criteria definition. Standard testing procedures and reporting requirements are currently being developed which will provide a reliable mechanism for environmental evaluation. However, until this framework is developed and accepted, building practitioners can only qualitatively access the durability of a product.

Maintenance requirements should be assessed to ensure that a product will maintain its aesthetic and functional value and manufacturer's warranties can be used to provide a marginal measure of a products durability. Product testimonials are another source of information which can be used to verify durability claims. Although this issue is marginally quantifiable, a mechanism for reliable quantitative analysis is not yet available.

RECYCLABLE PRODUCTS

The use of recyclable products provides efficient and effective use of natural resources. The benefits are achieved by diverting the products from the waste stream and directing them to a recycling facility.

A product that is recyclable can be returned for reprocessing into new material. However, a product is not considered recyclable simply because the material is technically recyclable or there are anticipated developments in the future. Recycling programs and facilities vary regionally throughout Canada. A product can only claim to be recyclable if one-third of the population has access to recycling facilities or drop-off points.

In situations where products are fabricated from numerous materials, the product design should facilitate recycling options by design for easy disassembly and identification of materials types. For example, plastic components should contain plastic sorting codes. Instructions explaining disassembly and sorting requirements for inclusion in recycling systems should also be included with products.

THE CRD WASTE MANAGEMENT PROCESS *8.7*

As with most project requirements, CRD waste management should reflect the nature and scope of the project. Smaller projects may have less on-site storage space, lower waste volumes and may be located in an occupied area. Larger projects may involve multiple subcontractors, large amounts of similar wastes and be subject to design constraints. Intense short schedules may limit the practicality of implementing waste management strategies to the same degree as projects with protracted schedules where waste management requirements will not affect the critical path. Screening is an important first step to understanding the level of effort and scheduling that will be required. Smaller projects may be able to achieve the same waste diversion through a scaled down audit and workplan, whereas larger projects often require a more detailed evaluation.

Another very important part of this early stage is commitment from the tenant or owner of the property. Some clients have a mandate to track and report on their progress in this area. This will allow for a more detailed on-site monitoring and facilitation program than is the case for those that are committed solely to meeting the minimum objectives.

Teamwork is essential to the success of an environmentally responsible-CRD project. Communicating and working together with designers, energy efficiency experts, water conservation specialists, and other facility personnel ensures efficiency, avoids duplication of effort, and facilitates future cooperation. Communication allows team members to coordinate future work with current renovation or demolition activity.

A summary of the waste audit and waste reduction workplan, based on the audit inventory results, should be incorporated into the general contract specifications. This should emphasize the cost savings that can be achieved through responsible waste management practices, and should also include site management plans, monitoring and reporting requirements. This information should be included as a guide to the contractor and the workplan should present recommendations. The audit and workplan results are estimates that cannot account for all the conditions that may exist at a particular site. Unanticipated conditions or problems that have a negative impact in actual diversion rates should not result in penalties for the contractor. They should however, be documented to substantiate the variance from the expected result and to provide insight for future projects.

The waste audit is integrated throughout the project's design and implementation process. Project modifications are represented below:

REQUEST FOR PROPOSAL: The request for proposal for potential prime consultants should include a requirement for the basic contract to include a waste management specialist on the team and a commitment to specify environmentally preferred materials where applicable. The additional sections should give the flexibility to adjust the waste requirements in light of the recommendations made by the Waste Management Specialist on the CRD Waste Assessment checklist, workplan or Waste Management Report.

PRIME CONSULTANT: The prime consultant should have an in-house specialist or an additional subcontractor to perform and integrate the waste audit and workplan throughout the project.

WASTE SPECIALIST: The waste specialist will be responsible for developing the audit and workplan and will, in most cases, also be responsible for the implementation and follow-up of the workplan.

WASTE MANAGEMENT: This includes auditing the project for the types and quantities of materials and expected wastes, generating a workplan for the reduction, reuse, and recycling of these materials, monitoring the wastes and reporting all successes.

PROJECT DESIGNERS: The project designers should schedule the waste audit early in this phase so that opportunities resulting from the reuse of materials or reduction of waste can be incorporated. This is especially important for the construction aspect of the project.

CONSTRUCTION DOCUMENTS: The construction documents should include the waste reduction workplan and the specifications should include environmental clauses for material procurement and waste management.

CONTRACT ADMINISTRATION: This phase includes providing direction to the general contractor, facilitating the implementation and tracking of the workplan and reporting on the results.

GENERAL CONTRACTOR: The general contractor is ultimately responsible for responding to applicable legislation and meeting the contract specifications.

The project team should remember that waste management in CRD projects is a relatively new field for most contractors. As with the procurement of any services, a clear description of the project requirements in the tender documents is necessary to ensure the respondent and the client are aware of the responsibilities, deliverables and results that are expected. The client will maximize cost savings if the tender documents clearly demonstrate that there is potential for the salvage of materials.

INTEGRATING CRD WASTE MANAGEMENT *8.8*

The following section summarizes the development and incorporation of a waste diversion program into a project.

PLANNING ACTIVITIES

CRD waste management should be incorporated into all projects. This is accomplished in-house by including environmental requirements into each request for proposal. These requirements include the need for a waste specialist on the team and individuals who are willing to co-operate with the waste reduction strategy, and who are experienced in reuse and recycling operations.

The project team should ensure the project timeline allows sufficient time for material sorting and salvage activities to maximize material recovery. These activities may take additional person-hours compared to a traditional demolition where minimal salvage is performed.

Project designers should be made aware of the waste reduction objectives at the planning stage of the project. Their participation will allow for design considerations that will reduce waste generation during future renovations. Designers should be encouraged to design with maximum use of standard-sized materials and where possible, to include pre-fabricated systems. Designers should also consider the use of recyclable, reusable, refurbishable or remanufactureable products.

THE WASTE AUDIT

The purpose of a construction, renovation, or demolition waste audit is to identify the types and quantities of waste materials that will be produced during the project. The Ontario 3Rs Regulations identifies materials that must be included in the waste audit.

For construction projects they are:
- brick and Portland cement concrete;
- corrugated cardboard;
- unpainted drywall;
- steel (e.g. ductwork, frames, studs); and
- wood (including painted, treated, or laminated wood).

For demolition projects, they are:
- brick and Portland cement concrete;
- steel; and
- wood (not including painted, treated, or laminated wood).

However, there are often significant quantities of other materials that can also be included in the waste audit. These include:
- rigid plastic, plastic film, and polystyrene packaging;
- wooden shipping pallets;
- doors and hardware;
- thermal insulation;
- ceiling tiles;
- architectural hardware such as curtain rods;
- leftover paint;
- carpeting, and hardwood flooring; and
- window glass.

All of these materials can be quantified using floor plans, specifications, site visits, and/or interviews. For some projects, such as the demolition of old buildings, floor plans may not be available. When this occurs, it may be necessary to cut-away sections of surface materials, such as gypsum and ceiling tile in order to verify internal components such as joists, insulation, and sound baffles.

Material quantities are usually estimated in units of volume based on the overall building dimensions, structural components and assembly. However, waste diversion is usually expressed in units of weight. The auditing process should use conversion factors to convert the material volumes to weights. Conversion factors can be found in The Ontario 3Rs Regulations and in architectural and engineering publications.

It should be noted that a waste audit is not intended to identify, quantify, or specify handling information for hazardous wastes such as ballasts that contain PCBs or paint that contains lead. Handling procedures for these materials should be addressed in an environmental impact assessment and/or a designated substances report.

WASTE REDUCTION WORKPLAN

The purpose of a waste reduction workplan is to identify opportunities, and to explain the required actions for diverting from landfill the materials identified in the audit. The initiatives outlined in the waste reduction workplan should follow the 3Rs hierarchy of reuse, recycle and reduce, with priority being apportioned respectively. The following is a description of the reduction, reuse, and recycling options for CRD waste.

REUSE

Materials can be reused in a number of ways. Again, proper planning before the project begins will facilitate the implementation of an effective waste diversion program for the project.

In construction related projects, the design phase allows for the use of materials that have been deconstructed elsewhere. The materials may be reused on or off-site, or for a similar or different application to their original function. Contractors can reuse materials such as metal studs and fiberglass insulation salvaged on Project A to build and insulate new walls on Project A, or they can use damaged concrete blocks from Project B as backfill on Project C.

During demolition projects, proper deconstruction planning can allow for material to be salvaged in a reusable form. Contractors can divert materials from landfill by sending them to used building material depots for reuse by a third party. When the need for this alternative is anticipated, the waste reduction workplan should include a list of potential off-site end users. If end users are identified, it is suggested that letters of intent be obtained. These letters should include the potential purchase price, minimum quantities, and handling and shipping details where appropriate.

When contacting potential end users, it is important to specify the type of materials, volume, weight and condition of the materials to be diverted. On-site storage and handling limitations and the expected construction and demolition schedule should also be specified.

Many building systems such as demountable partitions consist of a number of components such as metal framing, plastic moulding and gypsum wallboard. These systems can be taken apart and the constituent components may be used individually. However, it should be noted that the individual reuse of one component often reduces the reusability of other components. For this reason, it is recommended that the components be considered as a system for evaluation purposes. By maintaining the integrity of the system it becomes more marketable and hauling and tipping fees to landfill can be dramatically reduced.

RECYCLING

In some situations materials cannot be reused. When this occurs, waste diversion can still be achieved by recycling.

The waste reduction workplan should also identify materials for which recycling opportunities exist. The workplan should contain a list of potential recyclers. When contacting and identifying potential recyclers, it is important to specify the material types, the volume, and the weight. The workplan should identify on-site storage and handling limitations and the expected construction and demolition schedule. It is also suggested that letters of interest be obtained from the recycler, including the potential purchase price, minimum accepted quantities and handling and shipping details.

It should be noted that recyclers typically pay more for separated materials that are free of contaminants than for materials that are co-mingled or mixed with contaminants

REDUCE

The amount of material generated by a demolition project is defined by the project scope.

There is little potential for waste reduction, therefore comments presented below focus on construction projects. Reduction initiatives directly affect the amount of resources that are used and the amount of waste that is generated, during a project. Due to the nature of the activity, the design phase of construction related projects offers the greatest potential for waste reduction. Although the full potential may not be achievable due to cost and design constraints, for example, proper planning during the design stage can ensure that structure dimensions correspond to standard construction material dimensions. This not only reduces the amount of waste that is produced, but also reduces the need for cutting and decreases labour costs.

Waste reduction can be achieved by making contractors accountable for the waste they generate. Under these conditions, contractors will try to minimize their waste in order to maintain their profit margins. Another method for reducing on-site waste generation levels is to include a take back policy for packaging. A clause in purchase contracts can stipulate that packaging be either returned in empty delivery trucks, or at a later time.

Some suggestions for reducing waste on a construction project include:
- detailed framing layouts allow for optimized use of material through accurate take-offs;
- reduce waste allowances from the traditional 10% to a more responsible 5%;
- issue clear instructions to tradespeople as to which materials are designated for which component of the structure;
- specify durable products, such as kiln dried lumber that is less likely to warp on site;
- specify pre-cut materials to minimize site cutting and waste;
- materials should arrive on site as they are needed during the construction process–this way less materials are wasted by weathering, improper storage or on-site damage;
- instruct the contractor to inspect each material delivered and immediately return damaged goods;
- preference should be given to suppliers who will offer credit for unused materials;
- materials should be stored on a level surface and elevated above grade level;
- materials should be protected from exposure to the elements;
- give preference to suppliers who will retrieve their packaging materials;
- incorporate prefabricated elements into the design;
- specify the purchase of materials in bulk to minimize packaging waste; and
- inventory all surplus materials so that future orders can be adjusted.

IMPLEMENTATION OF A WASTE REDUCTION AND RECYCLING PROGRAM

The project team should also clearly outline who is responsible for the implementation of the waste reduction workplan. The general contractor is responsible for ensuring that subcontractors adhere to the terms of the tender documents, including all specified waste diversion initiatives. The project team is also responsible for ensuring that the general contractor makes the subcontractors aware of the waste diversion initiatives.

The project manager should appoint a facilitator for the project. A facilitator is a person who is responsible for assisting the general contractor and all subcontractors with the implementation of the waste reduction workplan throughout the project. The facilitator ensures that the implementation of waste diversion initiatives is made as simple as possible. Specifically, this includes the following:

- meeting with the successful contractor to go over the waste diversion specifications to answer any questions that may be brought up;
- providing checklists for the project manager and general contractor to assist in the implementation of this program;
- providing disposal tracking forms for the project to support the reporting structure which will be established. The project manager can track the disposal of material leaving the site to ensure that the spirit of the project is being met and to provide follow-up figures for the case study at the end of the project; and
- providing telephone assistance to the general contractor throughout the demolition process to ensure that any concerns may be promptly dealt with to maintain the spirit and schedule of the project.

The facilitator may be one of the following individuals depending on the nature of the work and on the size of the project:
- a contracted waste specialist;
- a member of the Prime Consultants team;
- a waste specialist hired by the prime consultant, or
- an experienced member of the General Contractors team.

The tender documents should clearly indicate whether or not a facilitator has been appointed for the project, who the facilitator will be and a description of the facilitator's role.

MEASUREMENT AND DOCUMENTATION OF THE WASTE DIVERSION SUCCESSES 8.9

The successes of a CRD waste diversion project should be communicated to employees, patrons and tenants. The communication of the project successes is very important since reported successes for the current project, particularly the achievement of cost savings, will help obtain buy-in for future projects.

The most effective way to communicate the CRD waste management project successes is to prepare a success measurement document. In large, phased projects, it is recommended that a monitoring report be provided by the prime consultant at the end of each phase so that resulting recommendations can be incorporated into subsequent phases. This ensures that there is continual improvement in the process and that substantial opportunities are not missed. It is suggested that a waste management success measurement report contain the following information:

- a summary of the weight and volume of the materials that were actually generated throughout the project;
- a summary of the weight and volume of the materials that were reduced, reused, and recycled; and
- a summary of the costs and savings related to the waste management project including added labour costs and shipping and disposal costs and savings.

The facilitator should compare this quantitative information, which should be obtained from the tracking sheets and interviews with the general contractor, with the information contained within the waste audit report. The use of the waste material tracking sheets is essential while the project is occurring. It is the responsibility of the facilitator to ensure the sheets are all signed by both the truck driver and the receiver at the recycling facility. It is suggested that the facilitator address significant discrepancies between the audit material weights and volumes and the actual material weights and volumes. This will assist in further refining the process and understanding the contractor's approach for future efforts.

Based on the facilitator's observations, the report should also contain the following qualitative information:

- the condition of the reusable/recyclable materials upon shipping/receiving;
- the general and subcontractors' responses to the project including criticisms and suggestions that may have been offered;
- a summary of problems incurred and potential solutions;
- feedback from local market sources; and
- a list of recommendations for future projects.

It is suggested that the project manager state in the RFP that this quantitative and qualitative information is to be collected and included in the success measurement report. This will help to ensure that the appropriate data is collected throughout the project. 9.0

CONSTRUCTION, RENOVATION & DEMOLITION WASTE MANAGMENT MEASURES

9.0

CONSTRUCTION, RENOVATION & DEMOLITION WASTE MANAGEMENT MEASURES 9.0

Construction, renovation, and demolition (CRD) waste is solid, non-hazardous material generated during construction, demolition, and/or renovation projects. Since EC and PWGSC Real Property Services (RPS) are involved in few new construction projects, most CRD wastes are generated during demolition, and particularly, renovation, recapitalization and fit-up projects.

The following two goals have been established by PWGSC with respect to CRD solid waste management:

- Incorporate, by March 31, 2000, construction solid waste diversion practices into the Real Property Service Project Delivery System and implement these practices for all future construction, renovation and demolition projects as applicable.
- Develop in concert with the Canadian Construction Association by March 31, 2000, construction industry best practices for solid waste management to disseminate these practices throughout the industry.

RPS has included CRD waste management sections in their revised Request for Proposal (RFP) and Project Management Practice Standard. The CRD waste management section includes the requirement of the contractor to conduct a waste audit and to prepare a solid waste reduction workplan. The revised RFP and Standard is being used in various regions as the Branch's generic document for project management. It is an editable document and Project Managers are expected to use their judgement when applying it to their projects. It is expected that the waste management requirements will be implemented on every project where it is feasible, and in Ontario where it is mandatory.

RPS has been actively involved in the development of pilot programs, protocols and standards with regards to economically diverting wastes from CRD activities. The measures required for GOP have been taken from existing practices and protocols that have been developed and implemented by RPS, with minor modifications for EC.

In most cases work carried out on behalf of PWGSC will be contracted to a third party, and will not be carried out by PWGSC forces directly. For this reason, the Project Manager will need to liaise closely with the contractor during the project and also include options in the bid package, in order to assess the economic viability of some of the measures recommended.

For most federal government projects, project managers use the National Master Specification (NMS) as a resource tool for writing construction, renovation and demolition specifications. Developed jointly by the public and private sector, the NMS is recognized by the Canadian construction industry as the leading construction specification tool. The NMS is a comprehensive library of construction specifications written in contract specification format. The level of detail and complexity allows for maximum protection against duplication and errors, while minimizing the chances of misunderstandings, and liability in the delivery of construction contracts. The NMS is currently being revised to incorporate environmental consideration into all aspects of PWGSC projects.

The following measures must be implemented to meet the GOBP requirements:

- Require waste diversion be a key consideration is all construction, renovation/retrofit and demolition projects where the floor area involved is greater than 2,000 m2;
- Waste audits and waste diversion workplans be contractually required of prime contractor;
- All wastes and building materials that can economically be diverted through deconstruction, reuse and recycling practices will be identified and implemented through the workplan;
- The diversion activities will be monitored by RPS project managers.

COST BENEFIT ANALYSIS *9.1*

The availability and costs of waste haulage, landfilling, reuse, recycling and refurbishing, and other waste handling alternatives varies from region to region across Canada. Accordingly, the economic costs and benefits of implementing recycling and other waste diversion initiatives for CRD waste will vary from region to region as well. A methodology for conducting a preliminary estimate of the cost effectiveness of a CRD waste diversion program is presented in this section. However, because the Project Manager will depend on the cooperation of the contractor to develop some of this information, it will be an iterative process to identify the most economically viable approach to managing CRD waste. Table 2.1 provides a sample cost benefit analysis worksheet for CRD waste diversion.

DATA COLLECTION: Determine the following:
- the cost of the current waste management practices;
- the cost of implementing a CRD waste diversion program; and
- the savings and benefits resulting from a recycling, reuse, and waste reduction programs.

COMPARISON OF EXPENDITURES AND SAVINGS: Once all the relevant information is collected and entered in the worksheet, the totals for each category must be summed and compared. If the total cost of the waste management program including deconstruction, reuse, and recycling, is less than the total savings, then recycling and other waste reduction programs would be cost effective and should be further investigated.

FURTHER ANALYSIS OR CONTINUE WITH SOLID WASTE MANAGEMENT PROGRAM: If the cost benefit analysis showed that either recycling or other waste reduction programs are feasible, then a more detailed waste management audit and workplan are recommended.

**The following sections describe the activities involved in more detail.*

TABLE 9.1
CONSTRUCTION, DEMOLITION AND RENOVATION WASTE MANAGEMENT COST BENEFIT ANALYSIS

PART A	CURRENT WASTE MANAGEMENT COSTS	EST.	ACTUAL
1	***Fixed Asset Costs of Waste Handling:*** rent or purchase of compactors, roll-off containers, dedicated trucks		
2	***In-house Waste Operations Costs:*** personnel & maintenance (CRD workers)		
3	***Hauling Costs:*** contract prices for hauling.		
4	***Disposal Costs:*** total tipping fees at the landfill		
5	***Minus Revenues:*** best estimate of potential revenue received from the sale of reusable and recyclable materials		
6	**Total Current Waste Costs**		

PART B	REUSE AND RECYCLING COSTS	EST.	ACTUAL
7	***Project Management Costs:*** anticipated costs to implement and monitor the program		
8	***CR&D Waste Audit and Waste Reduction Workplan Costs*** potential consulting fees		
9	***Fixed Asset Costs:*** purchase or rental costs of cardboard balers, roll-off containers costs for creating & setting up collection & storage processes & areas		
10	***Operational Costs:*** labour costs for deconstruction & source separation of reusable/recyclable materials cost of additional electricity, water, and maintenance of equipment communication and education programs		
11	***Hauling Costs:*** cost to locate buyers or collectors and the cost to transport reusable and recyclable materials to market		
12	**Total Reusing and Recycling Costs**		

PART C	POTENTIAL SAVINGS FROM WASTE MANAGEMENT	EST.	ACTUAL
13	***Avoided Fixed Costs:*** savings from avoided rental of dumpsters, roll-off containers, etc.		
14	***Avoided Waste Hauling and Disposal Costs:*** savings from reduced number of hauls & in tipping fees at the landfill		
15	***If Applicable, Tax Credit for Waste Reduction:*** savings from statutory tax breaks from dedicated recycling equipment		
16	***Revenues:*** money received from the sale of reusable and recyclable materials		
17	***Costs Avoided Through Reduction and Reuse Initiatives*** savings achieved by reducing materials purchased, reusing suitable construction or renovation materials, etc.		
18	***Other Benefits Associated with CR&D Waste Management:*** environmental benefits, policy commitments, enhanced public image.		
19	**Total Savings From Waste Management**		

PART D	FEASIBILITY, OR NET SAVINGS FROM WASTE MANAGEMENT	EST.	ACTUAL
20	***Feasibility = Total Waste Management Savings – (Total Current Waste Management Costs + Total Reuse & Recycling Costs)*** ***= Line 19–(Line 6 + Line 12)***		

STEP 1: COMPLETE WASTE AUDIT

A waste audit should be carried out by the Project Manager or contractor, to identify the types and quantities of waste materials that will be produced during the project. The audit process includes assembling and reviewing background information, site visits to identify material types and to quantify and inventory materials that will be generated. The audit should identify any reusable fixtures or materials These items should be inventoried and included in the waste audit summary information.

A sample waste audit form is available from the PWGSC Project Manager or from Craig Boyle, 613-956-1553 or HYPERLINK mail to:* **craig.boyle@pwgsc.gc.ca

STEP 2: DEVELOP WASTE DIVERSION WORKPLAN

The waste diversion workplan is a plan of action that is based on the findings from the audit. The purpose of the workplan is to identify opportunities and actions that will divert materials from disposal. The focus of the workplan should be on identifying reuse opportunities first, recycling opportunities second and finally disposal options if required. The workplan should include:

- a list of materials identified for reuse from the waste audit and potential diversion options and a summary of the weight and volume of materials that can be diverted to reuse;
- a list of materials identified as recyclable and potential diversion options for each of these materials including a description of the market outlet should include name, location, contacts, type of operation and a summary of the weight and volume of materials that can be diverted to recycling;
- anticipated costs associated with handling and storage on-site (e.g. bin rental costs), transportation costs (delivery to market or disposal outlet), tipping fees and potential revenues from the sales of materials

REUSE

Reuse initiatives should be given the highest priority, as optimization of reuse provides the most efficient use of natural resources and frequently yields the greatest economic benefit. Proper planning before commencement of the project will facilitate the identification of reuse options.

Reuse of CRD wastes and building materials can include a range of activities available to the project proponents and contractors such as:

- Reuse materials on-site in rebuild stage of the project (e.g. doors, raised flooring, demountable drywall partions, using masonry as backfill).
- Separate and reuse materials for another off-site project (e.g. cabinetry, acoustical tiles, doors etc.).
- Ensure that Crown Assets removes all materials identified in their report. Crown Assets (part of PWGSC) is responsible for the sale of surplus assets for the Federal Government including moveable equipment and materials. Crown Assets offers many items for reuse through sales held in each region.
- Separate building materials for donation or sale to used building materials centre for resale (e.g. acoustical tiles and suspended tracking system are sold to reuse centre who then sell them to contractors renovating a local business). Used building material centres are found in most major cities across Canada. The Used Building Material Association (UBMA), which has a listing of its members across the county, can be contacted at (877) 221-8262.
- Many demolition contractors and some building contractors operate their own salvage or reuse operations for reusable materials that are generated from projects. Check local yellow pages or local recycling coordinators for names of demolition salvage yards in the community.
- Careful removal and handling of reusable building materials and equipment typically require additional labour time than would traditional “tear out” and removal retrofits. The additional project time and impact on labour costs needs to be outlined and included in the diversion workplan.

RECYCLING

The waste diversion workplan should identify materials for which local recycling options exist. When contacting and identifying potential recyclers, it is important to itemize the following:

- the type and condition of the materials to be diverted;
- the volume and weight of the materials;
- on site storage and handling limitations; and
- the expected construction, renovation and demolition schedule.

Recycling markets for CRD wastes typically fall into one of two categories: single material outlets or full-service or mixed recycling outlets.

Single material outlets accept a single or limited range of materials that require source separation on the job site. Source separation on the job site improves the quality of material to be sent to a recycling operation. However, source separation requires extra storage and removal bin, plus greater awareness on the part of job site workers. Typical examples of single material recycling outlets include:

- scrap metal companies,
- wood waste recycling;
- drywall recycling
- concrete/aggregate companies

In some regions of the country, mixed CRD waste recycling operations are developing. These outlets typically allow building contractors to place mixed CRD wastes in a single waste collection bin, thereby reducing space requirements on-site. The mixed wastes are then transported to a processing or transfer facility where some level of separation and recycling takes place. The level of diversion in these types of operations tend to be lower due to contamination and breakage. These operations also typically charge tipping or processing fees for providing this type of service.

The waste diversion workplan goals should be reflected in any agreement with a haulage firm. The agreement should specify the list of materials that are to be recycled, a price schedule, pickup requirements, and documentation of recycling.

HAZARDOUS WASTES

By definition, CRD wastes do not include hazardous materials. However, materials that are hazardous or that contain hazardous materials can be present in CRD wastes. These include the following:

- fluorescent light tubes that contain mercury vapour;
- paints that contain lead;
- fluorescent light ballasts containing PCB's;
- lead sound barriers;
- ceiling tiles with asbestos fibres; and
- air conditioning units with ozone depleting substances.

These materials require special handling which is described in Public Works and Government Services Canada publication *A&ES, Realty and Real Property Interim Joint Operating Procedures, Checklists: Hazardous Materials Management Checklist.* Refer to this document for further information.

MONITORING AND REPORTING *9.2*

Each project should include a brief measurement report following completion of the project, documenting the following information:

- a summary of the weight and volume of the materials that were actually generated throughout the project;
- a summary of the weight and volume of the materials that were reused, and recycled;
- a summary of the costs and savings related to the waste management initiatives including labour costs, and shipping and disposal costs and savings;
- a comparison of projected diversion percentages from the rates predicted in the waste audit;
- the condition of the reusable and recyclable materials upon shipping and receiving;
- a summary of problems incurred and potential solutions; and
- a list of recommendations for future projects should be developed and submitted to PWGSC in order to continuously improve the approach to these projects, and ensure that valuable information is shared among interested parties.

The activities will be summarized in the GOP Documentation Report which will be prepared for each building.

CRD WASTE MANAGEMENT CASE STUDIES *9.3*

There are a number of excellent examples of building projects which have diverted significant amounts of CRD waste from landfill. Some of these are described briefly below.

NRCAN–GREEN FLOORS PROJECT, OTTAWA, ONTARIO 9.3.1

PROJECT OVERVIEW

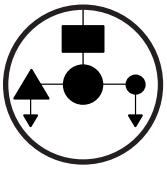
Natural Resources Canada (NRCan) is committed to the promotion of resource conservation and environmentally sustainable technologies. In keeping with their mandate, the Green Floors Initiative was developed for NRCan's headquarters located at 580 Booth Street in Ottawa. The Department of Public Works and Government Services (PWGSC) owns the building. The Green Floors Project was developed to demonstrate improved energy efficiency and to incorporate the best available lowered environmental impact construction products and processes during demolition and construction of a refit during a space optimization project.

PWGSC had scheduled the 7th and 13th floors of this building for base upgrades and space optimization. The Green Floors Initiative was developed in conjunction with the Facility Management Branch, the Efficiency and Alternative Energy Technology Branch and Forestry Canada at NRCan. The project was implemented through PWGSC, Architecture and Engineering Services. While environmental considerations were prioritized, it was also imperative that the Green Floors Refits be cost effective and maintain the construction schedule. The demolition of the 13th floor was accomplished in February and March of 1995 and served as the blueprint for the 7th floor demolition that was scheduled for January of 1996.

ENVIRONMENTAL ACHIEVEMENTS

Listed below are the materials that were removed from the site during the demolition. The issues concerning the successful removal of each material and the diversion destinations are also outlined.

Procedures



- The glass fiber ceiling tiles were carefully removed to facilitate reuse. The level of care that was used in the tile removal resulted in over 90% of the tiles being diverted from the waste stream.
- Power source poles have a high value and are often salvaged from demolition sites. This product is primarily metal. It was important that these poles were removed carefully to prevent any damage that would limit their reuse.
- Demountable partitions were carefully dismantled to maximize reuse.
- Draperies from the building were used to bundle the salvaged insulation materials for delivery to the Ottawa Re-store, a used building materials outlet.

Refurbishable

- Draperies and other window coverings are sometimes salvaged from demolition sites by contractors for personal reuse. The Ottawa Re-Store expressed interest in cleaning the drapes and constructing reusable shopping bags from the material.

Reuse

- The glass fiber ceiling tiles that were salvaged during demolition procedures were sent to a used building materials retail outlet for reuse. These tiles are expensive and are therefore often salvaged by contractors as part of normal demolition procedures. There are facilities that will refurbish the tiles for reuse.
- Mineral fiber ceiling tiles are a different type of product and are traditionally sent to landfills. Salvage and resale of over 90% of this material was considered a success.
- Almost all of the power source poles were salvaged for resale.
- Careful demolition of the demountable partitions allowed for the sheets of vinyl covered drywall to be sent to the Ottawa Re-Store for resale. Almost 100% of the associated vinyl trim was salvaged. Only 10–15% of the vinyl coated drywall was sent to landfill.
- Contractors often salvage tracks and blinds. In this situation, arrangements were made by the contractor to ship the blinds to Bernel Blinds for reuse or resale. All of the blinds, tracks and associated hardware was salvaged.
- Insulation can easily be reused on future construction sites. As the contractor was conducting another renovation in the same building, over 30 m2 of insulation was reused. The remaining insulation was bundled into the salvaged draperies and sent for resale.
- Serviceable areas of the carpet were cut into 3m x 6m sections and sent for resale.
- Over 40 doors per floor were stockpiled from this site and sent for resale. The contractor salvaged all of the associated hardware for later use.

Recyclable

- Over 6 m3 per floor, of wiring, conduit and electrical boxes were stockpiled and delivered for recycling.
- All of the metal mechanical ductwork was sent for recycling.
- The carpet for the second phase (7th Floor) of the project was diverted through a reclamation initiative offered by Dupont Canada.
- Scrap metal has a high financial value and is easily salvaged and recycled. For this reason, contractors often divert metal generated from demolition sites to scrap metal dealers. Metals were diverted for recycling, including reusable steel studs (250 reused on site), metal framing and miscellaneous scrap.

ECONOMIC FACTORS

Of concern to all participants was that the application of green practices would slow down the construction schedule. It was found that the demolition of the 13th floor took 8 person days longer than a standard demolition that was carried out for the 15th floor of the same building, with increased labor costs of $2,000. However, savings that were achieved through reuse and recycling offset all additional costs.

Tipping fees were substantially reduced by the intensive diversion practices. Revenue was generated through the sale of materials that were delivered to Bakermet for recycling. The class "A" estimate for the demolition of the 13th floor was originally $15,600. Following the project, it was determined that the actual costs were less than $8,000. Considering this information, the class "A" estimate for the 7th floor demolition was reduced to $10,000.

The success of this project demonstrated that the application of green demolition procedures can be successfully and economically accomplished when supported through careful planning and facilitation.

THE WESTGATE ANNEX OF THE OAKALLA PRISON COMPLEX, BRITISH COLUMBIA 9.3.2

PROJECT OVERVIEW

The British Columbia Ministry of the Environment predicts that 60% of the landfill sites in BC will close within the next ten years. In order to expand the expected life of the current landfill sites. The Greater Vancouver Regional District set a waste reduction goal of 50% by the year 2000.

The British Columbia Building Corporation (BCBC) decided that it should show corporate leadership in the area of waste reduction. It is recognized that the burial of construction waste consumes large quantities of limited landfill space and wastes natural resources. Therefore, it was decided to dismantle the Westgate Annex of the Oakalla Prison as a green demolition pilot project. The primary goal of the project was to demonstrate that green demolition was economically feasible and that it was possible to divert demolition waste from landfill through reuse options and recycling facilities.

The main cellblock of the Oakalla Prison had been constructed between 1912 and 1915, other additions had been added to the complex over the next 50 odd years. However, by 1991 the facilities had become outdated and were no longer able to accommodate modern programs. Thus, it was decided to demolish the facility and develop the land into residential housing and green space.

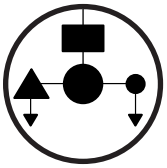
The Westgate Annex of the complex had been constructed between 1963 and 1964. The Annex housed a license plate manufacturing shop, a shoe repair shop, a tailor shop and a warehouse space. The Annex was 24.38m x 45.72m (80ft x150 ft). Exterior walls were constructed of concrete block with columns that had 3m centers. There was a concrete floor, tongue and groove roof decking and laminated fir beam roof joists which had an average measure of 1.82m x 7.31m x 12.19m (6 ft x 24 ft" x 40 ft). The interior walls had been constructed of hemlock and plywood. The windows were covered with 1.27cm (1/2 in) steel bars.

The Westgate Annex was closed in October of 1990. A specialized contractor completed asbestos removal in October of 1991 and the actual demolition commenced November 1 of 1991 and took six weeks to complete.

ENVIRONMENTAL ACHIEVEMENTS

During the demolition, materials were sorted and stockpiled in a designated area on site. As the demolition progressed "garage sales" were held that permitted the general public and other contractors to purchase materials. Other materials were salvaged and sent directly to available recycling facilities. The following is a detailed description of the disposal options used.

Procedures



- The drywall was manually stripped from the interior walls.
- Lumber was manually stripped to allow for capture of as much material as possible.
- Tar and gravel on the roof were manually removed to allow for effective reuse options.

Reusable

- Salvageable pieces of drywall were sent to the on site garage sale.
- Salvageable pieces of lumber were sold for reuse at the on site garage sale.
- Lighting fixtures, electrical panels and plumbing fixtures were salvaged for reuse and sold at the on-site garage sale.
- A landscaping contractor reused the gravel from the roof.
- The roof decking was manually removed, denailed and reused at a number of different locations for storage sheds.
- The beams were carefully lowered by forklift and were sold for reuse.
- Seventy-five percent of the concrete blocks were dismantled into one-meter sections and were donated to a local boy's club for reuse as a storage shed.

Recyclable

- Any unsold drywall was shipped to local recycling facilities.
- Any unsold lumber was recycled at a local facility. A minimal amount of wood was unsalvageable and was shipped to landfill.
- The heat exchanger was salvaged for the copper contained in the core.
- The remaining twenty-five percent of the concrete blocks was crushed and used for aggregate.
- The concrete slabs were crushed and used for aggregate.
- The building's footing contained a large percentage of wire and could not be used as aggregate, however, they were used as a sub-base for a private road.

ECONOMIC FACTORS

Contractors that had been asked to submit bids for this project had initially been asked for a bid for standard demolition along with a separate bid that would utilize reuse and recycling options. The tender request clearly indicated that the only waste that could be sent to landfill was material that did not have a reuse or recycling option. The successful contractor had submitted a quotation where the "green" demolition price was 35% lower than the standard demolition quotes.

The final analysis of the project indicates that the additional time and revenues received from the sale of the demolished materials offset labour costs incurred during the salvage operations. For a demolition of this type to be successful careful planning is required by both the building owner and the contractor.

Both the building owner and the contractor agreed that a demolition of this type can be cost effective and successful providing markets for salvaged waste materials continues to grow. Further economic benefits can be achieved if a new project is planned for the existing site that will utilize the demolished materials in the new project.

DEMOLITION PROJECT OF ARGENTIA, NEWFOUNDLAND 9.3.3

- Demolition of 7 buildings, as part of the 10 year Remedial Action Plan for the former U.S. Naval Facility in Argentia, Newfoundland.
- Materials included 9,472 m3of wood, 1600m3 of pipe, 782 kg copper, 574 tonnes scrap metal and 996 m3 concrete
- 95% diverted from landfill

RENOVATION, CENTRE BLOCK, PARLIAMENTARY PRECINCT, OTTAWA, ONTARIO 9.3.4

- Renovation of the commissioner area (1000m2).
- Total budget for the project is $1.2 million.The budget for the waste audit is $20,000.
- Waste Audit identified 37% of waste could be diverted with little or no effort
- 94% of waste diverted if all diversion options implemented
- Amount of waste diverted would equal 170.2 tonnes

JUSTICE BUILDING RENOVATION AND FIT-UP, PARLIAMENTARY PRECINCT, OTTAWA, ONTARIO 9.3.5

- Demolition of interior space conducted June 1996–Feb. 1997
- The renovation of 30,660 m2 included removal of all asbestos, complete interior demolition, partial mechanical demolition, and fit-up for future occupancy.
- Estimated waste generated is 1770 tonnes
- 89% diverted from landfill (77% reused, 12% recycled, 11% landfilled)
- Potential disposal cost $118,637. Potential savings of $92,150 in tipping fees.

RENOVATION OF THE FEDERAL BUILDING IN WINNIPEG, MANITOBA 9.3.6

- Demolition and renovation of 3rd, 4th, and 5th floors (3,100m2) of the building.
- Total budget of the project is $1.4 million. The waste audit and construction waste management costs are approximately $25,000.
- 96% of the materials diverted (20% reused and 76% recycled; 4% sent to landfill.

OFFICE SOLID WASTE MANAGEMENT

10.0

OFFICE SOLID WASTE MANAGEMENT 10.0

There are many opportunities to reduce the amount of waste disposed from office buildings through comprehensive recycling and composting programs. This approach not only saves resources, but also saves money. Environment Canada estimates that the federal government disposes some 95,000 tonnes of office waste costing $6.5 million for disposal (Auditor General's Report). Even though many Environment Canada buildings have good recycling and composting programs in place, there is always room for improvement. To meet GOBP requirements, buildings will need to demonstrate that they have done as much as possible to divert as much waste as possible. This section will outline the approaches to achieve this objective.

The activities required to achieve the diversion goal are dependent on local services, the support of senior management and the employee's willingness to participate in diversion programs. One area where there is a positive impact is where recycling and waste receptacles are built into counter tops and cabinetry for lunchrooms, coffee stations and cafeterias. Integrating waste management collection bins into new cabinetry helps to reduce floor space requirements. Some examples include:

- Build in recycling bins into counter space for cans, bottles and plastics in a lunchroom;
- Build in a smaller bin into the counter to collected organics such as coffee grounds at a coffee station;
- Include container recycling receptacles in renovated cafeteria.

These examples will improve the aesthetics and possibly convenience of the diversion activities, but they will not be key to meeting diversion objectives.

EXISTING TARGETS 10.1

There have been a number of regulatory drivers focussed on reducing solid waste disposal across Canada in the last 10 years. In 1989, the Canadian Council of Ministers of the Environment (CCME) challenged all government departments to reduce the amount of waste they produced by 50% by the year 2000, using 1988 as the base year.

Environment Canada (EC) has a stated waste diversion goal of 80% in their Sustainable Development Strategy (SDS) that was tabled with the Commissioner of the Environment and Sustainable Development in 1997. This aggressive goal has been developed based on results of implementing the NO WASTE program in many of its office buildings. EC's objective is to maintain or improve upon the standard of 38 kg/person/year of solid waste sent to landfill that was attained in 1997. This standard meets EC's SDS target for achieving an 80% diversion on an employee basis over a base year waste generation number of 190 kg/person/year.

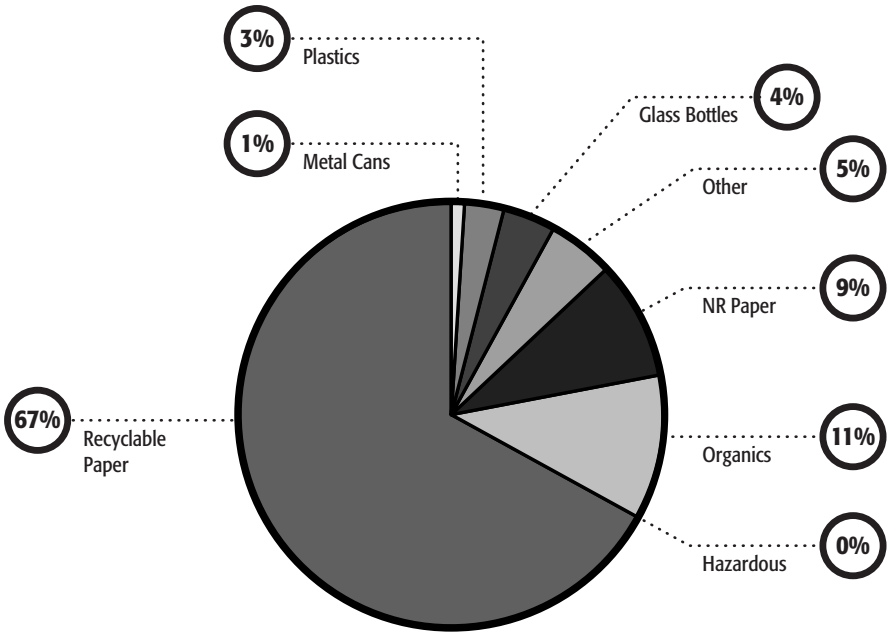
Through Real Property Services (PRS) Branch, PWGSC provides working environments for 160,000 public servants in approximately 2,500 locations. As custodian of $6.8 billion worth of real property holdings and administrator of 2,000 leases RPS has been directly involved in all office building functions and management including establishing and managing recycling programs, conducting waste audits and management of waste related contracts. In their SDS, PWGSC commits to recycling all wastes where practical. However, no specific waste reduction targets are provided.

Local waste management requirements and bylaws vary across the country and need to be taken into consideration when planning waste diversion activities. Some local regulations take the form of landfill disposal bans such as cardboard disposal bans in Vancouver, Halifax and Toronto. Some provinces also have specific requirements. For example, in 1994, the Ontario Ministry of the Environment and Energy passed the 3Rs Regulations which require industrial, commercial and institutional office facilities with areas greater than 10,000 square metres to undertake waste audits and implement waste diversion workplans. When developing the GOBP, the local waste management authority, hauler or recycling contractor should be contacted for any specific local waste management requirements.

TYPICAL OFFICE BUILDING WASTE COMPOSITION *10.2*

PWGSC have conducted annual waste audits at many of their properties in the NCR. The average waste composition (by weight) from the five largest properties (DND HQ, Place du Portage, Phases III) is summarized below:

FIGURE 10.1
FEDERAL OFFICE BUILDING WASTE COMPOSITION



ELEMENTS OF NO WASTE PROGRAM *10.3*

In keeping with its responsibility to provide environmental leadership to the federal government, EC developed a solid waste reduction management plan called the NO WASTE program. The NO WASTE program was pilot tested on six floors at Les Terrasses de la Chaudiere (TLC) and Place Vincent Massey (PVM) in Hull, Quebec in 1994. The diversion impact of NO WASTE is summarized in Table 10.1 below:

TABLE 10.1
IMPACTS OF NO WASTE PROGRAM

	BEFORE NO WASTE (1994)	AFTER NO WASTE (1995)	CURRENT PERFORMANCE (1998)
RECYCLING DIVERSION	51%	72%	82%
WASTE LANDFILLED	49%	28%	18%

The NO WASTE Program is based on the premise that employees need to participate in and take responsibility for managing the waste they generate. The key elements of the program include:

- Collection of recyclable wastepaper at individual workstations;
- Expanding recycling program to include metal cans, glass bottles, rigid plastic containers and polystyrene;
- Removing garbage cans from individual workstations and replacing them with small desk-top containers (Mini-Bins) for the temporary storage of waste material. Garbage removal service for individual workstations is cancelled and employees are required to transport waste to the central waste and recycling stations;
- Establishing new central recycling and waste stations on each floor.

Elements of the NO WASTE program are described in detail below, as this approach is appropriate for some office buildings and achieves very high diversion. PWGSC has a very successful system called the "National 5-Phase Non-Hazardous Solid Waste Management Protocol."

STEP 1: RECYCLABLE PAPER

Office buildings generate large volumes of recyclable wastepaper. In most federal buildings, recyclable paper typically represents 75-80% of all waste generated. As such, paper is and has been the focus of most office building waste diversion programs.

In 1976, the federal government implemented the PaperSave program. The program has distributed more than 104,000 blue baskets in over 200 federal government office buildings for the collection of office waste paper. Over 13,000 tonnes of various grades of wastepaper are collected each year.

The diversion of paper through the PaperSave program typically represents a significant portion of all material recycled from office buildings where the NO WASTE program is in place. The recovered paper includes computer printout, white and coloured ledger, newspaper, magazines, catalogues, telephone directories, boxboard and corrugated cardboard.

STEP 2: EXPAND RECYCLING PROGRAMS BEYOND PAPER

Successful waste diversion programs in office buildings go beyond diverting just wastepaper. Under the NO WASTE program in NCR buildings, the range of materials collected for recycling includes glass bottles, metal cans, rigid plastics and polystyrene. These recyclable items are collected at recycling centres established in convenient, high traffic areas and in food service areas (coffee station, lunchroom, cafeteria).

STEP 3: REMOVE WASTE RECEPTACLES FROM WORKSTATIONS

Under the NO WASTE program, the traditional garbage can at each workstation is removed and replaced with a much smaller desk-top waste container (referred to as a Mini-bin). The smaller waste bin is intended to reflect that the majority of waste generated at an employee's workstation is either recyclable wastepaper (recycled for years through PaperSave program) or recyclable packaging (cans, bottles etc.).

A second key component is that the workstation garbage collection service provided by the contract cleaners is cancelled. The individual employee is given the responsibility of transporting the garbage they generate to a central waste collection station.

STEP 4: ESTABLISH CENTRAL WASTE AND RECYCLING STATIONS

Under the NO WASTE Program, central waste and recycling stations are established on each floor. The stations are placed in convenient, high traffic areas such as by the elevators, near coffee stations, photocopiers, lunchrooms or close to washroom facilities. It is important to ensure that the station does not block emergency routes or impede access to fire safety equipment.

The recycling station is a receptacle that has different compartments to handle the range of material collected. Typical configurations include a receptacle for non-recyclable waste, metal cans, glass bottles, rigid plastics and polystyrene (where feasible). This basic configuration can be expanded or reduced to meet the needs of the floor and can be complemented with external bins (e.g. for garbage).

OFFICE RECYCLING PROGRAM CONSIDERATIONS 10.4

Federal office buildings should meet or exceed all local, provincial or federal waste management regulations.
Local waste management requirements and bylaws vary across the country and need to be taken into consideration when planning waste diversion activities. Some local regulations take the form of landfill disposal bans such as cardboard disposal bans in Vancouver, Halifax and Toronto. The local waste management authority, hauler or recycling contractor should be contacted for specific local source separation, recycling and other requirements.

Provincial regulations vary throughout the country. In Ontario, the 3Rs Regulations require industrial, commercial and institutional office facilities with areas greater than 10,000 square metres to undertake waste audits and implement waste diversion workplans. PWGSC likely strives to achieve the 50% diversion objective set out by CCME in 1989. Environment Canada's SDS commitments to 80% waste diversion exceed local or provincial requirements and are therefore the key requirement to achieve.

The following measures should be implemented in all office buildings where feasible:
- Recycling of paper, metal cans and glass bottles, rigid plastics, polystyrene and wooden pallets, and
- Organic waste diversion.

RECYCLABLE PAPER

With recyclable paper representing 60-70% of the total waste generated in a typical office building, an effective paper recycling program should be in place in all office buildings. While many federal office buildings have implemented paper recycling programs, a benefit of the NO WASTE program has been to increase the recovery of recyclable paper from 70-80% up to 90%+. This improved recovery not only reduces landfill disposal costs, but also improves the potential for revenues from the sale of the recovered paper.

METAL CANS AND GLASS BOTTLES

Glass and metal food and beverage containers together typically represent between 5-7% of waste generated within office buildings. These containers are generated at individual workstations and in lunchrooms, cafeterias and outdoor lunch areas.

A central recycling station should be placed at convenient locations on each floor for the collection of glass and metal containers. Recycling stations can be placed by elevators, coffee stations, lunchrooms or any other high traffic area.

RIGID PLASTICS

PET and HDPE are the most common rigid plastics recycled in Canada and are collected by many commercial recycling operators. However in some regions of the country, commercial recycling companies may not be able to accept this wide range of mixed plastics. The ability to collect and recycle polypropylene containers is limited to selected communities in Canada including the NCR. The viability of this measure needs to be established on a location by location basis.

The rigid plastics that have been collected in some office recycling programs include:
- PET (beverage containers)
- HDPE (beverage containers, cleaning products)
- Polypropylene (dairy food containers)

Collectively, these plastic containers represent approximately 1% by weight (much more when considering volume) of waste generated with an office building. Volume is an important consideration when compactors are not used separate compartment of the recycling station.

POLYSTYRENE RECYCLING

Polystyrene (PS) food service packaging such as foam coffee cups, lids, plates, 'clamshell' trays represent between 1-3% by weight of office waste generation. The program could also accept expanded polystyrene (EPS) foam packaging that is used to protect products (e.g. computers, monitors etc.) during shipping.

PS needs to be kept separate from other plastics or containers due to market requirements. In the NO WASTE Programs in the NCR, PS is collected in a

PS recycling is not readily available across Canada, and is currently limited to southern Ontario. It is necessary to check with local commercial recyclers about availability of PS recycling and requirements in your area. The Canadian Polystyrene Recycling Association (CPRA) is a source of information on PS program development and material collection. They can be contacted at (905) 612-8290.

PLASTIC FILM

Plastic film represents 1-2% of total waste generated in office buildings. Plastic film including pallet wrap and clean carryout bags (e.g. lunch bags, retail bags) is recyclable in a few communities across Canada. If collected by commercial recyclers, plastic film will either be collected separately or possibly combined with mixed rigid plastics. Ensuring that the plastic film is dry and free from food contamination is very important.

ORGANIC WASTE DIVERSION

Organic waste generated within office buildings includes food waste and compostable paper waste.

Compostable food waste represents approximately 11% of waste generation within an office building. Food waste is generated in three general areas. First is at the individual workstations where employees consume snacks and lunches at their desks. Typically, the quantity generated is small, consisting of apple cores, peelings, tea bags, and leftover or uneaten food. The second area of generation is in common eating areas on each floor such lunchrooms and coffee stations. Again lunches, snacks and coffee grounds typically are generated in larger, more concentrated quantities. The third area of food waste generation is in food preparation areas such as building cafeterias and food court that may or may not be within a building.

Paper towels generated in washroom facilities are also compostable. Paper towels comprise approximately 7-8% by weight of waste generated within office buildings. Paper towels are removed from the washrooms by cleaning staff. However, the paper towels need to be emptied from the plastic bags, and contamination such as metal cans or plastics needs to be removed. These additional handling tasks need to be factored in when considering this option. Also note that paper towels, like plastics, take up a lot of volume but do not have much weight. This also needs to be considered when determining storage requirements and costs.

Off-site organic waste management options are very dependent upon regional opportunities available. While composting is expanding across the country, not all facilities are permitted to handle food waste. Organic wastes are also being managed through aerobic and anaerobic digesters or in some cases, are used in animal feed operations (food waste used as animal feed). Each operation will have its own specifications about what is and is not acceptable. A thorough review of requirements and contamination issues of local organic diversion options needs to take place in reviewing the technical and cost feasibility of this option. It is important to note that a high percentage of food waste from office buildings is coffee grounds that are not suitable for animal feed operations.

On-site composting is also an option. Small commercial composting units are available from a number of suppliers and are being used in various offices and institutions around Canada. The benefits of on-site composting are the elimination of off-site collection costs and tipping fees. There are additional "internal" costs for collection, bulking, operating and maintenance (cleaning, etc.). On-site composting units also require accessible space, electrical hook-ups and possible ventilation changes.

Information on composting opportunities across the country can be obtained from the Composting Council of Canada.

PHONE: (416) 535-0240
INTERNET: www.compost.org

WOOD PALLETS

Wooden shipping pallets are used for deliveries of large volume goods and materials and often discarded in the shipping and receiving areas. Over time, the accumulated pallets can become obstacles in vehicle traffic and a fire hazard.

Pallets are either recyclable or reusable and should not be landfilled. In the NCR, PWGSC (Roston Gordon at RPS–phone: (819) 956-0623) can arrange for a collection service. In other parts of the country, contact the local recycling authority to identify diversion options.

ECONOMIC AND ENVIRONMENTAL ANALYSIS OF DIVERSION OPTIONS 10.5

The Life Cycle Costing (LCC) approach used for waste management is designed to address the less capital intensive, but more operational nature of waste diversion and disposal activities. There is a limited range of options available to meet high diversion targets. The economic analysis is therefore simplified to encompass a straight cost comparison between diverting waste or disposing of it, on a cost per tonne basis.

This section includes two tables that will guide the comparative analysis, and two checklists that will assist in covering the key items and points to remember.

To carry out the economic analysis of waste diversion options, the proponent should work through the simple cost calculations presented in Tables 10.2 and 10.3. Information required should be readily available from files, contractors, suppliers and waste audit reports. As long as the cost per tonne from Table 10.3 does not exceed the cost from Table 10.2, then the cost effectiveness goal will have been met.

The per tonne costs for recycling materials such as glass and metal containers, rigid plastics or polystyrene on an individual material basis will always be higher than disposal costs due to their inherent low weight to volume ratio. Also, paper will be the only significant material recycled from office buildings that has the potential to generate revenues. Typically, office paper recycling services are either revenue generating or revenue neutral, depending on market conditions for mixed office paper and volumes generated. Therefore it is important to consider recycling program costs as a "basket of goods" when assessing costs and benefits.

Capital costs for the recycling programs include desk-side wastepaper collections bins for the central waste and recycling centres, desk-top bins plus other handling and storage equipment (e.g. carts).

Multi-material recycling programs costs are dependent on the cost to collect and process (separate) and market the recyclable materials. Costs are typically priced as a fee for collecting one or a number of collection bins. The recycling contractor provides storage and collection bins and carts either as part of the service or on a rental basis. These arrangements and costs must be identified as part of the cost analysis as they vary significantly across the country and also from one building and contractor to another.

Waste disposal contracts are sometimes negotiated on a regional basis. Some offices have greater autonomy in contracting for waste collection. Waste disposal charges typically include a collection or service fee, plus a tipping fee for the disposal of the garbage on a per tonne or cubic yard basis. Waste haulers should also provide you with information about the final disposal location, including name, location and number for the facility, plus the current tipping fee structure.

To assist in working through the steps required for waste diversion and waste management planning, check lists are included as Tables 10.4 and 10.5.

In leased facilities where waste management may be the responsibility of the building owner/operator, recycling options available to tenants my be limited by a number of factors, including limited available material storage room, existing contracts in place etc. These issues can be discussed with the building owner/operatior, and practical options can be implemented over time.

TABLE 10.2
WASTE DISPOSAL COST CALCULATOR

ANNUAL WASTE DISPOSAL COST ITEMS	DESCRIPTION OF COST ITEM	$ PER YEAR
WASTE COLLECTION COSTS (cost/collection; collections/month or year)		
WASTE DISPOSAL TIPPING COSTS/CHARGES		
EQUIPMENT COSTS–LEASE, RENTAL, AMORTIZED CAPITAL (list costs for each equipment item)		
MAINTENANCE AND REPAIR COSTS (scheduled and unscheduled)		
COMMUNICATION & EDUCATION COSTS		
LABOUR AND ADMINISTRATION COST (describe allocation of labour costs)		
	A TOTAL ANNUAL COSTS	
	B TOTAL TONNES OF WASTE DISPOSED IN A YEAR	
	C COST/TONNE (A DIVIDED BY B)	

TABLE 10.3
WASTE DIVERSION COST CALCULATOR

ANNUAL WASTE COST ITEMS	DESCRIPTION OF COST ITEM	$ PER YEAR
RECYCLING COLLECTION COSTS (all materials; cost/collection; collections/month or year)		
ORGANIC COLLECTION COSTS (cost/bin or collection; collections/month or year)		
EQUIPMENT COSTS–LEASE, RENTAL, AMORTIZED CAPITAL (list costs for each equipment item; bag costs)		
MAINTENANCE AND REPAIR COSTS (scheduled and unscheduled)		
COMMUNICATION & EDUCATION COSTS		
LABOUR AND ADMINISTRATION COST (describe allocation of labour costs)		
	A Total Gross Costs	
	B Revenue from sale of recyclables	
	C *Net recycling costs (A–B)	
	D Total tonnes recycled + composted/year	
	E Cost/tonne (C divided by D)	

** Note that reduced tipping fees at landfill are reflected in Table 10.2*

TABLE10.4
OFFICE WASTE DIVERSION CHECKLIST

PAPER

- ☐ each desk has a small desktop bin for recycling paper
- ☐ Paper recycling bins are located close to central photocopiers, printers and mail centres
- ☐ Sufficient and appropriate signage is in place
- ☐ New employees are made aware of recycling programs

MULTI-MATERIALS

- ☐ Central recycling bins have the appropriate number of compartments to meet separation requirements of recycling company
- ☐ Central recycling bins for glass, metal, plastics and polystyrene are conveniently placed on each floor and properly signed
- ☐ Sufficient and properly signed bins are placed in areas throughout the building where recyclable containers are generated such as lunchrooms, cafeterias, catering areas and outdoor lunch areas
- ☐ Bins are checked frequently by cleaning staff to ensure they do not overflow
- ☐ Bins are wiped down periodically
- ☐ New employees are made aware of recycling programs
- ☐ Employees are instructed to remove excess food and liquids from packaging before placement in recycling bins

ORGANIC COLLECTION (IF APPLICABLE)

- ☐ Be clear what is and what is not acceptable by the organic processor
- ☐ Ensure that there is full property management and staff support for handling organics (especially on floors)
- ☐ Educate employees the importance of eliminating contamination
- ☐ Organics needs to be removed from floor bins and cafeterias daily to reduce odours and pests (flies)
- ☐ Organic collection should be at least every second or third day, unless there is cold storage in the building
- ☐ Address only health and safety concerns

WASTE AND RECYCLING COLLECTION SERVICES

- ☐ Waste collection bins meet the needs of the building
- ☐ Waste should be compacted where possible
- ☐ Collection frequency for recycling and garbage should not exceed building requirements
- ☐ Review waste collection storage and collection frequencies quarterly
- ☐ Insure that waste hauler can provide you with name, phone number and tipping rate structure for disposal facilities used. Disposal facility should be within the region and needs to be a licensed operation
- ☐ Contract should allow flexibility in service frequency
- ☐ Waste and recycling contracts should have weight collected included on invoices or by separate monthly reporting
- ☐ Provide feedback to employees about their waste diversion performance
- ☐ Amend cleaning contract as required to meet recycling needs

TABLE 10.5
CHECKLIST FOR WASTE DISPOSAL PLANNING

- ☐ waste collection bins meet the needs of the building
- ☐ waste should be compacted where possible
- ☐ waste collection frequency should not exceed building requirements
- ☐ review waste collection storage and collection frequencies quarterly
- ☐ ensure that the waste hauler can provide you with name, phone number and tipping rate structure for disposal facilities. Disposal facility should be within the region and needs to be a licensed operation
- ☐ contract should allow flexibility in service frequency

MONITORING AND PROGRAM IMPROVEMENT 10.6

On-going monitoring of waste diversion performance is required to ensure that the program stays on track, take mitigative action where required or simply identify areas where improvement can be achieved. Waste disposal records should be assembled on a monthly basis (waste hauler invoices, reports) as should waste diversion tonnages from the PaperSave program and other multi-material recycling activities. From these records, a running monthly summary of materials diverted and recycled can be kept up to date.

The EC Departmental Solid Waste Management Working Group has adopted the following criteria for assessing building performance and to identify those buildings where further monitoring and evaluation are required:

- For any facility where the per capita waste production is greater than 60 kg/person/year, a waste reduction action plan is developed which documents the reduction and recycling activities;
- For any facility where the per capita waste production is greater than 80 kg/person/year, a waste reduction action plan is developed which documents the reduction and recycling activities. In addition, a follow-up waste audit is conducted upon the implementation of recommendations within the action plan.

Programs can always be improved through ongoing communication and education to staff. Keeping employees informed, providing reminders and addressing problems (e.g. contamination) quickly and directly have proven an effective enhancement to program performance. In addition, it is important to report successes to act as encouragement to continued participation in the program.

Modifications or changes to any diversion program (e.g. adding rigid plastics to recycling program) should be communicated to staff through notices, emails and face-to-face contact.

ADDITIONAL WASTE REDUCTION OPPORTUNITIES 10.7

There are many cost-effective methods of reducing office waste generation. These include:
- Evaluating potential purchases with Treasury Board Material Management Environmental Guidelines;
- Use products from Environmental Choice Program where feasible;
- Reduce paper use through electronic distribution of files, reports, documents;
- Arrange for toner cartridges to be collected and returned to suppliers to be refilled;
- Make note pads from printed paper;
- Printing draft reports/letters on backside of printed paper;
- Double sided photocopying of reports;
- Investigate use of double sided printers.

Green procurement policies and guidelines are available from Environment Canada's Administration Directorate.

HAZARDOUS WASTES GENERATED IN OFFICE BUILDINGS *10.8*

Very small quantities of potentially hazardous wastes are generated within office buildings on a periodic basis primarily for building maintenance operations. These include used fluorescent lamps, batteries, used paints and solvents.

Fluorescent lamps generated in office buildings includes small quantities resulting from daily maintenance or in large volumes during one-time lamp upgrades. The lamps are comprised of a glass tube, metal ends, plus small amounts of mercury. Recent technological developments in some regions of the country now allow building maintenance staff to store used lamps for collection and recycling. In the NCR, fluorescent lamps are collected and stored by building maintenance staff in the original shipping boxes. Once sufficient quantities have been stored, PWGSC is contacted and they collect the boxed lamps as part of their hazardous waste management service. The lamps are then accumulated and eventually shipped to lamp recyclers. In NCR, call Environmental Services at (xxx) 956-1541 (Brian Stevenson)

Other potentially hazardous wastes can also be collected and managed by PWGSC including batteries, paints and solvents.

In parts of the country where a systematic approach to management of hazardous wastes centrally is not in place, each building must develop their own system to address hazardous wastes. These are small quantities for office buildings, and should be stored, or combined with hazardous wastes from other buildings, and given to a licenced company to manage and dispose.

CASE STUDIES OF OFFICE WASTE RECYCLING *10.9*

MAXIMUM GREEN PROGRAM–THE GREEN WORKPLACE, MANAGEMENT BOARD SECRETARIAT

DESCRIPTION: Maximum Green pilot programs were tested in three Ontario Government buildings in Toronto in 1992 and 1993. The three buildings included the Ministry of Environment, the Management Board Secretariat and the Attorney General. The objective of the pilot program was to divert 50% of the waste that was going to landfill.

FEATURES: The program included the replacement of the traditional garbage bin with a small desk-top mini bin and the expansion of materials collected at central recycling stations. Food waste was collected for composting at the new Ontario Science Centre facility.

The program included a comprehensive communications program including a co-ordinating committee, building coordinator, volunteer floor representatives, staff meeting, and regular feedback, including baseline and follow-up waste audits.

RESULTS: Each one of the three buildings achieved the objective. The Ministry of Environment building diverted 66% of waste that was going to landfill for an overall diversion rate of 88%. The Management Board building diverted 60% of waste that was going to landfill and achieved an 85% overall waste diversion. The employees at the Attorney General building reduced waste by 55% and achieved an overall diversion rate of 75%.

As of March 2000, the comprehensive program is in place in most of the provincial buildings in downtown Toronto and diverts over 70% of all office waste from disposal.

PRODUCTS DIRECTORY

appendix A

APPENDIX A

Air and Vapour Barriers *A.1*

NMS Sections 07160, 07271 & 07272

- ➔ **Vapour barriers save heating energy, keep pollutants out of work areas and prevent build up of damaging moisture.**
- ➔ **Plastic vapour barriers contain stabilizers that emit VOC emissions. Adhesives and sealants associated with the installation processes can also effect indoor air quality.**
- ➔ **Aluminum foil vapour barriers do not off-gas and adhesive-backed foil tape can be used for installation instead of sealants.**

Airtightness is an essential quality of energy efficient buildings. Vapour barriers are required to prevent the condensation of water in walls and ceilings, since moisture reduces thermal values and can damage and discolour building materials. In addition, moisture can contribute to the growth of microbial matter that can adversely affect indoor air quality. Common types of air and vapour barriers are polyethylene sheeting, foil and untreated Kraft paper.

POLYETHYLENE AIR/VAPOUR BARRIERS

Sheets of polyethylene are installed just inside the interior surface of exterior walls and ceiling. When properly installed and sealed, they can do an excellent job. However, some 6-mm films can degrade in a relatively short time, defeating the purpose of the barrier and leading to potential IAQ problems. More stable types of polyethylene are available for this purpose, however the stabilizers used may affect IAQ. The sealants used to eliminate leaks between sheets may also contribute to IAQ problems.

RENEWABLE RESOURCES: Vapour barriers are manufactured from non-renewable resources.

RECYCLED CONTENT: Some products are currently being manufactured with recycled content.

ENERGY SAVINGS: Airtightness is an essential part of energy-efficient buildings.

IAQ: Tight air and vapour barriers are essential for good IAQ. They prevent emissions from walls and ceiling materials from reaching the living area and mould from growing. Foil barriers may be better than polyethylene, since polyethylene may off-gas and degrade.

RECYCLABLE PRODUCTS: Polyethylene can be recycled at some recycling facilities.

ALUMINUM FOIL AIR/VAPOUR BARRIERS

Aluminum foil, usually on a paper backing, is installed just inside the interior surface of exterior walls and ceilings. The foil saves heating energy by eliminating airflow, prevents moisture from damaging the wall/ceiling and keeps pollutants from construction materials from entering the living area. It also adds to the insulation value. Foil is more difficult to join and seal than polyethylene. Adhesive-backed foil tape should be used rather than sealants.

RENEWABLE RESOURCES: Aluminum is a non-renewable resource.

RECYCLED CONTENT: Almost all aluminum products contain some recycled aluminum.

ENERGY SAVINGS: Airtightness is an essential part of energy-efficient buildings.

INDOOR AIR QUALITY: Tight air and vapour barriers are essential for good IAQ. They prevent emissions from walls and ceiling materials from reaching the living area and mould from growing. Foil barriers may be better than polyethylene, since polyethylene may off-gas and degrade.

RECYCLABLE PRODUCTS: Almost all aluminum products can be recycled

AIRTIGHT DRYWALL APPROACH (ADA)

An alternative to air/vapour barriers is the airtight drywall approach (ADA) in which the gypsum board of the interior walls is sealed so tightly that it acts as the barrier. Special hardware is available, such as rubber foam gaskets to seal joints between gypsum boards and electrical boxes with foam-backed edges to prevent air leaks. This hardware does not present IAQ problems. Some sealants are required and compromises may be necessary regarding air tightness and IAQ in the selection of sealants.

RENEWABLE RESOURCES: Natural gypsum is a non-renewable resource. However some manufactures are now creating wallboard using synthetic gypsum which is a by-product of flue gas desulpherization.

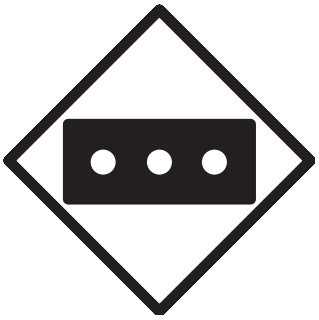
RECYCLED CONTENT: Wallboard manufactured with synthetic gypsum can be considered to contain recycled content. Also, unpainted gypsum can be recycled and some manufactures are utilizing this option.

ENERGY SAVINGS: Airtightness is an essential pant of energy-efficient buildings.

INDOOR AIR QUALITY: Tight air and vapour barriers are essential for good IAQ. They prevent emissions from walls and ceiling materials from reaching the living area and mould from growing. Foil barriers may be better than polyethylene, since polyethylene may off-gas and degrade.

RECYCLABLE PRODUCTS: Although this service may not be available in all regions recycling facilities do exist for unpainted drywall.

Brick A.2



NMS Sections 04051 to 04924

➔ **Bricks are very energy-intensive to produce.**

➔ **Bricks and plain mortar do not negatively impact on indoor air quality, but mortar additives, brick veneer and plastic bricks can off-gas considerably.**

➔ **Bricks are easily recycled when separated at source.**

The raw materials for brick are relatively abundant and occur in many areas. Their extraction and processing are energy-intensive, however in instances where all thermal-barrier, storage, structural and finish properties can be realized in one application, brick masonry is relatively resource effective.

New masonry products are being manufactured using an astonishing array of recycled materials. For example, paving, fire and drain tile brick that uses fly ash reclaimed from the pollution control scrubbers of municipal solid waste incinerators is available. Recycled brick is frequently preferred for its architectural qualities and visual appeal. New masonry units made of expanded polystyrene beads in a concrete mixture allow for greater design flexibility and a higher load bearing capacity than traditional masonry bricks. Technological advances in this area have also produced masonry units with enhanced thermal performance that are, in some instances, lighter in weight.

The environmental effects of chemicals used to treat mortar should be understood and considered. For example, muriatic acid is traditionally used to clean brick, while calcium chloride is applied to prevent freezing. Both materials are considered toxic and can have negative impacts upon ecosystems.

Reducing the amount of discarded brick masonry on the construction site begins with improved takeoffs and ordering procedures. Unused brick can be stored properly, and used for another job.

BRICK WITH PLAIN MORTAR JOINTS

Brick walls joined with plain mortar have excellent IAQ characteristics, need little or no maintenance and are extremely durable. Brick veneers and plastic bricks can cause IAQ problems.

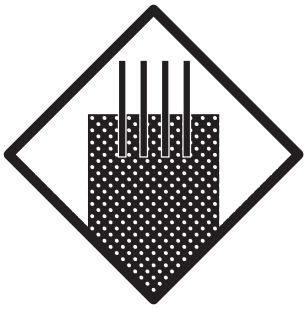
RENEWABLE RESOURCES: Although the resources used for the manufacture of bricks are finite, they are readily available and abundant.

RECYCLED CONTENT: New products are available that are manufactured with recycled content such as those made of expanded polystyrene beads in a concrete mixture. These products are often lighter in weight, but provide the same degree of performance and visual appearance.

INDOOR AIR QUALITY: Bricks and plain mortar have excellent IAQ characteristics. Avoid mortar additives, brick veneers and plastic bricks, all of which can cause IAQ problems.

REUSABLE PRODUCTS: Bricks can be and often are salvaged, cleaned and reused.

Concrete A.3



NMS Division 3

➔ **Concrete production and transportation is very energy-intensive.**

➔ **The use of reusable forms avoid large amounts of concrete related waste.**

➔ **Curing agents and additives may off-gas and some aggregates may emit radioactive radon gas**

Concrete produced using recycled aggregates, or at a kiln that burns toxic waste for fuel, can be contaminated, as can the dust concrete gives off naturally over its life span.

Concrete is a mixture of stone, sand and cement. It is a unique and very desirable product for structural use because of its high and calculable strength, mouldability and transportability. Substitutes for concrete do exist in cladding and finishing, but not for structural applications.

Although the raw materials for concrete are generally abundant throughout the world, converting these materials into a usable product requires a large amount of energy. The mining and production of cement and aggregate is particularly energy-intensive. Aggregate is mined from gravel pits or blasted from quarries, after which it is sorted, cleaned and sized by machine, using large crushing rollers and sifters. The blended materials are then fired in a kiln at temperatures around 27000F. An energy premium must also be assigned to the transportation of very heavy bulk and precast material, even if it is usually shipped by more energy efficient modes such as barge or rail. The use of locally mined or produced materials assures the lowest embodied energy cost.

The greatest consumption of resources is usually associated with the making of forms. Often good quality timber is used to make forms that are subsequently discarded. Form assemblies that can be dismantled and repositioned quickly and easily are another way to reduce embodied energy values. Recently, reusable fibreglass and steel panels have been developed that can be used with steel scaffolding and lightweight aluminum purlins. Exposed-t-view applications make extensive use of plywood, which is generally discarded after only a few uses. In its place, specially coated plywood or styrofoam systems are available that can be used up to 100 times.

The cement industry has made some efforts to reduce environmental effects by replacing raw materials with industrial by-products such as aluminum ore refuse, rice-hull ash, blast furnace slag, steel mill scale, furnace flue dust and fly ash. The use of the by-products increases the strength of concrete and improves its impermeability, while reducing the amount of cement required. In place of concrete blocks, lightweight and mortarless blocks are available in which some of the aggregate has been replaced with foam pellets, wood chips, or slag (cinder block). Some of these alternatives also offer improved insulation value. They can be used as replacements for traditional concrete blocks or they can be dry stacked and reinforced with a mortar and scrim coating. The industry also uses scrap tires, used motor fuels and other special solvents as fuel for the kilns. Care should be taken to ensure the use of these alternatives does not compromise product performance.

Since some cement kilns use toxic waste as a fuel, some potential for cross contamination exists. Recycled aggregates may contain contaminants and some aggregates are associated with toxic substances such as radon. Other concerns are concrete curing agents and additives as they can off gas and negatively impact on IAQ. In their place, a low solvent, non-toxic or high-solids alternative is preferred. In addition, concrete can generate dust naturally over its life span, creating a significant irritant. Dust control can be achieved by painting the concrete with cementitious or low toxic paint. (See Paints and Coatings.)

Since concrete is the heaviest component of C&D waste and since burying it in the ground is sometimes discouraged or prohibited, careful consideration must be given to reduction and reuse. However, the concrete can be crushed and used as aggregate. On large demolition jobs, an on-site mobile crusher may be economically justifiable. Although recycled concrete is of relatively low quality, it can be used as roadbed fill or as aggregate in asphalt paving. It is also possible to re-sell concrete residue from forming for use in retaining walls.

Avoiding extensive use of concrete as a finishing material minimizes the need for forming lumber. When plywood forming is essential, planning flat surfaces in sizes to match plywood dimensions reduces waste. Using repetitive shapes allows formwork to be reused. Consulting with a forming contractor during the design stage permits the development of an efficient approach to forming needs. Another point to remember is that careful attention to the use of specified mixture formulation can eliminate the unnecessary rejection of mixed concrete. Finally, by ensuring that unused concrete blocks are picked up promptly on the job site, waste can be reduced even further. If not picked up, blocks have a tendency to sink into the mud on the work site. When properly stored, unused blocks can be used for another job.

CONCRETE SLAB SUBFLOORS

These consist of a layer of reinforced concrete a few centimeters thick upon which cement, tile, wood or carpet floor covering can be applied. Untreated concrete does not off-gas after curing, but additives such as formaldehyde, petroleum oils and detergents may off gas.

RENEWABLE RESOURCES: Most of the traditional materials used in the manufacture of cement are abundant.

RECYCLED CONTENT: Although there are often regional limitations, concrete products are available that are manufactured using aluminum ore refuse, rice-hull ash, blast furnace slag, steel mill scale, furnace flue dust and fly ash. When properly formulated performance is not compromised.

INDOOR AIR QUALITY: Untreated concrete has excellent IAQ characteristics.

REUSABLE PRODUCTS: Crushed concrete can be used as aggregate materials.

Floor Coverings *A.4*

NMS Sections 09310, 09330, 09410, 09420, 09440, 09641, 09642, 09643, 09651, 09652, 09680

- ➔ **For each option, factor in the impact of maintenance, disposal and replacement over the life of the structure.**
- ➔ **Carpets often off-gas, are a sink for pollutants from other sources, collect dust and provide a medium for moulds.**
- ➔ **Floor coverings made of natural materials, hardwood flooring, stone, woven wool or woven plant fibre carpets tend to off-gas the least.**
- ➔ **Adhesives, dyes, sealers and backing preservatives are a major source of indoor pollutants.**
- ➔ **Linoleum consists entirely of renewable resources and does not emit serious pollutants. Vinyl is made of non-renewable petroleum, is not biodegradable and gives off the greatest amount of emissions of all common floor coverings.**

Floor coverings range from stone and ceramic to wood and cork and from vinyl and linoleum to carpets. Each has its own aesthetic and practical features as well as environmental considerations.

Vinyl flooring is currently one of the most popular types. An alternative to vinyl that is regaining popularity is linoleum. Linoleum is made from natural, renewable products, is even more durable than vinyl, is theoretically biodegradable and has good IAQ characteristics.

Carpets are used in almost all office buildings and come in a wide variety, each with its own characteristics and properties. Generally, carpet manufacture requires large amounts of water about 68 litres of water per square metre of carpet and batch dyed saxony carpets may require three or four times as much. Carpet dyes are not removed by wastewater treatment, thus posing a pollution problem.

Floors must be maintained periodically through cleaning, waxing or refinishing. The chemicals and finishes used in maintenance can decrease IAQ and their disposal can cause environmental problems. When deciding on a new floor, consider not only the flooring material itself and its undercushion and adhesives, but also its maintenance. Look for the best environmental choice for each type.

CEMENT FINISHES

This category consists of a topping layer of cement applied to a concrete slab floor. The finishing layer includes colorant and finish additives and is trowelled smooth. The surface can be maintained with a paste wax.

RENEWABLE RESOURCES: The raw materials used in the manufacture of cement are available in an abundant supply.

RECYCLED CONTENT: Although there are often regional limitations, concrete products are available that are manufactured using aluminum ore refuse, rice-hull ash, blast furnace slag, steel mill scale, furnace flue dust and fly ash. When properly formulated performance is not compromised.

TOXICITY: Some additives and sealants used in the finishing of concrete and may be toxic. Care should be taken when selecting and disposing of these products.

INDOOR AIR QUALITY: Concrete does not have strong negative impacts on IAQ, however some finishing materials may have high VOC emissions. Low emission products are available and whenever possible these materials should be specified.

REFURBISHABLE PRODUCT: The aesthetic qualities of concrete finishes can be restored as required.

CERAMIC TILE

Ceramics are glazed or unglazed fired clays. Ceramic tile set in cement may be the most acceptable floor, wall and fixture covering in terms of IAQ. Ceramics fastened with adhesives will have some effect on IAQ and are not as durable. Unglazed tiles will need periodic resealing.

RENEWABLE RESOURCES: The raw materials used in the manufacture of ceramic tiles are available in abundant supply.

RECYCLED CONTENT: Ceramic tiles are now being manufactured that contain glass reclaimed from the waste stream. Some materials used are discarded automobile windshields and fluorescent light tubes.

TOXICITY: Some adhesives used in the setting of ceramic tiles may be considered toxic. Care should be taken when selecting and disposing of these materials. Sealers used on unglazed product may also have high toxicity levels.

INDOOR AIR QUALITY: When set in cement (thin-set) without additives, ceramic tiles have the best IAQ characteristics of all surfaces.

RECYCLABLE PRODUCT: Used ceramic tiles can be crushed and used as aggregate.

HARDWOOD PLANK

This product group consists of solid dimensional stock of hardwoods or softwoods in various sixes. Softwoods are rarely used for flooring now, however,some older buildings may contain this product. The most common North American trees harvested for this purpose include red and white oak, maple and sometimes birch or ash. Imported products include beech, eucalyptus and bamboo.

RENEWABLE RESOURCES: The forestry industry is moving towards the implementation of sustainable forestry practices. At present the replenishing of harvested wood is controlled through the issuing of cutting permits, so most wood harvested in North America can be considered a renewable resource. North American beech is a very depleted hardwood species and should be avoided. Some wood species are contained on the Convention on International Trade in Endangered Species (CITIES) and these products should be avoided.

RECYCLED CONTENT: Composite wood products are available that simulate the appearance of natural wood. Many of these products are manufactured with recycled content.

TOXICITY: Some solvent based finishes used in the finishing of wood products may be toxic or hazardous materials, however, alternative options are available and these options should be selected or specified.

INDOOR AIR QUALITY: Most wood products do not adversely effect indoor air quality. However, some unfinished softwoods such as pine and cedar may emit odours. Some sealers and finishing materials may be high VOC emission products and care should be taken to select low emission products.

REUSABLE PRODUCT: Many types of wood flooring can be lifted and reused. There are suppliers of salvaged wood from demolished building.

REFURBISHABLE PRODUCT: Most types of wood flooring can be sanded and refurbished to restore aesthetic values.

RECYCLABLE PRODUCT: Wood products can be diverted from landfill through numerous options. The materials can be mulched, used as biomass fuels and chipped for use in the manufacture of particleboard and other composite wood products.

DEGRADABLE PRODUCT: Wood is a degradable under appropriate conditions.

STONE

This type of floor covering consists of numerous types of cut stone used as a finish for floors and walls. The finish is available in a variety of types including sandstone, slate, marble, limestone and granite. Most stones require periodic application of a sealer. Some stones are exported internationally at very high-energy costs, while others are quarried and used locally. As long as stone does not emit radon it has excellent IAQ characteristics, providing the setting materials and sealers used are low emitting products.

RENEWABLE RESOURCES: Quarrying stone can have adverse effects on land and water, if quarries are not restored. There are some types of stone that have been quarried to depletion.

RECYCLED CONTENT: Some products have been developed that simulate natural stone and some of these materials may contain recycled content.

TOXICITY: Some sealers and setting materials that are used with stone flooring may be considered toxic or hazardous materials. Care should be used when selecting, specifying or disposing of these products.

INDOOR AIR QUALITY: Some natural stone materials may emit radon gas. This is a naturally occurring radiation that has been associated with lung cancer. Suppliers should be queried to ensure that radon gas is not a concern in the area where the product has been quarried.

Some setting materials and sealers may emit high levels of VOCs, however, there are numerous low emission products available.

REUSABLE PRODUCT: Used stone can be crushed and used as aggregate material.

WOOD PARQUET, WIRE BOUND

Wire-bound wood parquet consists of small, thin pieces of hardwood joined by staples or wire. It is attached to the subfloor by an adhesive and finished in the same manner as hardwood planking.

RENEWABLE RESOURCES: The forestry industry is moving towards the implementation of sustainable forestry practices. At present the replenishing of harvested wood is controlled through the issuing of cutting permits, so most wood harvested in North America can be considered a renewable resource. North American beech is a very depleted hardwood species and should be avoided. Some wood species are contained on the Convention on International Trade in Endangered Species (CITIES) and these products should be avoided. This product uses less wood and lower quality material than hardwood planking.

TOXICITY: Some solvent based finishes used in the finishing of wood products may be toxic or hazardous materials, however alternative options are available and these options should be selected or specified.

INDOOR AIR QUALITY: Most wood products do not adversely effect indoor air quality. However, some unfinished softwoods such as pine and cedar may emit odours. Some sealers and finishing materials may be high VOC emission products and care should be taken to select low emission products.

REFURBISHABLE PRODUCT: Parquet flooring can be sanded and refurbished to restore aesthetic values, however this product type can only be refinished one or twice due to the thickness of the product.

RECYCLABLE PRODUCT: Wood products can be diverted from landfill through numerous options. The materials can be mulched, used as biomass fuels and chipped for use in the manufacture of particleboard and other composite wood products.

DEGRADABLE PRODUCT: Wood is a degradable under appropriate conditions.

LINOLEUM

Linoleum is resilient sheet and tile flooring made from natural, renewable products. The ingredients of linoleum are linseed oil, resin, wood flour, cork powder, pigments and natural mildew inhibitors. The backing is made of jute, canvas or felt. Lead monoxide or red lead, both poisons, may be used as driers, but most manufacturing processes have eliminated this component. Linoleum is now produced in a wide variety of patterns and colours. It can be cleaned with natural soaps and water.

RENEWABLE RESOURCES: Linoleum's raw materials are renewable and can be produced with little environmental impacts. Cork is an outer layer of a specific species, which can be harvested without damaging the tree and the other raw ingredients are planted and harvested on yearly cycles.

TOXICITY: Some sealers and waxes and other topical dressings may be toxic or hazardous. Care should be taken to select or specify nontoxic products.

INDOOR AIR QUALITY: Newly installed linoleum may have a detectable odour that is caused by the oxidation of fatty acids and these odours do not adversely effect human health. Some adhesives, sealers and waxes and other topical dressings, may emit high levels of VOCs. Care should be taken to select or specify low emission products.

RECYCLABLE PRODUCT: Used linoleum can be recycled into new products, however this option is not currently available in North America.

DEGRADABLE PRODUCT: Linoleum is degradable under appropriate conditions.

CORK SHEETING AND TILE

Cork sheeting and tiles are made from compressed cork dust, a waste product resulting from bottle cork manufacturing. The products can be used as flooring, tackboards and wall covering. Cork is durable and water-resistant and has natural sound attenuation properties. It also provides anti static performance as it's elastic texture dissipates static electricity,.

RENEWABLE RESOURCES: Cork is a renewable resource that can be harvested with minimal environmental impacts. The cork is harvested from the outer layer of cork oak trees every eight or ten years without damage to the trees.

RECYCLED CONTENT: Cork sheeting and tiles are manufactured from post-industrial wastes from the bottle cork industry.

TOXICITY: Cork itself is non-toxic, but care should be taken to select low toxicity installation adhesives.

INDOOR AIR QUALITY: While unsealed cork may initially emit strong odours the product has not been associated with adverse human health effects. Some installation products may have negative impacts on IAQ and care should be taken to select or specify low emission materials.

RECYCLABLE PRODUCT: Although cork materials are recyclable these facilities do not exist in North America.

RECYCLED RUBBER FLOOR TILE

Floor tiles made from recycled tires are very durable, resilient, shock resistant and sound absorbing. Recycled rubber is well suited to recreational areas and can also be used in paving and landscaping, however the rubber is flammable and produces odours.

RENEWABLE RESOURCES: Virgin rubber is a renewable resource that is manufactured from the sap of rubber trees. However, rubber present in most consumer goods contains petroleum additives that are manufactured from a finite resource.

RECYCLED CONTENT: Tire dumps are a serious environmental hazard and recycled rubber products help to alleviate this problem. Some tiles are made from both pre and post-consumer waste, others are 100% post-consumer. One manufacturer states that the making of five square feet of tile requires one scrap tire. Post consumer rubber can be recycled into numerous types of flooring and there are numerous products available.

INDOOR AIR QUALITY: The odours emitted from rubber products may be objectionable to some persons, however they have not been associated with adverse effects on human health. Care should be taken to select low VOC emitting installation materials.

RECYCLABLE PRODUCT: Used rubber products can be recycled where facilities exist.

FLEXIBLE VINYL FLOORING

Vinyl is manufactured from petroleum which is a finite resource. The product is comfortable, durable, and easy to clean. It may last fifteen years or more and "no-wax vinyl" eliminates the need for strippers and waxes that can adversely affect indoor air quality. Nonetheless, it is not recommended for use due to environmental and indoor air quality reasons. Old vinyl may contain asbestos, so its removal can require special handling and disposal practices

INDOOR AIR QUALITY: Vinyl's emissions are by far the highest of all common flooring materials. Flexible vinyl products contain plastizers that are added to give the product pliability. These additives have been associated with negative impacts on human health. Until the mid-1970's, rigid vinyl products contained asbestos, but this component has been replaced with mineral fibre. Many of the adhesives, waxes and sealers that are associated with the care and installation of this product type can have negative impacts on human health. Alternative low emitting products are available and should be selected or specified.

RECYCLABLE PRODUCT: Vinyl is technically recyclable, however facilities do not presently exist.

WOOL CARPETS

Wool carpets are naturally stain resistant, easy to vacuum and wash, fast drying and flame resistant. Untreated woven natural fibres have very good Indoor Air Quality characteristics, but treatments for mothproofing, fireproofing, stain and wrinkle resistance and sizing can cause problems, as can backings. Natural fibres are recyclable and biodegradable, as long as they are not blended with synthetics.

Renewable Resources: Sheep and other wool producing animals can be raised sustainably on suitable terrain as long as overgrazing does not take place. Overgrazing could result in deforestation and erosion.

Toxicity: Pesticide sprays and dips are used on animals for parasite control, however the manufacturing process removes most of the residual product. Specific breeds of animals can produce naturally coloured fibres that eliminate the need for the use of dyes.

Indoor Air Quality: Wool responds to fluctuating humidity levels eliminating the need for chemical anti-microbial treatments. As the product is naturally stain and fire retardant these chemical treatments are also not required. Most of the IAQ issues associated with wool carpet have been identified with the components associated with the chemicals used in the tufting process. The specification of woven wool carpets eliminates these concerns. Care should be taken to specify low emission installation materials.

Reusable Product: Wool carpet is extremely durable and providing proper installation processes are selected this product type can often be lifted and reused in alternative locations.

Degradable Product: Wool surface fibres are degradable under appropriate conditions.

COTTON CARPETS

Untreated cotton carpets have excellent IAQ characteristics. However; most are treated with flame-retardants, stain and wrinkle inhibitors and with sizing, all of which may cause indoor air quality problems. The growing of cotton can require high fertilizer and pesticide applications.

RENEWABLE RESOURCES: Cotton is a renewable resource, although traditional cotton production has been associated with numerous environmental impacts. Programs have now been developed that allow products to carry certification that these impacts have been minimized through organic agricultural practices.

INDOOR AIR QUALITY: Raw cotton does not have negative impacts on IAQ, however many of the topical treatments can result in interior air problems. When selecting these products care should be taken to minimize topical treatments or to specifically select treatments that do not adversely effect IAQ.

RECYCLABLE PRODUCT: Cotton like other textiles can be recycled and numerous facilities exist.

DEGRADABLE PRODUCT: Cotton is degradable under appropriate conditions.

CARPETS FROM OTHER PLANT FIBRES

Carpets are made from a variety of plant fibres other than cotton. These include sisal, coir, hemp, jute, reeds and grasses. Plant fibres have poor stain resistance, so they are often treated with toxic sealers. It is better to use untreated carpets in areas where food spills are unlikely. Their appearance varies from coarse and rustic to very fine texture. Many are very durable.

RENEWABLE RESOURCES: All plant fibres are renewable resources and can be grown under sustainable conditions. Plant fibres are either collected in their wild state or raised on plantations.

RECYCLED CONTENT: Coir, the fibre from coconut husks, is a post industrial waste by-product of coconut harvesting.

TOXICITY: The major concern with plant fibres is their lack of stain resistance. The fibre is very porous and absorbs liquid spills. Spray on sealers are used to reduce to porosity of the fibres, but these products are often made of toxic solvents.

INDOOR AIR QUALITY: Natural plant fibres do not adversely effect IAQ, however some topical treatments can pose problems. Therefore the products should be thoroughly examined before specification. Products are available that have been treated with low emitting treatments.

DEGRADABLE PRODUCT: All plant fibres are degradable under appropriate conditions.

NYLON CARPETS

Nylon carpets have the largest market share within North America, but they have only a small percentage of the market in Europe and other areas of the world. They have excellent resistance to stains as the fibres are nonabsorbent. Like all synthetic fibre carpets, their indoor air quality characteristics depend on their backings. Those with SB latex should be avoided.

RECYCLED CONTENT: Some specific types of carpet fibres may contain recycled content from carpet reclamation programs.

INDOOR AIR QUALITY: Although nylon itself has good IAQ characteristics, backings and treatments can cause problems. All carpets can collect dust and synthetic fibres are not responsive to humidity fluctuations and in many applications require anti-microbial treatments to deter the growth of mould. The choice of adhesive is important.

RECYCLABLE PRODUCT: Synthetic carpet accounts for approximately 3% of all material in landfill sites. Facilities do exist for the recycling of some synthetic carpet fibres. The fibres are recycled into interior automobile components, parking stops and other consumer goods.

CARPET FROM RECYCLED PET CONTAINERS

These carpets are primarily residential quality carpets made from post consumer polyethylene terephthalate (PET) such as soft drink containers. The fibres are very strong and stain resistant and come in a variety of styles and colours. The very low moisture absorption of bottle-grade PET carpets makes them among the most stain-resistant carpets, without the use of additives.

RECYCLED CONTENT: Once the backing is included, the carpets contain approximately 52% post-consumer materials.

INDOOR AIR QUALITY: Although PET itself has good IAQ characteristics, backings and treatments can cause problems. All carpets can collect dust and synthetic fibres are not responsive to humidity fluctuations and in many applications require anti-microbial treatments to deter the growth of mould. The choice of adhesive is important. Because SB latex is used in the backing, these carpets can produce poor IAQ. The choice of adhesive is important.

RECYCLABLE PRODUCT: Although the fibres are technically recyclable, facilities do not currently exist.

MODULAR CARPET

This product category identifies lines of carpet tiles. This product group has three main advantages:

- tiles are dimensionally stable so that only a small amount of adhesive is required;
- tiles in high-traffic areas can be removed and replaced, and
- it is claimed that the product has no 4-PC or formaldehyde, the main sources of carpet-related indoor air quality problems.

The backing contains a biocide to inhibit the growth of micro-organisms that can also cause IAQ problems. The manufacturing process has significantly reduced and recycled waste products.

RECYCLED CONTENT: Some face fibres on carpet tiles may contain recycled content.

INDOOR AIR QUALITY: These products eliminate many of the traditional IAQ issues associated with tufted carpets, but the incorporation of a biocide may raise other concerns.

REUSABLE PRODUCT: Carpet tiles can be lifted and reused in an alternative location.

REFURBISHABLE PRODUCT: Some manufacturers offer a refurbishing service for carpet tiles. The tiles are cleaned and re-coloured to restore aesthetic value of the product.

RECYCLABLE PRODUCT: Carpet tiles can be recycled into various consumer goods. Numerous manufacturers throughout North America offer this service.

RECYCLED CARPET UNDERCUSHION

There are numerous manufacturers that produce undercushion by recycling old tires. Rubber granules are ground from old automobile tires and compressed with binding agents and latex foam without the use of blowing agents.

RECYCLED CONTENT: Recycling of scrap tires has a positive environmental impact. Most products of this type contains a minimum of 50% post consumer waste from recycled scrap tires.

OZONE DEPLETION: All of the present manufacturers in Canada have eliminated the use of CFC-based blowing agents from the manufacturing process. However, some manufacturers are using carbon dioxide as a blowing agent and there are atmospheric impacts associated with CO_2.

INDOOR AIR QUALITY: Although there may be some odours associated with these products they do not have any known adverse effects on human health. Some manufacturers include baking soda in the manufacturing process to reduce the odorous qualities.

RECYCLABLE PRODUCT: Although the product may be recyclable, there are presently no facilities for recycling it.

ADHESIVE-FREE INSTALLATION OF FLOOR COVERINGS

Carpets can sometimes be installed without using any adhesives by using the stretched-in, tackless strip method. Linoleum and rubber flooring can be laid dry without adhesives in kitchens, bathrooms and other small rooms. Linoleum and vinyl can be heat welded

INDOOR AIR QUALITY: Since adhesives are a major source of indoor pollutants, eliminating them can significantly improve IAQ

REUSABLE PRODUCT: This type of installation allows the floorcovering to be lifted and reused at a secondary location

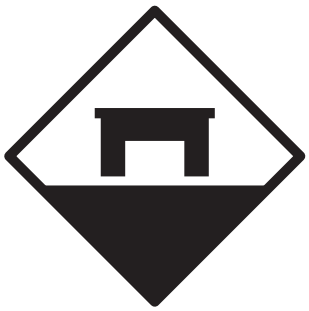
ADHESIVES FOR CARPETS, LINOLEUM AND VINYL

Adhesives are used to attach carpets, parquet, linoleum and vinyl to the floor. Traditional adhesives—both solvent and water-based—have very high emissions, a source of serious indoor air quality problems. Low-emitting adhesives are now on the market. Check with manufacturers for emission rates of individual products. In the case of carpets, investigate whether stretched-in, tackless strip installation is possible, as this procedure eliminates adhesives altogether. Avoid double glue down, which increases emissions. Linoleum and vinyl can be heat-welded.

TOXICITY: Solvent-based adhesives are often manufactured with toxic or hazardous ingredients. Water-based adhesives are usually a less toxic alternative. Worker's Hazardous Materials Information System (WHMIS) sheets are available for each adhesive product and these sheets should be examined for listings of hazardous or toxic components.

INDOOR AIR QUALITY: Verify with manufacturers of products for each application to minimize IAQ problems. Avoid solvent-based adhesives. Look for alternatives that minimize or eliminate adhesives such as tackless strip installation, modular carpets, or heat welding of linoleum or vinyl

Furnishings A.5



NMS Section 12500

➔ **Consider how durable, adaptable and recyclable each option is.**

➔ **Vinyl, interior plywood and particleboard are among the worst off-gassers. Metal gives off little or no indoor pollutants, but is energy-intensive and polluting to produce.**

➔ **Furniture covering and stuffing made of untreated natural fibres off-gas the least, while soft plastics give off a number of indoor pollutants.**

Furniture is a composite product made of many of the materials covered in other sections. For example, the materials discussed in Floor Coverings include vinyl, which is used in wall and furniture coverings and for working surfaces. Vinyl is not recommended in terms of resource use or pollution created in manufacturing. If indoor air quality (IAQ) is a concern, vinyl should be avoided for all these uses, since the plastizers in the formulation emits volatile organic compounds (VOCs) that can negatively impact IAQ. Linoleum can be used for working surfaces, while ceramic tiles can be used on both working surfaces and walls. Paints and Coatings should be selected carefully, especially if IAQ is important. Many of these items can be made with Wood Products, including tropical, hardwoods, plywood and particleboard. Tropical hardwoods should be avoided, unless they are from certified growers and processors. Interior plywood's (hardwood veneers) and particleboard have particularly high VOC emissions unless they are made with special adhesives and/or sealed with paints or finishes.

Metal can be used in cabinets, furniture frames and mattress springs. Its production is energy-intensive and polluting, but its IAQ characteristics are excellent. Hard plastic laminate tops such as Formica(and Arborite(are also resource and energy-intensive to produce, but they have acceptable IAQ ratings once the adhesives used during installation cure. Soft plastics, PVC and A.B.S., plastics, polyester resins (in fibreglass and clear plastic castings) and acrylic resin (Plexiglas(and Lucite() should be avoided, as they contain a variety of toxic and carcinogenic chemicals.

The fillings or stuffings used in furniture can also cause IAQ problems. The most acceptable are untreated natural fibres such as cotton, wool, jute and silk, along with metal springs. Animal products such as feathers, down and hair are allergens for many people, and polyurethane foams, styrene foam chips and foam rubber may have been manufactured with blowing agents that contribute to global warming.

Similarly, the most acceptable covers are made of untreated natural fibres, and cotton barrier cloth can be used to block allergens such as down, feathers, dust and mites. Acetate, rayon and natural leather are acceptable to most people, while nylon, polyester and vinyl fabrics, as well as imitation leather should be avoided.

Products used to clean office furniture can off-gas and have negative effects on building inhabitants. Traditional furniture polish, Danish oil finish and liquid floor wax have the worst ratings. Although natural walnut or olive oil has a tendency to attract dust, they are considered to have the least IAQ impacts. Mineral oil and paste waxes have an intermediate rating. (See Paints and Coatings)

When properly installed and used, window coverings can save energy, provide privacy and reduce glare. Some manufacturers supply automatic controls to eliminate glare and reduce cooling energy needs by preventing direct sun from entering. Many vertical and horizontal louvers are made of PVC plastic with other materials attached by adhesives. Both the PVC and the adhesives may cause IAQ problems.

OPEN OFFICE FURNITURE SYSTEMS

Open office furnishing systems combine flexible partitions with desks and other work surfaces. Some of these are designed especially with accessible passages for offices with extensive telephone and computer networks wires. These can greatly reduce work disruption and noise and dust generation caused by changing wiring in floors, walls and ceilings. However, many of these systems make extensive use of plastics, particleboard and adhesives, which can cause serious IAQ problems. (Also see Access Flooring in the section on Floor Coverings.)

RENEWABLE RESOURCES: Although wood is considered a renewable resource, care should be taken to ensure that wooden components are not manufactured from wood species that are listed on the Convention on International Trade in Endangered Species (CITIES).

RECYCLED CONTENT: Many components of the system can be manufactured with recycled content. For example, fabrics for screens can be manufactured from recycled polyethylene terephthalate (PET) plastic.

REMANUFACTURED PRODUCTS: There are numerous manufacturers that offer remanufactured furniture systems. These pieces of furniture have been manufactured with components that have been taken apart, upgraded and reassembled to renew the aesthetic and functional aspects of the system.

OZONE DEPLETION: Since the ban of the production of CFC's by the Montreal Protocol, the use of CFC blowing agents has been largely discontinued. However, products manufactured in countries that were not part of the Protocol may still contribute to ozone depletion. Furthermore, many manufacturers are now using carbon dioxide as a blowing agent, but atmospheric C02 has also been associated with global warming issues.

INDOOR AIR QUALITY: There are numerous IAQ issues that can be associated with furnishings. Many of the substrates used in construction may contain urea formaldehyde that can off-gas and have negative impacts on human health. Specifying the use of particleboard that contains phenol-formaldehyde resins can reduce this problem. This resin type contains a more stable chemical bond that significantly reduces emission rates. Another alternative is to encapsulate the particleboard on all sides with laminates or other nonporous material.

The adhesives used in the construction of the system may also have negative IAQ aspects. Chemical solvent-based adhesives usually have higher VOC emission rates than water based products.

REUSABLE PRODUCTS: In many cases furniture can be reused with minimal refurbishing. Diverting used pieces to facilities that specialize in the redistribution of used furniture averts a significant quantity of material from the waste stream.

REFURBISHABLE PRODUCTS: Careful product design alternations can promote the ease of product restoration.

RECYCLABLE PRODUCTS: Product design can also facilitate recycling of discarded furniture. The coding of plastic components and provision of instructions for dismantling considerations can allow the furniture to be dismantled and sorted for component recycling.

REBUILT OFFICE FURNITURE SYSTEMS

This category consists of open office furniture systems that are rebuilt by the manufacturer or a third party. The flexibility of these systems reduces replacement costs and environmentally impact.

RECYCLED CONTENT: The refurbishing of furniture provides the opportunity to increase the percentage of recycled content incorporated into the system.

OZONE DEPLETION: There are many IAQ issues that can be associated with furnishings. Many of the substrates used in the construction may contain urea formaldehyde that can off-gas and provide negative impacts on human health. Specifying the use of particleboard that contains phenol-formaldehyde resins can reduce this aspect. Another alternative is to encapsulate the particleboard on all sides with laminates or other nonporous material.

The adhesives used in the construction of the system may also have negative IAQ aspects. Chemical solvent-based adhesives usually have higher VOC emission rates than water based products.

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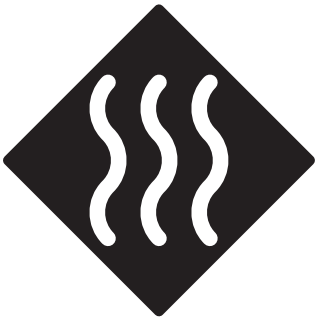
The adhesives used in the construction of the system may also have negative IAQ aspects. Chemical solvent-based adhesives usually have a higher VOC emission rate that water based products.

REFURBISHABLE PRODUCTS: If a product has been refurbished once it is safe to assume that the process can be repeated. Careful design alternations during the refabrication process can facilitate this option.

RECYCLABLE PRODUCTS: Product design can also facilitate recycling of discarded furniture. The coding of plastic components and provision of instructions for dismantling considerations can allow the furniture to be dismantled and sorted for component recycling.

Heating, Ventilation and Air Conditioning (HVAC) *A.6*



NMS Sections 15510 to 15950

➔ **Consider tapping naturally occurring sources of energy via solar collectors or heat pumps, and recovering waste energy with heat exchangers like heat recovery ventilators.**

➔ **Good building design can reduce demands for artificial heating and air conditioning.**

➔ **Controls can vary ventilation according to occupancy.**

Heating, ventilation and air-conditioning can have significant environmental impacts given their demands on two primary resources water and energy. Protecting our resources for the future will increasingly require clients and designers to undertake life cycle analyses, including calculations of the relationship between energy consumption and, for example, the release of greenhouse gases such as C02, the main by-product of indoor environments.

Large buildings use substantial amounts of heating, not only because of their size but also because of the need for more ventilation than is necessary in a residential project. Passive solar load from sunlight coming through glass to heat large surface areas should be considered during the assessment of both heating and cooling requirements. For heating needs, solar energy can be considered the most efficient and environmentally responsible use of resources and technology available. The use of low temperature distribution systems can be seen as an interim step, allowing for easier conversion to solar power at a later stage. Hydronic heating systems may also be a good choice. They are more efficient than forced air systems and do not distribute dust and other contaminants throughout a building. They can move more heat through a small pipe than can be moved through ducts in a forced air system.

Ventilation is important for its ability to remove moisture and heat that can damage building components and cause the interior to overheat. Reducing ventilation to save on energy consumption is not a wise choice when it results in poor IAQ and therefore poor employee health and performance. Air exchange rates must meet the minimum standards set out in ASHRAE 62-1989 (American Society of Heating, Refrigerating and Air-Conditioning Engineers) which calls for O.4m3 (15 cubic feet) per minute of air exchange per person.

When balancing the need for resource efficiency and a healthy interior, a few options are available. Controls can be installed to vary ventilation according to occupancy levels. A C02 measuring device connected to a ventilation control; for example, would use the C02 level as an indicator for the number of occupants. Ventilation quantities should not be reduced below a designated minimum level, regardless of the measured amount of C02. An even better approach involves the use of heat recovery ventilators to transfer heat energy from exhaust air to incoming air. With this system, generous amounts of ventilated air are present, maintaining an indoor environment of high quality at a modest energy cost.

Air conditioning systems are extremely resource-intensive. A good building design and construction can contribute significantly to reducing the energy burden. In addition, much can be accomplished by cleaning HVAC filters, ducts and coils regularly.

Thermal Insulation *A.7*

NMS Division 7

- ➔ **Some brands of cellulose, fibreglass and rock wool insulations include a percentage of recycled material.**
- ➔ **The off gassing of dust suppressors, binders and fire retardants added to insulation vary greatly among manufacturers and should be kept out of living areas through the use of vapour barriers.**
- ➔ **Plastic foam insulation types may use blowing agents that have atmospherics impacts as a blowing agent.**

Thermal insulation pays for itself financially and environmentally by saving energy. Any renovation project involving the outside walls or ceilings of a building should include an increase in the amount of insulation appropriate to the climate, building size and type and heating and cooling system. The choice of insulation type may be difficult to determine, since several important factors vary significantly from one product to another, even for the same type of insulation.

Most insulation gives off some volatile organic compounds (VOCs) which are a problem for indoor air quality (IAQ). In the case of fibreglass, mineral wool, and cellulose insulations, VOC emissions result mainly or entirely from the dust suppressors, binders and fire retardants added, and these vary greatly from one manufacturer to another.

CELLULOSE INSULATION

Cellulose insulation is made from recycled newsprint and other papers. It is available as a loose fill and can be sprayed into place wet or dry. It is treated with fire retardants and may contain other chemicals for rodent resistance or to prevent settling. These chemicals may affect IAQ. There are building code restrictions on the use of loose fill insulation in walls and below ground.

RENEWABLE RESOURCES: Some cellulose insulation is treated with borax for fire retardation. Currently there are only two reserves where borax is being mined, one in California and one in Turkey. Under these circumstances borax content should be avoided.

RECYCLED CONTENT: Many cellulose insulations are manufactured with post consumer newsprint. The Environmental ChoiceM Program calls for a minimum of 75% recycled content in licensed cellulose insulation.

ENERGY SAVINGS: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings when heating and cooling. The greatest energy savings will be achieved if other aspects of the building envelope are designed to prevent exterior air infiltration.

INDOOR AIR QUALITY: Since printing ink residues and additives can be toxic and produce an odour, all cellulose insulation should be well sealed behind air/vapour barriers.

RECYCLED FIBREGLASS INSULATION

Some manufacturers are currently producing fibreglass insulation products with 75% to 80% recycled glass. The products include bats, blowing wool, exterior sheathing and acoustical ceiling tiles. The recycled glass is purchased from brokers and contains an unknown ratio of pre and post consumer waste. This is one of the few processes that can use recycled coloured glass.

RECYCLED CONTENT: Some products contain up to 75 to 80% industrial and pre or post consumer glass waste.

ENERGY SAVINGS: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

INDOOR AIR QUALITY: Fibreglass fibres are possibly carcinogenic and may emit pollutants. Binders used in the manufacture can release VOCs and can increase toxic emissions in the event of fire. All insulation should be well-sealed behind air/vapour barriers.

REUSABLE PRODUCT: When carefully dismantled these products can be reused. Many used building material facilities redistribute materials of this type.

RECYCLABLE PRODUCT: Although the product can be theoretically recycled, this is not being done at the present time.

ROCK WOOL OR MINERAL FIBRE INSULATION

Rock wool insulation consists of spun type fibre, similar to fibreglass. It is made primarily from slag, a waste product resulting from the production of iron and steel. Slag comprises up to 99.5% of the final product. Approximately 0.5% is oil to prevent dust and the remainder is rock. Rock wool is also used as a fire retardant and is not affected by moisture.

RECYCLED CONTENT: Rock wool insulation is manufactured from mining waste, which is an industrial waste.

ENERGY SAVINGS: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

INDOOR AIR QUALITY: Mineral fibres may be irritating if released into the interior cavity of a building and may emit pollutants. Depending upon where the source of the raw materials trace heavy metals may be present. All insulation should be well-sealed behind air/vapour barriers.

REUSABLE PRODUCT: When carefully dismantled these products can be reused. Many used building materials facilities redistribute materials of this type.

RECYCLABLE PRODUCT: This product is theoretically recyclable although facilities do not currently exist.

PLASTIC AND CEMENTITIOUS FOAM INSULATION

Urea-formaldehyde foam insulation (UFFI) was banned for most uses in the mid 1980's due to off gassing and related health concerns. Although UFFI does not produce gases after several years the dust is very irritating and special procedures should be used during renovations in a building containing UFFI. New generations of foamed-in-place insulations are manufactured form polyurethane and silicate.

OZONE DEPLETION: Care should be taken to select a product that is not installed with a blowing agent that contributes to ozone depletion or global warming. Most manufacturers have discontinued the use of CFC based blowing agents but some products may use HCFC based agents, methane or carbon dioxide. Products are available that are installed using only compressed air.

ENERGY SAVINGS: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

INDOOR AIR QUALITY: Foamed plastics release toxic gases if cut with power tools or hot wires. Some products may contain a dye that can be irritating to some persons. The product can usually be special ordered without the dye to eliminate this concern. All insulation should be well sealed behind air/vapour barriers.

VERMICULITE AND PERLITE INSULATION

These products are poured in place and used primarily in the cavities of concrete or masonry blocks, or in insulating plaster and lightweight concrete. Both products are expanded by heat and are inherently flame retardant.

RENEWABLE RESOURCES: Vermiculite is a mineral that resembles mica and contains both free and chemically bound water. Perlite is a volcanic rock.

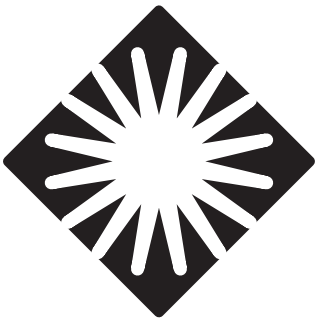
TOXICITY: Older vermiculite may contain asbestos and should be handled with caution during renovations.

ENERGY SAVINGS: This product is designed to improve the thermal value of the building. Increasing the thermal value provides energy savings during both the heating and cooling cycle. The greatest energy savings will be achieved if other parts of the building envelope are designed to prevent exterior air infiltration.

INDOOR AIR QUALITY: Both product types produce hazardous dusts during handling, but are safe and odour free once installed.

REUSABLE PRODUCT: When carefully dismantled, these products can be reused. Many used building materials facilities redistribute materials of this type for reuse

Lighting A.8



NMS Sections 16505 to 16594

➔ **Fluorescent lights are the most energy efficient alternative.**

➔ **Energy saving ballasts use 1/2 to 1/3 of the energy of standard ballasts.**

➔ **Parabolic reflectors maximize illumination.**

Full spectrum tubes are believed to improve employee health and performance and should be used with open, non-styrene louvers.

Elements that affect operational energy in most lighting systems are the lamp or tube, ballast and reflector. Fluorescent lights are the most energy efficient approach to lighting, particularly in large buildings. Tubes emit warm white, cool white, daylight or full spectrum light. The spectrum selected may have an effect on employee health, performance and comfort. It is thought that full-spectrum lighting is the most beneficial to people working indoors for long periods because it closely mimics the full spectrum of natural light. Tubes should be removed and cleaned regularly, as dirt contributes to lower light levels and wasted energy. Tubes that go grey at the ends and start flickering need replacement to maintain energy efficiency and lighting performance.

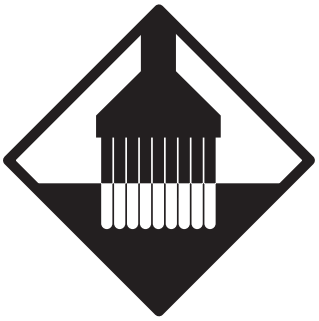
Energy saving ballasts for fluorescent systems include core and coil, solid state and hybrid systems. Each of these has different characteristics and each allows for energy savings that are two to three times those of standard fluorescent ballasts.

Parabolic reflectors reduce the wattage required for a given degree of illumination and are available for new and retrofit applications. Companies have been able to reduce their energy expenditures significantly simply by cleaning the reflectors.

Plastic, glass and metal louvers typically reduce light levels. Open, 'egg crate' louvers should be specified when full spectrum or daylight tubes are used so that the beneficial UV rays are not absorbed by the louver. Styrene louvers are not recommended because of their negative effects on human comfort and health when heated.

Fluorescent tubes contain gases such as argon and mercury vapour and should be handled with care. Because of the possibility of breakage, safety gloves, respirators and safety glasses should be worn at all times during handling, installation and removal. Disposal is restricted and local regulations must be followed.

Paints and Coatings A.9



NMS Section 0990

- ➔ **Technological advances have eliminated the performance differences that were initially evident between chemical solvent based and water based products.**
- ➔ **Water-based or latex paints are generally less hazardous than chemical solvent based products. However, these products still contain a variety of toxic ingredients and biocidal additives to prevent fungus growth and spoilage in the can.**
- ➔ **Dark pigments added to paint base can greatly increase the emission rates of volatile organic compounds and can have adverse effects on indoor air quality (IAQ).**
- ➔ **Many paints, sealers and finishes contain highly toxic chemicals and should be applied wearing the appropriate safety gear and any waste should be disposed of properly.**

Traditionally, paints and other coatings have posed significant environmental problems at every stage of their life cycle, from manufacturing through application and disposal. Although caution and care are still required many of these risks have been reduced.

Appropriate precautions should be taken in removing and disposing of demolition waste, as older paint coverings contained lead. Painting over lead paint is not recommended because surface preparation by sanding will produce lead dust, and if the new surface wears off, the lead is exposed again. Covering with wallpaper or another covering is probably the most cost-effective approach.

The Environmental Choice[M] Program and other international eco-labeling programs have developed guidelines for paints. The purchase and specification of products that have been licensed to carry an eco-label provides a degree of ensurance of reduced environmental impacts. A small number of chemical solvent-based paints have been certified, but these products are slowly being phased out by the industry. These paints contain somewhat reduced levels of VOCs and other substances. Some specialty paints, exist that meet more stringent environmental criteria with respect to VOCs, heavy metals or biocides, such as milk paint.

Cementitious paint is made from finely ground cement. When wetted and painted on masonry or concrete, it forms an inert waterproof coating. For reasons of environmental health, it is preferred over latex or chemical solvent-based paints. It also tends to be more durable than other coatings, but the product cannot be used on floors.

A selection of clear, water based urethane and acrylic coatings is now available for protection of wood surfaces. To ensure durability and a smooth finish, special application procedures must be followed. It is important to use the primer and type of applicator specified.

There is not enough information to evaluate other wood finishes except in terms of IAQ. In this regard, natural walnut and natural olive oil are considered the best, although they have a tendency to attract dust. Intermediate ratings are given to mineral oil, which must be reapplied frequently, natural shellac, lacquer paints and wood sealer and paste waxes. The worst ratings are given to furniture polish, Danish oil finish and liquid floor wax. There are also a number of sealers that can be used to seal products such as particleboard to reduce their emissions of formaldehyde, and other agents.

In all instances, tradespeople should wear carbon facemasks or respirators when applying paints and other coverings. Proper ventilation should be provided and smoking should be avoided. Damp conditions will delay drying and encourage biological growth. Old latex paints should not be used if they smell mouldy since this is a sign of biological contamination.

Calculating the amount of paint or other coating required as closely as possible can minimize waste. Buying in bulk will reduce container waste. Proper storage eliminates waste caused by biological or other forms of contamination. Where facilities exist, leftover paint can be recycled to make 'new' paint. This reduces some of the environmental burden of hazardous waste disposal. Recycled paints are, however, difficult to classify with respect to environmental or health impacts.

Paints, coatings, solvents and sealants must be disposed of at proper facilities as they are considered hazardous waste. If not disposed of properly, they release toxic chemicals that pollute soil, groundwater and the atmosphere.

ECO-LABELED PAINTS

The application of paints and coatings releases thousands of tonnes of VOCs into the atmosphere each year.

RECYCLED CONTENT: Old paints reclaimed through hazardous waste depots can be recycled into new products. Therefore any new paint product may contain recycled content, but the percentage is not quantifiable.

TOXICITY: Paints that are licensed to carry the EcoLogo must not be formulated with aromatic solvents, fibrous talc, asbestos, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium, or barium and their compounds, except barium sulfate. Manufacturers should be asked to provide Worker Hazardous Materials Information System (WHMIS) sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Water based paints and stains that carry the EcoLogo must not contain VOCs in excess of 250 g/L and chemical solvent based products must not contain VOCs in excess of 5% by weight. However these guidelines are currently under review and the acceptable certification criteria levels are being reduced for water based products. The chemical solvent-based guideline is being retired. Products that are manufactured to the criteria of the guideline reduce adverse effects on IAQ.

Water-based paints have biocides to prevent spoilage and extend shelf life. Some persons may have adverse reactions to these additives. Paints can be specially ordered without biocides, but they must be applied immediately. Paints have very high emission rates during application. Once the products have cured the emission rates decrease and stabilize. It should be noted that emission rates are calculated for base product, the addition of pigments will alter tested emission rates.

RECYCLABLE PRODUCT: All traditional paints can be recycled through hazardous material facilities that are available nation wide. As paints can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

NATURAL PAINTS

Natural paints are prepared from plant resins and oils and mineral fillers. Their pigments are made from clay and minerals and do not contain heavy metals. The solvents are often citrus-based and may have stronger odours and be more irritating than petroleum solvents. They cost two or three times as much as conventional paint, are sometimes difficult to find, are available in limited colours and may have longer drying times. *(See also Milk Paints.)*

RENEWABLE RESOURCES: Natural paints are mostly formulated from renewable resources such as water, linseed oil, tree resins, vegetable oils, chalk and mineral pigments.

TOXICITY: Solvents contained in the formulations are usually citrus based. However manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Citrus-based solvents can be irritating. Otherwise these paints are excellent for IAQ.

RECYCLABLE PRODUCT: All natural paints can be recycled through hazardous material facilities that are available nation wide. As paint can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

MILK PAINTS

This type of product was originally developed at the time of the American Revolution and has been recently commercialized. The product provides a flat, grainy appearance. The new formulations are based upon authentic recipes. Milk paints are sold as a powder to be mixed with water and have a very long shelf life. They come in a limited range of colours.

Milk paint should not be used in damp rooms as it may support bacterial and fungal growth. The final finish is not washable or highly durable unless it is sealed. Adhesion to raw wood is permanent and paint strippers do not affect the finish. They do not contain any lead, preservatives, fungicides or petroleum products.

RENEWABLE RESOURCES: These are natural paints made from milk protein (casein), clay, lime and mineral pigments. All ingredients in the formulation are renewable resources.

TOXICITY: The products do not contain lead, chemical preservatives, fungicides, hydrocarbons or other petroleum derivatives. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Milk paints have excellent IAQ characteristics, but should not be used in damp locations.

HYPOALLERGENIC PAINTS

Some manufacturers offer special order formulations that have either zero or extremely low VOC emissions. The products contain water-based emulsions. They are available only in white and bone. Tints can be added, but these may affect the environmental impacts and increase adverse effects on IAQ. These paints have limited shelf life and require special care in application.

TOXICITY: These products are formulated without petroleum products and toxic materials. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products have been specifically formulated to have negligible impacts on IAQ.

RECYCLABLE PRODUCT: All traditional paints can be recycled through hazardous material facilities that are available nation wide. As paints can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

LOW BIOCIDE PAINTS

These products are conventional waster based products that have been formulated without biocides. They do not contain fungicides or preservatives and have very low VOC emissions. They do contain petroleum-based chemicals. They are available in a wide range of colours. Oil-based versions of these paints should be used in humid spaces. Their shelf life is limited. They are made to order and delivery may take one or two months.

TOXICITY: These products may contain toxic materials. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products have been specifically formulated to have low VOC emission rates and the absence of biocides allows these products to be tolerated by extremely sensitive individuals.

RECYCLABLE PRODUCT: All paints can be recycled through hazardous material facilities that are available nation wide. As paint can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

RECYCLED PAINTS

These latex paints are made from 50% to 100% recycled post-consumer paint. The paint is collected from partially used cans delivered to municipal hazardous waste depots. Most colours are available in the 50% recycled variety. Because recycled paint is made from paint that may be up to ten years old, it may contain chemicals banned from paint made today.

RECYCLED CONTENT: These products contain 50% to 100% post consumer recycled contents.

TOXICITY: These products may contain toxic ingredients. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products should not be used where IAQ is a concern.

RECYCLABLE PRODUCT: All paints can be recycled through hazardous material facilities that are available nation wide. As paint can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

URETHANE VARNISH

Urethane floor varnish is perhaps the most popular finish for wood floors and woodwork. Urethane varnish consists of isocyanurates in a petroleum based solvent. It is toxic to handle, and clean-up materials, wastes and leftovers are also toxic. The finish is very durable and IAQ problems are moderate once it has cured. The product has an 'ambering' effect following application.

TOXICITY: These products are toxic, similar to solvent-based paints. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: This product type produces high VOC emission rates until the product has cured. Following a cure time the emission rate is negligible, but the emissions given off during the cure may be trapped in other materials in the building and will continue to effect IAQ for an extended period of time.

RECYCLABLE PRODUCT: Like traditional paints, these products can be recycled through hazardous material facilities that are available nation wide. As varnishes can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

WATER BASED VARNISH

This type of floor varnish is a safe and practical alternative to urethane varnish. The product is formulated as a water emulsion urethane or acrylic urethane. These water-based, penetrating polymer finishes clean up with water and are available in clear and translucent colours. A one-part system can be used for light traffic areas and a two-part system for heavy traffic areas. The two-part system uses a catalyst that forms a cross-linked polymer resulting in a very durable finish. These products do not alter the colour of the original surface following application.

TOXICITY: This option is usually less toxic than traditional urethane varnishes. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products have low emission rates during the cure time. Once the product has cured emission rates are negligible.

RECYCLABLE PRODUCT: Like traditional paints, these products can be recycled through hazardous material facilities that are available nation wide. As varnishes can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

LOW TOXICITY SEALERS

These sealers are similar to acrylic-urethane finishes, but are made to penetrate and waterproof rather than produce a hard finish. They are used on wood, unglazed tile, grout and mortar, gypsum board and other porous surfaces which need to be sealed to prevent soiling and staining. Traditional sealers can cause serious IAQ problems, but low emission sealers are now available. Some of these sealers can also be used to encapsulate high emission products such as urea-formaldehyde particleboard.

TOXICITY: These product types usually have reduced toxicity levels. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products usually have a low VOC content and do not have adverse effects on IAQ. These products can also be used to encapsulate emissions from other high emitting sources such as urea-formaldehyde particleboard, interior plywood and softwoods.

RECYCLABLE PRODUCT: Like traditional paints, these products can be recycled through hazardous material facilities that are available nation wide. As varnishes can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

PENETRATING OIL FINISH

This is a very popular finish for hardwood floors and cabinets. The product penetrates, hardens and seals wood without producing a glossy finish. Penetrating oil finishes are commonly known as Danish oil or Swedish oil. It is formaldehyde based and emits large amounts of formaldehyde and other gases during application and for weeks after causing serious IAQ problems.

TOXICITY: These products are considered toxic. Manufacturers should be asked to WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products usually have very high VOC emission rates and should not be used or specified where IAQ is a concern.

RECYCLABLE PRODUCT: Like traditional paints, these products can be recycled through hazardous material facilities that are available nation wide. As varnishes can have severe environmental impacts when introduced to ecosystems, this option should be the only acceptable disposal route.

NATURAL WAXES

These product types are traditionally manufactured in Europe from natural ingredients. The products are designed to provide a protective coating for wood, cork, stone and porous tile. Some of the products have impregnating qualities that protect surfaces against water, soil and dust. The products usually have antistatic qualities.

RENEWABLE RESOURCES: These products are formulated from renewable resources such as linseed oil, beeswax, carnauba wax, and natural resins.

TOXICITY: These products traditionally are considered nontoxic. However manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: These products are usually formulated to have low VOC contents and therefore have negligible adverse effects on IAQ. However, each product should be individually assessed.

NATURAL OIL AND MINERAL OIL WOOD FINISHES

Natural walnut oil and olive oil can be used as wood polishes. They have excellent IAQ characteristics but may attract dust. Although mineral oil (a petroleum product) is good for IAQ it needs to be reapplied periodically.

RENEWABLE RESOURCES: Natural walnut oil and olive oil are formulated from renewable resources. However mineral oil products are petroleum based and therefore considered non-renewable resource based.

TOXICITY: Manufacturers should be able to verify non-toxicity claims. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Most natural oils do not have adverse effects on IAQ.

DEGRADABLE PRODUCT: Natural oils based from agricultural products are usually degradable under appropriate conditions. Some petroleum-based products can be formulated to be degradable. Manufacturers should be able to supply test results that verify the degradability of a petroleum product.

Plastics A.10

➔ **Plastics are made of non-renewable resources, are energy-intensive to manufacture and generate toxic waste during manufacturing and disposal.**

➔ **Most plastics are not biodegradable.**

The principal raw material used in the manufacturing of plastics is petroleum, a non-renewable fossil fuel. The fact that plastic manufacturing is energy-intensive and that plastics are often thrown away after just one use, makes the embodied energy value extremely high.

The main ecological concern about plastic is the toxic waste that arises from manufacturing and disposal. PVC's are used widely in floor tiles, window frames, pipes and a wide range of home and office products. Disposal of plastics poses a serious problem since their volume is always increasing and because landfilling them can result in leaching of organochlorine substances into the soil and groundwater. Most plastic is not biodegradable. However, some plastics that are manufactured with agricultural products are degradable. Incineration produces chlorinated hydrocarbons and hydrochloric acid.

When choosing plastic building products, explore alternatives to petroleum-based plastics such as using linoleum in place of plastic laminate. Avoid plastic foams that use CFCs or HCFCs as blowing agents (see Insulation). Avoid plastics for coating, bonding or sealing. Otherwise, use plastics sparingly, in areas where their easy workability, lightweight and resistance to moisture make them the most appropriate choice.

The Society of the Plastic Industry has developed a set of symbols that identifies various plastic resins for the purpose of sorting and recycling. In most cases these codes are applied on the bottom of products. The symbols and an explanation of plastic types are displayed below. Plastic waste destined for recycling must be kept clean and most recyclers will not pick it up unless a substantial volume has been accumulated. Many building products are now manufactured with recycled plastic content. Some examples are drainage tiles, sump liners and wood substitutes containing recycled plastics.

Sealants and Caulks *A.11*

NMS Section 07900

➔ **Outdoor caulking should never be used indoors because of severe off gassing. Acrylic and latex caulking create less of a problem, and low-toxicity caulking is suitable for some applications.**

➔ **Most caulking is manufactured from non-renewable petroleum products and generate toxic waste.**

Energy losses due to air leaks can account for up to 50% of the total energy bill. Sealants and caulking compounds significantly reduce unintentional air exchange thereby lowering heating and cooling losses and conserving energy. Caulking is used to fill gaps or create a seal usually where some flexibility is required. The many sealants available are designed for different applications and have different effects on indoor air quality.

Caulkings are made from synthetic polymers, some of which are from the same chemical groupings as paints – latex, acrylics and urethanes. Others, such as silicone, butyl, polychloroprenes and polysulfides are formulated very differently from paint. Polyurethane, latex, polysulphide and silicone sealants have lower emissions than xylene and other solvents and can be used with greater safety indoors, providing safety procedures are followed during application.

Caulking designed for exterior use should never be used indoors. Acoustical caulks used for vapour barriers can off-gas substantially and should be avoided if contact with chemically sensitive individuals is likely. Paintable acrylic latex caulking is tolerated by most people, as is polyurethane foam caulk.

BUTYL RUBBER CAULKING

These sealants are made from synthetic rubber compounds. SBR's stick to almost anything and are moisture resistant. Butyl rubber is hard to apply. Since both product types emit VOCs their use inside should be limited.

TOXICITY: Butyl caulking contains hazardous solvents. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Caulking and sealants are recognized to provide reduced air leakage, which reduces energy requirements for heating and cooling.

INDOOR AIR QUALITY: These products emit high levels of VOCs and should never be used indoors.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

LATEX CAULKING

Latex caulking is made from synthetic latex mixed with fillers, glycols and colorants. The formulation of this product is very similar to that of latex paints. Fresh latex caulking can be cleaned up with water. It is the safest of the paintable caulks.

TOXICITY: Latex caulking is one of the least toxic formulations of caulking. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Caulking and sealants are recognized to provide reduced air leakage, which reduces energy requirements for heating and cooling.

INDOOR AIR QUALITY: Although latex caulking does contain fungus retarding biocides, exposure is minimized due to the small quantities of material usually applied.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

ACRYLIC CAULKING

Acrylic caulking is made of acrylic resins, usually blended with latex and glycol, petroleum solvents and fungicides. Fresh acrylic caulking can be cleaned up with water. This product can cause more IAQ problems than latex caulking.

TOXICITY: This type of product formulation contains chemical solvents and resins and is therefore more toxic than latex products. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Caulking and sealants are recognized to provide reduced air leakage, which reduces energy requirements for heating and cooling.

INDOOR AIR QUALITY: Acrylic caulking contains petroleum solvents and fungicides. Although only a small quantity of the material is usually applied, this material may have adverse effects on IAQ.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

PLAIN SILICONE CAULKING

Plain silicone caulking contains silicone resin and vinegar. The manufacturing process results in air and water pollution and toxic wastes and its clean up requires the use of solvents. Silicone caulk cannot be painted and does not stick well to concrete or rough wood. It is susceptible to fungus and discolouration. The vinegar content in this caulking gives it a strong, but not harmful, odour when curing. After curing it has excellent IAQ characteristics.

TOXICITY: Depending upon the formulation silicone caulking may contain toxic ingredients. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Caulking and sealants are recognized to provide reduced air leakage, which reduces energy requirements for heating and cooling.

INDOOR AIR QUALITY: Although this product has a strong vinegar odour during curing, the odour only lasts a few hours. Once cured the product has the fewest health risks of any available indoor caulking.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

LOW TOXICITY CAULKING

Specialty suppliers formulate low toxicity caulking. They contain synthetic resins, but few, if any hazardous solvents or fungicides. Although it is not as durable or flexible as conventional caulks, it is good for interior uses such as stopping drafts. However, it is not advisable for damp spaces or exterior use.

TOXICITY: These products usually do not contain toxic ingredients, however, manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Caulking and sealants are recognized to provide reduced air leakage, which reduces energy requirements for heating and cooling.

INDOOR AIR QUALITY: These products usually do not contain solvents or fungicides and therefore do not have any impacts on IAQ.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

SILICONE BATH CAULKING

Silicone bath caulking is similar to plain silicone caulking, but contains toxic fungicides which make it more hazardous to produce and handle. Its application should be limited to areas where persistent moisture occurs.

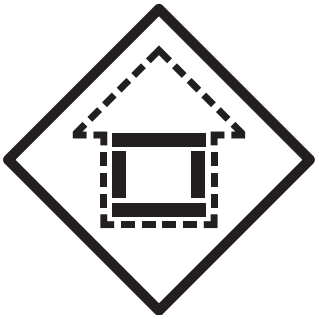
TOXICITY: Silicone bath caulking contains toxic fungicide additives. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

ENERGY SAVINGS: Although caulking are usually used to inhibit air infiltration, this particular product is designed to provide a moisture seal and therefore does not provide energy savings.

INDOOR AIR QUALITY: These products contain fungicides that may have adverse effects on IAQ. The products should only be applied where persistent moisture appears, such as bath enclosures.

RECYCLABLE PRODUCT: These products can be recycled through hazardous material facilities that are available nation wide.

Walls, Ceilings and Floors A.12



NMS Sections 09211 to 09250 and 09511 to 09520

- ➔ **Drywall's main component is strip mined gypsum, which gives off hydrogen sulphide when breaking down.**
- ➔ **If the recycled paper used to make drywall is old newsprint, the inks and solvents can affect indoor air quality.**
- ➔ **Untreated plaster on metal lath emits the least amount of gas of any wall finish.**
- ➔ **Sound-absorbing paneling, ceiling tiles, and in-wall/floor/ceiling padding made of recycled materials are available which emit little, if any, gas.**

Many of the materials used in walls, ceilings and floors are covered in other sections such as Wood Products, Insulation, Air and Vapour Barriers, Sealants and Caulks, Floor Coverings, and Paints and Coatings.

Detailed installation of air and vapour barriers is important for energy efficiency, preventing structural and aesthetic damage, and reducing IAQ. Critical areas include floor framing, interior partitions at ceilings and exterior walls, stair landings, windows, electrical boxes and ceiling fixtures. For best IAQ, electrical boxes and fixtures should be made of steel or plastic that do not emit VOCs. Metal boxes can be connected to thin steel conduits, which reduce exposure to the plastic insulation on wires and to the electrical fields caused by wiring. Some plastic boxes are designed to seal around wires and work with vapour barriers or airtight drywall.

Acoustical panels are often used in public places and offices to reduce noise levels. One type of panel is made from a combination of wood fibre wastes from sawmills and recycled paper. Another variety made from mineral wool and portland cement includes fire retardants, thermal insulation and acoustic insulation. Sound absorbing padding can also be installed within walls and floor/ceilings of multi-storey buildings.

Access flooring is widely used in computer rooms, communications centres and other places with large amounts of wiring, especially wiring that must be changed as systems are expanded or upgraded (see also Office Furniture Systems in the Furnishings section). Access flooring systems are available that also include ducting for airflow. Many systems make extensive use of vinyl and other plastics, as well as carpeting and adhesives, which can cause IAQ problems. They may also hide wet or damp areas, leading to mould and rust.

Where IAQ is a major concern, steel framing may be used to eliminate the VOCs given off by softwood joists, studs, or rafters. However, it should be noted that the embodied energy of steel per kilogram is about six times that of wood with lumber's embodied energy at 7.4 MJ/kg and steel's at 44.6 MJ/kg. Lumber, especially if untreated, is usually acceptable since good construction practices isolate it from the interior with air and vapour barriers. The adhesives present in laminated lumber may have strong VOC emissions.

Existing walls and ceilings can be refinished so as to isolate sources of VOCs from the interior. First, extension rings are added to all electrical outlets. Next, a foil air/vapour barrier sealed with foil tape is used to cover the existing surfaces. Then, expanded metal lath is attached and finally, base and finishing coats of untreated plaster are applied.

Virgin gypsum is generally strip-mined. This results in many serious environmental consequences. Tailing wastes pollute waterways and mining methods result in soil erosion.

Gypsum board is often laminated with recycled paper containing ink and solvent residues, which can affect people with chemical sensitivities. More recently, synthetic gypsum, which is a waste material from flue gas scrubbers, has been used in the manufacture of wallboard. Pre-mixed drywall compounds contain fungicides, which may affect the health of tradespeople and building occupants. It is important that sanding dust not be allowed to enter ducts or wall cavities as the ventilation system may circulate contaminates throughout the building. Sponging can be substituted for sanding.

Designing walls and ceilings to fit gypsum board sizes can minimize waste. This will also minimize the amount of dust created through cutting. If unpainted and separated from other waste, gypsum board can be recycled and made into new gypsum products. Although it is degradable, gypsum gives off hydrogen sulphide when breaking down. Disposal should occur only under proper conditions.

GYPSUM WALLBOARD

Gypsum wallboard was developed as a faster and less costly alternative to traditional plastering methods. Gypsum wallboard consists of a core of gypsum plaster laminated with paper on both sides. Gypsum board also known as drywall, sheetroc or gyproc, is probably the most commonly used material for permanent walls and ceilings. It provides a surface that can be painted, papered or plastered and aids sound proofing and fire resistance.

RENEWABLE RESOURCES: Although gypsum is a non-renewable resource it is available in abundant supply. However, there are numerous environmental impacts associated with the open-pit practices that are used to mine this material.

RECYCLED CONTENT: Some manufacturers are now creating gypsum board using desulphogypsum (DSG). This is a high purity gypsum which is fundamentally the same as mined gypsum, but is produced instead of mined. It is a clean by-product produced from the process known as 'flue gas desulphurisation' a process used by coal fired thermal electric generating stations to remove sulpher dioxide from the flue gas created during the burning of coal in thermal electric generating stations.

INDOOR AIR QUALITY: If recycled paper is used in the surface coating during the manufacture of the board, the inks contained in the paper may be irritating to sensitive individuals. Premixed joint compound contains fungicides and biocides to prevent spoilage. When IAQ is a concern, specifications should call for the use of dry mix joint compound.

RECYCLABLE PRODUCT: Unpainted gypsum is recyclable, but facilities are regionally limited.

FIBRE WALLBOARD

Fibreboard is a common term used for products that are manufactured from wood that has been ground and pressed into a solid board. These products can be made without resins as wood contains lignin, which is a natural polymer resin that will hold wood fibers together. However, glues or other additives are usually added to give the product special properties.

RENEWABLE RESOURCES: The wood used in the fabrication of these products is considered to be a renewable resource as regeneration occurs in time and can be controlled through the issuing of cutting permits.

RECYCLED CONTENT: Wood used in the manufacture of these products are either post industrial sawmill wastes or woods of lesser quality that would otherwise be discarded. The recycled content of these products is between 90% to 95%.

TOXICITY: Some additives used may be classified as toxic substances. Although these materials are not considered toxic in a cured state, dusts and fibers generated during installation procedures may pose a hazard. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Urea formaldehyde resins are often used in the manufacturing process of fibre wallboard. This resin can emit formaldehyde that can be irritating to humans. Although the emission rate will somewhat subside after a period of time, fluctuations in humidity levels can escalate emissions. This cycle continues for the life of the product.

An alternative,is the use of products that have been manufactured with phenol formaldehyde. This resin has a more stable chemical composition and does not emit formaldehyde even when humidity levels are high.

RECYCLABLE PRODUCTS: All wood products can be recycled, although facilities may be regionally limited.

DEGRADABLE PRODUCTS: Wood products are degradable under appropriate conditions. Manufacturers should be able to supply information on the required conditions.

PLASTER ON METAL LATH

Extruded metal lath covered with untreated plaster is the wall finish with the best IAQ characteristics. Untreated plaster contains only cement, lime or lime putty, sand and gypsum. In recent years additives such as polyvinyl, acrylic and mineral fibres have been added to the formulation to improve the workability of the product. Until the mid 1980's asbestos was also often included in the mixture, therefore care should be taken when removing old plaster. This application can also be used for covering existing walls. Extension rings for electrical outlets are available for this purpose.

RENEWABLE RESOURCES: The raw materials used in the formulation of plaster are not renewable resources, but they are currently available in abundant supply.

TOXICITY: These products are usually manufactured to have very low toxicity levels. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Plaster and lath has the best IAQ qualities of any interior wall finish, as long as only untreated plaster is used. This application can usually be tolerated by even the most sensitive of individuals.

NATURAL FIBRE WALL COVERING

Natural fibre wall coverings come in a wide variety of types, such as jute, sisal, silk, cotton or cellulosics. The backing is usually made of paper but may also be a padded panel. The fibres can be attached as strings or woven. Some shed, and all require regular vacuuming to remove dust, bacteria, odours and gases. Natural fibres have a poor resistance to soil and stains. This problem can be off set with the application of low toxicity soil and water repellents.

RENEWABLE RESOURCES: Natural fibres are renewable resources that can be harvested and replenished on planned cycles.

RECYCLED CONTENT: Some paper backings or skrims may contain recycled content.

TOXICITY: Some dyes or inks may be very toxic and contain heavy metals such as cadmium and mercury. Products are available that are manufactured using vegetable dyes. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Some sealants and dyes may adversely effect IAQ. Low toxicity, low emitting products are available and should be selected were IAQ is a concern. Some wallpaper adhesives, particularly premixed products, may contain fungicides and biocides.

DEGRADABLE PRODUCTS: Some natural fibre wallcoverings may be degradable. Manufacturers should be able to supply information regarding this disposal option.

WALLPAPER WITH RECYCLED PAPER

Wallpaper can now be obtained with various percentages of recycled paper. The higher the recycled content and particularly the higher the post-consumer recycled content, the better. One type also contains fine wood chips to provide texture and help cover wall imperfections.

RECYCLED CONTENT: The use of recycled paper helps to preserve forests and reduces energy use and pollution. The percentage of recycled content can vary greatly. Manufactures should be able to supply information regarding the percentage of post-consumer material.

TOXICITY: Some dyes or inks may be very toxic and contain heavy metals such as cadmium and mercury. Products are available that are manufactured using vegetable dyes. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components

INDOOR AIR QUALITY: Some sealants and dyes may adversely effect IAQ. Low toxicity and low emitting products are available and should be selected were IAQ is a concern. Some wallpaper adhesives particularly premixed products, may contain fungicides and biocides.

VINYL WALL COVERING

Vinyl wallcoverings consist of a flexible vinyl plastic with a backing of paper or scrim (a loosely woven fabric). All vinyl is made from petroleum, which is a finite resource. Although vinyl is durable and easy to clean, it is not recommended for environmental and IAQ reasons.

TOXICITY: Many of the ingredients used in the manufacture of vinyl wall coverings are considered toxic or hazardous materials. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: The vinyl in the product is made soft and pliable through the addition of plastizers. Although vinyl is stable, the additives may off gas for extended periods of time. Chemical biocides are also a common ingredient. Many heavy metals such as cadmium, mercury and lead have traditionally been used for colourings. The use of these ingredients has been restricted in some countries, but products that use these components are still available for sale. Fungicides and biocides are common ingredients in vinyl wallcovering adhesives. All of these factors can negatively impact on IAQ.

ADHESIVES FOR WALL COVERINGS

Traditional sizing and adhesives for wallpaper are made of starch and water and are non-toxic. They are susceptible to mould and mildew, so they often contain biocides. Although wall coverings with self-adhesive backings create less waste and exposure to adhesives, the backing creates waste paper or plastic. Solvent-based adhesives have toxic emissions that affect IAQ.

RENEWABLE RESOURCES: Starch glues are manufactured from vegetable starch and may contain other plant and animal extracts such as casein (milk protein).

TOXICITY: Wallpaper adhesives are basically nontoxic. However some products may contain additives that are toxic or hazardous. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Fungicides and biocides are often added to adhesives to deter microbial growth. The best choice to alleviate this concern is the selection or specification of dry mix products that are mixed at the time of installation.

DEGRADABLE PRODUCTS: Many starch based adhesives are degradable. Manufacturers should be able to supply information on appropriate conditions.

CEILING TILES WITH RECYCLED PAPER

Ceiling tiles with recycled paper are sound absorbing ceiling tiles made from a combination of wood fibre wastes from saw-mills and recycled paper. The paper can include both pre and post consumer wastes.

RECYCLED CONTENT: The percentage of recycled content varies greatly between manufacturers

INDOOR AIR QUALITY: Inks contained in the recycled paper may present adverse IAQ effects for sensitive persons.

REUSABLE PRODUCT: Although careful dismantling may be required these products can often be reused. Numerous used building materials facilities often redistribute these products.

LIGHT STEEL STRUCTURAL FRAMING

This is a system of steel studs, rafters, joists, tracks and bridging that can be used for structures or partitions. It is recommended that when IAQ is of concern softwood structures should be avoided. *(See also Steel Channel Flooring Anchors and Plaster on Metal Lath.)*

RECYCLED CONTENT: Almost all steel products contain some recycled iron and steel. However, no specific data exists on the recycled content of these products.

INDOOR AIR QUALITY: Steel structuring is an excellent choice when resins from softwood are a concern for IAQ.

REUSABLE PRODUCT: Steel framing is reusable.

RECYCLABLE PRODUCT: All steel can be recycled.

STEEL CHANNEL FLOORING ANCHORS

These are shallow U-shaped steel members that can be used to attach hardwood plank flooring to a concrete slab. They are recommended when IAQ is of such concern that softwood structures should be avoided. *(See also Light Steel Structural Framing.)*

RECYCLED CONTENT: Almost all steel products contain some recycled iron and steel. No specific data exists on the recycled content of these products.

INDOOR AIR QUALITY: Steel structuring is an excellent choice when resins from softwood are a concern for IAQ.

REUSABLE PRODUCT: Steel framing is reusable.

RECYCLABLE PRODUCT: All steel can be recycled.

ELECTRICAL BOXES AND CONDUIT

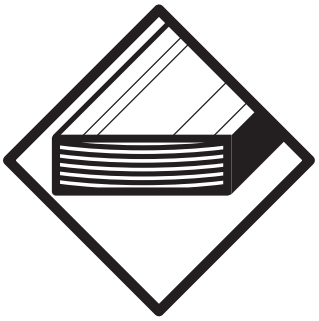
For best IAQ electrical boxes and fixtures should be made of steel or plastic that do not emit VOCs. Metal boxes can be connected to thinwall steel conduits that reduce exposure to plastic insulation on wires and to electrical fields associated with wiring. Some plastic boxes are designed to seal around wires and work with air/vapour barriers or airtight drywall.

RECYCLED CONTENT: Almost all steel products contain some recycled iron and steel. No specific data exists on the recycled content of these products.

REUSABLE: Electrical boxes can reused. Conduit and other wiring can rarely be reused as the wire must often be cut during demolition procedures and splicing the wire reduces product performance.

RECYCLABILITY: All steel and metals can be recycled.

Wood Products A.13



NMS Sections 06100, 06101, 06200, 06400

- ➔ **Relative to other building materials, wood has low embodied energy and neither hard nor soft woods off-gas significantly.**
- ➔ **Manufactured wood products can include waste wood and low grade timber, provide better strength per weight than solid timber and use virgin timber more efficiently. However, they can contain large amounts of adhesives.**
- ➔ **Conventional adhesives, finishes and preservatives used in wood products can be a source of IAQ problems. However, a growing range of alternatives that produce little or no off gassing is available.**
- ➔ **Low emission particleboard, made from a variety of recycled materials, is available.**

In its natural state within a forest ecosystem, wood is an extremely valuable resource, regulating the amount of carbon dioxide in the Earth's atmosphere. Over the last two centuries however, the amount of forested land has declined dramatically while our use of wood products has increased. At the same time, there has been a rapid increase in the amount of carbon being discharged into the atmosphere. The result has been rising temperatures and the phenomenon referred to as the 'greenhouse effect.' To offset these and other environmental effects, resource extraction must take place at a reduced, more sustainable rate and reforestation programs must be firmly enforced

Concerns about the destruction of tropical rainforests have led to programs of certification. These programs, such as the Smart Wood and the Green Cross Wood certification programs, ensure that wood is grown, harvested, replanted and processed in a sustainable manner. Such programs also promote the use of lesser known and less endangered species. The Green Cross certification program applies to temperate forests as well, and negotiations are under way to certify a large Canadian forest products company.

New wood products that combine increased strength with the ability to use wood waste include oriented-strand board (OSB) and Parallam®. OSB is often used to make I-joists, which consist of a thin vertical member of OSB or plywood connecting top and bottom flanges of solid sawn lumber or laminated veneer lumber. A variation on I-joists is open-webbed joists, which use vertical trusses between horizontal members. Finger-jointed lumber combines short pieces of wood into dimensional, structural lumber. It is as strong as normal lumber and resists stress, warping and twisting. Laminated lumber, plywood and particleboard are more traditional products that also allow for efficient use of trees.

Greater availability of salvaged lumber, as well as wood substitutes made from materials such as recycled plastics and newspaper, are among the many other options that can be pursued in the interests of sustainability. Plastic wood for example, can be substituted for pressure-treated wood in some outdoor, non-structural applications.

Materials such as steel studs, composite joists, trusses and parallel strand beams can also be considered as substitutes for wood. The embodied energy value of steel, kilogram for kilogram, is about six times that of wood, and its manufacturing generates more pollution.

Natural woods products–softwoods generally more than hardwoods–emit small amounts of organic compounds such as aldehydes. Of a much more serious concern however, are the adhesives and finishes used in installing wood products. The three major wood preservatives are creosote,

pentachorophenol and inorganic arsenicals. All three contain cancer and mutation causing agents. Creosote and pentachorophenol should not be used on wood products destined for indoor use.

The glue used most often in the manufacturing of interior particleboard and plywood is urea formaldehyde (UF), classified as a 'probable' human carcinogen. The rate and extent of off gassing varies widely with heat, humidity and material combinations. Particleboard made with phenol formaldehyde has much lower emission rates.

Fortunately, a large range of alternatives exists and is growing all the time. Products are available for sheathing for example, that claim to use a formaldehyde-free adhesive. Floor decking with no urea formaldehyde or asbestos additives can now be purchased. Boric acid, copper napthenate and other substances might be considered as replacements for traditional preservatives against fungus and insects. Where no alternatives to traditionally treated wood are available, the wood can be sealed with an oil-based penetrating stain.

Lumber usually makes up the largest proportion of demolition or renovation waste, especially with residential construction. Hardwood waste and a smaller percentage of softwood waste, can be reused as kindling or if collected in large enough quantities, as fuel for central heating plants. It can also be recycled into products such as feedstock for pressboard, chipboard, pressed logs, animal bedding and landscaping cover. Most wood grinders accept wood that still has embedded nails, staples and fasteners or paint.

ORIENTED STRAND BOARD (OSB)

OSB is a type of structural board made of small wood chips from fast growing tree species. The manufacturing process uses low-grade and waste wood efficiently. The adhesive is usually waterproof phenol formaldehyde, which has low emissions.

RENEWABLE RESOURCES: Particleboard is manufactured from sawmill wastes, reclaimed woods or low quality wood products. Wood is a renewable resource whose regeneration is currently controlled through the issue of cutting permits

RECYCLED CONTENT: The manufacture of OBS utilizes wood materials that are generated waste from other sawmill activities.

TOXICITY: Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: The phenol formaldehyde adhesive has much lower emissions than the urea formaldehyde adhesive used in particleboard and interior plywood.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT : All wood products are degradable under appropriate conditions.

PARALLAM®

Parallam® is a type of structural board made by gluing together long strands of softwood veneer and is twice as strong as traditional lumber. The adhesive used is phenol formaldehyde, which has low emissions. The manufacturing of Parallam® can make use of second-growth trees and allows approximately 85% utilization of wood fibre from a tree, compared with 50% in sawmills.

RENEWABLE RESOURCES: Particleboard is manufactured from sawmill wastes, reclaimed woods or low quality wood products. Wood is a renewable resource whose regeneration is currently controlled through the issue of cutting permits

RECYCLED CONTENT: The manufacture of OBS utilizes wood materials that are waste from other sawmill activities.

TOXICITY: Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Phenol formaldehyde adhesives have much lower emissions than urea formaldehyde adhesives used in particleboard and interior plywood.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

I JOISTS

I-joists consist of a thin vertical member of OSB or plywood connecting top and bottom flanges of solid sawn lumber or laminated veneer lumber. I-joists are very strong for their weight and provide structural support for floors and roofs while using fewer trees than conventional joists.

RENEWABLE RESOURCES: Particleboard is manufactured from sawmill wastes, reclaimed woods or low quality wood products. Wood is a renewable resource whose regeneration is currently controlled through the issuing of cutting permits

RECYCLED CONTENT: The manufacture of OBS utilizes wood materials that is waste from other sawmill activities.

TOXICITY: Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Phenol-formaldehyde adhesives have much lower emissions than urea formaldehyde adhesive used in particleboard and interior plywood.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

STANDARD PARTICLEBOARD

These are sheets made of wood chips or residue bound together by an adhesive. Standard particleboard is made with urea formaldehyde adhesive, which can emit significant amounts of formaldehyde. Sawmill waste makes up 90% of the wood. Manufacturing waste is recovered or used as fuel. Particleboard is used primarily in furniture and cabinets and for floor underlay.

RENEWABLE RESOURCES: Particleboard is manufactured from sawmill wastes, reclaimed woods or low quality wood products. Wood is a renewable resource whose regeneration is currently controlled through the issue of cutting permits.

RECYCLED CONTENT: Standard particleboard is manufactured from post industrial waste generated by other sawmill activities.

TOXICITY: Some of the ingredients used in the manufacture of some particleboard may be toxic in their uncured state. Fumes released during cutting procedures may be toxic during installation procedures. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Urea formaldehyde resin emissions can have adverse effects on IAQ. These emissions can be encapsulated through the application of nonporous laminates or with low toxicity, low VOC sealers.

RECYCLABILITY: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABILITY: All wood products are degradable under appropriate conditions.

LOW EMISSION PARTICLEBOARD WITH RECYCLED CONTENT

A variety of products are available that emit very low levels of air pollutants. Some also contain agricultural waste products such as husks, shells or straw and recycled material such as newsprint. Some manufacturing processes recover waste materials and heat.

RENEWABLE RESOURCES: Particleboard is manufactured from sawmill wastes, reclaimed woods or lower quality wood products. Wood is a renewable resource whose regeneration is currently controlled through the issuing of cutting permits

RECYCLED CONTENT: Urea formaldehyde resins can emit formaldehyde that can have adverse effects on IAQ. These emissions can be encapsulated through the application of nonporous laminates or with low toxicity, low VOC sealers.

TOXICITY: Urea formaldehyde resin emissions can have adverse effects on IAQ. These emissions can be encapsulated through the application of nonporous laminates or with low toxicity, low VOC sealers. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components.

INDOOR AIR QUALITY: Phenol formaldehyde is the most common resin used in the manufacture of low emission particleboard. The chemical structure of this resin is more stable than that found in urea formaldehyde, which results in reduced emissions.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

HARDWOOD PANELING FOR WALLS

Hardwood paneling consists of solid hardwood panels, not veneer. It is an expensive option with excellent IAQ characteristics and durability.

RENEWABLE RESOURCES: Hardwood paneling requires very high-grade lumber from slow growing trees. However, the regeneration of wood is controlled through the issue of cutting permits. It is preferable to find sustainable sources of high grade lumber. Tropical hardwoods should be purchased only from certified sources.

INDOOR AIR QUALITY: Hardwood paneling has excellent IAQ qualities, providing the topical treatments selected do not create adverse IAQ qualities.

REUSABLE: If carefully dismantled, this product can often be distributed for reuse.

RECYCLABLE PRODUCTS: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCTS: All wood products are degradable under appropriate conditions.

SOFTWOOD PANELING FOR WALLS

This product group is made of solid softwood paneling, not veneer. Common species of wood used include pine, cedar, spruce and fir. These have good IAQ characteristics and are more sustainable than hardwoods.

RENEWABLE RESOURCES: High-grade lumber is required to manufacture softwood paneling for walls. However, the regeneration of wood species is monitored through the issuing of cutting permits.

INDOOR AIR QUALITY: Softwood paneling may emit VOCs that can be irritating to sensitive individuals. Surface treatments and sealers should be carefully selected to ensure that emission rates are not increased. The application of low toxicity, low VOC sealers to all sides of the product can seal in offensive emissions.

REUSABLE PRODUCT: If carefully dismantled, this product can often be distributed for reuse.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

EXTERIOR PLYWOOD

Plywood is available in a variety of thicknesses and grades. It is made by gluing together thin veneers of wood with the grain oriented in different directions for strength. The adhesive used is phenol-formaldehyde, which emits low levels of indoor air pollutants. Exterior grade plywood is usually used for exterior applications and therefore not affected by moisture or humidity. Plywood is usually used for nonstructural purposes such as sheathing, siding and concrete forms. It can also be used instead of particleboard in the construction of subfloors and furniture.

RENEWABLE RESOURCES: Good quality plywood must be made from good quality lumber, so it is not as efficient as particleboard. However, the wood usually used in the manufacture of plywood is taken from fast growing species whose regeneration is controlled through the issue of cutting permits.

TOXICITY: Exterior grade plywood is not usually manufactured with toxic ingredients, however cutting procedures during installation may generate some toxic emissions. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components

INDOOR AIR QUALITY: The phenol formaldehyde resins used in the manufacture of exterior grade plywood are chemically stable and do not adversely effect IAQ.

REUSABLE PRODUCT: If carefully dismantled, this product can often be distributed for reuse.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

INTERIOR PLYWOOD

Interior plywood is generally thinner than exterior plywood and may have a decorative veneer on one side that allows it to be used for decorative purposes, such as cabinets and paneling. It is usually manufactured with urea formaldehyde adhesives. While formaldehyde emissions from hardwood plywood have decreased in the last decade, they can still be significant.

RENEWABLE RESOURCES: Good quality plywood must be made from good quality lumber, so it is not as resource efficient as particleboard. However, the wood usually used in the manufacture of plywood is taken from fast growing species whose regeneration is controlled through the issuing of cutting permits. Veneers included on finished plywood may sometimes be of a species that is classified as endangered.

TOXICITY: Interior grade plywood is not usually manufactured with toxic ingredients, however cutting procedures during installation may generate some toxic emissions. Manufacturers should be asked to provide WHMIS sheets to verify the inclusion of hazardous or toxic components

INDOOR AIR QUALITY: Interior grade plywood emits formaldehyde from the urea formaldehyde resin, that can be irritating. Surface treatments and sealers can be carefully selected to ensure that emissions are encapsulated. The application of low toxicity, low VOC sealers to all sides of the product can seal in offensive emissions.

REUSABLE PRODUCT: If carefully dismantled, this product can often be distributed for reuse.

RECYCLABLE PRODUCT: All wood products can be diverted from landfill through appropriate facilities.

DEGRADABLE PRODUCT: All wood products are degradable under appropriate conditions.

appendix B

APPENDIX B

	RENEWABLE RESOURCES	RECYCLED CONTENT	REMANUFACTURED PRODUCTS	TOXICITY	OZONE DEPLETION	ENERGY EFFICIENCY	ENERGY SAVINGS	REDUCED WATER USE	INDOOR AIR QUALITY	REDUCED VOCS	FORMALDEHYDE EMISSIONS	ANTI-MICROBIAL TREATMENTS	REUSABLE PRODUCT	REFURBISHABLE PRODUCT	REMANUFACTUABLE PRODUCT	RECYCLABLE PRODUCTS	DEGRADABLE PRODUCT
 **AIR AND VAPOUR BARRIERS**																	
Polyethylene Air/Vapour Barriers	N	S				P		N								P	
Aluminum Foil Air/Vapour Barriers	N	P				P		P								P	
Airtight Drywall Approach (ADA)	S	S				P		P								P	
 **BRICK**																	
Brick with Plain Mortar Joints	O	S							O				P			P	
 **CONCRETE SLAB SUBFLOORS**																	
Concrete Slab Subfloors	O	S							O							P	
 **FLOOR COVERINGS**																	
Cement Finishes	O	S		C					C							P	
Ceramic Tile	O	S		C					C							P	
Stone	C	S		C												P	
Hardwood Plank	C	S		C					C				P	P		P	P
Wood Parquet, Wire Bound	C			C					C					P		P	P
Linoleum	P			C					C			P				P	P
Cork Sheeting and Tile	P	P		C					C							P	
Recycled Rubber Floor Tile	C	P							C							P	
Flexible Vinyl Flooring	N	S							N							N	
Wool Carpets	P			O					P				P				P
Cotton Carpets	C								C							P	P
Carpets From Other Plant Fibres	P	S		C					C								P
Nylon Carpets	N	S							N			N				S	
Carpet From Recycled PET	N	P							N							P	
Modular Carpet	N	S	S	C					C			N	P	P	P	S	
Recycled Carpet Undercushion		P			C				C							P	
Adhesive Free Installation of Flooring									P				P				
Adhesives For Flooring				C					C								
 **FURNISHINGS**																	
Open Office Furniture Systems	C	C	S		C				C	S			P	S	S	C	
Open Office Furniture Systems	C	C	P		C				C	S			P	P	P	C	

	RENEWABLE RESOURCES	RECYCLED CONTENT	REMANUFACTURED PRODUCTS	TOXICITY	OZONE DEPLETION	ENERGY EFFICIENCY	ENERGY SAVINGS	REDUCED WATER USE	INDOOR AIR QUALITY	REDUCED VOCS	FORMALDEHYDE EMISSIONS	ANTI-MICROBIAL TREATMENTS	REUSABLE PRODUCT	REFURBISHABLE PRODUCT	REMANUFACTUABLE PRODUCT	RECYCLABLE PRODUCTS	DEGRADABLE PRODUCT
THERMAL INSULATION																	
Cellulose Insulation	C	S					P		C								
Recycled Fibreglass Insulation		P					P		O				P			P	
Rock Wool or Mineral Fibre Insulation		P					P		C				P			P	
Plastic/Cementitous Foam Insulation					C		P		C								
Vermiculite and Perlite Insulation	P			S			P		O				P				
PAINTS AND COATINGS																	
Eco-labeled Paints		S		P					C	P		P				P	
Natural Paints	P			P					P	P						P	
Milk Paints	P			P					P	P							
Hypoallergenic Paints				P					P	P						P	
Low Biocide Paints				C					P	P						P	
Recycled Paints		P		N					N	N						P	
Urethane Varnish				N					N	N						P	
Water Based Varnish				N					P	P						P	
Low Toxicity Sealers				C					P	P						P	
Penetrating Oil Finish				N					N	N						P	
Natural Waxes	P			N					O	P							
Natural & Mineral Oil Wood Finishes	P			P					P	P							
SEALANTS AND CAULKS																	
Butyl Rubber Caulking				N			P		N	N						P	
Latex Caulking				P			P		O	O						P	
Acrylic Caulking				C			P		O	O						P	
Plain Silicone Caulking				C			P		O	O		N				P	
Low Toxicity Caulking				P			P		O	O						P	
Silicone Bath Caulking				C					N	N						P	

	RENEWABLE RESOURCES	RECYCLED CONTENT	REMANUFACTURED PRODUCTS	TOXICITY	OZONE DEPLETION	ENERGY EFFICIENCY	ENERGY SAVINGS	REDUCED WATER USE	INDOOR AIR QUALITY	REDUCED VOCS	FORMALDEHYDE EMISSIONS	ANTI-MICROBIAL TREATMENTS	REUSABLE PRODUCT	REFURBISHABLE PRODUCT	REMANUFACTUABLE PRODUCT	RECYCLABLE PRODUCTS	DEGRADABLE PRODUCT
WALLS, CEILINGS & FLOORS																	
Gypsum Wallboard	O	S							O	O						P	
Fibre Wallboard	C	S		C					N		N					P	
Plaster on Metal Lath	O			P					P	P							
Natural Fibre Wall Coverings	P	S		C					C							P	
Wallpaper with Recycled Content		P		C					C								
Vinyl Wall Covering	N			C					N	N							
Adhesives for Wall Covering	S			C					C	C						S	
Ceiling Tiles With Recycled Paper		P							C	C						S	
Light Steel Framing		P							O				P			P	
Steel Channel Flooriung Anchors		P							P	P			P			P	
Electrical Boxes & Conduit		P											S			P	
WOOD PRODUCTS																	
Oriented Strand Board (OBS)	P	P		C					P		P		P			P	P
Parallam®	P	P		C					P		P		P			P	P
I-Joists	P	P		C					P		P		P			P	P
Standard Particleboard	P	P		C					N		N		P			P	P
Low Emission Particleboard	P	P		C					P		P					P	P
Hardwood Paneling for Walls	C								P	P			P			P	P
Softwood Paneling for Walls	C								N	N			P			P	P
Exterior Plywood	P			C					P		P		P			P	P
Interior Plywood	P			C					N		N		P			P	P

LEGEND

VP - Very Positive
P - Positive
O - Neutral
N - Negative
VN - Very Negative

S - Only some products of this type meet the concern
C - There are critical choices to be made

REDUCING ENERGY USE PRODUCT DIRECTORY

appendix C

APPENDIX C

Thermal Insulation *C.1*

NMS Sections 07211 to 07240

- ➔ **Insulation is the only material whose main function is to keep the heat where it belongs, inside in the winter and outside in the summer.**
- ➔ **Insulations are manufactured from a wide range of materials including melted glass spun into fibres, expanded volcanic rock, recycled newsprint and foam plastic.**
- ➔ **Several different insulation materials may be used at different locations in a building envelope, depending on the space available, ease of access and other installation requirements.**

Insulation is like a giant sleeping bag. It wraps a building in a layer of materials that slows the rate of heat transference between interior and exterior air. Heat flows from warm to cold abd visa-versa. In a part of a building such as a wall, heat can be moving in one, two or three directions at the same time.

CONDUCTION
Heat can be transferred directly from one object to another by the particles bumping into each other. Some materials conduct heat better than others depending upon the structure of the material. Insulation works by reducing the heat flow with tiny pockets of air, which are relativily poor conductors of heat.

CONVECTION
Heat can also be transfered by movement of a fluid such as water or air. In an insulated wall space, air picks up heat from the warm wall and then circulates it to the cold wall, where it loses heat. Some heat is also transferred by the mixing of warm and cold air.

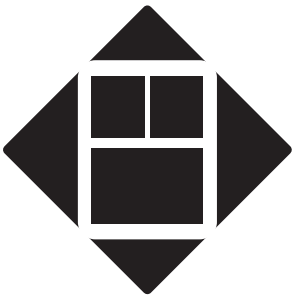
RADIATION
Any object will radiate heat in the same way the sun radiates heat. When you stand in front of a cold window, your body radiates heat to the window so you feel cold, even though the room temperture may be high.

Insulation is manufactured and sold by its thermal resistance value or Resistance System International (RSI) value which is a prescise measurement of the insulation's resistance to heat flow. The higher the resistance value, the slower the rate of heat transfer through the insulating material. One brand or type of insulation may be thicker or thinner than another, but if they both have the same RSI values, they both control heat flow equally well.

The proper choice of insulation depends on its final use. In most appications, good resistance to heat flow is not the only consideration. In specific situations, the insulations may also need to have any number of the following properties:

- the ability to resist high temperatures,
- reistance to moisture,
- the ability to act as an air barrier, and
- does the insulation need a fire rated protection.

Windows C.2



NMS Sections 08500 to 08975

➔ **Windows make up to 15–40% of a building's envelope, which presents the potential for large heat loss.**

➔ **Windows can account for up to 37% of a buildings total heat loss.**

➔ **Window technology has undergone rapid development in the past few years. Windows with improved thermal performance are quickly replacing the standard double-glazed, sealed unit.**

The glazing or glass layers of a window are usually double or triple paned, with the glass separated by an air space. The glazing in standard double-glazed windows accounts for two thirds of the heat loss. Thin metal coatings (low emissivity or low E) applied to the glazing reduce the amount of heat radiated from the inside of the building to the outside. Emissivity is the ability of a surface to radiate heat. Low-E coatings reduce the ability of glass to radiate heat.

Coatings are either soft or hard. A soft coating is a thin metal layer sandwiched between two protective oxide layers, applied to the inner surfaces in sealed units. Soft coatings are easily damaged, but have high insulation values and allow for some solar gain. A hard coating is a tin-oxide coating, fused to the glass surface. Hard coatings are very durable, have somewhat lower insulation values than soft coatings and tend to allow for full solar gain. Coatings can also be applied to polyester films that can be installed between two glazings, providing a lightweight third glazing.

The thermal performance of a window is improved by replacing the air with an inert gas such as argon or krypton. Spacers are used to separate the glass layers within the sealed unit. Metal spacers readily conduct heat and are therefore being replaced with low conductivity spacers. Heat loss can be reduced by 20% when using spacers such as rigid foam, butyl tape with an aluminum strip, fibreglass extrusions and wood.

The frame in a conventional window is 25–30% of the total window area. Common frame materials are wood, polyvinyl chloride (PVC), aluminum or fiberglass. These materials may also be used in combination, such as vinyl-clad wood.

The performance of windows is primarily rated in terms of energy savings. Several aids are available to help form decisions based upon energy performance.

ENERGY RATING

The Energy Rating (ER) number is determined by the average performance of standard size windows, at different orientations, during the heating season. The single ER number allows for comparison of various windows. If the ER number is positive, the window will allow solar gains and retain heat in the building, thereby increasing the energy rating of the building envelope.

R-VALUE/RSI

This number represents the thermal resistance of the window. The R-value of the window is usually measured at the center of the glass area and does not indicate the heat loss for the entire window unit. RSI (Resistance System International) is the metric equivalent.

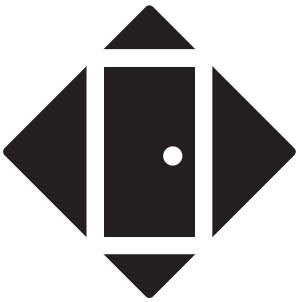
SHADING COEFFICIENT

This is the measure of the amount of the solar heat gain through the glazing.

U-VALUE

This indicates the overall amount of heat transmitted through the entire window system, the glazing, the frame and the spacers. U-value is the reciprocal of the R-value.

Doors C.3



NMS Sections 08110 to 08460

➔ **Exterior doors allow air to be exchanged between the outside and inside of a building. A well-insulated and sealed exterior door will minimize the heat loss and air infiltration reducing energy use.**

➔ **Materials used in the fabrication of doors, including finishes, glues, insulation and the framing materials, may off gas and negatively affect indoor air quality.**

Doors have less impact than windows on the energy consumption of a building. This is simply because there are fewer of them. Doors come in a variety of materials, some of which reduce heat flow better than others. For example, metal clad doors are more energy saving than solid wooden doors. No matter what the material, ill-fitting doors lose energy and can make a building drafty.

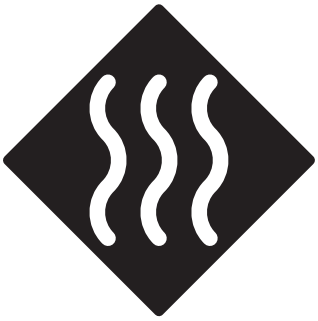
Heat may be lost through the door and frame, between the door, frame and sill, through the glazing, and between the doorframe and the rough frame opening. Heat loss via doors can be reduced through the careful choice of the door, its location and proper installation and maintenance. Heat loss can be reduced by placing the door out of the direction of prevailing winds on the leeward side of a building, or by providing windbreaks. Another option is the installation of an air-lock vestibule that traps the air between the exterior and interior of the building.

Missing or worn weather stripping, improperly installed strike plates, frames which no longer fit the door correctly, or warped doors that no longer contact the stops, are the main contributors to air leakage.

New style insulated doors are usually made from foam and wood covered with metal. Doorframes are normally wood, clad with metal or vinyl. Doors that are mainly glass and are used as windows should be compared for energy performance by their ER rating. Glass inserts and sidelights should have at least double-glazing with at least 12 mm of air space between glazings and be compared on the basis of the U-value calculated for the complete door system.

Using an existing casing, a factory made, core insulated, pre-hung unit can be installed. Installation of factory hung units takes less time than on site assembly. Factory made systems usually have tighter air seals and thermally broken adjustable sills that will further reduce heat loss. A variety of materials can be used for the door face and framing, insulation and weather stripping.

Heating C.4



NMS Sections 15510 to 15950

- ➔ **Space and water heating are responsible for the bulk of the energy used in a building.**
- ➔ **In general, all types of heating equipment offer improved energy efficiency when compared to products and equipment manufactured a decade ago.**
- ➔ **Gas, oil and propane space heating systems are available that are rated above 90% efficiency.**

Space heating systems fall into three broad categories–conventional, hybrid and integrated. In conventional systems, fuel or energy is used to directly create heat. Conventional systems include natural gas and propane furnaces and heaters, electric furnaces and heaters, oil-fired furnaces and heaters and wood fired furnaces and stoves.

Gas heating equipment is available in natural draft and fan assisted natural draft. Direct vent heating systems deliver the highest degree of efficiency and have lower environmental impacts than other systems.

All electrical resistance heating equipment, whether forced air furnaces or unitary baseboard type heaters, operate at the same conversion efficiency. In general, electrical resistance heating is not environmentally preferred.

There are two general types of oil heating equipment–conventional furnaces and boilers and high efficiency heating equipment. High efficiency oil heating equipment that delivers heat within higher efficiency ranges, are considered to have low environmental impacts.

In hybrid systems, fuel or energy is used to collect heat from another source. This category includes electric and gas assisted air-to-air heat pumps and electric-ground and water source heat pumps. Commercially available hybrid heating systems utilize heat pump technology and rely on an electrically driven refrigerant cycle to collect heat from outside air on the ground itself. These systems also provide a reverse cooling cycle for summer operation and some offer the option of water heating. Hybrid systems use electricity to collect heat. They offer the advantage of producing more energy than they require during operation. This high level of operating efficiency offsets, to some extent, the inherent inefficiency of electrical production and distribution.

Air to air heat pumps salvage heat from outdoor air. The efficiency with which they operate decreases as outside temperature falls. As a result, the actual seasonal efficiency of these units is climate related and they offer less efficiency in the coldest regions of Canada. Some systems are bivalent, which means they incorporate a gas burner on the collection circuit that assists the heat pump when outside temperatures fall below the level where efficient operation is possible.

Ground source heat pumps collect heat from the earth or from a water source through a series of buried pipes. Water source systems draw heat from wells or adjacent bodies of water. These systems offer higher efficiency than air-to-air systems, as the subsurface or water temperatures are relatively constant throughout the year. High capital costs and a requirement for an appropriate site and/or soil conditions are potential disadvantages.

Integrated heating systems combine a variety of heating and cooling functions and possibly ventilation, within a single mechanical unit. While efficiency testing and rating procedures for these systems are still under development, demonstrations indicate that high overall efficiencies are achieved by integrated systems.

Water Heating C.5

NMS Section 15480

➔ **The energy efficiency of water heaters depends upon two factors–how effectively energy is used to heat the water and how much energy is required to keep the water in the tank hot until it is used.**

Oil, gas and electrically fired domestic water heaters represent the conventional options available for water heating. An Energy Factor (EF) rating system has been developed to assess the relative performance of these units. Water heaters with EF ratings include combustion units with higher conversion efficiencies and electric combustion units with higher levels of tank insulation.

Solar energy is a clean and renewable source of producing hot water. This option produces none of the operational emissions of other energy sources. Solar water heaters are designed to provide 35–75% of hot water needs. Any hot water heating system that utilizes active solar energy is also considered to have lower environmental impacts.

The energy efficiency of water heaters depends upon two factors–how effectively energy is used to heat the water and how much energy is required to keep the water in the tank hot until it is used. The overall efficiency of conventional storage type water heaters is determined through testing and is expressed as the energy factor (EF).

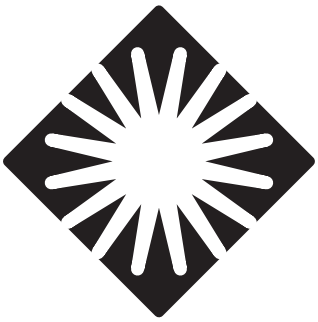
The heating elements of a hot water heater are immersed in the water. They convert energy into heat and in turn heat the water by conduction. New water heaters are connected for 'flip flop' operation. When the tank is started cold or when all the hot water has been used, the upper element comes on. The upper element heats the top one third of the tank so water on the top is brought up to temperature quickly. When the water reaches the temperature setting the top element shuts off. The bottom element then comes on and heats the water in the bottom of the tank.

There are a number of things that can be done to reduce energy waste and lower water heating costs. Insulating hot water pipes, particularly long runs that through cold or unheated areas will ensure that hot water arrives at the faucet at a higher temperature and more quickly. The two basic types of pipe insulation are wrapped and slip on. Both are easy to install and are readily available for a minimal cost.

In any installation, heat from the tank will move up the water supply line when the water is not being used. This pipe will be hot to the touch at all times and will waste heat continuously. To reduce this loss, install a heat trap. Although this procedure requires some plumbing modification, eventual savings will out weigh the initial expense.

Although an electric water heater has 50–75 mm of insulation, the hot water will slowly lose its heat to the surrounding air even if no hot water is drawn off. To reduce this effect, an insulating blanket can be installed around the water heater. This will add further insulation and reduce heat loss. Insulating blankets can only be installed on CSA performance certified water heaters. The temperature must not exceed 600 C. and the supply wiring to the fuse box must be at least 12 gauge.

Lighting C.6



NMS Sections 16505 to 16572

➔ **Three to five percent of Canada's electrical consumption is attributed to lighting.**

➔ **A fixture with a single bulb gives more useful light than one with several bulbs having the same total wattage.**

➔ **Keep light fixtures clean. Dirt cuts down light levels, which can lead to additional lights being switched on or higher wattage lamps being used.**

When addressing lighting concerns the first decision is how much light is required. There is a natural tendency to provide too much light. Lighting requirements should specifically address the tasks and purposes of the area. Several light sources create a uniform lighting and minimize glare and contrasts. Task lighting facilitates specific activities such as reading or computer work. Protective or safety lighting requirements are mandatory in many office buildings, especially in stairwells.

The second decision is what type of fixture will satisfy light-source needs. The three main types of lighting fixtures available are standard incandescent, fluorescent and tungsten-halogen. With incandescent lighting only a very small percentage of the electricity used actually becomes light. Fluorescent and tungsten-halogen lamps are much more energy efficient.

Most light fixtures use incandescent bulbs. Incandescents have a low initial cost, are compact and produce a warm colour tone. However, incandescents are not very energy efficient as only 5–8 % of the input energy results in light and the rest dissipates as heat.

Energy efficient incandescent bulbs that have been improved to use less energy, but with slightly less light output. They do not offer energy savings as large as the compact fluorescents, but they are compatible with dimmers, work well outdoors, and fit any light fixture that takes a regular bulb.

Long life or extended life incandescent bulbs last longer than regular ones, but put out up to 30% less light while using the same amount of energy. Bulbs with a higher than normal voltage rating are available. These are intended for use where the electrical voltage fluctuates. These bulbs are less efficient than standard incandescents.

Older fluorescent lamps were large and the light quality was poor. New types of fluorescent tubes and lamps produce light comparable to incandescent lighting and a new generation of compact fluorescent lamps and fixtures have been developed that are smaller and less bulky.

Fluorescent tubes use 60–80% less energy and last 10–20 times longer than incandescents. Fluorescents also work with conventional switches, however they do require special dimmer switches. Fluorescent lamps can have a high colour-rendering index and do not distort colours. Brightness and glare are relatively low, thereby causing little discomfort.

Using compact fluorescents can allow for the use of fluorescent lighting in most standard light fixtures. Compact fluorescents use about 25% of the energy of an incandescent bulb and last up to 10 times longer. This makes this product ideal for application in hard to reach locations such as stairwells. To maximize the efficiency of compact fluorescents they are best used where they would be illuminated for extended periods of time—three or more hours per day.

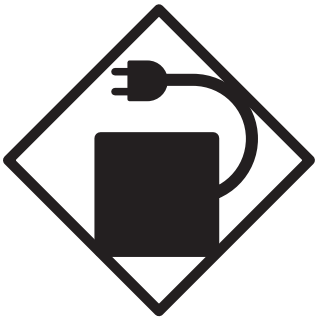
Compact fluorescents function most efficiently when the lamp is orientated downwards, with the base up. This is because the efficiency of the lamp depends upon the temperature of the coldest part of the lamp, which is the end furthest away from the ballast. As the heat rises, a base up lamp is the coolest at the bottom and it therefore produces the most light. Compact fluorescent lamps produce the same kind of light as natural incandescents. Most are not compatible with dimmer switches and are not recommended for outdoor applications. Tungsten-halogen lamps are incandescent lamps containing sealed gases from the halogen family. They have the same light out put as regular incandescent bulbs, but consume up to 50% less energy. Although they are more expensive to purchase, tungsten-halogens last 2–4 times longer than incandescent bulbs.

Tungsten-halogen lighting provides excellent colour rendering and produces a whiter light than conventional products. The lamps are small and lightweight. As the light in Parabolic Aluminum Reflector (PAR) type lamps is quite focused, tungsten-halogen lamps are perfect for aiming light to specific areas.

Tungsten-halogen lamps are low wattage flood lamps. A standard 150-watt incandescent spotlight can be replaced with a 90-watt PAR lamp and this will cut down on energy consumption by up to 40%. Tungsten-halogen lamps can be used either indoors or outside.

High-density discharge lamps (HID) include high-pressure sodium (HPS) and metal halide types. HPS lamps are an efficient source of exterior lighting. They provide bright light, which is ideal for safety purposes. HPS lamps use 70% less energy than standard floodlights and last up to eight times longer. This type of luminary is estimated to have useful lifespans of 10 years. Metal halides provide a blue-white light than is excellent for highlighting landscaping.

Appliances C.7



- ➔ **In 1992, the Federal Government of Canada passed the Energy Efficiency Act that regulates minimum efficiency standards for 'energy using products'.**
- ➔ **Appliance selected from the top 33% of the Energuide ratings are considered to provide the least environmental impacts.**
- ➔ **Correctly sizing an appliance to its intended purpose provides additional energy efficiency.**

Appliance manufacturers have made progress in improving the energy performance of their products. Many refrigerator models manufactured today consume one quarter to one third as much electricity as similar models made 10 years ago.

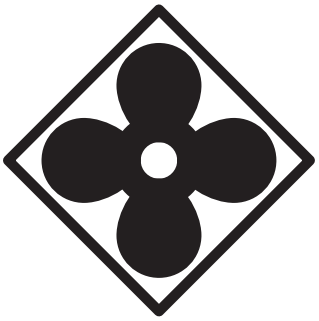
In 1992, the federal government passed the Energy Efficiency Act that regulates minimum efficiency standards for 'energy using products'. Under this legislation, energy labeling is required for all major household type electrical appliances sold in Canada. At the same time, significant improvements have been made to the Energuide labeling program.

EnerGuide is a program of Natural Resources Canada in partnership with electric utilities across Canada. Its goal is to help consumers identify the most energy-efficient products available on the market today. Energy efficiency saves money, builds a stronger economy and contributes to Canada's environmental objective of stabilizing greenhouse gas emissions. With these benefits in mind, EnerGuide works with manufacturers and retailers to promote the sale of products that will save Canadians energy and money while ensuring a healthy environment for future generations.

The Energuide concept is simple. Using standardized methods, all models of refrigerators, freezers, dishwashers, ranges, clothes dryers and washers sold in Canada are tested to determine energy use. The results of these tests must be indicated on a label attached to every new appliance; the information is also published in the Natural Resources Canada's Energuide Directory.

All results are presented in kilowatt hours (kWh) per month. For instance, an efficient freezer might be listed as using about 45 kWh of electricity per month, while a less efficient unit in the same size range might use about 65 kWh per month. The lower the Energuide rating the more efficient the appliance.

Ventilation C.8



NMS Sections 15510 to 15781 and 15805 to 15950

➔ **The 1995 edition of the National Building Code includes a completely rewritten ventilation section. Changes include two system design options, a performance approach and a prescriptive approach.**

➔ **Ventilation needs vary at different times and in specific areas of any building. The use of sensors will allow the ventilation system to respond to specific needs.**

➔ **The importance of ventilation in buildings that have upgraded the building envelope to decrease air infiltration is universally recognized.**

The importance of ventilation in today's energy conscious buildings is universally recognized. Mechanical ventilation makes a building healthier, cleaner and more comfortable by continuously replacing stale indoor air with fresh exterior air.

The main environmental concerns related to ventilation are:
- Indoor air quality–mechanical ventilation systems supply fresh outdoor air and exhaust stale indoor air and excess humidity. A regular exchange of air prevents pollution from accumulating and affecting occupants.
- Reduction of energy loss to outdoors–the replacement of climatized air with exterior air can negatively impact on energy use within a building unless heat recovery is integrated into the ventilation system.

There are three basic types of ventilation systems. They are exhaust only, supply only and balanced supply and exhaust systems.

Exhaust systems include central exhaust and equipment venting systems. These systems rely on fans to mechanically exhaust air from the building, and fresh air inlets, or breaks, in the building envelope to draw in fresh air. Exhaust only systems have some disadvantages, including adding to a buildings heat load. The supply of fresh air is uncontrolled and may not meet the needs of the occupants. These systems can create negative pressure that may cause back drafting of combustion appliances and they also increase the possibility of radon (a known carcinogenic) being drawn into the building from the soil. While such systems are not environmentally preferred, they make sense in some situations such as cafeterias.

Supply only systems include central supply, local supply and make-up air systems. These types of systems rely on fans to pull fresh air into the building and on stale air being forced out through breaks in the building envelope. Supply only systems have many disadvantages. The exhaust of stale air is uncontrolled and may not meet the needs of the occupants. Positive pressure within the building can be created and this forces moist air into the building envelope and can result in the formation of condensation in the walls.

Balanced supply and exhaust systems include systems with or without heat recovery. Balanced systems rely on fans to draw fresh air into the interior cavities and expel stale indoor air from the or contaminated areas of the building. The supply and exhaust flows are adjusted to create neutral pressure in the building.

Balanced ventilation systems can be achieved using several configurations. Balanced systems include a central forced air system using a central supply and exhaust system, a forced air system incorporating a powered ventilator without heat recovery, a forced air system incorporating a heat recovery ventilator, or an independent heat recovery ventilator.

Balanced ventilation systems that include heat recovery offer many advantages. The supply of fresh air and the exhaust of stale air is controlled to meet the needs of the occupants. Cold air is preheated as it enters the building and does not cause drafts or discomfort to occupants.

Pay-back costs for heat recovery balanced ventilation systems will vary depending on local energy costs and differences in regional temperatures. While these systems do represent an increase in capital costs the increase is offset by reduced costs to preheat the ventilation air. The current trends in building technologies towards prescriptive solutions, such as the selection of building materials with lower emissions rates, will result in reduced ventilation requirements.

WATER CONSERVATION PRODUCT DIRECTORY

appendix D

APPENDIX D

Toilets *D.1*

- **Conventional toilets require between 16 and 20 litres per flush compared to low consumption toilets that require 6 litres or less.**
- **Toilets are notorious for their hidden water leaks. They can waste hundreds of gallons of water a day.**
- **Dual flush toilets are currently available that provide the option of selecting the amount of water used with each flushing action.**

Everytime a toilet is flushed, as much as 67 litres of water goes into the sewer. Most toilets use more water than is really necessary and work just as well with less. Low-flush toilets use a smaller tank and a specially designed bowl to give the same flush power with a lot less water. A model using six litres or less of water per flush can significantly impact on water consumption levels. Dual flush toilets are available that provide the option of selecting the amount of water used with each flushing action.

Toilets are notorious for their hidden leaks. They can waste hundreds of gallons a day, undetected. Leaks occur when the toilet is out of adjustement or when parts are worn. It is important to check the mechanics of the toilet on a periodic basis.

Most toilet leaks are at the overflow pipe or at the plunger ball. If the leak is at the overflow, the water level is too high. Slight adjustments to the float arm will lower the water level. Sometimes, the valve is worn and the appliance will run like a leaky faucet. In this scenario, the water valve must be replaced.

Plunger-ball leaks are not as easy to detect. These types of leaks can be identified by dropping a little food colouring or specifically designed dyes into the clear water in the tank and waiting to see if the colour appears in the bowl. If the dye appears in the bowl, there is a leak at the plunger ball. Thus, either the mechanism needs replacing or the mechanism is out of alignment.

Toilet retrofit kits are available that will reduce the waste consumption of conventional toilets. These kits include a plastic bottle or bag that is filled with water and placed inside the toilet tank. Bricks should never be used as a substitute for this purpose as the weight may crack the tank or the brick may disintegrate causing serious and expensive problems in the plumbing system.

Faucets *D.2*

➔ **The use of low-flow faucets provides environmental benefits by reducing water use and in turn, easing the burden on municipal sewer systems and reducing energy requirements to heat water.**

Conventional kitchen and lavatory faucets have flow rates between 25–50 litres per minute. These products are no longer certified in Canada. Water conserving faucets and aerators reduce the flow rate significantly, saving both water and energy used to heat water. Use of these appliances also reduces the burden on municipal wastewater treatment facilities. The current Canadian Standards Association (CSA) guideline stipulates a maximum flow rate of 8.3 litres per minute at 60 psi.

Repair dripping faucets by replacing washers. If a faucet is dripping at a rate of one drop per second, this translates into 11,340 litres of wasted water per year. Retrofiitting faucets by installing aerators with flow restrictors will also slow the flow of water without comprimising performance.

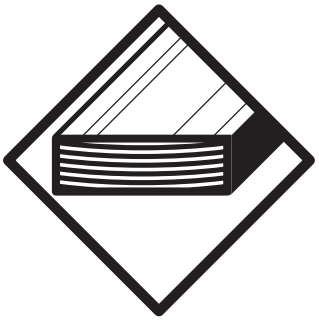
Infrared sensors can also reduce water wastage as the sensor turns taps on when an object is sensed below the faucet and turn the tap off when the object is removed.

CONSTRUCTION, RENOVATION & DEMOLITION WASTE DIVERSION OPTIONS

appendix E

APPENDIX E

Wood Products *E.1*



➔ **Sheathing and dimensional lumber are often the largest components of new construction and demolition projects.**

➔ **Most wood materials can be diverted for use as feedstock in manufacturing processes.**

REUSE

Clean, dimensionally stable wood can be reused in a number of ways. It can be reused on an alternative construction site or diverted for reuse through used building material outlets. Cut-offs can be used as bridging and backing materials. The use of a central cutting area where all cut-offs are kept will facilitate this procedure.

RECYCLING

Wood products can be diverted to appropriate facilities that will use the material as feedstock in the production of pallets, particleboard, fire logs animal bedding and landscaping material. Lumber that has been pressure treated, painted or stained, as well as plywood and other glued wood products is not acceptable for use as feedstock for animal bedding or landscaping materials as the glues that hold the product together are contaminates and in some cases toxic.

REDUCE

For construction projects, minimizing waste allowances during estimating procedures can reduce wood waste. Using advanced framing techniques can use 10–15% less wood by having wider spans between studs and two studs per corner rather than four. Use prefabricated systems when ever possible. The purchase of pre-cut kiln dried lumber will also reduce on site off-cuts. Unused materials should be returned for credit or immediately removed from the site for use at an alternative site.

Cardboard and Paper Products *E.2*

➔ **Every square foot of new construction generates approximately one kilogram of cardboard waste. Most of it being generated by packaging materials associated with materials used on site.**

➔ **Cardboard is easily recycled in most municipalities in Canada.**

REUSE

Purchasing products in bulk often allows for the use of reusable pallets for packaging. Products such as furnishings can be ordered to be shipped with reusable blankets rather than shipping crates. Suppliers should be questioned to determine alternative options.

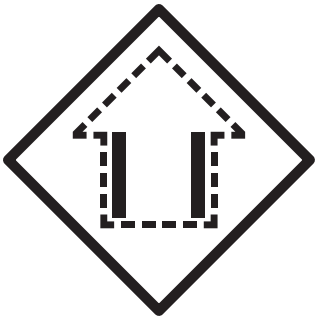
RECYCLING

Uncontaminated cardboard and paper waste, with the exception of building paper, can be recycled in most municipalities in Canada. Cardboard can be recycled repeatedly into new cardboard, boxboard and shingles. Paper waste can also be recycled into new paper products. Building paper, tissue paper and contaminated paper and cardboard, such as caulking tubes cannot be recycled.

REDUCE

Purchasing products in bulk with reusable packing will reduce cardboard and paper waste. In addition, specifying that suppliers and sub-trades are responsible for the removal of their own wastes, will reduce packaging waste.

Drywall *E.3*



➔ **Next to wood, drywall is the second largest component of the construction industry waste stream.**

REUSE

The specification of component systems, such as demountable partitions, allows for drywall to be refurbished and reused either within the same facility or diverted to an alternative site for reuse. Large off-cuts can be distributed for reuse through used building materials outlets. Scrap pieces can be used for patching purposes.

RECYCLING

Clean and uncontaminated drywall has been banned from landfill sites in Toronto and Vancouver. Although facilities are regionally limited drywall can be recycled. Clean scrap drywall is reprocessed into new products, or used as a soil stabilizer or pet litter.

REDUCE

Design specifications that allow for the use of standard board sizes can significantly reduce on-site waste.

Metals *E.4*

➔ **New construction sites generate a relatively small amount of metal materials. The waste material usually consists of rebar, metal banding, sheet metal, wiring cut-offs, aluminum cutting and paint cans.**

➔ **On the other hand, a demolition site can generate a considerable amount of metal material, most of which is generally recyclable in all municipalities in Canada.**

REUSE

Items such as circuit breaker boxes, hot water tanks, HVAC equipment, metal studs and other building components may be reusable depending upon the condition. These materials can often be diverted for reuse through used building product facilities.

RECYCLING

Almost all metals can be recycled through scrap yards. Any materials that have metal parts combined with other materials require sorting prior to recycling.

REDUCE

Beyond accurate cutting procedures and take-off calculations during construction procedures, there are few initiatives that will reduce metal waste.

Plastic *E.5*

➔ **Packaging, vinyl siding, polyethylene sheets, water supply and drain lines and foam insulations generate plastic materials on both construction and demolition sites.**

REUSE

If quantity and condition is appropriate, some materials such as vinyl siding can be diverted for reuse through used building material facilities.

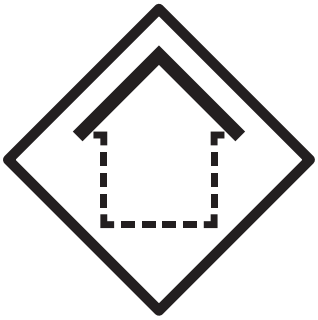
RECYCLING

Most plastic waste can be recycled. However it must be sorted by type. Plastic can be recycled into a variety of products including pails, fence posts, plastic bags, road signs and horticulture products.

REDUCE

Plastic packaging materials can often be reduced through the specification of reduced packaging requirements. Beyond accurate cutting procedures and take-off calculations during construction procedures, there are few initiatives that will reduce other plastic waste.

Roofing E.6



➔ **There are numerous types of roofing materials. They include asphalt shingles, steel roofing, tar and gravel, wooden shakes and concrete or tile roofing. All of these products have diversion opportunities.**

REUSE

If quantity and condition is appropriate, some materials such as leftover asphalt shingles or steel roofing can be diverted for reuse through used building material facilities.

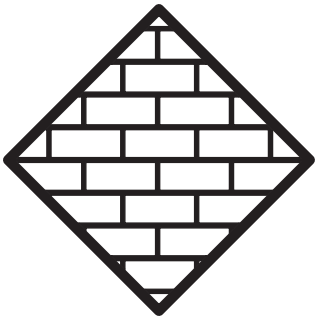
RECYCLING

Recycling options exist for all roofing products. Asphalt shingles and tar and gravel roofing can be used as feedstock for asphalt mixes used in road construction. Steel roofing can be recycled through scrap yards and concrete tiles can be crushed and used as road bed or backfill. Depending on the condition, wood shingles can be diverted with other wood products.

REDUCE

Beyond accurate cutting procedures and take-off calculations during construction procedures, there are few initiatives that will reduce roofing waste.

Concrete, Brick and Mortar *E.7*



➔ **There are numerous types of roofing materials. They include asphalt shingles, steel roofing, tar and gravel, wooden shakes and concrete or tile roofing. All of these products have diversion opportunities.These materials are more often found in the waste stream of demolition projects rather than construction sites.**

REUSE

Used bricks can be cleaned and reused either while on site or through an alternative location. Some bricks of older vintage are considered a valued architectural feature and are in demand for historical restorations. Excess ready-mixed concrete can be used for parking curbs, planters or landscaping.

RECYCLING

Bricks, concrete and mortar can be crushed and used as aggregate for road bed construction, backfilling, decorative landscaping and other construction applications.

REDUCE

Care should be taken during construction projects to endure that excess materials are not inadvertently ordered.

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appendix F

APPENDIX F

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Fax: 819-953-225

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ENVIRONMENT CANADA
123 Main St.; Suite 150
Winnipeg, MB
R3C 4W2
Phone: 204-983-4812
Fax: 204-983-0960
Email: adolf.andres@ec.gc.ca

CANADA MORTGAGE AND HOUSING CORPORATION
700 Montreal Road
Ottawa, Ontario
K1A 0P7
http://www.cmhc-schl.gc.ca/

GREEN BUILDING INFORMATION COUNCIL (GBIC

PRESIDENT DR. RAY COLE,
University of British Columbia,
Fax: 604 822-3808, Email: cole@architecture.ubc.ca

PRAIRIES - ROBERT DUMONT
Research Council,
Fax: 306 933-6431

ONTARIO - CRAIG CRAWFORD,
EcoDesign Group,
Fax: 519 393-6803,
Email: crawford@cyg.net

QUEBEC - ROBERT THIBODEAU,
Klein Thibodeau Henderson, Architecture & Design,
Fax: 514 484-0852, Email: Email:cxrt@musica.mcgill.ca

ATLANTIC - DAVID STEWART,
Jacques Whitford Environment Ltd.,
Fax: 902 468-9009, Email: dstewart@jacqueswhitford.com

FEDERAL GOVERNMENT - NILS LARSSON,
CETC, Natural Resources Canada,
Fax: 613 232-7018 Email:larsson@greenbuilding.ca

GREEN BUILDING INFORMATION COUNCIL (GBIC) CONTINUED
OTTAWA CHAPTER - VINCE CATALLI,
by dEsign Consultants,
Fax: 613 230-4149,
Email: vcatalli@cyberus.ca

GREEN LANE ON THE INFORMATION HIGHWAY
Environmental Canada
http://www.ec.gc.ca

ALBERTA ENVIRONMENTAL NETWORK (AEN)
10511 Saskatchewan Drive
Edmonton, AB
T6E 4S1
Phone: 403-433-9302
Fax: 403-439-5081
http://www.web.net/~aen/

ALBERTA ENVIRONMENTAL PROTECTION
Alberta Waste Materials Exchange (AWME)
12th Floor, 9915 - 108 Street, Edmonton Alberta T5K 2G8
Phone: 403-427-6982
Alberta: 1-800-463-6326
Fax: 403-427-1594
Email: wastenot@env.gov.ab.ca
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BC ENVIRONMENTAL NETWORK (BCEN)
1672 - 10th Avenue East
Vancouver, BC
V5N 1X5
Phone: 604-869-2279
Fax: 604-879-2272
Email: info@bcen.bc.ca
http://www.bcen.bc.ca/moreabout.html

BUILDING ENVIRONMENTAL PERFORMANCE ASSESSMENT CRITERIA (BEPAC)

CHAIR :

Milton Gardner, FRAIC MAIBC
Poon Gardner Garrett
301-1770 W Seventh Street
Vancouver, British Columbia
Canada, V6J 4Y6
Phone: 604-736-0013
Fax: 604-736-4277
Email: 103052.1256@compuserve.com

BUILDING ENVIRONMENTAL PERFORMANCE ASSESSMENT CRITERIA (BEPAC) CONTINUED

EXECUTIVE DIRECTOR :

Peter Horvatis,
Peter Horvatis Consultants
1663 Book Road West
Jerseyville, Ontario
Canada, L0R 1R0
Phone: 905-648-0536
Fax: 905-48-8926
Email: 102361.356@compuserve.com

BRITISH COLUMBIA

Teresa Coady
Bunting Coady Architects
171 Water Street, Suite 300
Vancouver, British Columbia
Canada, V6B IA7
Email: tcoady@cyberstore.ca

ONTARIO

Vince Catalli
by dEsign consultants
417 Bronson Avenue, Suite 2
Ottawa, Ontario
Canada, KIR 6J6
Phone: 613-230-5776
Fax: 613-2304149
Email: vcatalli@cyerus.ca

QUEBEC

Robert Thibodeau
Klein Thibodeau Henderson, Architecture + Design
214 Victoria Avenue
Westmount, Quebec
Canada, H3Z 2M4
Phone: 514-484-4407
Fax: 514-497-4539
Email: cxrt@musica.mcgill.ca

ATLANTIC CANADA

David Stewart
Jacques Whitford Environmental Ltd.
3 Spectacle Lake Road
Dartmouth, Nova Scotia
Canada, B3B 1W8
Phone: 902-468-7777 ext. 303
Fax: 902-468-9009
Email: stewart@jacqueswhitford.com
http://www.greenbuilding.ca/bepac1.html

CANADIAN ASSOCIATION FOR ENVIRONMENTAL ANALYTICAL LABORATORIES (CAEAL)

Suite 300, 265 Carling Avenue
Ottawa, Ontario
K1S 2E1
Phone: 613-233-5300
Fax: 613-233-5501
http://www.caeal.ca/

MANITOBA ECO-NETWORK, INC.

#2 - 70 Albert Street
Winnipeg, Manitoba
R3B 1E7
Phone: 204-947-6511
Fax: 204-947-6514
http://www.gatewest.net/green/men/

TORONTO COMMERCIAL & INDUSTRIAL WASTE REDUCTION HOTLINE

55 John Street, 19th floor
Toronto, ON
M5V 3C6
Phone: 416-392-4200
Fax: 416-392-4754
http://www.city.toronto.on.ca

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RR#4
Sussex, NB
E0E 1P0
Phone: 506-433-6101
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NEWFOUNDLAND & LABRADOR ENVIRONMENTAL NETWORK

P.O. Box 944
Corner Brook, NF
A2H 6L2
Phone: 709-634-2520
Fax: call first
Email: cbnlen@nfld.net

NOVA SCOTIA ENVIRONMENTAL NETWORK
PO Box 223
Pictou, NS
B0K 1H0
Phone: 902-485-8013
Fax: 902-485-6017
Email: nsen@web.net
http://juliet.stfx.ca/people/sta/dspencer/www/nsen.html

ONTARIO ENVIRONMENTAL NETWORK
25 Douglas Street
Guelph, ON
N1H 2S7
Phone: 519-837-2565
Fax: 519-837-8113
Email: oen@wet.net

GREEN BUILDING INFORMATION COUNCIL
130 Lewis Street, Ottawa, ON K2P 0S7
Phone: 613-232-2330
Fax: 613-232-7018

ENVIRONMENTAL CHOICE PROGRAM
Terrachoice Environmental Services Inc.
Phone 613-247-1900
Fax: 613-247-2228
Email: ecoinfo@terrachoice.ca

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Natural Resources Canada
Phone: 613-992-3900
Fax: 613-943-1590

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582 Somerset West
Ottawa, ON
K1R 5K2
Phone: 613-237-6937
Fax: 613-237-9900
Email: mmi@thewillowgroup.com
http://thewillowgroup.com/mmi/mmi.html

GREEN PROCUREMENT INSTITUTE
582 Somerset West
Ottawa, ON
K1R 5K2
Phone: 613-237-6937
Fax: 613-237-9900
Email: gpi@thewillowgroup.com
http://thewillowgroup.com

CANADIAN STEEL PRODUCERS ASSOCIATION ENVIRONMENT COMMITTEE
#1425, 50 O'Connor Street
Ottawa, ON
K1P 6L2
Phone: 613-238-6049
Fax: 613-238-1832
Email: cspacpa@canadiansteel.ca
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13th Floor, Section C9
580 Booth Street
Ottawa, ON
K1A 0E4
Phone: 613-996-6220
Fax: 613-996-9416
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ECOLOGY ACTION CENTRE (EAC)
Suite 31, 1568 Argyle Street
Halifax, Nova Scotia
B3J 2B3
Phone: 902-429-2202
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Ottawa, ON
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Phone: 613-234-4151
Fax: 613-234-2988
Email: sesci@cyberus.ca
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Phone: 613-232-2330
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27 Goulborn Avenue, Ottawa, ON
K1N 8C7
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TORONTO WORKS AND EMERGENCY SERVICES
55 John Street, STN 1180 18th Floor, Metro Hall
Toronto, ON
M5V 3C6
Phone: 416-397-7100
Fax: 416-392-2974
http://www.metrotor.on.ca/works/

AMERICAN WATER WORKS ASSOCIATION
6666 West Quincy Avenue, Denver CO 80235

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Realty Services, National Capital Region and Environmental Services Directorate

WATER EFFICIENCY GUIDE FOR BUSINESS MANAGERS AND FACILITY ENGINEERS
State of California Department of Water Resource

WATER EFFICIENCY–A RESOURCE FOR UTILITY MANGERS, COMMUNITY PLANNERS AND OTHER DECISION-MAKERS
The Rocky Mountain Institute

WATER EFFICIENCY STRATEGY FOR ONTARIO MINISTRY OF NATURAL RESOURCES
Water Policy Branch

ENVIRONMENTALLY CONSCIOUS DESIGN STANDARDS FOR ONTARIO GOVERNMENT BUILDINGS (1993)
Ministry of Government Services, Realty Group, Design Services Branch

References

PART FOUR: CONSTRUCTION RENOVATIONS AND DEMOLITION WASTE DIVERSION

USED BUILDING MATERIAL ASSOCIATION (UBMA)
Rosemary Trachsel,
Used Building Materials Association
#2-70 Albert Street
Winnipeg, Manitoba, Canada
R3B 1E7
Phone: 204-947-0848
Fax: 204-942-4207
Email: ubma@pangea.ca
Canadian Construction Association (CCA)
85 Albert Street, 10th floor
Ottawa, Ontario
K1P 6A4
http://www.cca-acc.com/

CANADIAN HOME BUILDERS ASSOCIATION (CHBA)
150 Laurier Avenue W.
Ottawa, ON
K1P 5J4
Phone: 613-230-3060
Fax: 613-232-8214
http://www.chba.ca/

CONSTRUCTION ASSOCIATION OF NOVA SCOTIA
260 Brownlow Avenue, Unit 3
P.O. Box 38100
Dartmouth, Nova Scotia
B3B 1X2
Phone: 902-468-2267
Fax: 902-468-2470
http://ctca.unb.ca/CANS/

EARTHCYCLE - A DIVISION OF BODNER METAL & IRON CORPORATION
http://www.bmicorp.com/

ONTARIO WASTE MANAGEMENT ASSOCIATION
Suite 211, 2150 Winston Park Drive
Oakville, Ontario
L6H 5V1
Phone: 905-829-8585
Fax: 905-829-8181
http://www.owma.org/

SOCIETE QUEBECOISE DE RECUPERATION ET DE RECYCLAGE (RECYC QUEBEC)
14 Place du Commerce Bureau 350,
Isle De Soeurs, Quebec
H3E 1T5
Phone: 514-762-3333
Fax: 514-873-6542

RECYCLING COUNCIL OF ALBERTA
Box 23
Bluffton, Alberta
T0C 0M0
Phone: 403-843-6563
Fax: 403-843-4156
http://www.recycle.ab.ca/

RECYCLING COUNCIL OF BRITISH COLUMBIA
225 Smithe St., # 201
Vancouver British Columbia
Canada V6B 2X7
Phone: 604-683-6009

RECYCLING COUNCIL OF ONTARIO
489 Collage St., # 504
Toronto Ontario
Canada M6G 1A5
Phone: 416 960-1025
Fax: 416 960-8053
Email: rco@rco.on.ca
http://www.rco.on.ca/

SASKATCHEWAN WASTE REDUCTION COUNCIL
203-115 2nd Avenue North
Saskatoon, SK
S7K 2B1
Phone: 931-3242
Email: swrc@web.apc.org
http://198.169.128.1/science/swrc/

MORE THAN 100 EASY WAYS TO CUT COSTS BY REDUCING WASTE
Waste Reduction Office
Regional Municipality of Waterloo