April 29, 2002

Mr. Eric Bottomley, Education Coordinator
Centre for Education and Research in Environmental Strategies
East Brunswick, Victoria 3057

Dear Mr. Bottomley,

Enclosed is our report entitled Sustainable Development in Victorian Schools: A Checklist and Technology Review to Further Understanding. It was written at the Centre for Education and Research in Environmental Strategies during the period of the 12th of March, 2002 through the 29th of April, 2002. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Australia. Copies of this report are being submitted simultaneously to Professors Gerstenfeld and Vernon-Gerstenfeld for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you and Ms. Zanni Waldstein have devoted to us.

Sincerely,

Matthew Cote
Scott Dolan
Dennis Mayo
Ashley Walsh

Report Submitted to:

Prof. Susan Vernon-Gerstenfeld & Prof. Arthur Gerstenfeld

Australia, Project Centre

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In Cooperation With

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CERES - Centre for Education and Research in Environmental Strategies

SUSTAINABLE DEVELOPMENT IN VICTORIAN SCHOOLS: A CHECKLIST AND TECHNOLOGY REVIEW TO FURTHER UNDERSTANDING

29th of April 2002

This project is submitted in partial fulfilment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Centre for Education and Research in Environmental Strategies or Worcester Polytechnic Institute.

ABSTRACT

The Sustainable Schools program was designed to help schools become more sustainable with regards to water, waste, energy, and biodiversity. Meetings, research, and interviews were conducted to develop tools for the program. A checklist was compiled containing actions to increase sustainability and referencing the technology review. This review features explanations, calculations for cost-benefit analysis, and resources where more information can be gathered for each technology. Together, these tools enable schools to better understand the technologies available to become more sustainable.

AUTHORSHIP PAGE

During the completion of this report, the group wrote the executive summary, introduction, analysis of results, conclusions and recommendations, and appendix B, with all members contributing equally. The sustainable development section of the literature review was originally written by Scott Dolan and subsequently edited by the remainder of the group. Matthew Cote composed the sustainable schools section of the literature review, the methodology chapter, and appendix C before they were edited and/or supplemented by the rest of the group.

The research was divided up into the four main areas, which CERES will incorporate into the Sustainable Schools program: energy, water, waste, and biodiversity. Dennis Mayo's research focus was energy, and he was the author of the energy sections of the literature review, technology review, and checklists. While Matthew Cote, Scott Dolan, and Ashley Walsh completed the research for the corresponding sections of biodiversity, water, and waste sections, respectively. All the members of the group, however, helped edit each section. The group developed the final format for the checklists and technology review with suggestions and recommendations from Eric Bottomley and Zanni Waldstein.

Ashley Walsh and Dennis Mayo developed appendices A, D, and E after being created by Scott Dolan and Matthew Cote. Dennis Mayo was responsible for the original transcription of appendix C before it was group edited. *En toto*, the paper was a true collaborative effort from all group members.

ACKNOWLEDGEMENT

We would like to express our sincere appreciation to Eric Bottomley and Zanni Waldstein for allowing us the chance to sculpt this report at such a unique organisation as CERES. Through their vision and continuous efforts, the Sustainable Schools program is now off the ground and gaining momentum around Victoria.

We would also like to thank the remaining CERES employees for putting up with four American students, who for seven weeks constantly occupied PC1 and PC2, in spite of the efforts to be removed. Our appreciation goes out to the employees of the CERES Café, who supplied Ashley with her daily lemon slice and generously allowed our group to eat any of the left over food at the end of each day. We would like to thank Ryan Petti for the use of most of his laptop, with the exception of the space bar.

We would like to express our gratitude to our project advisors, Professors V-G and Gerstenfeld, for the genuine concern and support that they showed in guiding us through the development and completion of our project and for the sustenance with which we were provided at V-G's Gipps St. Bakery, upstairs in Room #9.

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EXECUTIVE SUMMARY

The Centre for Education and Research in Environmental Strategies (CERES), along with the Gould Group, are developing a Sustainable Schools program to be implemented across the Victorian school system. CERES and the Gould Group's goal is to provide material and guidance necessary for schools to take action and become a Five-Star Sustainable School. This information is divided into the five separate units with a star given upon completion of each. The five units are sustainability, biodiversity, waste, water, and energy. This multifaceted program brings together a montage of resources and information to assist schools at each stage of the program.

This report focuses on helping school staff develop an action plan to implement technologies and reduce their school's ecological footprint, by reducing their consumption of energy, water, waste, and promoting biodiversity. We completed research in each of these areas in order to create a technology review that will help school staff understand many of the basic concepts behind using and educating their students about these innovative technologies. The technology review incorporates explanations that are easy to understand, and that are complemented with diagrams and references. The technology review lists resources where schools can collect further information on topics of interest. From this technology review, a checklist of recommendations was created to be distributed to schools, advising school staff on actions that might aid them in reducing resource consumption. The checklist also refers the reader back to the technology review, where they can increase their understanding of a specific technology and its use.

The manner with which the research was conducted depended entirely on the type of information sought. Initially, the project group attended meetings between CERES'

Sustainable School coordinator and the four pilot schools, in order to better understand the Sustainable Schools program. The project group conducted extensive informational research on sustainable technologies, using a variety of online and paper resources complemented with numerous case studies and benchmarks. The information discovered during the research was then compiled into the technology review and checklist.

The project group also developed and administered semi-structured interviews with authorities in each area of research, in order to verify the accuracy and plausibility of the information included in the technology review and checklist. During the interviews, additional resources were gathered to enhance the technology review. Questions about the format and clarity of the presentation were also asked of these authorities, because many of them were involved with school programs in the past and have experience in providing information that is understandable for schools.

The research showed that technologies, which reduce resource consumption, are available to schools. They are spread amongst a myriad of other information, however, and are not differentiated in a way that would be meaningful to an inexperienced researcher. Therefore, the technology review acts to organise and give a basic understanding of these available technologies, so that the cost of time and effort the school staff spends on researching and implementing these technological advances will be reduced. It was also found that by incorporating many of these technologies, schools could reap the benefits of long-term cost savings, after an initial investment.

Due to the past success of the Waste Wise program, the project group recommends that its steps be fully integrated into the Sustainable Schools program. Benefits of this could include organised guidelines that allow schools to understand the program in greater depth and streamline the process of initiating each school into the Sustainable Schools program.

We highly recommend the establishment of a communication network that allows schools within the program to contact one another or other schools around the world working towards similar goals. This would allow for schools to work in conjunction with one another and provide assistance that CERES and the Gould Group cannot. Such a network would also allow the interchange of ideas and programs that have found success in one school to be adapted into others, without program coordinators being involved. Given the lack of time and limited resources, a means of intercommunication among schools could vastly improve the program without drastically increasing the amount of time required from CERES and the Gould Group.

The project group also recommends that a recognition program be established and be marketed to the public to increase their understanding of the Sustainable Schools program. If the phrase "Five-Star Sustainable School" achieves recognition from the general public, then its impact will be more effective and meaningful.

In conclusion, the project group recommends that further research projects be conducted once the Sustainable Schools program has been fully established and has been integrated by several schools. These research projects should entail evaluating the effectiveness of the program and changes that need to be made to assure the program continues successfully. If the research shows that there are specific areas posing significant problems for schools, a second project should examine the reasons behind these and identify methods to remedy them. A third research project should investigate the effects of sustainable technologies on students, and their ability to learn and function in the school environment. Are sustainable technologies that save the most money and resources always the best choice for the school community?

I. INTRODUCTION

Imagine a world where there is, "No playing on the swing set until someone washes off the black dust. No barbecues at Grandma's, where the view from the picnic table is of an enormous slag pile. No digging in the backyard." (Wilgoren, 2002, January 19). What would it be like to live in such a place, where going outdoors could be deadly? This is a possible consequence that environmental negligence could unleash on society, placing the public health at risk and harming environmental integrity. Environmentally detrimental actions can have predictable long-term effects and hence, become ethically unjustifiable if future generations bear moral consideration. Wilgoren's quote refers directly to the town of Hercules, Missouri, the location of a smelting plant; however, this description could easily be of any small town in the United States or Australia.

The Centre for Education and Research in Environmental Strategies (CERES) is but one of numerous organisations making environmental issues paramount (Appendix A). They have started a number of projects dealing with such problems by integrating typical economic decision making with the ideas of sustainable development. Their Sustainable Schools program works to simplify the integration of ecological awareness and preservation into schools throughout Victoria. This program is currently in the pilot stages of development and is being incorporated into the Environmental Protection Agency (EPA) of Victoria's Eco-Footprint[1] pilot project's initial programs.

Research shows that technologies exist, which can be incorporated into schools to make them more sustainable. The problem, however, remains assimilating these

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[1]The EPA of Victoria's Eco-footprint pilot project is being conducted with thirteen organisations that are putting the theory behind eco-footprint into practice. An eco-footprint measures an individual's impact on the environment by converting all aspects of their lifestyle into the equivalent land area, required to maintain it.For example, energy usage is first converted from kilojoules to an equivalent tonnage of carbon dioxide, then into the area of land needed to remove that amount of carbon dioxide from the atmosphere.

technologies into today's school systems. Hence, the goal of this project is to assist in promoting the efficiency and reduction of resource use by creating a tool, which consists of a comprehensive technology review and checklist tailored to Victorian schools, which incorporate information about biodiversity, energy, water, and waste management. The technology review and the checklist include lists and descriptions of available technologies, simple costs and benefits of each, and local contacts. This will include information gathered from resource authorities, such as the Victorian Department of Environment and Training (DE&T), the Gould Group[2], and CERES, as well as information on similar initiatives around the world.

[2]The Gould Group is a group that is environmentally active in the Melbourne community, and provides the community, especially schools, with materials, histories, and programs about current environmental issues.

II. LITERATURE REVIEW

This section of the proposal examines literature on sustainability, waste reduction, water and energy conservation, biodiversity planning, and their possible application by schools in Victoria. Case studies were cited to demonstrate the potential for success, should these ideas be integrated into school planning in the future.

Sustainable Development

Sustainable development is *anthropocentric* economic activity that entitles all humans, present and future, to health and productivity, providing the development is in harmony with nature (U.N. Council on Sustainable Development, 1992). Agenda 21, as created by the United Nations (U.N.) and ratified by the Australian government, defined sustainable development on national and international levels during the 1992 Earth Summit in Rio (U.N. General Assembly, 1992). With its endorsement, the Australian government committed itself to an international spirit of cooperation, protection of endogenous cultures and species, advancement of the overall technological understanding of nature, and reactionary measures based on this new understanding that assures the durability of the ecosystem and promotes economic growth on a timeline suited to the government's needs. The Report of the United Nations Conference on the Environment and Development, by the U.N. General Assembly (1993), unambiguously stated such commitments within its list of principles.

In Australia, however, the constitution bestows much of the authority necessary for compliance with Agenda 21 to state and territorial governments (U.N. Council on Sustainable Development, 1997). Therefore, the State of Victoria has committed itself to a 15 percent reduction in what the government has deemed unsustainable energy production. More specifically, the Victorian Government has judged global warming, and thus, greenhouse gas emissions, as the *cause celebre* for compliance with Agenda 21, marked by the creation of the Victorian Greenhouse Strategy[3] (Minister of Energy and Resources, May 16, 2000). This choice of compliance finds justification by being one of five major criteria used in the Environmental Sustainability Index (ESI)[4] sponsored annually by the World Economic Forum (Global Leader of Tomorrows Economic Task Force: World Economic Forum, et al., 2002). In addition to mandates in the area of energy reductions, the Victorian government encourages efficient use of all other recourses through voluntary incentive programs, including the EPA of Victoria's Eco-footprint program.

[3]The Department of National Recourses and Environment of Victoria developed the Victorian Greenhouse Strategy as plan to reduce greenhouse gas emissions statewide. The strategy integrates policy review and development with measurements and community partnerships. The strategy has attempted to restrain from creating mandates or regulation to force compliance, but instead encouraged self-induced improvements in emission level through an incentive program.

[4]The Environmental Sustainability Index is rating of countries based on four major factors of sustainability by teams from Columbia University and Yale. The factors are air quality, water quality, land protection, and climate change. The quantifiable data is used a much as possible while tabulating the scores of each factor.

Sustainable Schools

California State Polytechnic University states that the only fully functional sustainable system is the natural ecosystem, whereas a sustainable school explores the possibilities for a designed ecosystem that is improved by human presence. Projects to create sustainable schools, also referred to as eco-schools, have already taken place or are currently in progress around the world. Countries in Europe, such as Hungary and Great Britain, as well as the United States are just a few places where eco-schools are currently operating. David Orr, while speaking about the Adam Joseph Lewis Centre at Oberlin College, described an eco-school as "not just a place for classes, but rather a building that would help to redefine the relationship between humankind and the environment--one that would expand our sense of ecological possibilities" (Oberlin College, 2002). California State Polytechnic University in Pomona, California has a sustainable building in the John T. Lyle Centre. The University views the building as an attempt to create a "human habitat that is truly sustainable and ultimately regenerative." Therefore, a sustainable school is a school that makes continuous efforts to act in harmony with its ecosystem.

The Hungarian Network of Ecoschools, which currently oversees thirty-three schools, has created a list of guidelines that attempt to define the separation between an eco-school and the majority of schools around the world. Figure 1 lists the characteristics of an eco-school, as defined by the Hungarian Network of Ecoschools.

- *Environmental education and the question of sustainability have an important role in the local curriculum and in the pedagogical program of the school.*
- *Pedagogical work takes the age and the personal characteristics of the children into consideration (differentiates and accommodates).*
- *Students are actively and equally take part in the school life, with the right of intervention in the affairs concerning them.*
- *The employees of the schools (management, teachers, technical staff) are aware of the importance of the question of sustainability and they respect this viewpoint in their everyday work.*
- *Co-operating with the parents and with the local community the school takes part in the investigation and solving of the local environmental problems.*
- *Functioning of the school (lighting, heating, cleaning, catering, water usage...) is carried out in the most environment friendly way.*
- *The school provides students with the possibility of extra-curricular education form (open-air school, projects, field works).*
- *The institutional appearance -face- is determined, and it represents the pedagogical values of sustainability.*
- *Sufficient amount of exercise, freetime and relaxing possibilities are provided for the students and for the teachers.*

Figure 1: Characteristics of a Hungarian Ecoschool
Hungarian Ecoschools Network. Hungarian Ecoschools. Retrieved from the World Wide Web on the 15th of January, 2002, at http://www.okoiskola.hu/background.html

The Network summarises these criteria in saying that an eco-school is a school that is implemented in such a manner that it attempts to reduce the amount of damage to the ecosystem and maintain the highest regards for the interests of the environment (Hungarian Network of Ecoschools).

Sustainability is a developing practice, and thus, difficult to measure empirically. As varied as the definition of a sustainable school is, suggestions for measuring its progress seem to be even more wide-ranging. A choice of indicators on which to base decisions about the successfulness of a project are dependent upon the scope, the goal, and above all else, the underlying importance of each aspect affected. Both the precise definition of a "sustainable" school and the meaning of the data that validates the progress is the decision of those who are measuring it. There has been a generic agreement about what indicators of success should be chosen based upon the changes in the external world as a result of a project's methodologies and procedures (Peter Hardi et al., 1997). This agreement is very broad and general, however, leaving a great deal of room for individual interpretation and personal importance. In the case of CERES, while a sustainable school system may be the final goal, their primary objective is a system of sustainable schools. The indicators chosen for analysis will then be specific to the school's own individual ecosystem. The well being of an ecosystem is traditionally assessed on five major factors: 1) land, 2) water, 3) air, 4) biodiversity, and 5) resource use (Peter Hardi et. al., 1997). These five factors, as well as any others an analyser feels are important to sustainable development in terms of the project, should be measured or observed as indicators of success. CERES and the Gould Group are focusing on four areas where schools can take action to become more sustainable: energy, water, waste, and biodiversity.

Energy Efficiency

Different actions and technologies can be implemented to reduce energy consumption. These can be as complicated and costly as installing a new central heating/cooling system or as easy and inexpensive as turning off the lights when leaving a room. The first and most common way to save electricity is for a school to install and use only those products that have a high energy star rating. The Energy Rating labels use stars to depict the energy efficiency of the appliances. The higher the rating is (the more stars), the more energy efficient the appliance. Figure 2 is an example of this energy star rating.

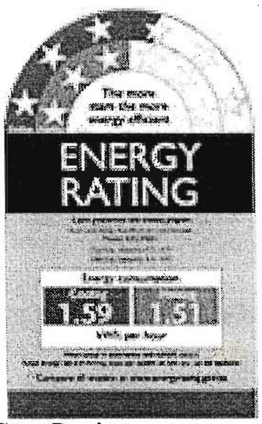

Figure 2. Example of an Energy Star Rating
Sustainable Energy Authority (August 2000). So you want to become more energy smart? Melbourne: Author

Improving lighting systems is another common method for saving electricity. Energy efficient bulbs, such as fluorescent or halogen, can be used instead of incandescent. Typical cost savings using energy efficient bulbs are shown in Table 1.

Table 1. Cost Savings of energy efficient light bulbs

Equivalent Luminare	20 watt compact Fluorescent	65 watt quartz Halogen	100 watt Incandescent
Running cost (8,000 hours)	$21	$68	$104
Purchase Cost	$25	$5	$1
Average Life	8,000 hours	2,000 hours	1,000 hours
Total Cost (Over 8,000 hours)	$46	$88	$112
Running costs are based on the domestic electricity tariff as at April, 1997			
Quartz halogen includes power consumption by the transformer but does not include cost of the light fitting, transformer and installation.			

Energy Smart Lighting. Sustainable Energy Authority of Victoria. Retrieved from the World Wide Web on the 15th of April, 2002, at http://www.energyvic.vic.gov.au/energy%5Fsmart/energy%5Fconservation/lighting/index.html

A school can also reduce the portion of their energy bill from lighting by installing energy efficient light controls that can determine the natural light levels in a room and adjust the artificial lighting accordingly. By cleaning lighting fixtures, the amount of light provided is increased, and fewer lights will be needed and energy may be saved (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting; Sustainable Energy Authority of Victoria, Lighting Control Systems).

Heating and cooling of schools are two other areas that contribute greatly to the schools' energy bill. The Sustainable Energy Authority of Victoria estimates that 36 percent of a school's energy consumption is a result of heating. One method for lowering heating costs would be for a school to install a new and more efficient heating system with a higher energy rating or a passive heating system. Harnessing passive solar energy from the sun reduces the amount of heating and cooling that is needed to be performed by ventilation and cooling systems (VAC). The simplest passive design is one that allows the sun to shine directly into a building, thereby heating it. This is known as direct gain. Areas that require more heating should be positioned along the northern facing walls, while those that require the least amount of heating should be located along the southern facing walls. The cooling of a school may be accomplished by installing vertical panels, called wing walls, on the side of the school that receives the most wind. This type of cooling is referred to as passive and is designed to increase the natural breeze that travels through the structure (Passive Solar Heating, Cooling, and Daylighting, January 26, 2002).

Another common method used to lower energy costs is for a school to start producing some of its own energy. CitiPower estimates that the average household, with a twenty square metre array, can produce 5.5 kilowatt-hours (kWh) of electricity per day. This system can save the household about $250 per year. (CitiPower)

The Hopkinton High School / Middle School in Hopkinton, New Hampshire has fitted their school with sixteen, 120 watt Astro Power Modules along with two Advanced Energy GC-1000 inverters. This instalment allowed the school to save from three hundred to four hundred dollars (USD) per year on their energy bill (U.S. Department of Energy, Energy Efficiency, and Energy Network, January 1, 2002). However, one negative aspect attributed to using photovoltaic cells is the overall area they occupy. This is shown in Table 2, taken from a report issued by the National Renewable Energy Laboratory, a United States Department of Energy National Laboratory.

Table 2. Roof area needed for photovoltaic cells

PV module efficiency (%)	PV capacity rating (watts)							
	100	250	500	1,000	2,000	4,000	10,000	100,000
4	**3**	**7**	**14**	**28**	**56**	**111**	**279**	**2787**
8	**1**	**4**	**7**	**14**	**28**	**56**	**140**	**1394**
12	**1**	**2**	**5**	**9**	**19**	**37**	**93**	**929**
16	**1**	**2**	**3**	**7**	**15**	**30**	**74**	**743**

National Center for Photovoltaics. United States Department of Energy. Retrieved from the World Wide Web on the 15th of April, 2002, at http://www.nrel.gov/ncpv/

While both of the previous examples consist of flat-panel solar panels, there are several other types of systems that use the energy of the sun. A Parabolic trough system is one example. They use parabolic mirrors to focus sunlight on an absorber tube filled with fluid. The hot oil boils water to produce steam, which is used to generate electricity through a turbine. A Power Tower System works in roughly the same way as a parabolic trough system. A large field of sun-tracking mirrors are used to concentrate the sunlight, much like the parabolic mirrors, to heat fluid in the top of a tower that is used to create steam and then electricity. The third type is a Dish/Engine system that is similar to the previous systems, but instead of the sunlight heating a fluid to create steam, the sunlight is used to heat an engine—usually a sterling engine—to create mechanical energy. (United States Department of Energy, National Center for Photovoltaics)

Harvesting the power of wind is another method of natural energy production. Wind turbines are becoming more popular in areas where there is substantial wind (U.S. Department of Energy, Energy Efficiency, and Energy Network, Wind Energy Program, October 2001). Turbines cost anywhere from $5000 to $250,000 (USD). For a large school trying to supplement their energy consumption from the public utilities, however, a wind turbine could be an ideal solution (Gipe, 1993). Long-term energy and cost savings will vary depending on the generation capacity of local wind currents and fluctuations in energy prices.

Another aspect that often contributes greatly to the school's energy bill is water heating. The most common device for saving money by heating water through solar energy is the flat plate collector. The flat plate collector consists of a rectangular box with a transparent cover that is installed on a building's roof. Small tubes, which are attached to a black plate, run through the box and carry water that is heated as the plate heats up. The hot water then goes into a storage tank where it can be transferred to the building. This hot water heating system can reduce household greenhouse gas emissions by 20 percent (CitiPower)

The most important factor in a building's overall energy efficiency is building design (Asian Development Bank, 1997; Schaeffer, 1997) because it can reduce the dependence of a structure on electric power. Careful planning during site development can effectively reduce annual energy consumption by up to 90 percent. This was the case for the Solar Living Centre in Hopland, California, a building designed using almost all atypical methods (Schaeffer, 1997).

In general, design work for any building, not just one that is energy efficient, takes into consideration the surrounding land and overall appearance of the finished product. Only energy efficient designs, however, harness the naturally provided wealth of the environment (Marsh, 1983; Schaeffer, 1997). This demonstration of a lack of holistic thinking resounds in many structural design and engineering textbooks. The Handbook of Structural Engineering (1997) only mentions a connection to the environment in the mathematical analysis of structural resistance to wind forces. To fully utilize surrounding natural resources, an architect with experience in tapping ecological resources should be sought (Schaeffer, 1997). A high-quality architect should be able to examine the site and specifically outline what could be of use. It is unlikely that a structure will fully use the ecological resources of a site if designed *en masse* by someone working to simply meet the initial functionality requirement. This is often the case with American fast-food chains. In the case of the Solar Living Centre, the design phase of the project was able to eliminate the need for a standard VAC entirely, because testing showed that airflow and temperature variation could be passively controlled (Schaeffer, 1997).

Water Conservation

Many methods of water conservation can be utilized most effectively only with a comprehensive knowledge of local regulations and environment. Australia is the driest of all the inhabited continents, with an average annual rainfall of only 455 mm. The country accounts for 5 percent of the world's land area and yet only 1 percent of the river runoff. Australians have settled the country accordingly, however, concentrating the population on areas with higher rainfall and river runoff, and thus, the entire continent is partitioned into only thirteen drainage divisions. In Victoria, the water resources are overseen by five corporate businesses in metropolitan Melbourne, with fifteen independent regional water authorities supplying water to the rest of the state. Both the Department of Natural Resources and Environment and the EPA of Victoria are the regulatory agencies in charge of regional water policy, regulation and monitoring, with the National Health and Medical Research Council providing information and regulation of *potable* water issues (Water Resource Strategy Committee for the Melbourne Area, June 2001).

The two most important aspects of water conservation are the **elimination of leaks** and the creation of a sound **water use policy**. Leak elimination can be accomplished in several ways. The simplest method is to investigate any visual signs of water loss, such as leaks, corrosion, and mineral build-up. Schools may attempt this with regular inspections of the water systems by experts or trained school staff. Any source of water loss discovered should immediately be reported and fixed. Thus, if the inspector cannot authorize the required maintenance, appropriate channels of communication need to be established and open, in order for water conservation to be successful. These channels could include open communication between students and principals. For example, a leaky toilet that goes unnoticed can waste upwards of sixteen thousand litres of water per year (Yarra Valley Water, 2001a). Water meter, record and bill monitoring is a less direct method that can be employed to screen a system for water loss. This requires some sort of accurate data for comparison, however, as well as reliable measurements. If done correctly, though, loss of water can be reduced, and money can be saved. Metering can also help track a school's conservation progress, either on a school-wide basis or in a specific area, as well as assisting conservation policy modification (City West Water, 2002). Through these examples, it is suggested that policy has a much larger influence on total water consumption than technological solutions can have alone.

In order for schools to move on a more sustainable path, a culture of conservation should be established and integrated into school policy and curriculum to increase awareness of the issue. Specific curriculum changes should be done on an individual basis, however, government regulations and incentives could expedite the integration process. Teachers can deal with the issues in a variety of ways, and to differing degrees, depending on their appropriateness at each school. Materials and general guidelines relating to water-saving curricula have been well documented and researched. Organisations such as the EPA of Victoria, SeaWorld, and water councils, such as Yarra Valley Water, provide material for teachers and students that is free and readily accessible, either online or by request. Some of these have been specifically tailored to the Australian Schools' Science and Study of Society and the Environment (SOSE) curricula similar those provided by Yarra Valley Water (2001e). Others, like SeaWorld (2001), only provide information to teachers and students, to be used as they deem necessary. These are only a few of the many examples of what is available. Teachers and students should be encouraged to search for other materials, which are being published frequently, and to communicate this information to others. Other sources that have been useful are http://www.savewater.com.au/ and http://www.eclink.com, which both have an array of curriculum material. In this way, curricula can be continually improved and updated while students are encouraged to take an active roll in their own education.

Installing specific **water-saving technologies** is another way for schools to conserve water. Water-saving technologies can reduce the amount of water input a school requires by as much as 100 percent in some applications (Global Environmental Centre Foundation, 2002). Technologies as basic as low flow or pressure-reducing caps or discs can be installed in current water fixtures at a low cost, decreasing the water used per minute in water taps, baths, and shower roses. Water-saving appliances are also available in order to replace those that are more wasteful. Numerous online resources, such as http://www.savewater.com.au/, provide up-to-date lists of products and businesses that provided these services. Where replacing all the appliances at once may not be cost effective, pressure-reducing technologies can be used to immediately reduce the water pressure of an entire building. This, in turn, reduces the pressure of individual appliances and saves money. Local water councils can be consulted to determine the optimal water pressure for schools and provide a list of distributors that can provide the products and services.

In the case of toilets, many options are available to replace the single flush models that normally use eleven litres of water per flush. Dual flush toilets reduce the consumption of water to as little as three litres per flush (Yarra Valley Water, 2001b). The annual water savings can amount to as much as 36,000 litres of water per toilet

(Yarra Valley Water, 2001a). Composting toilets are a waterless option, however, these toilets are two to three times more expensive than typical single and double flush toilets. A typical commercial composting toilet costs between $600 and $3600, depending on the style chosen. (Yarra Valley Water, 2001b, Nature Loo, 2002 & Envirolet, 2002). Given all of these options, schools must review the material and exact figures to devise a plan that works best on an individual basis.

Similar to toilets, modern water-saving appliances such as taps, shower roses, drinking fountains, laundry machines, and dishwashers are available that pose similar water-saving potential. These appliances need to be investigated and implemented as appropriate for each school. An easy way to identify water efficient technology is to look for the Water Conservation Label. This labelling scheme is currently based on a

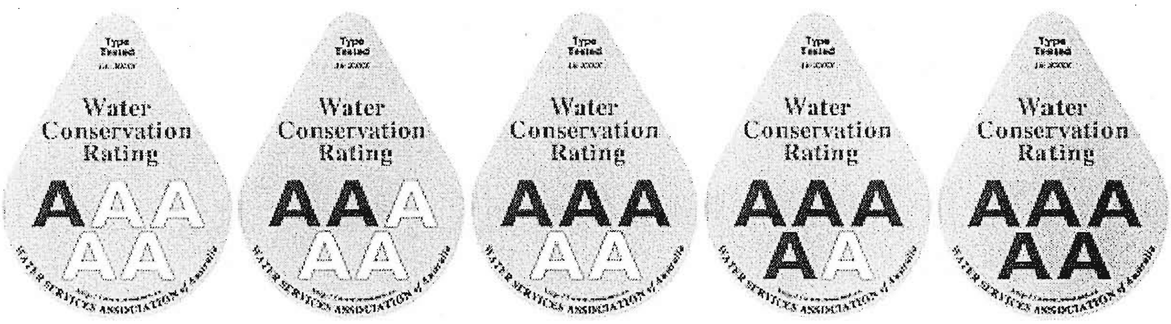

Figure 3. Water Conservation Rating
Water Services Association of Australia. Product Labelling Scheme. Retrieved from the World Wide Web on 19th March 2002 at http://ratings.wsaa.asn.au/about.html.

triple "A" system, where a single "A" is acceptable and a three "A" rating is excellent. This labelling scheme, however, is changing to a five "A" system, as soon as product standards are upgraded. In this new system, an "A" rating is an acceptable or moderate rating, "AA" is a good rating, and "AAA" represents a high rating. The "AAAA" is a very high rating and "AAAAA" is an excellent rating (Water Service Association of Australia). Figure 3 shows the standardized symbol format, displayed on each appliance that received the rating. This general standards system has been adapted to fit each appliance. For instance, shower roses that use twelve to fifteen litres a minute currently receive the "A" rating, while shower roses that use between nine and twelve litres per minute, and those that use less than nine litres per minute, receive "AA" and "AAA" ratings, respectively (Quality Assurance Services). This rating scheme is only voluntary however, so it should not be the sole criteria for choosing appliances.

A school's need for municipal water may be reduced further through the **collection of rainwater**. The design of such a system would consist of a cistern to store the water as it travels off the roof and through the gutters. The water gathered in this manner may be used for irrigation, or if treated, the water may be applied to other areas of the school, including washing machines, toilets and possibly for drinking. Such a system was installed in Oregon in 1996 at an expense of about six thousand dollars (Rainwater Harvesting, 15th of January 2002). Collecting rainwater reduces the school's reliance on municipal water and places fewer demands on groundwater.

Water recycling allows for additional cuts in consumption by connecting the output of one part of the system with the inputs of others. The basic idea of water recycling is to collect the cleanest wastewater, also called greywater, and reuse it to supply water to applications where the sanitation requirements are less stringent. Typically, water collected from drinking fountains, taps, sinks, washing machines, bath, spas, showers, dishwashers, and laundry troughs can be reused to water lawns and gardens, fill toilets, and in other non-potable applications (FitzGerald, S. & Bastian, R., 2001, & City of San Jose).

The EPA of Victoria (2001) recognises two types of wastewater: greywater and blackwater. While blackwater contains faeces or urine, greywater does not. Although, there are very few regulations regarding domestic wastewater reuse, the EPA of Victoria (2001) oversees these systems and requires that they do not produce public health hazards.

Currently, few household systems are capable of purifying water to a degree necessary for direct human intake. Many systems however, exist which can clean the water sufficiently for qualified reuse because the degree to which the water is cleaned delineates where its use is permitted (Robinson, 2000). Many companies, such as Electropure Industrial Australia Pty. Ltd. classify this type of water reuse as non-contact reuse, because the recycled water has little or no contact with humans. This broad classification officially consists of three water classes. Class A water can be used for above ground irrigation, washing machines, and in toilets. Class B water can be used in near ground and surface irrigation. While class C is only suitable for subsurface disposal.

Commercial and residential systems are available in the Victorian area from companies such as Wattworks Water Recycling Systems and Electropure Industrial Australia Pty Ltd. Costs range from two thousand dollars for a two toilet residential system to ten thousand dollars for a twelve toilet commercial system (Wattworks, 2002). These systems do not need to be implemented on a site-specific basis. In communities where water conservation is of paramount concern, the school could consider pressuring city officials to start a town-wide water recycling system. The city of San Jose, California has incorporated water recycling into their public utility service for the past several years and has a variety of customers, including local schools. These schools use the semitreated wastewater, bought at a lower price than potable water, for horticulture, irrigation, and grounds maintenance. This water would also be appropriate for use in toilets, though it would require alterations to the internal plumbing systems.

In order to save money in the long term, schools could pressure their water supplier to collect and re-sell recycled water because there is no initial investment needed on the part of the school and recycled water should cost less per litre than purified water. Actual savings, however, will be unknown until the vendor sets the price at which the school would be able to purchase the water.

Several schools presently receiving recycled water in San Jose, California are also part of a pilot program in which students learn about local water issues and solutions to the problems. This program has developed a variety of teaching tools that help students to better understand why water conservation is important, and how it is being addressed locally.

Another important consideration for reducing the water use of a school is the development of a **water-efficient landscape**. Residentially, 35 percent of water used is for irrigation, and in commercial applications it is most likely higher (Water Resource Strategy Committee for the Melbourne Area, June 2001). A water-efficient landscape, or Xeriscape, makes the most use out of the smallest volume of water. The Royal Botanic Gardens in Melbourne uses Australia's first Xeriscape conservation system. One of the first steps to creating or renovating an existing landscape is choosing an appropriate soil mixture. Some of the most efficient soils for Australian gardens include Dawson Creeping Bluegrass, Windsor Green, Greenless Park, and WinterGreen (Yarra Valley Water, 2001b). Plants and Shrubs should be chosen to make the most use of the water.

Figure 4 lists the characteristics of water friendly plants, while a specific list of water friendly plants for different Australian regions may be found at www.savewater.com.au/, Basaltica, local water councils, and nurseries.

- Small Leaves
- Light Leaf Colours (even Silver Foliage)
- Hairy Leaves
- Tough Surface
- Protected Pores
- Internal Water Sources (such as Succulents)
- Deep Root System

Figure 4. Characteristics of Water Friendly Plants
Adapted from Yarra Valley Water. 2001b. Saving water around your home and garden. Victoria, AUS: Author.

There are two main options for the watering of the landscape: subsurface and surface watering. When irrigating the surface, one should soak the soil with a fine spray and allow the water to sink deep into the soil, water twice a week rather than every single day, and never water in the middle of the day (Yarra Valley Water, 2001d). Subsurface irrigation uses a drip system, which is permanently fixed underground and delivers water through the soil. The benefits of drip watering include allowing the soil to absorb nearly all the water used and watering deeply, creating deep root systems (Yarra Valley Water, 2001d).

The **outputs of systems** can address the problem of water-efficiency by quickly and naturally filtering wastewater and replenishing natural water sinks such as aquifers and groundwater tables. These natural wastewater treatment systems, or "Living Machines," combine a standard grease trap and a specific blend of vegetation to remove contamination from wastewater, can be both beneficial to the environment and cost effective. Bacteria, plants, snails, and fish aid in the process by breaking down and digesting the organic pollutants in the water and can be good indicators of overall water quality (discussed further in Biodiversity section). Leftover food waste from the canteen could serve as a high protein food for fish and reduces (or even eliminates) the need for expensive commercial fish feeds, which contributes to the depletion of ocean fish stocks (Horizons, 1997). It could also serve as a teaching tool to students and teachers on natural processes and sustainability.

Current methods of wastewater treatment are not only expensive and often environmentally unfriendly, but they are very energy intensive, as well. Estimated sewer rates for an average Australian school building using a common sewer treatment system are about two hundred dollars per year plus $0.82 per kilolitre of water use, according to the Yarra Valley Water (2002) and South East Water (2002). By implementing a biologically diverse option, such as a "Living Machine" (Horizons, 1997), costs could be cut after the initial installation expense was paid since the system runs unassisted. Not only would this alternative be operationally cheaper, it would be cleaner and chemical-free (Horizons, 1997). Essentially, a "Living Machine" is a group of specifically chosen plants that remove nearly all the common household pollutants from wastewater. The specifications of these systems should be design to meet the future needs of each individual school.

CERES uses a similar system of man-made wetlands to filter the waste from their café and is a prime example of how these systems need to be properly sized or the end water quality will be less than desired. Their system originally worked very well, but as the café grew and began to service more costumers, more wastewater was rinsed down the drain, over extending the system. The water that exits their "Living Machine" is still cleaner compared with what goes down the drain, but when facing tough environmental standards it fairs somewhat poorly. Therefore, when these systems are designed, they should be planned based on predictions of use because altering these systems to meet rising demands requires additional investments.

Waste and Litter

Since the 1970's, lifestyles have been steadily changing. Disposable products have taken the place of reusable products. Tissues have replaced handkerchiefs. Paper and plastic cups have replaced washable ones. Supermarkets provide disposable bags and packaging to shoppers, in which to take their merchandise home. Rather than repair damaged appliances and clothes, a person will usually throw them away and purchase new products. While these numerous adaptations have assisted in creating much more convenient lifestyles for members of Victorian society, the large amount of waste being produced is having a negative impact on the environment. According to the Australian Bureau of Statistics, in 1996-97, Australians threw away over 21 million tons of garbage, which cost about $1256 million to collect and dispose of. Proper handling of waste and litter in schools provides numerous important benefits. Not only does it help to reduce the negative impact on the environment, it acts as an educational tool for students, allowing them to apply what they learn in the classroom. In order to achieve a higher level of sustainability, a number of issues regarding waste and litter should be addressed. Waste policies and strategies should be developed, and it should include plans for recycling, composting, reduction and reuse practices, and an overall integration of waste management into the school curriculum.

Of the commonly practiced methods of managing waste, **recycling** is predominant in schools. When planning a recycling program, the first step is to identify which materials can be recycled in the local community. While completing this research, more specific information should be collected on what local recycling service providers require from customers, such as the sorting of items. Then it must be decided which materials the school is going to recycle. Some of the materials currently recycled by schools include glass, paper, cardboard, aluminium and steel cans, beverage cartons, plastics, and computer cartridges (EcoRecycle Victoria, 1999).

Recycling glass saves 74 percent of the energy it takes to make glass from raw materials. Glass manufacturing in Australia often uses crushed glass, called cullet, which reduces resource use. According to EcoRecycle Victoria (1999), each tonne of cullet used saves 1.1 tonnes of raw materials.

Most primary schools do not allow students to have glass due to safety concerns. Any glass used by the staff should be taken home and recycled, eliminating the need for the school to recycle glass. Some post-primary schools allow glass bottles and may even sell them in the canteen. In this case, the school's kerbside council should be contacted, as some are able to help set up a recycling system for the school.

EcoRecycle Victoria, Environs Australia, and the Gould League (1996-2000) stated that at least half of the waste generated by schools is paper and cardboard, most of which is recyclable. The waste paper may need to be separated into two types--mixed paper and cardboard, and clean white paper--as some companies collect these two separately (Visy Recycling). If schools are provided with a choice of collection method, it is often more convenient to have all the paper collected together. Teaching pupils to distinguish between the two types, however, may increase their awareness of recycling.

According to EcoRecycle et al. (1996-2000), aluminium cans are one of the advantageous materials to recycle. The cans themselves are worth about $0.75 per kilogram, and recycling them saves vast amounts of energy and conserves ore, from which aluminium is made. The cans may be collected and sold back at a buy-back centre, or the school may contact a local scrap merchant who will arrange collection and payment. Similarly, steel containers may be collected and recycled by most schools through their local recycling service providers or scrap merchants. If these options are not available for a school, the steel cans can be taken home by staff and left out in their home kerbside container.

Beverage cartons, commonly used to package milk and juice, can be recycled into photocopy paper. However, they present a hygiene problem if they are not emptied, opened, and cleaned before being stored for recycling. Based on the pickup schedule of recyclables, schools should set up a cleaning system or a suitable storage area for these cartons.

There are three common types of plastic used to package drinks: PET (code 1), consisting of soft drink and some fruit juice bottles; HDPE (code 2), including white milk, cream and some juice bottles; and Vinyl (code 3), comprising some juice containers and cordials (EcoRecycle Victoria, 1999). In general, local council should be contacted to arrange for proper collection of all recyclable materials.

According to Carleton (2002), empty inkjet cartridges are, kilogram for kilogram, the most valuable post-consumer item in the recycling market. They are one of the newest and least-known recyclable products, and as a result, approximately three hundred million empty inkjet cartridges are thrown into United States landfills annually, the equivalent of 30,500 African Elephants (Funding Factory and the Environment). With the average recycled value of a cartridge, minus its initial cost, being $2.50 (USD), roughly $500,000,000 (USD) is wasted each year.

After deciding which materials will be recycled, a school should designate central and secondary collection sites. The central collection site should be convenient and accessible to all recyclers, as well as protected from the weather and vandals. Secondary collection sites should be located at convenient places throughout the rest of the school, such as classrooms, staffrooms, administration areas, photocopy rooms, libraries, and in the canteen. These secondary locations help to encourage recycling, as it is more convenient.

The containers used to collect and store recyclable waste should be visible, convenient, accessible, safe, well organised, and tidy. Clear instructions should be written on them for the convenience of those recycling. Some commonly used containers include wire cages (for cans), boxes (for paper), 240 litre wheelie bins, wool bales (for cardboard), hoppers, and skips.

Composting is an induced form of the natural decaying process, through which waste and organic materials are broken down into a dark, nutrient-rich soil (EcoRecycle Victoria, 1999). This takes place through the actions of naturally occurring bacteria and fungi. Earthworms and millipedes can be added to the heap as a catalyst to the decomposition process. Along with being easy to practice, composting provides numerous environmental benefits, such as the conservation of valuable landfill space and the production of fertilizer (EcoRecycle et al., 1996-2000).

There are two types of decomposition—anaerobic and aerobic. Anaerobic decomposition occurs without oxygen, and as a result, presents several disadvantages. It occurs slower than aerobic decomposition and produces unpleasant odours such as methane gas. Aerobic decomposition occurs relatively quickly, because of microorganisms that thrive in the presence of oxygen, and does not usually produce unpleasant odours. Composting worms can be added to aerate the organic material and reduce anaerobic breakdown (EcoRecycle et al., 1996-2000).

There are many easy and advantageous ways to **reduce and reuse** (or minimise) waste. Not only does this assist the environment by conserving valuable resources, but purchasing less materials and fully utilizing products also saves money. As a result of reducing the resources used in everyday life and living more carefully, there is a reduction in the amount of waste to dispose of. Reusing the same item many times, rather than disposing of it after a single use, conserves energy and resources that would have been used to make a new product (EcoRecycle Victoria, 1999). These may be small changes but are worthwhile and will contribute to decreasing the overall amount of waste expended by people of Victoria.

Biodiversity

The term biodiversity implies two distinct attributes of an ecosystem: the variety of *indigenous species* present, and the genetic diversity within each species (Walker, 1999). In both cases, Reaka-Kudla, Wilson, and Wilson (1997) claim that high levels of diversity are seen as attributes because they provide stability to an ecosystem that is under duress, and can be seen as measures of the health of the ecosystem and organisms within it. No systems are stagnant throughout time, and the most important test of biodiversity in an ecosystem is its ability to cope with change while averting an ecological collapse. All organisms perform a specific operation, which helps other animals to live. Therefore, when *invasive species* or climatic change encroaches on an ecosystem, depending on the form the interjection takes, the natural order can be interrupted. A notable example was the introduction of rabbits into the Australian ecosystem, where they decimated domestic crops, indigenous plants and, in turn, the animals that rely on them.

Humans can be destructive as well, by altering and fragmenting habitats for their own purposes, forcing species to adapt, retreat, or become extinct (Reaka-Kudla, et al, 1997). As mankind spreads across the landscape, the area for other species consequentially diminishes, but the lasting affect that this encroachment has depends greatly on the details of its occurrence. For instance, haphazard development is a major cause of fragmentation in species' populations. If no corridors of undeveloped land remain where species will be able to migrate and interbreed, then genetic diversity can be lost (Marsh, 1983). With careful forethought, these problems can be avoided.

A school may become more aware and active in regards to their own biodiversity by following these three steps: save it, study it, and use it. The first step is to **save it** by preserving the biodiversity that presently exists in and around a school. This can be done by sustaining local and natural habitats. With each action and decision a school makes, it should question the impact it may have on those habitats and species. It should also take notice of other outside influences–apart from the school–that may be altering the biodiversity and take measures to reduce their effects. Since many of the habitats have already been disturbed, efforts should be made to re-introduce species that no longer reside on the school grounds (World Resource Institute).

The second step a school may take to preserve their biodiversity is to increase the awareness of the students and staff through **studying it**. Biodiversity should be integrated into the curriculum, with students striving to understand what it is, how it works, and why it's important. Projects should be undertaken to document its many aspects (World Resource Institute).

Finally, a school should **use** the available biodiversity resources in such a way that allows them to be maintained and learned from, rather than depleted (World Resource Institute). Biodiversity can be used to beautify, educate, and provide other benefits to the school. Preserving biodiversity is not completely *altruistic* on the part of humans, for there are many links between biodiversity and human health. A variety of species ensures that ecosystems are filtered properly. As different species take-in natural and man-made toxins, they can indicate the level of these toxins in an ecological system. These so called *indicator species* are sensitive to chemicals alien to the environment and by monitoring their condition, checking if they are dieing in unusual numbers, or in some cases if they exist at all, schools can recognise and monitor progress or problems in the local environment (Grifo & Rosenthal, 1997). Frog species are one of the best examples of an *indicator species* because their populations have dropped dramatically in specific locations around the world as toxin levels have increased (Reaka-Kudla, et al, 1997). Numerous types of insects are also good indicators of overall pollution in streams or other aquatic regions (Van Dort, F., Smith, G., Chessman, B., Chemke, R., & Salt D.). Schools with such species in their environment should monitor them in order to evade possible health emergencies. Population monitoring does not have to be an expensive process; a class of biology students can do it once a year as part of their curriculum. This can be done by using a pollution indexing system similar to the one promoted by Van Dort et al. (1992), which gives each insect species a number based on its sensitivity. The students can then look for the existence of these species and use the indexing system to record and monitor the condition of the ecosystem (Van Dort et al., 1992).

III. METHODOLOGY

Objective

The objective of this project was to create a comprehensive technology review of sustainable technologies for use in schools, as well as a checklist tailored specifically to schools in Victoria. The technology review contains technologies available, simple cost-benefits analysis of each, and local contacts. The combination of the technology review and the checklist should assist schools in understanding the options available to them to make themselves more sustainable.

Methods

Initially, we familiarized ourselves with the working environment at CERES and the current intricacies of their Sustainable Schools Program. Meetings with the liaisons, as well as tours around the grounds, facilitated our understanding about the staff of CERES – their style, thinking, and expectations.

Then, in pairs, we accompanied our liaison to his four meetings with principals and teachers of the four pilot schools, in order to observe discussions between them. The pair of students were different for each of the school visits, so that, all of us could have first hand experience with the presentation of the program and develop individual impressions of the schools in Australia. By doing this we gained insight into the viewpoints of both of CERES and the participating schools, an understanding of the school system, the overall Sustainable Schools project, and how our project was to be a part of it.

We took field notes during the observation to increase the accuracy of the data for analysis. These initial outlines were later expanded to a formal sequential account of our observations. One account of each school visit was developed by both observing students because they were exposed to almost entirely the same experience, thus two separate accounts would have been repetitive.

Meanwhile, extensive research into the four main aspects of sustainability—water, energy, waste, and biodiversity—was then completed by our team, in order to complement the original literature review and create a much more comprehensive technology review. Resources from CERES, the Sustainable Energy Authority of Victoria, the Gould Group, Alternative Technology Association, and the EPA were utilized to understand previous experiences with the issues. Many reliable web-based resources, benchmarks, and case studies were also used. The technology review details the technological options that schools may use to become more sustainable. Alongside the technologies we designed a cost-benefit analysis, searched for case studies and contacts to be used as resources for further information.

We then derived the sustainability checklist from the findings of the research by using CERES and the Gould Group's "Waste-Wise" checklist as a guide. The checklist suggest possible steps or technologies that assist schools in becoming more sustainable. The descriptions of each action are brief, referring to the technology review for an in-depth explanation. Both the checklist and the technology review were divided into the four groups to comply with the way CERES' Sustainable School program is organised.

We tailored the sustainability checklist to those actions and technologies most appropriate for use in the Victorian schools. It was tailored by taking into account the local resources and the schools' environment. The original checklist was generic to the majority of schools around the world. The checklist was made more specific to Victoria, by explaining some of the steps more precisely. A basic example was replacing "towards the equator" with "north" or "indigenous species" with actual names.

In order to consider the local resources, we conducted confidential semi-standardized interviews with resource authorities and providers in each area of research to obtain their opinion on the suggestions made on the checklist and the information in the technology review. The semi-standardized interview structure was chosen to make the data collected from each interview comparable while still allowing probing questions to increase the depth of our understanding and minimize intersubjectivity.

The interviewees were directors of current programs working towards energy and waste minimization in schools, an employee of a water utility company, and a biodiversity researcher. We designed the interviews to determine the plausibility of a Victorian school implementing the technologies we listed in the checklist and technology review. Due to the specifics of Victoria, some technologies may work exceptionally well while others may not be applicable. These findings were reflected in the checklist, but were never cause for the elimination of a technology or recommendation.

IV. TECHNOLOGY REVIEWS

The following pages contain the technology review, designed to assist staff members when developing a basic understanding of the technology available that may be utilized to become more sustainable. Explanations of specific technologies, why, and how they work are explained and complemented with figures and tables whenever possible. Some of the descriptions include formulas to calculate the potential costs and benefits of implementation. All sections contain a list of contact information where more detailed resources may be obtained.

The technology review is divided up into the four sections of sustainability that the Sustainable Schools program encompasses: energy, water, waste, and biodiversity. It is then further divided into subsections by the type of technology, such as lighting or heating. Each of these subsections has a header on the top containing both the name of the section as well as the reference number. These numbers may also be found throughout the checklist, directing the reader to the technology review for further information on the subject.

Slightly different approaches are taken with each of the four sections, as the material they cover varies in both size and content. There are many more options available to save energy than for any other area. In presenting as many of these options as possible, the energy section does not posses the depth or the detail about each topic as the other sections. Biodiversity is at the other end of the spectrum. A school's actions towards promoting biodiversity is more of a set of principles to be incorporated into all its actions, rather than a quantifiable consumption technology can help to reduce. There are a few specific actions that add to a school's biodiversity, but it is more an idea to be followed.

Energy

Energy Rating Labels **Reference # E1**

Energy Rating labels use stars to depict the energy efficiency of an appliance. Appliances that have a high-energy rating will have more stars highlighted than those with a low energy rating. The National Appliance and Equipment Energy Efficiency Committee (NAEEEC) is the organisation tasked with implementing and enforcing the energy star rating system, while the Energy Management Task Force (EMTF) developed the policies and funds ratings program. Both the NAEEEC and the EMTF advise the Australian and New Zealand Minerals and Energy Council (ANZMEC), responsible for supporting the national appliance and equipment energy efficiency program (Australian Greenhouse Office, National Appliance and Equipment Energy Efficiency Program Council, Achievements 2000). Figure 5, described in more detail below, is an example of this energy star rating for a reverse cycle air conditioning & heating unit.

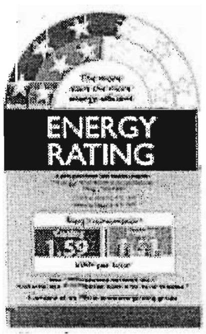

Figure 5. Example of an Energy Star Rating
Sustainable Energy Authority of Victoria. Using the new Energy Rating Labels. (2001). Retrieved from the World Wide Web on the 14th of April, 2002, at http://www.seav.vic.gov.au/appliance/aircon/label.html

Figure 6 shows the star-rating portion of the energy-rating label. The two rows of stars depict the rating that this unit received. The more highlighted stars, the higher the rating. The top row of stars shows the rating for the cooling aspect of the air conditioning unit and the bottom row shows the rating for the heating aspect.

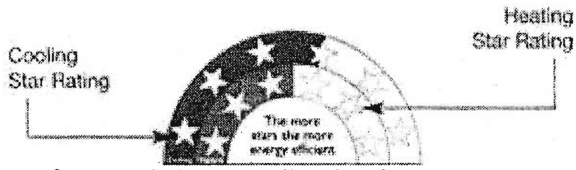

Figure 6. Top portion of example Energy Star Rating
Sustainable Energy Authority of Victoria. Using the new Energy Rating Labels. (2001). Retrieved from the World Wide Web on the 14th of April, 2002, at http://www.seav.vic.gov.au/appliance/aircon/label.html

Figure 7 shows the energy consumption portion of the rating. The boxes on the left and the right of the label give the amount of electricity consumed (in kilowatt-hours) running the unit for one hour. The lower the energy consumption, the more energy efficient the unit.

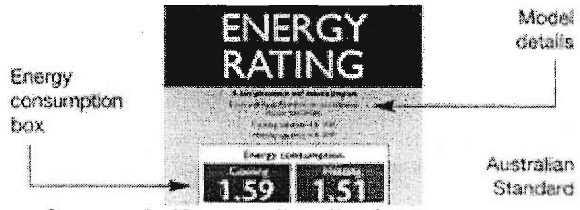

Figure 7. Middle portion of example Energy Star Rating
Sustainable Energy Authority of Victoria. Using the new Energy Rating Labels. (2001). Retrieved from the World Wide Web on the 14th of April, 2002, at http://www.seav.vic.gov.au/appliance/aircon/label.html

Galaxy Award

The Galaxy Award is given to energy efficient appliances that display excellence in design, manufacture, and promotion. Figure 8 is an example of a Galaxy Energy Award label (Sustainable Energy Authority of Victoria, Using the new Energy Rating Labels).

Figure 8. Galaxy Energy Award
Sustainable Energy Authority of Victoria. Using the new Energy Rating Labels. (2001). Retrieved from the World Wide Web on the 14th of April, 2002, at http://www.seav.vic.gov.au/appliance/aircon/label.html

Energy Star

The energy star label is given to the most energy efficient product within its category and to those appliances that have minimum energy standards in place, as set by the United States Department of Energy. Over the years, the energy star rating has become an international standard for energy efficient electrical equipment. Figure 9 depicts the comparison in running costs between energy star and conventional office equipment (Energy Star; Sustainable Energy Authority of Victoria, Energy Smart Home Office Equipment).

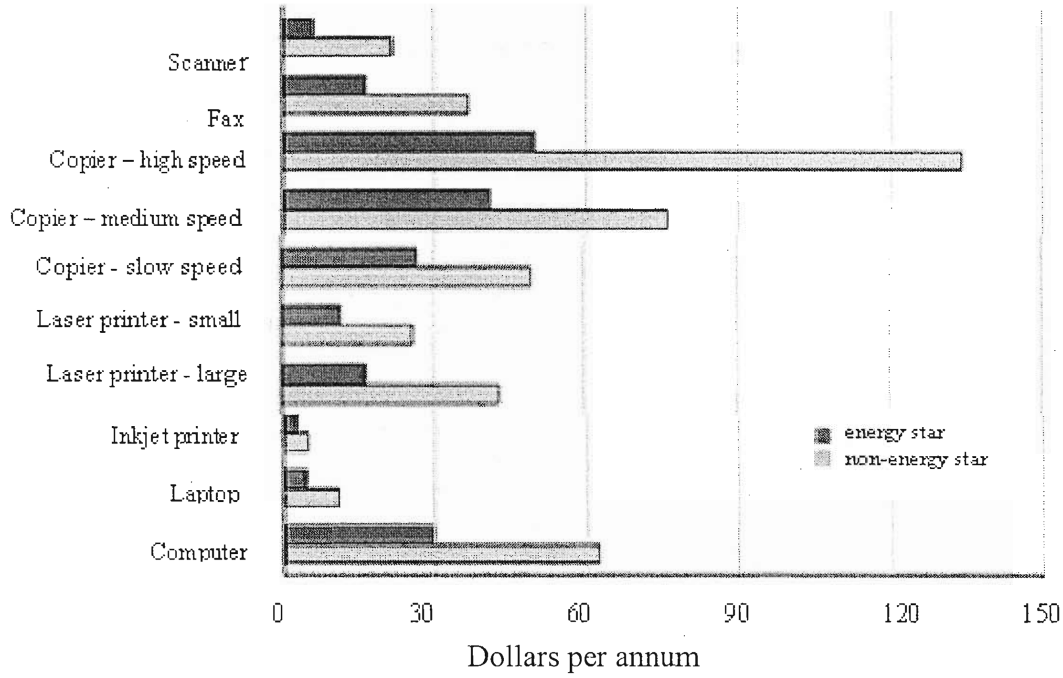

Figure 9. Running costs: energy star vs. non-energy star appliances
Sustainable Energy Authority of Victoria. Energy Smart Home Office Equipment. (2001). Retrieved from the World Wide Web on the 15th of April, 2002, at http://www.energyvic.vic.gov.au/energy%5Fsmart/energy%5Fconservation/office%5Fequipment/index.html

Cost of energy efficient appliances (total) $_________(1)
Cost of electricity per year before installing energy efficient appliances $_________(2)
Cost of electricity per year after installing energy efficient appliances $_________(3)
Number of students in school #_________(4)
Number of appliances replaced #_________(5)
Number of school days in a year #_________(6)

(2) – (3) = Savings on electricity per year $_________(7)
(2) / (5) = Average cost per appliance before installing energy efficient appliance $_________(8)
(3) / (5) = Average cost per appliance after installing energy efficient appliance $_________(9)
(8) – (9) = Savings per addition $_________
(7) / (4) = Savings per student $_________
(7) / (6) = Savings per day $_________
(1) / (7) = Years to recover initial costs (approx) #_________

Resources:

Sustainable Energy Authority of Victoria

(Information and list of contacts)
Sustainable Energy Authority
Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3222
Fax 03 9655 3255
Website: http://www.seav.vic.gov.au
Email: advice@sea.vic.gov.au

Energy Smart Schools Program
Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3268
Fax 03 9655 3255
Website:
http://www.seav.vic.gov.au/schools/intro.html
Email: phil.munari@seav.vic.gov.au

Australian Greenhouse Office

(Information resources)
Australian Greenhouse Office
John Gorton Building
GPO Box 621
Canberra ACT 2601
Tel 02 6274 1888
Fax 02 6274 1390
AGO Info line: 1300 130 606
Website:
http://www.greenhouse.gov.au/energyefficiency/appliances/

Energy Star, United States Environmental Protection Agency

(Information and list of contacts)
Tel 1-888-782-7937
Website: www.energystar.com

Lighting - Bulbs **Reference # E2**

Incandescent

Incandescent bulbs are the most common form of lighting, largely due to their low cost, however, they are expensive to operate due to their high energy consumption. While incandescent lights have a high operating cost, they can be effectively in areas used less frequently, such as closets. Incandescent lights produce between ten and twenty lumens per watt (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995; U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Smart Schools). A one hundred watt incandescent bulb has a purchase cost of approximately one dollar and an average running life of one thousand hours. The average operating cost (for eight thousand hours) is a bit over one hundred dollars (Sustainable Energy Authority of Victoria, Energy Smart Lighting, 2001).

Halogen

Halogen bulbs are mostly used in spaces that demand high levels of lighting, such as gymnasiums and outdoor areas. Halogen bulbs consist of a gas filling and a reflective coating. The reflective coating allows the filament to remain hot, therefore using less electricity and helping the bulb direct its twenty to thirty-five lumens per watt (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995; U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Smart Schools). A sixty-five watt quartz halogen bulb costs five dollars and has a life of about two thousand hours. The average running cost (for eight thousand hours) is about seventy-five dollars (Sustainable Energy Authority of Victoria, Energy Smart Lighting, 2001).

Sodium

High-pressure sodium lighting is one of the most common types of outdoor illumination, due mostly to the quantity of lumens per watt it provides—between forty-five and one hundred and ten. Low-pressure sodium lighting works in the same manner as fluorescents. Since a yellow or grey light is produced, these low-pressure bulbs are used where the colour of the light given off is unimportant. This type of bulb is one of the most efficient and longest lasting (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995; U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Smart Schools).

Fluorescent

Fluorescent bulbs produce light by passing an electrical current through an inert gas. Fluorescents are normally used in those areas that require continuous lighting. Tube fluorescents are one of the more popular fluorescent bulbs. These bulbs are used in indoor areas such as classrooms and hallways and produce between sixty-five and one hundred and ten lumens per watt. Compact fluorescent bulbs are the most common bulbs recommended for houses. They are used to replace incandescents that are three to four times their wattage, they can last up to fifteen times longer than incandescents, and they produce between twenty and eighty-five lumens per watt (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995; U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Smart Schools). An average fluorescent bulb costs twenty-five dollars and has an average running life of eight thousand hours with an average running cost (for eight thousand hours) marginally over twenty dollars (Sustainable Energy Authority of Victoria, Energy Smart Lighting, 2001).

Cost of energy efficient light bulbs (total)	$_________(1)
Cost of electricity per year before installing energy efficient bulbs	$_________(2)
Cost of electricity per year after installing energy efficient bulbs	$_________(3)
Number of students in school	#_________(4)
Number of bulbs replaced	#_________(5)
Number of school days in a year	#_________(6)
(2) – (3) = Savings on electricity per year	$_________(7)
(2) / (5) = Average cost per bulb before installing energy efficient bulbs	$_________(8)
(3) / (5) = Average cost per bulb after installing energy efficient bulbs	$_________(9)
(8) – (9) = Savings per addition	$_________
(7) / (4) = Savings per student	$_________
(7) / (6) = Savings per day	$_________
(1) / (7) = Years to recover initial costs (approx)	#_________

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Energy Smart Schools, United States Department of Energy

(Information resources)
Energy Design Guidelines for High Performance Schools
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Energy Efficiency and Renewable Energy Network, United States Department of Energy

(Information resources)
Energy Efficiency and Renewable Energy Clearinghouse
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Fax 1-703-893-0400
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http://www.eren.doe.gov/erec/factsheets/eelight.html
Email: doe.erec@nciinc.com

Solar lights are frequently used on outdoor pathways. The devices work by converting solar energy into electrical energy, during the daylight hours, by use of photovoltaic cells. The energy is then stored in a battery located in the unit. Up to eight hours of electricity can be stored in an average unit. During the night, the stored energy is used to power a bulb (Sustainable Energy Authority of Victoria, Energy Smart Lighting, 2001).

In March of 1996, Cornell University installed solar powered lights in two bus passenger shelters. The two systems were estimated to have an installation cost equal to the cost of bringing a traditional power supply to just one of the shelters. The university estimates that the solar shelters will save between twenty-five and thirty kilowatts per year. The photovoltaic modules cost roughly four hundred dollars (USD) and have a life span between twenty and thirty years. (Cornell University, Solar Power Lighting)

The County of Maui, Hawaii installed nineteen solar lights to illuminate a nineteen hundred foot trail inside Keopuolani Park. The county estimates that a traditional lighting system, comparable to the solar-lighting system, would have cost approximately $92,400 (USD). The solar-lighting system cost a total of $77,000 (USD) saving the county $15,400 (USD) in initial costs and about four hundred dollars in electrical costs per year (State of Hawaii, Energy Resources and Technology Division, Solar Powered Lighting at Keopuolani Park)

Cost of solar lights (total)	$_________(1)
Cost of electricity per year before installing solar lights	$_________(2)
Cost of electricity per year after installing solar lights	$_________(3)
Number of students in school	#_________(4)
Number of lights replaced	#_________(5)
Number of school days in a year	#_________(6)

(2) – (3) = Savings on electricity per year $________(7)
(2) / (5) = Average cost per light before installing solar lights $________(8)
(3) / (5) = Average cost per light after installing solar lights $________(9)
(8) – (9) = Savings per addition $________
(7) / (4) = Savings per student $________
(7) / (6) = Savings per day $________
(1) / (7) = Years to recover initial costs (approx) #________

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Lighting - Natural — Reference # E4

Natural lighting can also be used in schools. Sunlight has been shown to offer 110-130 lumens per watt, whereas light bulbs produce fewer lumens per watt, as shown in Figure 10. Some skylights and windows have the ability to be opened, allowing heat to escape during the summer months, and baffles can be used to block the direct sunlight from entering a room. A report issued by the United States National Renewable Energy Laboratory (Appendix F) states that students who learn under natural light have 7 to 18 percent higher test scores than those who learn under artificial light.

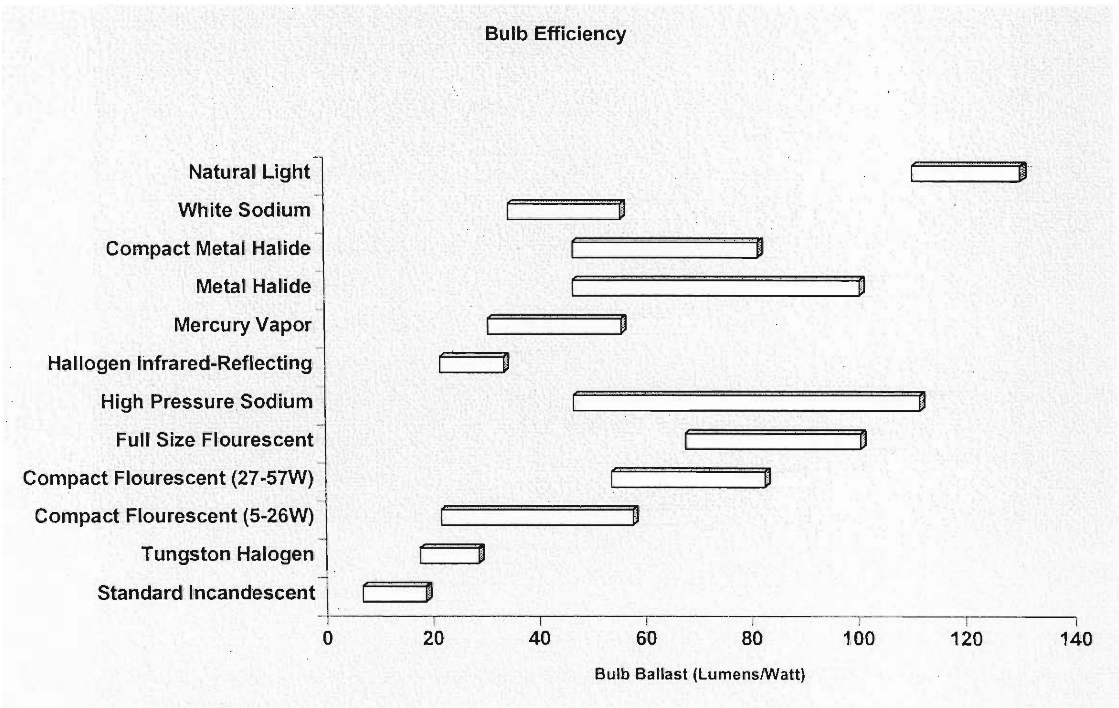

Figure 10. Lumens per Watt for certain bulbs
US Department of Energy, Energy Efficiency and Renewable Energy Network, Energy Smart Schools. Energy Design Guidelines for High Performance Schools. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Cost of skylights (total)	$________	(1)
Cost of electricity per year before installing skylights	$________	(2)
Cost of electricity per year after installing skylights	$________	(3)
Number of students in school	#________	(4)
Number of skylights installed	#________	(5)

Number of school days in a year #________(6)

(2) – (3) = Savings on electricity per year $________(7)
(7) / (5) = Savings per addition $________
(7) / (4) = Savings per student $________
(7) / (6) = Savings per day $________
(1) / (7) = Years to recover initial costs (approx) #________

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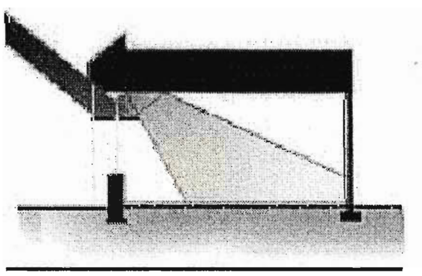
Energy Smart Schools, United States Department of Energy
(Information resources)
Energy Design Guidelines for High Performance Schools
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Lighting - Natural - Light Shelfs **Reference # E5**

Light shelves are used to direct sunlight to specific area, as shown in Figure 11 and Figure 12. The shelf is made of a material that can reflect the natural light entering the window onto the ceiling of the room, and further into the room. The light shelves also provide shading for the portion of the window below (Energy Design Guidelines for High Performance Schools, Energy Smart Schools, Energy Efficiency and Renewable Energy Network, US Department of Energy).



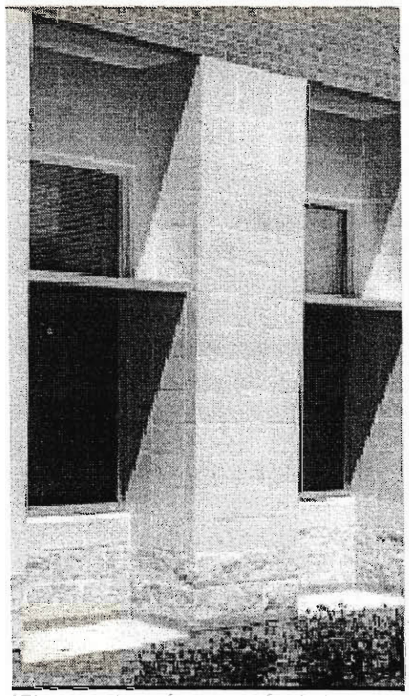


Figure 11. Diagram of Light Shelf **Figure 12** Picture of Light Shelfs

US Department of Energy, Energy Efficiency and Renewable Energy Network, Energy Smart Schools. Energy Design Guidelines for High Performance Schools. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Cost of light shelfs (total)	$________	(1)
Cost of electricity per year before installing light shelfs	$________	(2)
Cost of electricity per year after installing light shelfs	$________	(3)
Number of students in school	#________	(4)
Number of light shelfs installed	#________	(5)
Number of school days in a year	#________	(6)
(2) – (3) = Savings on electricity per year	$________	(7)
(7) / (5) = Savings per addition	$________	

(7) / (4) = Savings per student $________
(7) / (6) = Savings per day $________
(1) / (7) = Years to recover initial costs (approx) #________

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Energy Smart Schools, United States Department of Energy
(Information resources)
Energy Design Guidelines for High Performance Schools
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Lighting - Interior Finishes Reference # E6

Interior finishes need be taken into account when designing a lighting plan, because pale ceilings and walls colours reflect light better than dark colours. Therefore, bright coloured rooms will need less lumen to light them. Table 3 lists different materials and paints that can be used to lighten a room, along with their reflectivity (Energy Design Guidelines for High Performance Schools, Energy Smart Schools, Energy Efficiency and Renewable Energy Network, US Department of Energy).

Table 3. Paint and Wood Reflectivity

Reflectance Table: Paints

Color	Reflectance
Gloss White	75%
Semi-gloss White	70%
Light Green*	53%
Kelly Green*	49%
Medium Blue*	49%
Medium Yellow*	47%
Medium Orange*	42%
Medium Green*	41%
Medium Red*	20%
Medium Brown*	16%
Dark Blue-Grey*	16%
Dark Brown*	12%

Reflectance Table: Woods

Type	Reflectance
Maple	54%
Poplar	52%
White Pine	51%
Red Pine	49%
Oregon Pine	38%
Birch	35%
Beech	26%
Oak	23%
Cherry	20%

* These values are estimated for flat paints. For gloss paints, add 5%–10%. Source: SBIC, Passive Solar Design Strategies.

Careful consideration of interior finishes based on reflectance values can reduce lighting demands.

US Department of Energy, Energy Efficiency and Renewable Energy Network, Energy Smart Schools. Energy Design Guidelines for High Performance Schools. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Cost of reflective interior finish (total)	$________	(1)
Cost of electricity per year before applying reflective interior finish	$________	(2)
Cost of electricity per year after applying reflective interior finish	$________	(3)
Number of students in school	#________	(4)
Number of surfaces painted	#________	(5)
Number of school days in a year	#________	(6)

(2) – (3) = Savings on electricity per year	$________	(7)
(7) / (5) = Savings per surface	$________	

(7) / (4) = Savings per student $________
(7) / (6) = Savings per day $________
(1) / (7) = Years to recover initial costs (approx) #________

Resources:

Energy Smart Schools, United States Department of Energy

(Information resources)
Energy Design Guidelines for High Performance Schools
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Lighting Controls **Reference # E8**

Photocells

Photocells turn lights on and off in response to the amount of natural light in an area. These controls can be used either inside or outside. Since the change in the level of natural light can be sudden and unpredictable, a version of these controls can be used indoors that slowly dims the level of artificial light as the amount of natural light increases (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995; Sustainable Energy Authority of Victoria, Lighting Control Systems, 2001). These systems are similar to those used in automobiles to turn on the headlights when it gets dark (GMC, Yukon).

Occupational Sensors

Occupational sensors are devices that turn lights on and off as an individual enters or leaves a room. These devices are ideal for areas of infrequent use, such as bathrooms and warehouses (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Lighting, December 1995).

Cost of energy efficient light controls (total)	$________	(1)
Cost of electricity per year before installing energy efficient controls	$________	(2)
Cost of electricity per year after installing energy efficient controls	$________	(3)
Number of students in school	#________	(4)
Number of bulbs replaced	#________	(5)
Number of school days in a year	#________	(6)
(2) – (3) = Savings on electricity per year	$________	(7)
(2) / (5) = Cost per control before installing efficient controls	$________	(8)
(3) / (5) = Cost per control after installing efficient controls	$________	(9)
(8) – (9) = Savings per addition	$________	
(7) / (4) = Savings per student	$________	
(7) / (6) = Savings per day	$________	
(1) / (7) = Years to recover initial costs (approx)	#________	

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Direct Gain, Figure 13, occurs when the sun's heat warms the internal thermal mass of the structure. The internal thermal mass is a structure, usually a wall or floor, designed to capture and store heat from the sun and then radiate that heat into attached rooms. The material associated with the thermal mass is dense and heavy, with high radiation properties to facilitate the passive heating process. In warm climates, the windows should be positioned so that the mass receiving the heat will not be in direct sunlight. During winter months, heat is trapped in the area between the glass and the thermal mass, with cool air circulated into this area, heated, and returned to the room. Inversely, in the summer, the thermal mass is prevented from receiving the direct sunlight and absorbs the heat in the room (Direct Solar Gain, California Energy Commission).

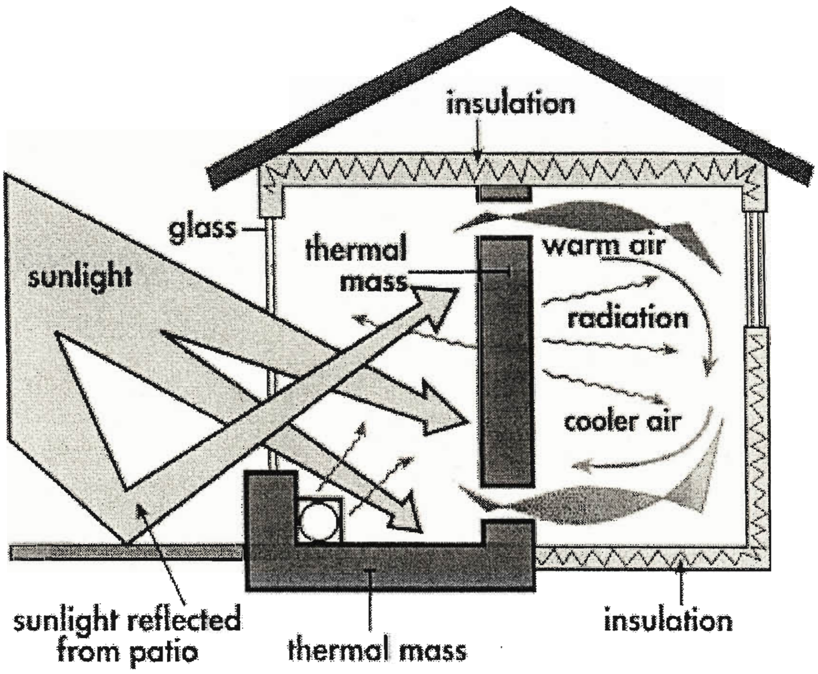

Figure 13. Example of a Direct Gain system
California Energy Commission. Direct Solar Gain. Retrieved from the World Wide Web on the 23rd of March, 2002, at
http://www.consumerenergycenter.org/homeandwork/homes/construction/solardesign/direct.html

Cost of direct solar gain system (total)	$_________	(1)
Cost of heating per year before installing direct solar gain system	$_________	(2)
Cost of heating per year after installing direct solar gain system	$_________	(3)
Number of students in school	#_________	(4)
Number of systems installed	#_________	(5)
Number of school days in a year	#_________	(6)

(2) – (3) = Savings on heating per year	$_________	(7)
(7) / (5) = Savings per addition	$_________	
(7) / (4) = Savings per student	$_________	
(7) / (6) = Savings per day	$_________	
(1) / (7) = Years to recover initial costs (approx)	#_________	

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California Energy Commission

(Information resources)
California Energy Commission
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5504
U S A
Tel 916-654-4287
Website:
http://www/consumerenergycenter.org/homeandwork/homes/construction/solardesign/direct.html
Email: renewable@energy.state.ca.us

Sustainable Building Sourcebook

(Information and Resource List)
Website:
http://www.greenbuilder.com/sourcebook/PassiveSol.html

Indirect Gain is another passive solar heating system, shown in Figure 14. The Indirect Gain system operates in the same way as the direct gain system, except the thermal mass is located separately from the room itself. The warm air travels from the thermal mass into the room and returns after cooling (Indirect Solar Gain System, California Energy Commission).

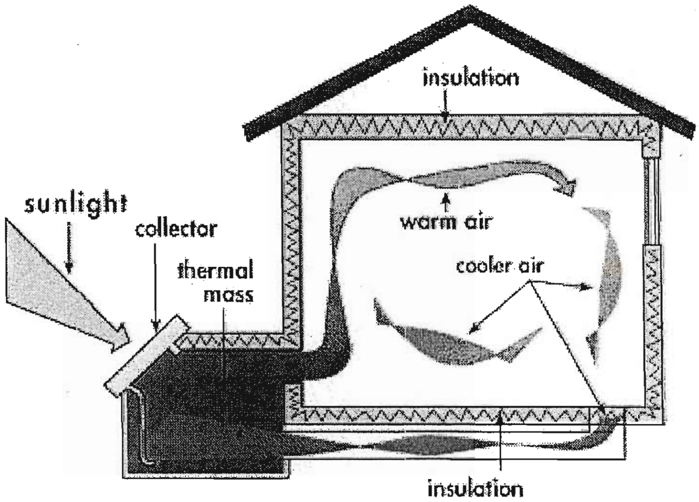

Figure 14. Example of an Indirect Gain system
California Energy Commission. Indirect Solar Gain System. Retrieved from the World Wide Web on the 23rd of March, 2002, at
http://www.consumerenergycenter.org/homeandwork/homes/construction/solardesign/indirect.html

Cost of indirect solar gain system (total)	$________	(1)
Cost of heating per year before installing indirect solar gain system	$________	(2)
Cost of heating per year after installing indirect solar gain system	$________	(3)
Number of students in school	#________	(4)
Number of systems installed	#________	(5)
Number of school days in a year	#________	(6)
(2) – (3) = Savings on heating per year	$________	(7)
(7) / (5) = Savings per addition	$________	
(7) / (4) = Savings per student	$________	
(7) / (6) = Savings per day	$________	
(1) / (7) = Years to recover initial costs (approx)	#________	

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California Energy Commission

(Information resources)
California Energy Commission
Media and Public Communications Office
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U S A
Tel 916-654-4287
Website:
http://www/consumerenergycenter.org/homeandwork/homes/construction/solardesign/indirect.html
Email: renewable@energy.state.ca.us

Sustainable Building Sourcebook

(Information and Resource List)
Website:
http://www.greenbuilder.com/sourcebook/PassiveSol.html

Passive Solar Heating and Cooling– Ground Heat Pump Reference # E11

A Geothermal Heat Pump (GHP) transfers the heat from the ground into a building and from the building into the ground. An example is shown in Figure 15. There are two common types of GHP systems: earth-coupled (closed-loop) and water-source (open-loop). The earth-coupled system works by running antifreeze or water through the building and then deep into the ground. It is important that the cooling liquid is environmentally sound and, in the event of a leak, does not pose a threat to the surrounding area. This system is considered closed-loop because the liquid does not leave the system. The pipes are made of a material with a low thermal resistance, such as high-density polyethylene, and are buried between 1.20 to 1.80 metres horizontally or 30 to 120 metres vertically.

Water-source systems work in a similar fashion, but instead of having a closed piping system, it continuously draws fresh water from a well or other source. This system is considered open-looped due to the fact that the liquid is drawn from an outside source and not from within the system.

Once the liquid has entered the building, it is sent to a heat exchanger that consists of an air blower and ductwork. The blower moves the air over the pipes, which in turn heats or cools the air. The ductwork then disperses the air throughout building (Energy Efficiency and Renewable Energy Network, US Department of Energy, Geothermal Heat Pumps, September 1998; Federal Energy Management Program, Energy Efficiency and Renewable Energy Network, US Department of Energy, Geothermal Heat Pumps, September 1999).

In Lincoln, Nebraska, four elementary schools installed GHP systems, estimated to save $3,800,000 (USD) over twenty years. This is a savings of about $470, 500 (USD) per school per year (Energy Efficiency and Renewable Energy Network, US Department of Energy, Geothermal Heat Pumps, September 1998).

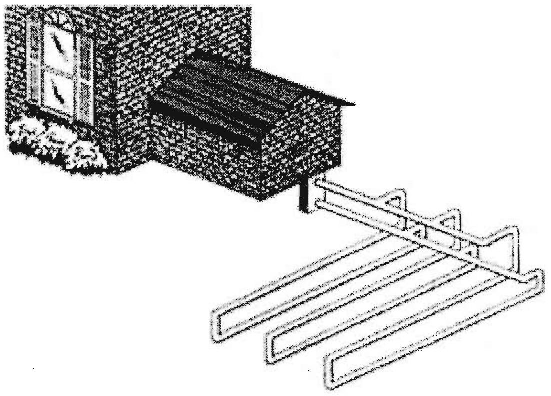

Figure 15. A typical Ground Heat Pump system
US Department of Energy, Energy Efficiency and Renewable Energy Network, Federal Energy Management Program. Geothermal Heat Pumps. (September 1999). Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/femp/techassist/geoheat.html

Cost of GHP system (total)	$__________	(1)
Cost of heating and cooling per year before installing GHP system	$__________	(2)
Cost of heating and cooling per year after installing GHP system	$__________	(3)
Number of students in school	#__________	(4)
Number of systems installed	#__________	(5)
Number of school days in a year	#__________	(6)
(2) – (3) = Savings on heating and cooling per year	$__________	(7)
(7) / (5) = Savings per addition	$__________	
(7) / (4) = Savings per student	$__________	
(7) / (6) = Savings per day	$__________	
(1) / (7) = Years to recover initial costs (approx)	#__________	

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Oak Ridge, TN 37831-6070
Tel 423-574-9337
Fax 423-574-9329
Website:
http://www.eren.doe.gov/femp/techassist/geoheat.html
Email: pj1@ornl.gov

Geothermal Heat Pump Consortium, Inc. (GHPC)

(Information resources)
701 Pennsylvania Avenue, NW
Washington, DC 20004-2696
Tel 1-800-255-4436
Website: http://www.ghpc.org/

International Ground-Source Heat Pump Association

(Information resources)
490 Cordell South
Stillwater, OK 74078
Tel 1-800-626-4747
Website: http://www.igshpa.okstate.edu

Wing Wall

While many of the techniques used for passive solar heating can also be used for cooling, there are other technologies a school can utilize to increase cooling. Devices known as Wing Walls, Figure 16, can be installed on the windward side of the building, allowing natural breeze to flow through a room. The wind transfers the heat out of the building as it passes through the structure (Passive Solar Heating, Cooling, and Daylighting, January 26, 2002).

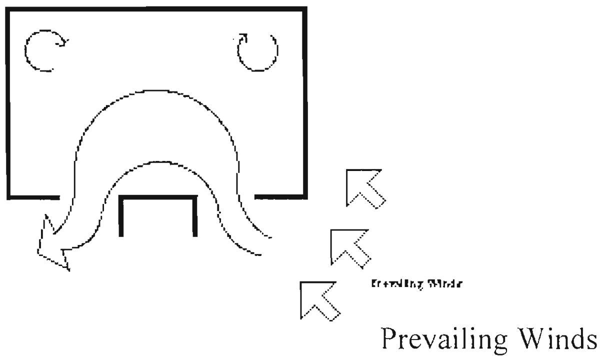

Figure 16. Example of a Wing Wall system
Sustainable Building Sourcebook. Passive Solar Design. (February 23, 2002). Retrieved from the World Wide Web on the 24th of March, 2002, at http://www.greenbuilder.com/sourcebook/PassiveSol.html

Thermal Chimney

Thermal Chimneys are passive, solar cooling devices that can be implemented by a school. This method, shown in Figure 17, uses a structure similar to a sunroom creating a zone that draws hot air out of an attached room and vents it outside. Alternative designs are shown in Figures 18 and 19 (Passive Solar Heating, Cooling, and Daylighting, January 26, 2002).

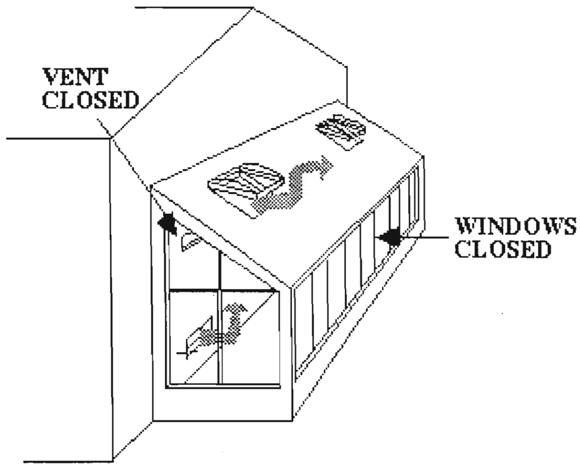

Figure 17. Example of a Thermal Chimney using a sunroom
Sustainable Building Sourcebook. Passive Solar Design. (February 23, 2002). Retrieved from the World Wide Web on the 24th of March, 2002, at http://www.greenbuilder.com/sourcebook/PassiveSol.html

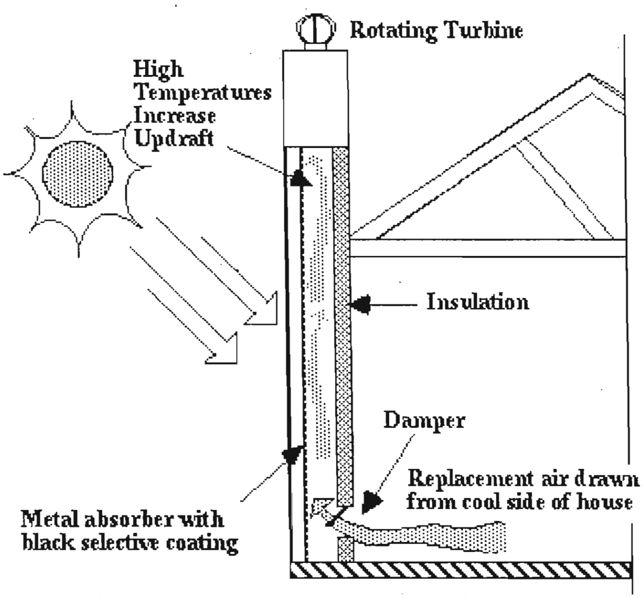

Figure 18. Example of a Thermal Chimney using a turbine
Sustainable Building Sourcebook. Passive Solar Design. (February 23, 2002). Retrieved from the World Wide Web on the 24th of March, 2002, at http://www.greenbuilder.com/sourcebook/PassiveSol.html

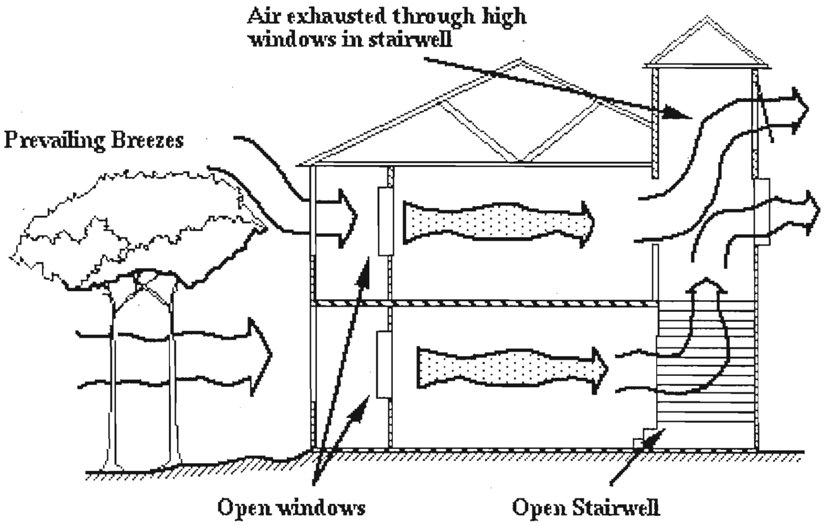

Figure 19. Example of a Thermal Chimney
Sustainable Building Sourcebook. Passive Solar Design. (February 23, 2002). Retrieved from the World Wide Web on the 24th of March, 2002, at http://www.greenbuilder.com/sourcebook/PassiveSol.html

Cost of passive cooling system (total)	$________(1)
Cost of cooling per year before installing passive cooling system	$________(2)
Cost of cooling per year after installing passive cooling system	$________(3)
Number of students in school	#________(4)
Number of systems installed	#________(5)
Number of school days in a year	#________(6)

(2) – (3) = Savings on cooling per year	$________(7)
(7) / (5) = Savings per addition	$________
(7) / (4) = Savings per student	$________
(7) / (6) = Savings per day	$________
(1) / (7) = Years to recover initial costs (approx)	#________

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http://www.seav.vic.gov.au/schools/intro.html
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Sustainable Building Sourcebook

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Website:
http://www.greenbuilder.com/sourcebook/PassiveSol.html

Energy Efficiency and Renewable Energy Network, United States Department of Energy

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Tel 1-800-363-3732
Fax 1-703-893-0400
Website: http://www.eren.doe.gov/RE/solar_passive.html
Email: doe.erec@nciinc.com

As shown in the Lighting - Interiors section (#E5), the surface finish of a room can affect the lighting. This is also true for roofs and exterior walls in regards to heating and cooling. For warm climates, light coloured roofs and walls reflect more of the sun's radiation away from the building. Table 4 lists materials and the percentage of solar radiation that they absorb and reflect (Energy Smart Schools, Energy Efficiency and Renewable Energy Network, US Department of Energy, Energy Design Guidelines for High Performance Schools).

Table 4. Reflectance Values for Exterior Surfaces

		% Reflected	% Absorbed
Roofing Material			
Single-ply roof membrane	Black EPDM	6	94
	Grey EPDM	23	77
	White EPDM	69	31
Asphalt Shingles	Black	5	95
	Medium brown	12	88
	Green	19	81
	Grey	22	78
	White	25	75
Metal Roof	Aluminium	61	39
	Metal white	67	33
Exterior Wall Material			
Brick	Light buff	45	55
	Dark buff	43	60
	Dark red	30	70
Concrete	Light	55	45
	Medium	20	80
	Dark	15	85

This table indicates the reflectance of various typical roofing materials when first installed. Materials that maintain their reflectivity characteristics should be preferred.

US Department of Energy, Energy Efficiency and Renewable Energy Network, Energy Smart Schools. Energy Design Guidelines for High Performance Schools. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Cost of reflective interior finish (total)	$________	(1)
Cost of electricity per year before applying reflective interior finish	$________	(2)
Cost of electricity per year after applying reflective interior finish	$________	(3)
Number of students in school	#________	(4)
Number of surfaces installed	#________	(5)
Number of school days in a year	#________	(6)

(2) – (3) = Savings on electricity per year	$________	(7)
(7) / (5) = Savings per surface	$________	
(7) / (4) = Savings per student	$________	
(7) / (6) = Savings per day	$________	
(1) / (7) = Years to recover initial costs (approx)	#________	

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Energy Smart Schools, United States Department of Energy

(Information resources)
Energy Design Guidelines for High Performance Schools
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Setback Thermostats **Reference # E14**

Setback thermostats are designed to automatically adjust the temperature settings in a room and can reduce a heating and cooling bill between 15 and 75 percent. These thermostats operate either at a predetermined time of day, for a predetermined period of time, or at a predetermined light level. While these thermostats are ideal for most central heating and cooling systems, it may cause problems when operating in conjunction with a heat pump system, such as a Ground Heat Pump (Energy Efficiency and Renewable Energy Network, US Department of Energy, Automatic and Programmable Thermostats, March 1997; California Energy Commission, Setback Thermostat).

Electromechanical

Electromechanical thermostats operate using moveable tabs, rotating timers, and sliding levers. The sliding levers are used to determine the night and day heating and cooling settings, while the moveable tabs are used to set the rotary timer, which in turns activates or deactivates the heating and cooling system at certain points in the day (Energy Efficiency and Renewable Energy Network, US Department of Energy, Automatic and Programmable Thermostats, March 1997).

Digital

Digital thermostats are designed to automatically activate and deactivate the central heating and/or cooling system, depending on the time of day. This type of thermostat works under a predetermined operating schedule that tells the thermostat what the room temperature should be at certain times. For the winter months, the thermostat is usually programmed to increase the room temperature just before the occupants arrive. In the summer months, the thermostat is usually programmed to let the room temperature raise during those times when the occupants are away and lower it before they arrive (Energy Efficiency and Renewable Energy Network, US Department of Energy, Automatic and Programmable Thermostats, March 1997).

Occupancy

Occupancy thermostats work in a similar fashion as the digital thermostats, in that they also can be programmed to reduce or raise the temperature of the room, however, this thermostat does not do it automatically. This thermostat uses predetermined 'comfort periods' to control the activation of the heating and cooling system. These comfort periods can usually be anywhere between thirty minutes and twelve hours. To activate a comfort period, an occupant must manually activate one on the thermostat (Energy Efficiency and Renewable Energy Network, US Department of Energy, Automatic and Programmable Thermostats, March 1997).

Light Sensing

Light sensing thermostats work in a similar manner to photocell lighting controls. Photocells are used to determine the lighting level in the room. When the lighting level reaches the pre-programmed level, the heating or cooling system is either activated or deactivated (Energy Efficiency and Renewable Energy Network, US Department of Energy, Automatic and Programmable Thermostats, March 1997).

Cost of setback thermostats (total)	$________	(1)
Cost of heating and cooling per year before installing setback thermostats	$________	(2)
Cost of heating and cooling per year after installing setback thermostats	$________	(3)
Number of students in school	#________	(4)
Number of units installed	#________	(5)
Number of school days in a year	#________	(6)
(2) – (3) = Savings on heating and cooling per year	$________	(7)
(7) / (5) = Savings per unit	$________	
(7) / (4) = Savings per student	$________	
(7) / (6) = Savings per day	$________	
(1) / (7) = Years to recover initial costs (approx)	#________	

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Energy Efficiency and Renewable Energy Network, United States Department of Energy

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Website:
http://www.eren.doe.gov/erec/factsheets/thermo.html
Email: doe.erec@nciinc.com

Windows with Spectrally Selective Coatings should be added to the building. These coatings reflect the infrared spectrum of sunlight while allowing the visible portion to pass through, Figure 20. Unlike insulation, measured by an R-value, windows are measured by a U-value (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Savers).

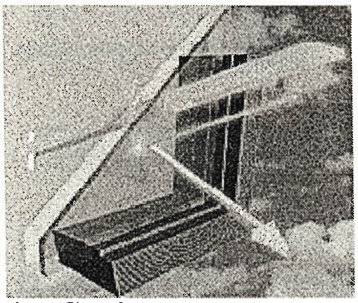

Figure 20. Spectrally Selective Coating
US Department of Energy , Energy Efficiency and Renewable Energy Network, Energy Savers. Retrieved from the World Wide Web on the 27th of March, 2002, at
http://www.eren.doe.gov/consumerinfo/energy_savers/insulation.html

There are many different types of spectrally selective coatings that can be applied to glass. Each of these coatings has a different light transmittal value, as shown in Figure 21. Low-emissivity glass is designed to reduce the heat transfer through the window. The glass allows the full amount of light to pass through while blocking 40 to 70 percent of the heat normally transmitted through regular glass. Heat-absorbing glass is tinted to absorb up to 45 percent of the sun's energy. This in turn, reduces the heat gain, but allows some of the heat to pass through while Reflective glass uses a reflective coating to reduce the amount of heat passing through. (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Windows, October 1994; Efficient Windows, How Windows Work).

Figure 21. Light Transmission Values
US Department of Energy, Energy Efficiency and Renewable Energy Network, Energy Smart Schools. Energy Design Guidelines for High Performance Schools. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Storm Windows

Storm windows are an inexpensive way to increase efficiency. Storm windows can be made of plastic film, glass, or rigid or semirigid plastic. The plastic film is attached to the outside of the window using an adhesive, such as tape. While plastic film is the cheapest form of a storm window, it is the most easily damaged. Glass and rigid or semirigid plastics are installed either directly onto the window or in the channels along the sides of the window. Storm windows are usually used in conjunction with single-pane windows (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Windows, October 1994).

Single and Double Glazing

Single glazed windows are the most inefficient type of window. Multi-glazed windows are designed with an insulating air or gas pocket between the sheets of glass.

This layer of air of gas increases the efficiency of the window by lowering the heat transfer rate of the window, and in turn, increasing the R-value and lowering the U-value (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Windows, October 1994).

Window Frames

The type of window frame also affects the energy efficiency of the window. Wood frames have a high R-value, are easy to install and paint or stain, and resist condensation. Wood frames, however, can swell and are susceptible to warping and rot. Aluminium frames are light, durable, and strong, and come in a number of colours. Aluminium frames, however, conduct heat at a high rate. Vinyl frames are usually made out of polyvinyl chloride (PVC) and have good insulating properties. While vinyl is not as strong as other materials—wood, steel, or aluminium can be added for reinforcement. Fiberglas is another type of window frame that is stronger than vinyl, and, when backed with insulation, offers a higher R-value than wood (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy-Efficient Windows, October 1994; Efficient Windows, How Windows Work).

Cost of energy efficient windows (total) $________(1)
Cost of heating and cooling per year before installing energy efficient windows
$________(2)
Cost of heating and cooling per year after installing energy efficient windows
$________(3)
Number of students in school #________(4)
Number of windows replaced #________(5)
Number of school days in a year #________(6)

(2) – (3) = Savings on heating and cooling per year $________(7)
(2) / (5) = Cost per window before installing energy efficient windows
$________(8)

(3) / (5) = Cost per windows after installing energy efficient windows

	$________(9)
(8) – (9) = Savings per addition	$________
(7) / (4) = Savings per student	$________
(7) / (6) = Savings per day	$________
(1) / (7) = Years to recover initial costs (approx)	#________

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Energy Smart Schools, United States Department of Energy

(Information resources)
Energy Design Guidelines for High Performance Schools
Website:
http://www.eren.doe.gov/energysmartschools/pdfs/designguide_hotdry.pdf

Energy Efficient Windows

(Information and resource list)
Kate Offringa
EWC Program Manager

Alliance to Save Energy

1200 18th Street N.W., Suite 900
Washington, D.C. 20036
Tel 202-530-2245
Fax 202-331-9588
Website: **http://www.efficientwindows.org**
Email: **ewc@ase.org**

Energy Efficiency and Renewable Energy Network, United States Department of Energy

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P.O. Box 3048
Merrifield, VA 22116
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Website:
http://www.eren.doe.gov/erec/factsheets/eewi
Email: doe.erec@nciinc.com

Natural

Trees and shrubs are a cheap and effective method of shading and cooling. Their evaporative cooling reduces the temperature of the surrounding area as well. Trees and shrubs that discard their leaves in the autumn also allow the sunlight to reach the building in the summer months. The closer the tree or shrub is to the building, the more hours of shading it will provide. Ideally, trees should be planted between five and twenty feet from the building. Shrubs offer less shading but do have advantages such as cost per required area. Attaching a trellis to the side of a building and allowing a shrub or vine to grow on it can also provide adequate shading in the summer months especially if vines are allowed to grow on them. Some vines are fast growing, while trees can take years to grow (California Energy Commission, Shades and Awnings; Oikos Green Building Source, Shading: First Steps Toward Natural Cooling).

Awnings

Awnings provide shade much in the same way as trees and shrubs. This is accomplished by blocking the direct sunlight before it reaches the window, as apparent in Figure 22. A light coloured awning will reflect the direct sunlight and diminish the amount of heat that is transferred from the awning to the window. Awnings come in many different shapes and sizes and can be designed to fit most buildings. Awnings can also contain adjustable slats that allow the option to control the level of light entering a room, Figure 23 (California Energy Commission, Shades and Awnings).

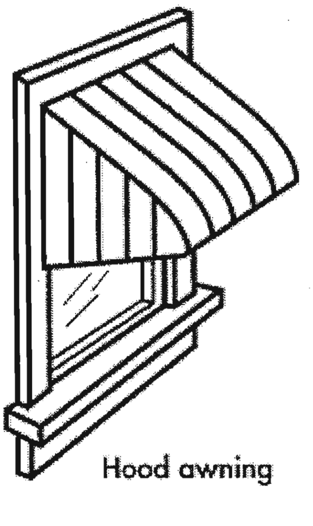

Figure 22. Hood Awning

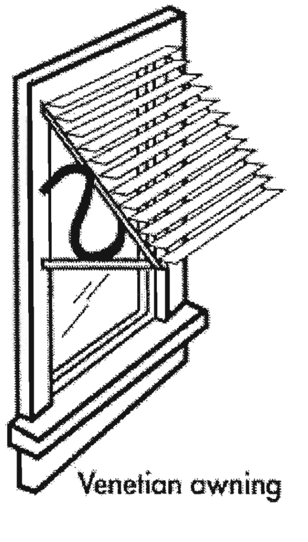

Figure 23. Venetian Awning

California Energy Commission. Shades and Awnings. Retrieved from the World Wide Web on the 9th of April, 2002, at http://www.consumerenergycenter.org/homeandwork/homes/inside/windows/shades.html#Awnings

Shutters and Interior Shades

Shutters are another method of shading windows. They are moveable wooden or metal coverings with fixed or adjustable slats. They offer privacy and security as well as shading. Interior shades and shutters reflect sunlight before it can turn into heat. Shades and shutters should be light coloured and tightly cover the entire window to prevent airflow into the room. While interior shades are not as effective as shutters, they usually cost less. (California Energy Commission, Shades and Awnings; Oikos Green Building Source, Shading: First Steps Toward Natural Cooling).

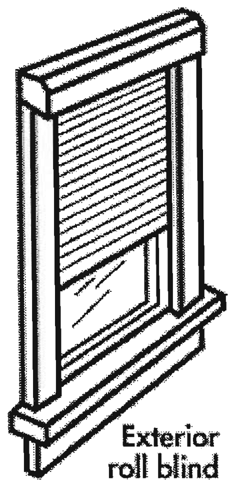

Figure 24. Exterior Roll Blind
California Energy Commission. Shades and Awnings. Retrieved from the World Wide Web on the 9th of April, 2002, at
http://www.consumerenergycenter.org/homeandwork/homes/inside/windows/shades.html#Awnings

Heating and cooling bill per year before installing awnings and shades $________(1)

Heating and cooling bill per year after installing awnings and shades $________(2)

Cost of awnings and shades (total)	$________(3)
Number of students in school	#________(4)
Number of days in year	#________(5)
(1) – (2) = Savings due to awnings and shades	$________(6)
(6) / 4 = Savings per student	$________
(3) / (6) = Years to recover initial cost (approx)	#________

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California Energy Commission

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California Energy Commission
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5504
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Tel 916-654-4287
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http://www/consumerenergycenter.org/homeandwork/homes/construction/solardesign/indirect.html
Email: renewable@energy.state.ca.us

Sustainable Building Sourcebook

(Information and resource list)
Website:
http://www.greenbuilder.com/sourcebook/PassiveSol.html

Oikos Green Building Source

(Information and resource list)
Website:
http://www.oikos.com/esb/34/shading.html

There are two common types of insulation: bulk and reflective. Insulation should be added to walls, floors, crawl spaces, and ceilings to prevent unwanted heat transfer (Sustainable Energy Authority, August 2000).

Bulk Insulation

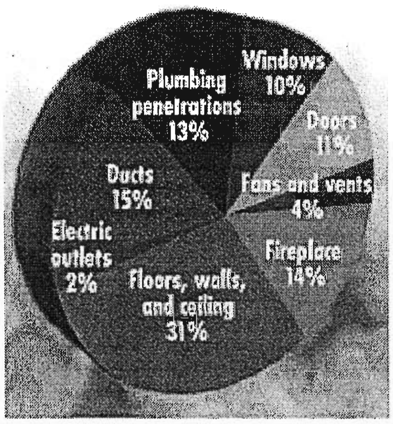
Bulk insulation works by trapping pockets of still air in the structure of a building. These air pockets provide resistance to heat transfer, preventing heat from leaving a building in the winter, or entering in the summer. This insulation generally it comes in four types: batts, rolls, loose-fill, and ridge foam boards. Batts and rolls are made to fit between studs in walls and the joists in ceilings and floors. They are made of fibreglass or rock wool. Loose fill is typically made of fibreglass, rock wool, or cellulous and are blown into walls and ceilings and works in roughly the same was as the batts. Ridge foam boards are generally made from polyisocyanurate, extruded polystyrene, or expanded polystyrene. These boards are made predominantly for tight spaces, such as crawl spaces, basement foundation walls, and exterior walls (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Savers).

Reflective

This type of insulation works by directing heat with reflective metallic sheets. These sheets usually work best when placed in an airspace that is at least twenty-five millimetres thick (Sustainable Energy Authority, August 2000). *See also Passive Solar Cooling – Exterior Finishes (Reference #E13)*

Weatherization

Weatherization is the sealing of a building to prevent air from leaking in or out. Figure 25 and Figure 26 show the usual sources of air leaks for the average home. The best method for doing this is to seal or insulate the areas that are leaking air (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Savers).



How Does the Air Escape?

Air infiltrates in and out of your home through every hole, nook, and cranny. About one third of this air infiltrates through openings in your ceilings, walls, and floors.

Figure 25. How Does Air Escape?
US Department of Energy , Energy Efficiency and Renewable Energy Network, Energy Savers. Retrieved from the World Wide Web on the 27th of March, 2002, at http://www.eren.doe.gov/consumerinfo/energy_savers/insulation.html

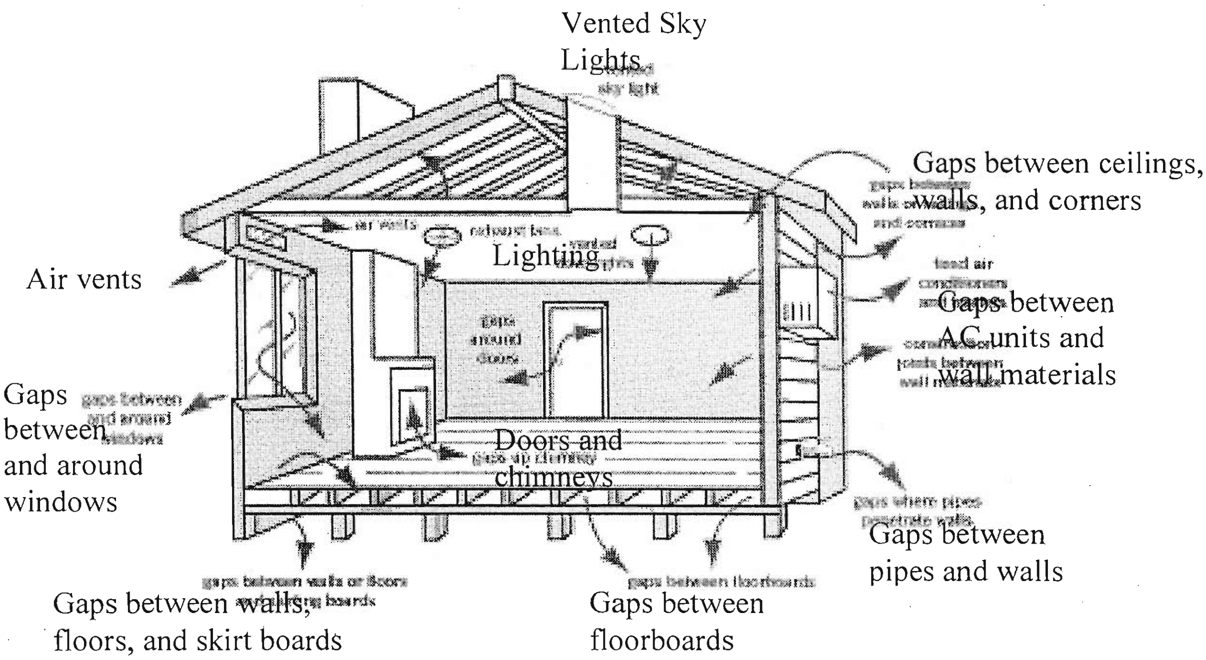


Figure 26. Air Leaks in a home
US Department of Energy , Energy Efficiency and Renewable Energy Network, Energy Savers. Retrieved from the World Wide Web on the 27th of March, 2002, at
http://www.eren.doe.gov/consumerinfo/energy_savers/insulation.html

Vapour Barriers

Vapour barriers should be installed along with insulation. Vapour barriers are designed to stop water condensation from entering the insulation and are made of paper or plastic. The R-value associated with a given insulation decreases with water accumulation (Owens Corning).

Heating and cooling bill per year before installing installation	$________(1)
Heating and cooling per year bill after installing installation	$________(2)
Cost of installation (total)	$________(3)
Number of students in school	#________(4)
Number of days in year	#________(5)
(1) – (2) = Savings due to installation	$________(6)
(6) / 4 = Savings per student	$________
(3) / (6) = Years to recover initial cost (approx)	#________

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Website:
http://www.eren.doe.gov/consumerinfo/energy_savers/insulation.html
Email: doe.erec@nciinc.com

Owens Corning

(Information and resource list)
Website: http://www.owenscorning.com/comminsul/faq-thermal.asp
Email and Feedback:
http://www.owenscorning.com/feedback/feedback.asp?SectionNum=1

The most common solar hot water system is known as a Flat Plate Collector, shown in Figure 27. The flat plate collector consists of a rectangular box with a transparent cover and is installed on a building's roof. Small tubes, attached to a black plate, run through the box and carry water that is heated as the plate heats. The heated water then goes into an insulated storage tank where it can be transferred to the building (CitiPower).

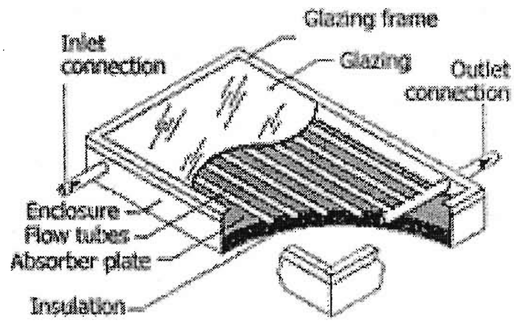

Figure 27. Cross Section of a Solar Water Heater
CitiPower. Solar Hot Water. Retrieved on the 24th of March, 2002, at http://www.citipower.com.au/

Electricity bill per year before installing solar hot water system	$_________(1)
Electricity bill per year after installing solar hot water system	$_________(2)
Cost of solar hot water system (total)	$_________(3)
Number of students in school	#_________(4)
Number of days in year	#_________(5)
(1) – (2) = Savings due to solar hot water system	$_________(6)
(6) / 4 = Savings per student	$_________
(3) / (6) = Years to recover initial cost (approx)	#_________

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Citipower

(Information resources)
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Solar Hot Water Hot Line
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Environment and Renewable Energy Line
Tel 1 800 650 540
Melbourne Office:
628 Bourke Street
Melbourne, Victoria 3000
Tel (03) 9297 8900
Fax (03) 92978905
Website: http://www.citipower.com.au
Email: information@citipower.com.au

Photovoltaic cells work by converting sunlight into electrical energy. Crystalline silicon (c-Si) is the leading material used for photovoltaic cells (U.S. Department of Energy, National Centre for Photovoltaics). The most common solar cell system is a flat plate system. The flat plate system allows the photovoltaic cell to absorb all the sunlight that strikes it, direct and indirect alike. Figure 28 shows a cross section of a flat plate collector.

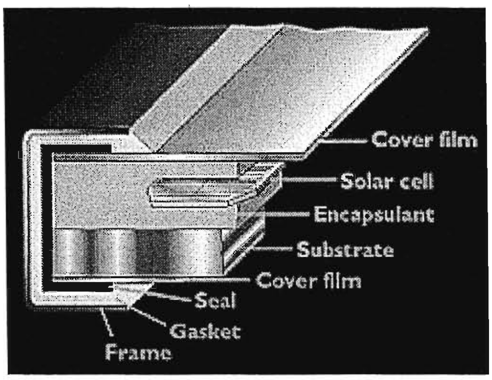

Figure 28. Cross section of a Flat Plate Collector
United States Department of Energy, National Center for Photovoltaics. Retrieved from the World Wide Web on the 15th of April, 2002, at http://www.nrel.gov/ncpv/

CitiPower estimates that the average household, with a twenty square metre array, will produce 5.5 kilowatt-hours (kWh) of electricity per day. This system can save the household about $250 per year. (CitiPower)

The Hopkinton High School / Middle School in Hopkinton, New Hampshire, USA, have fitted their school with sixteen, 120 watt Astro Power Modules, along with two Advanced Energy GC-1000 inverters. This installation allowed the school to save from $300 to $400 (US) per year on their energy bill (U.S. Department of Energy, Energy Efficiency, and Energy Network, January 1, 2002).

One negative aspect attributed to using photovoltaic cells is the overall area they occupy, as shown in Table 5, taken from a report issued by the National Renewable Energy Laboratory, a United States Department of Energy National Laboratory (U.S. Department of Energy, National Center for Photovoltaics).

Table 5. Roof areas needed for photovoltaic cells

PV module efficiency (%)	PV capacity rating (watts)							
	100	250	500	1,000	2,000	4,000	10,000	100,000
4	**3**	7	**14**	**28**	**56**	**111**	**279**	**2787**
8	**1**	**4**	7	**14**	**28**	**56**	**140**	**1394**
12	**1**	**2**	**5**	9	**19**	**37**	**93**	**929**
16	**1**	**2**	**3**	7	**15**	**30**	**74**	**743**

United States Department of Energy. National Center for Photovoltaics. Retrieved from the World Wide Web on the 15th of April, 2002, at http://www.nrel.gov/ncpv/

Electricity bill per year before installing photovoltaic cells	$_________(1)
Electricity bill per year after installing photovoltaic cells	$_________(2)
Cost of photovoltaic cells and system (total)	$_________(3)
Cost of electricity per kilowatt hour	$_________(4)
Number of students in school	#_________(5)
Number of days in year	#_________(6)
(1) – (2) = Savings due to photovoltaic cells	$_________(7)
(7) / (5) = Savings per student	$_________
(7) / (4) = Kilowatts produced by schools	#_________
(3) / (7) = Years to recover initial cost (approx)	#_________

Resources:

Sustainable Energy Authority of Victoria

(Information and list of contacts)
Sustainable Energy Authority
Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3222
Fax 03 9655 3255
Website: http://www.seav.vic.gov.au
Email: advice@sea.vic.gov.au

Energy Smart Schools Program
Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3268
Fax 03 9655 3255
Website: http://www.seav.vic.gov.au/schools/intro.html
Email: phil.munari@seav.vic.gov.au

Australian Greenhouse Office

(Information resources)
Australian Greenhouse Office
John Gorton Building
GPO Box 621
Canberra ACT 2601
Tel 02 6274 1888
Fax 02 6274 1390
Website:
http://www.greenhouse.gov.au/renewable/reis/technologies/thermal/hitemp.html

Citipower

(Information resources)
CitiPower Appliance Advisory Line
Tel 1 800 814 309
Solar Hot Water Hot Line
Tel 1 800 650 205
Environment and Renewable Energy Lin
Tel 1 800 650 540
Melbourne Office:
628 Bourke Street
Melbourne, Victoria 3000
Tel (03) 9297 8900
Fax (03) 92978905
Website: http://www.citipower.com.au
Email: information@citipower.com.au

National Center for Photovolt United States Department of Energy

(Information and resource list)
Energy Efficiency and Renewable Energ
P.O. Box 3048
Merrifield, VA 22116

Tel 1-800-363-3732
Fax 1-703-893-0400
Website: http://www.nrel.gov/ncpv/
Email: doe.erec@nciinc.com

There are three main types of solar thermal systems: Parabolic Trough, Parabolic Dish, and Power Towers. Parabolas are used because of their ability to direct light to a specific location, known as the focal point, as shown in Figure 29. This allows the systems using these parabolic mirrors to obtain the maximum amount of sunlight from the mirror (U.S. Department of Energy, National Center for Photovoltaics; Australian Greenhouse Office, Renewable Energy, June 1999).

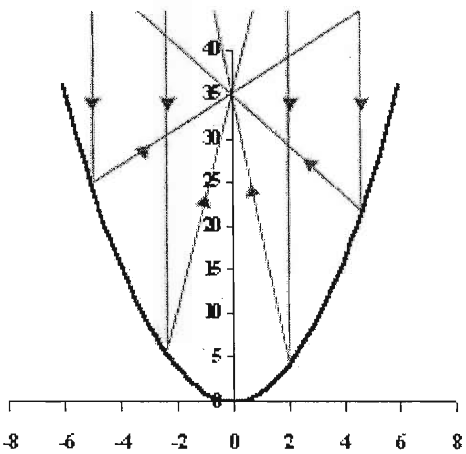

Figure 29. Parabola
Australian Greenhouse Office. Renewable Energy. (June 1999) Retrieved from the Word Wide Web on the 9th of April, 2002, at http://www.greenhouse.gov.au/renewable/reis/technologies/thermal/hitemp.html

Parabolic Trough

A Parabolic Trough uses parabolic mirrors to focus sunlight on a tube filled with water. The hot water boils to produce steam, used to generate electricity in a turbine (U.S. Department of Energy, National Center for Photovoltaics; Australian Greenhouse Office, Renewable Energy, June 1999).

Dish/Engine

A Dish/Engine system is similar to the trough systems, but instead of the sunlight heating water to create steam, the sunlight is used to heat an engine—usually a sterling engine–to create mechanical energy (U.S. Department of Energy, National Center for Photovoltaics; Australian Greenhouse Office, Renewable Energy, June 1999)

Power Tower

The third type is a Power Tower system that works basically the same way as a parabolic trough system. A large field of sun-tracking mirrors are used to concentrate the sunlight, much like the parabolic mirrors, to heat fluid in the top of the tower that is used to create steam and then electricity (U.S. Department of Energy, National Center for Photovoltaics; Australian Greenhouse Office, Renewable Energy, June 1999)

Electricity bill per year before installing solar thermal system	$________	(1)
Electricity bill per year after installing solar thermal system	$________	(2)
Cost of solar thermal system (total)	$________	(3)
Cost of electricity per kilowatt hour	$________	(4)
Number of students in school	#________	(5)
Number of days in year	#________	(6)
(1) – (2) = Savings due to solar thermal system	$________	(7)
(7) / (5) = Savings per student	$________	
(7) / (4) = Kilowatts produced by schools	#________	
(3) / (7) = Years to recover initial cost (approx)	#________	

Resources:

Sustainable Energy Authority of Victoria

(Information and list of contacts)
Sustainable Energy Authority

Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3222
Fax 03 9655 3255
Website: http://www.seav.vic.gov.au
Email: advice@sea.vic.gov.au

Energy Smart Schools Program

Ground floor, 215 Spring Street
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Tel 03 9655 3268
Fax 03 9655 3255
Website:
http://www.seav.vic.gov.au/schools/intro.html
Email: phil.munari@seav.vic.gov.au

Australian Greenhouse Office

(Information resources)
Australian Greenhouse Office
John Gorton Building
GPO Box 621
Canberra ACT 2601
Tel 02 6274 1888
Fax 02 6274 1390
Website:
http://www.greenhouse.gov.au/renewable/reis/technologies/thermal/hitemp.html

National Center for Photovoltaics, United States Department of Energy

(Information and resource list)
Energy Efficiency and Renewable Energy
P.O. Box 3048
Merrifield, VA 22116
Tel 1-800-363-3732
Fax 1-703-893-0400
Website: http://www.nrel.gov/ncpv/
Email: doe.erec@nciinc.com

Wind turbines work in the opposite manner of fans. Instead of using electricity to turn the turbine blades, producing wind, the wind is used to turn the blades, which in turn generates electricity. Figure 30 gives a cross section of an "upwind" wind turbine. Wind turbines are currently becoming popular in areas with substantial wind. While the initial investment for wind turbines can be costly, wind power is a clean and natural way to produce energy (U.S. Department of Energy, Energy Efficiency, and Energy Network, Wind Energy Program, October 2001).

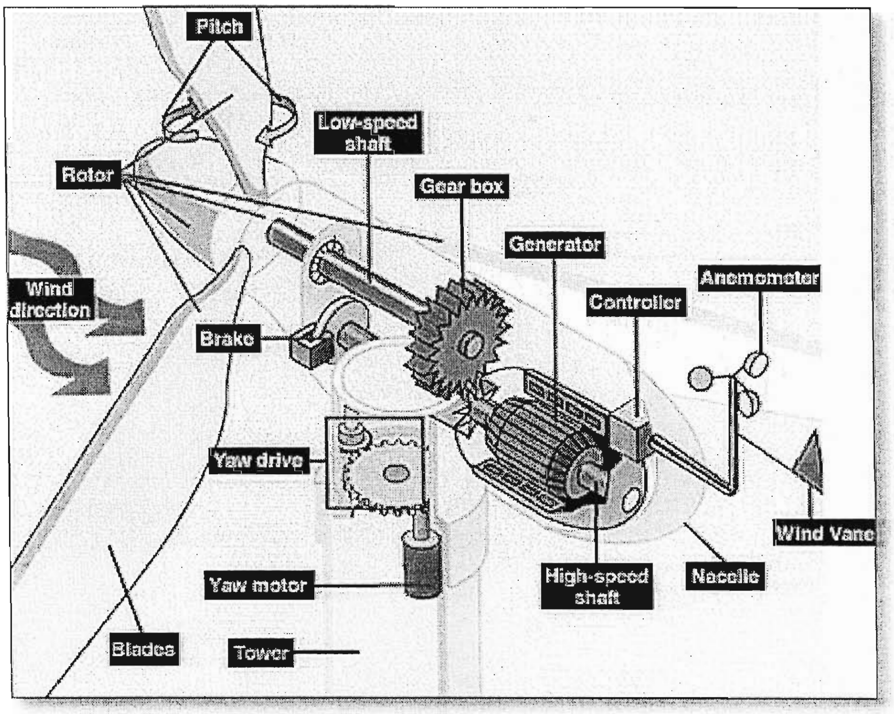


Figure 30. Internal workings of a wind turbine
US Department of Energy, Energy Efficiency and Renewable Energy Network. Wind Energy Program.. (October 11, 2001) Retrieved on the 24th of March, 2002, at http://www.eren.doe.gov/wind/wind.html

Electricity bill per year before installing wind turbines	$________	(1)
Electricity bill per year after installing wind turbines	$________	(2)
Cost of wind turbine system (total)	$________	(3)
Cost of electricity per kilowatt hour	$________	(4)
Number of students in school	#________	(5)
Number of days in year	#________	(6)

(1) – (2) = Savings due to wind turbines	$________(7)
(7) / (5) = Savings per student	$________
(7) / (4) = Kilowatts produced by schools	#________
(3) / (7) = Years to recover initial cost (approx)	#________

Resources:

Sustainable Energy Authority of Victoria

(Information and list of contacts)
Sustainable Energy Authority

Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3222
Fax 03 9655 3255
Website: http://www.seav.vic.gov.au
Email: advice@sea.vic.gov.au

Energy Smart Schools Program

Ground floor, 215 Spring Street
Melbourne Victoria 3000
Tel 03 9655 3268
Fax 03 9655 3255
Website:
http://www.seav.vic.gov.au/schools/intro.html
Email: phil.munari@seav.vic.gov.au

Citipower

(Information resources)
CitiPower Appliance Advisory Line
Tel 1 800 814 309
Solar Hot Water Hot Line
Tel 1 800 650 205
Environment and Renewable Energy Line
Tel 1 800 650 540
Melbourne Office:
628 Bourke Street
Melbourne, Victoria 3000
Tel (03) 9297 8900
Fax (03) 92978905
Website: http://www.citipower.com.au
Email: information@citipower.com.au

National Wind Energy Program, United States Department of Energy

(Information and resource list)
Energy Efficiency and Renewable Energy
P.O. Box 3048
Merrifield, VA 22116
Tel 1-800-363-3732
Fax 1-703-893-0400
Website: http://www.eren.doe.gov/wind/wind.html
Email: doe.erec@nciinc.com

Energy Definitions

R-Value – A measurement of a materials thermal resistance (how the material resists heat flow). The higher the R-value, the more efficient the insulation (Owens Corning)

U-Value - A measurement of the thermal conductivity of the window (how much heat passes through it). The lower the U-value, the more efficient the window (U.S. Department of Energy, Energy Efficiency, and Energy Network, Energy Savers).

Composting Toilets **Reference # W1**

Composting toilets use no water and rely on bacteria for the decomposition of excrement. These systems have been widely used throughout Australia and other parts of the world. National parks and campgrounds have successfully employed similar systems for a number of years. Only recently have schools and other institutions started implementing these systems on a broad basis (Roto-Loo, 2002).

It is preferable for this process to occur *aerobically* because *anaerobic* decomposition produces more odours and takes longer. Thus, many designs incorporate fans to increase air circulation in and around the compost, as show in Figure 31. Other

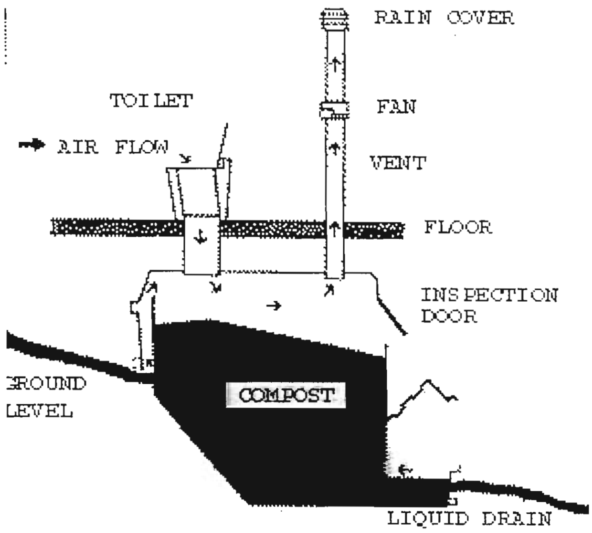


Figure 31. A typical chamber composting toilet system
Adapted from Australasian Connection P/L. 2000. Nature Loo. Retrieved from the World Wide Web on the 28th of March 2002 at http://www.nature-loo.com.au/.

common features of the basic composting toilet are an inclined base that spreads the waste out, increasing the capacity of the system, and an access panel, or door, adequate to inspect and clean the system when necessary. These systems may be self-contained and hold the liquid waste or the liquids can be expelled to the sewer or septic system (Wattworks, 2002, & Envirolet, 2002).

Australasian Connection P/L (2000), Asian-Pacific Manual for APNAN Countries (1995), and Kiwitaiki Organics for Tomorrow (2002) state that often enzymes or microorganisms are added to the composting material to both accelerate the decomposition process and reduce the smells generated during decomposition. Numerous companies supply Bokashi, which is a mixture of rice husks and rice pollard. The Asian-Pacific Natural Agriculture Network (1995) claims that anyone can produce Bokashi, but it takes some practice. It can also be purchased from distributors for around twenty cents per litre. The distributor, Kiwitaiki Organics for Tomorrow (2002), says the mixture can be applied to standard food composts as well as composting toilets. CERES is currently using Bokashi on its compost piles and their composting toilet system. This has caused a dramatic reduction of unwanted smells. The amount applied can be varied to eliminate odours as desired, however, as the amount of Bokashi used increases, the operating cost of the system increases.

The decomposition process occurs in several stages, since different bacteria process waste at different temperature levels. *Mesophilic* bacteria thrive in temperatures below forty degrees Celsius, while *thermophilic* bacteria decompose the waste at temperatures exceeding forty degrees Celsius. To destroy pathogen living in the waste, the temperature must reach at least fifty-five degrees Celsius for a period of twenty-four hours (Australasian Connection P/L, 2000).

Similar to standard composting, a moisture content of 40 to 60 percent is ideal for decomposition (Australasian Connection P/L, 2000). The process of composting human waste is the same as for composting food waste.

Cost of composting toilet	$______	(1)
Cost of water per kilolitre	$______	(2)
Cost of sewer service per kilolitre	$______	(3)
Number of student in school	#______	(4)
Number of toilets to be replaced	#______	(5)
Litres per flush of current toilets	#______	(6)
Number of school days in a year	#______	(7)
Estimated number of times a toilet is flushed per day	#______	(8)
(2) + (3) = Current cost per kilolitre of water	$______	(9)
(6) x (9) x .001 = Current costs per flush	$______	(10)
(1) x (5) = Total initial cost	$______	(11)
[(5) x (7) x (8) x (10)] - = Cost savings per year	$______	(12)
(12) / (5) = Savings per student per year	$______	
(11) / (12) = Number of years to recover initial costs	#______	years

Resources:

ReNew Magazine: issues #60 & #81

(Buyers Guide)
Alternative Technology Association
PO Box 2001
Lygon Street North
Brunswick East, VIC 3057
Website: http://www.ata.org.au

Nature Loo

(Information about composting)
http://www.nature-loo.com.au/tech.html

EM Application Manual for APNAN Countries

(Microorganism application)
http://www.agriton.nl/apnanman.html

Companies:

Biocycle

Factory 14
10 Norton Drive, Victoria
Fax 02 9979 9544
Free Call 1800 628 590

Clivus Multrum

PO Box 126
Strathpine, QLD 4500
Website: www.clivusmultrum.com.au
Email: info@clivusmultrum.com.au

Dowmus

PO Box 203
Geeburg, QLD 4034
Tel 07 3265 2755
Fax 07 3265 4900
Website: www.dowmus.com
Email: dowmus@ozemail.com.au

Enviro-Loo

(list of products and distributors)
Tel 02 9456 0172
Fax 02 9456 0173
Website: www.enviro-options.com.au
Email: enviro@spot.com.au

Environmental Equipment P/L

41a Jarrah Drive
Braeside VIC 3195
Tel 03 9587 2447
Fax 03 9587 5622
Free Call 1800 250 950
Website: www.waterless.com
Email: enquiry@rotaloo.com

A&a Worm Farm Waste Systems

2353 Morington-Flinders Road
Flinders, VIC 3929
Tel 5989 1088/5989
Fax 5989 1155
Website: www.wormfarm.com.au/index2.htm
Email: wormfarm@pacific.net.au

Going Solar

322 Victoria St
N. Melbourne, VIC 3051
Website: www.goingsolar.com.au
Email: retail@goingsolar.com.au

Gough Plastics

PO Box 7570
Garbutt BC, QLD 4814
Tel 07 4774 7606
Fax 07 4774 7608
Free Call 1800 069 805
Email: igough@gough.com.au

Garry Scott

Mullumbimby, NSW 2482
Tel 02 66 843 468
Fax 02 66 843 468

Rota-loo

(List of Distributors)
Website: http://www.rotaloo.com

Nature Loo

(List of distributors)
Tel 07 3870 5037
Fax 07 3870 5088
Website: http://www.nature-loo.com.au
Email: info@nature-loo.com.au

Wattworks

P.O. Box 569
North Balwyn VIC 3104
Tel 03 9859 8688
Fax 03 9859 8688
Website: www.wattworks.com.au

In contrast to the classic single flush toilets, dual flush toilets have two distinct flushes. One flush uses between 3 to 4.5 litres of water while the other uses between six and nine litres (Environment Australia, 2000). Environment Australia (2000) sites that the major challenges facing installation of dual flush toilets are regulations dealing with such issues as government standards and current sewer systems. Also, schools with poor sewer connections that use dual flush toilets could find that the sewer clogs more often because of a reduction in water flow.

Most dual flush systems receive the highest water conservation ratings. Therefore, when purchasing a toilet, the number of litres per flush should be compared to find which ones are most efficient.

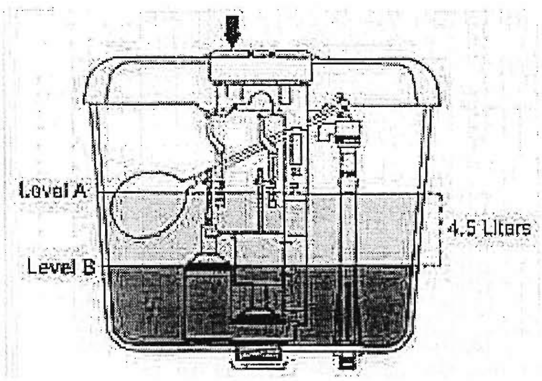


Figure 32. Dual flush toilet design.
GBH. (2002). Dual Flush Toilets. Retrieved from the World Wide Web on the 10th of April, 2002, at http://www3.jaring.my/gbhgroup/dualflush/dualflush.htm

Cost of composting toilet	$______	(1)
Cost of water per kilolitre	$______	(2)
Cost of sewer service per kilolitre	$______	(3)
Number of student in school	#______	(4)
Number of toilets to be replaced	#______	(5)
Litres per flush of current toilets	#______	(6)
Number of school days in a year	#______	(7)

Estimated number of times a toilet is flushed per day	#______	(8)
(2) + (3) = Current cost per kilolitre of water	$______	(9)
(6) x (9) x .001 = Current costs per flush	$______	(10)
(9) x 6 x .001 = Cost per flush of Dual Flush Toilet	$______	(11)
(1) x (5) = Total initial cost	$______	(12)
(10) – (11) = Savings per flush	$______	(13)
[(5) x (7) x (8) x (13)] = Cost savings per year	$______	(14)
(14) / (5) = Savings per student per year	$______	
(12) / (14) = Number of years to recover initial costs	#______	Years

Companies:

Caroma Industries Ltd.

(List of products and distributors)
Tel 131 774
Website: http://www.caroma.com.au

"Living Machine" systems operate by combining a standard grease trap, to remove solids, with the utilization of various organisms, to naturally remove material from wastewater. Bacteria, plants, snails and fish aid in the process by breaking down and digesting the organic pollutants in the water and are good indicators of overall water quality. Alternatively, leftover food waste from the canteen serves as a high protein food source for the fish. It also serves as a teaching tool to students and teachers on natural systems and the environment.

Current methods of wastewater treatment are expensive, environmentally unfriendly, and very energy intensive. The "Living Machine" provides a viable alternative. Estimated sewer rates for an average Australian school building, using a common sewer treatment system, are about two-hundred dollars per year, plus eighty-two cents per kilolitre of water used, according to the Yarra Valley Water (2002) and South East Water (2002). San Francisco's Oceanside Water Pollution Control Plant, in San Francisco, California, paid $440 million to install a "Living Machine" for wastewater treatment (the average prototype costs about $240,000). Before the addition of a "Living Machine", the average discharge of wastewater from the plant contained thirty-one milligrams per litre of ammonium. Afterwards, the concentration of ammonium was reduced by 90 percent (Horizons, 1997).

Other well-known corporations, such as the Ethel M. factory (creator of M&M-Mars chocolate) in Nevada (Ethel M Chocolates, 2002), the M&M-Mars chocolate plant in Waco, Texas, the community of South Burlington, Vermont, and in the Master Foods plant in Wyong, Australia have established "Living Machine" wastewater treatment systems. Tables 1 and 2 show the capability of the systems to remove Biochemical Oxygen Demand, total suspended solids, oil, and grease from the wastewater that is processed by the system at each factory.

Table 6. Effluent reduction by the Ethel M. Factory

		Actual	Design	Actual
Wastewater Characteristics	**Units**	**Influent**	**Effluent**	**Effluent**
Biochemical Oxygen Demand (BOD)	mg/L	1,270	10	6
Total Suspended Solids (TSS)	mg/L	309	10	5
Oils and Grease	mg/L	200	5	<1

Horizons. (1997). Living Machines. Retrieved from the World Wide Web on the 30th of January, 2002, at http://www.calacademy.org/calwild/pacdis/issues/spring97/horizon.htm

Table 7. Effluent reduction by South Burlington, VT

			Target
Wastewater Characteristics	**Units**	**Influent**	**Effluent**
Chemical Oxygen Demand (COD)	mg/L	454	<50
Biochemical Oxygen Demand (BOD)	mg/L	219	<10
Total Suspended Solids (TSS)	mg/L	174	<10
Total Nitrogen	mg/L	23	<10
Total Kjeldahl Nitrogen	mg/L	23	5

Horizons. (1997). Living Machines. Retrieved from the World Wide Web on the 30th of January, 2002, at http://www.calacademy.org/calwild/pacdis/issues/spring97/horizon.htm

The cost of these systems varies greatly, based upon specification. Any school intending to install such a system should have it properly designed by knowledgeable professionals. The design should not only take into account the present conditions, but future projections as well, reducing the amount of alterations the system will need in the future.

Resources:

Living Machine Inc.

(Background information)
http://www.calacademy.org/calwild/pacdis/issues/spring97/horizon.htm

US EPA

(Advisory briefing)
http://www.epa.gov/scipoly/sap/2001/june/sap14.pdf

Natural Wastewater Treatment Systems

(Examples and suggestions for possible use)
http://twri.tamu.edu/twripubs/WtrResrc/v14n2/text-0.html

Companies:

Bio-Tech Waste Management

PO Box 870
Armidale, NSW 2350
Tel 02 6772 8791
Fax 02 6771 3131
Website: http://www.northnet.com.au/~bellbtwm/btwm.html
Email: landline@your.abc.net.au

Aquatek Irrigation Systems (2002) states that twenty-five millimeters of water per week is adequate to maintain the growth of turf in most of Australia. The Irrigation Association of Australia (2002) is the monitoring body of Certified Irrigation Design and provides a list of qualified irrigation companies. In order to qualify as a Certified Irrigation Design Company, businesses must have sufficient experience and education in irrigation practices.

There are several irrigation methods that can deliver water to a school ground. The Irrigation Association of Australia (2002) and Aquatek Irrigation Systems (2002) divide these methods into three broad categories: drip or micro irrigation, surface irrigation, and sprinkler irrigation. All of these systems are either manually or computer moderated. Any above ground irrigation system should be operated between the hours of six in the evening and nine in the morning to limit water loss by evaporation (The Irrigation Association of Australia, 2002, & City West Water, 2002). Advantages to computer-controlled systems are that they can be equipped with sensors and react to the specific conditions of the weather and soil and that they can be programmed to turn on and off at specific times (Aquatek Irrigation Systems, 2002). Systems that run with timers should be monitored, so that they do not operate during or after a rainstorm or at other times when it is unnecessary. These systems are initially expensive and require electricity during operation, but generally use less water than manually controlled systems.

When using a sprinkler, water should spray the soil with a fine mist and be allowed to sink deeply into it. It should only be done twice a week rather than every day, and never in the middle of the day (Yarra Valley Water, 2001d). Near buildings and roads, directional sprinkles should be used to avoid unnecessary spraying onto pavement and walls. Regular inspections are needed to ensure that the systems have not been damaged and that nozzles are free of clogs and working properly (City West Water & Water Wise Victoria, 1996). The pressure of the entire system should also be measured occasionally to ensure that the system is operating as designed, because changes in the pressure of the water supply can adversely affect a systems performance.

Drip irrigation can be above or below the ground level. These systems have minimal waste because the water's exposure to direct sunlight, which causes evaporation, is minimized. Subterranean systems are more expensive than those above ground, but have several functional advantages (Sanders, 2001). The advantages are that the soil temperature is raised a few degrees, and soil compaction, along with the risk of flooding plants and evaporation are all reduced. These systems may also use Class B and C recycled water, which would reduce the cost of water for irrigation (EPA of Victoria, 2001). In this case, Class B water is suitable only for low level irrigation, and Class C water can only be used in subsurface irrigation.

Surface irrigation systems use natural waterways to irrigate. The advantage to using natural waterways is that no extra water is needed. This option, however, is not always available in Australia's dry climate (Australian Bureau of Metrological, 2002). Sprinklers are a surface watering system that must use a minimum of Class A water quality. If recycled water is used, then more purification is necessary than when using ground irrigation.

Cost analysis of these systems should be left to the individual companies, which provide the services due to the fact that no two systems or conditions will be exactly the same. This also means that schools should contact multiple companies to receive quotes on system installation.

Alternatively, an emerging technology, driwater, might provide a sufficient solution for irrigating school grounds. Driwater is composed of a nontoxic, biodegradable gel, which releases water as soil bacteria break it down (Driwater Australia Pty. Ltd., 1997). Each packet of driwater last sixty to ninety days, and once in place, it requires no additional attention, other than replenishing the supply when it runs out. Several trials have been run in South Australia, and the product was found to adequately supply water to sustain individual plants, and further tests are being conducted at Adelaide University (Driwater Australia Pty. Ltd., 1997).

Resource:
"The Water-efficient Garden" by W. van Dok (2000)

(Gardening and conserving water)
Local Book Store

Water and Rivers Commission

(General information on current water related issues)
http://www.wrc.wa.gov.au/.

Companies:
Aquatek Irrigation Consultants

PO Box 5126
Surrey Down, SA 5126
Tel 08 8289 4412
Fax 08 8289 4753
Website:
http://www.aquatekirrigation.com.au/tips.htm
Email: enquiries@aquatekirrigation.com.au

Leeaky Hoses

86 York St.
Richmond, VIC 3121
Tel 03 9429 2977
Fax 03 94298811
Email: leeaky@leeaky.com.au
Website: www.leeaky.com.au

PPI Corporation

275 Robinson Rd East
Geebung Brisbane, QLD 4034
Tel 07 3865 3699
Fax 07 3857 0058
Website: www.ppi.com.au

Water Corporation

(Curriculum materials for teachers and students)
http://www.watercorperation.com.au

Water Wise Watering and Irrigation Systems

(General Information on irrigation systems)
Available from your water council.

DRiWATER Australia Pty. Ltd.

Domenic Perre
75 Orsmond Street
Hindmarsh, S.A. 5007
Tel 08 8340 1022
Fax 08 8373 2814
Website: http://www.driwater.com.au/
Email: driwater@driwater.com.au

Nylex

25 Nepean Hwy
Mentone, VIC 3194
Tel 03 9581 0211
Fax 03 95 81 0517
Free Call 1800 333 426

Water Control Computers & Timers

25 Nepean Highway
Mentone, VIC 3194
Tel 03 9581 0211
Fax 03 9581 0517
Free Call 1800 333 416

Rainwater Harvesting and Purification System (15th of January, 2002), U.N. Environment Programme (2002), and Wack (2000) state that the basic components of a rainwater collection system are a tank to store the water, and an area to collect and direct the water to the tank. The initial flow of water carries dirt and dust that has built-up on the collecting surfaces, so many systems divert this initial water away from the tank, in what is called a first flush system. For instance, the rainwater collection system at CERES separates the first fifty litres of runoff before allowing water to collect in the storage tank, as shown in Figure 33.

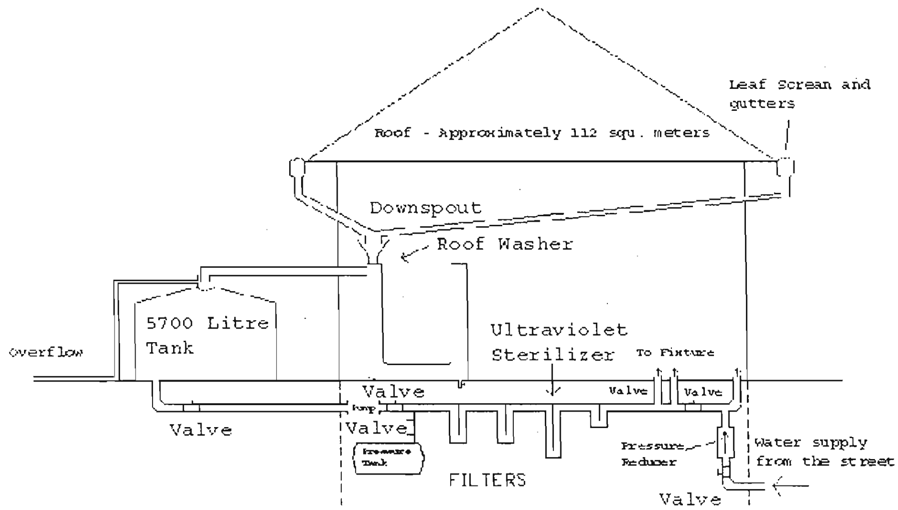


Figure 33. A rainwater collection and purification system
Adapted From Rainwater Harvesting and Purification System, 01/15/02. Retrieved from the World Wide Web on the 20th of March, 2002, at http://www.rdrop.com/users/krishna/rainwatr.htm

The water is directed by the roof into gutters. The gutters converge at a point referred to as the Roof Washer. Typically, these first flush systems are installed at this point to prevent the initial water from each rainfall from going into the system, as it will contain residue that gathered on the roof since the last rainfall (U.N. Environmental

Programme, 2002 & Wack, 2000). The simplest systems consist of a downspout—a vertical piece of drainpipe—with a cap on the end, which collects the first contaminated flow of water. Once this downspout fills the water overflows and fills the storage tank.

There are more advanced systems, which also remove material from rainwater. WISY: Products of rainwater utilization (2000) has developed a downspout filter, using a screen to remove particles larger than 0.18 millimetres from the rainwater. This style of system strains all the rainwater and collects nearly 90 percent of the overall rainfall. These systems are capable of dealing with roof areas up to five hundred square meters efficiently (WISY: Products of rainwater utilization, 2000).

The water is stored in a tank until it is ready to be used. Storage tanks or cisterns come in a plethora of shapes and materials, but there are certain qualities that should be sought out in all tanks. The United Nations Environmental Programme (2002) and Wack (2000) suggest choosing tanks that are easy to clean, neutralized against acid rain and the environment, have a sloped bottom, are closed to prevent animal infestation or contamination, and have a tap for easy drainage. The drainage tap should be a minimum of ten centimetres above the bottom of the tank. A slope on the bottom of the tank encourages sediment to *coagulate* and makes for easy cleaning (United Nations Environmental Programme, 2002). Depending on design specifications the price can range from $300 to over $3,500 depending on the required size and strength.

If the water is incorporated back into the potable water system of the school, then it must be pressurized, filtered, and sterilized. If however, it is only connected to the toilet and washing machines then simpler purification methods may be applied because water quality for these appliances only need to meet Class A standards. No matter what the end use, all pipe and fixtures, where untreated rainwater flows, must be clearly labelled as non-potable and colour coded pink, complying with international standards (EPA of Victoria, 2001).

These collection systems can be integrated with municipal water when the rainwater supply falls short of being fully adequate. However, proper valves and safety measures must be taken and a professional, who is knowledgeable in the field and local regulations, should complete the design of these systems.

Resources:

Victorian EPA

(Library Catalogue)
Website: http://www.epa.vic.gov.au/Library/EPAC/
(search for: Rainwater, greywater, or water harvesting)

Companies:

EnviroFLO Systems Limited

Newcastle, NSW
Tel 02 4957 5900
Fax 02 4957 5925
Website: www.enviroflo.com.au
Email: enviroflo@enviroflo.com.au

City Rainwater Tanks

11 Severn St
St. Marys, NSW 2760
Tel 02 9623 2414
Fax 02 9263 2428
Website: www.cityrainwatertanks.com.au
Email: sales@cityrainwatertanks.com.au

Leaf Beater

155 Old Pacific Hwy
Oxenford, QLD 4210
Tel 07 5573 1335
Fax 07 5573 4550
Website: www.leafbeater.com.au
Email: leafsyst@qld.net.au

RainSaver

12/16A Meadowbank Crescent
Meadow Bank, NSW 2114
Tel 02 9807 7595
Fax 02 9807 7595
Website: www.rainsaver.com.au
Email: gbrown@kgaust.com.au

SafeRain

PO Box 298
Blackburn, VUC 3130
Tel 03 9894 3302
Fax 03 9894 3302
Website: saferain.hypermart.net
Email: saferain@hotmail.com

A water hippo is simply an object that takes up space in a toilet or urinal's water tank. This reduces the water stored in the tank and thus the water per flush is reduced. Various objects can be used, such as balloons, bricks, bottles, jars, etc. Specific commercial devices have been developed, but the everyday objects previously listed work just as well. Caution must be urged in their use because many older style toilets require all the water to sufficiently clean the bowl and meet sanitation standards (Australian Water Association).

Water recycling systems collect water from some domestic sources and reuse it. Typically, in systems that reuse water domestically, water from the taps, showers, dishwashers, and washing machines is collected and undergoes purification to meet Class A water standards. It can then be recycled back through to supply water for toilets and washing machines. Currently, there is no legislation in place addressing water reuse techniques connected to *potable* systems, so non-contact dealings are the only sanctioned circumstances in which water can be reused. These systems for cleaning the wastewater vary greatly, and choosing the right system depends on the intended use.

An all on-site system that treats greywater for reuse must be approved by the EPA and issued a septic system permit by the local council (EPA of Victoria, 2001). The EPA also supplies a checklist of considerations when installing a water recycling system (see section 3.3.4 Checklist for Reuse Schemes in Publication 812: Reuse Options for Household Wastewater). Whatever the end uses, all pipe and fixtures where untreated rainwater flows must be clearly labelled as non-potable and colour-coded in pink to comply with international standards (EPA of Victoria, 2001).

Wattworks Water Recycling Systems (2002) and Electropure Industrial Australia Pty Ltd (2001) currently has several approved systems, which are being used in households throughout Victoria. Electropure Industrial Australia Pty Ltd (2001) is currently testing a system at Ballarat High School that is still seeking the EPA's final approval. This system combines worm farms and electrolysis methods to produce class A recycled water.

The cost savings of these systems will depend on the final system and specifics chosen during the design phase. Therefore, specific companies should be contacted in order to obtain these figures during the period of cost comparison.

Resources:
EPA of Victoria

EPA Publication 812: Reuse Options for Household Wastewater
EPA Publication 168: Guidelines for Wastewater Irrigations
EPA Publication 451: Code of Practice – Septic Tanks
EPA Publication 464: Guidelines for Wastewater Reuse
EPA Report 107: Model guidelines for domestic greywater reuse in Australia
(Regulations and Suggestions)
Website: www.epa.vic.gov.au (and search by publication number)

Queensland Water Recycling Strategy

Website: http://www.nrm.qld.gov.au/resourcenet/water/water-recycling/index.html

Companies:
Electropure Industrial Australia Pty

242 Canterbury Road
Canterbury, NSW 2193
Tel 02 9787 6333
Fax 02 9787 9766
Website: www.electropure.com.au
Email: enquiry@rotaloo.com

Environment Equipment Pty Ltd

41a Jarrah Drive
Braeside 3195
Tel 03 9587 2447
Fax 03 9587 6522
Free Call 1800 250 950
Website: www.rotoloo.com
Email: enquiry@rotaloo.com

Garden Master

PO Box 605
Wyong, NSW 2259
Fax 02 4353 4860
Free Call 1800 632 582
Website: www.gardenmaster.com.au
Email: sales@gardenmaster.com.au

Wattworks

P.O. Box 569
North Balwyn VIC 3104
Tel 03 9859 8688
Fax 03 9859 8688
Free Call 1800 069 046
Website: www.wattworks.com.au

There are two primary styles of waterless urinals, one that simply stores urine in a sealed container, and one that is connected to the sewer in the same manner as a conventional urinal. A variety of different designs exist that effectively seal and trap urine and odours. Although there are countless designs that accomplish this, only a few will be discussed here.

When urine is stored in sealed containers, the containers must be removed by a cleaner when full. The time a container will fill depends solely on its usage. Therefore, schools with larger numbers of students and faculty should expect to replace these containers more often than schools with fewer numbers. The amount of time a cleaner must spend dealing with the containers is only slightly longer than cleaning an average toilet. Schools must be prepared to dispose of the canisters properly and secure them from vandalism, as well as ensuring they meet the sanitation requirements of the local area.

Roto-loo Composting Toilets' (2002) waterless urinals use a patented Eco Trap system. This system traps the odours with a liquid that is lighter than urine. Thus, urine can be stored under this liquid without causing unwanted odours, as shown in Figure 34, until there is enough for it to enter the sewer. The Blue Seal liquid that is used must be replaced every thousand uses and cost $1.50 each time, but the cost of one thousand flushes is on average $4.50 in the Melbourne area.

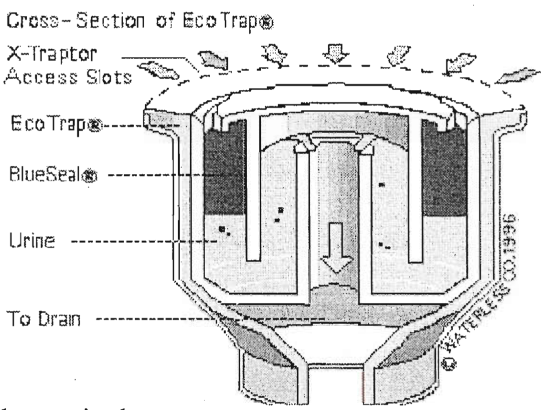


Figure 34. Eco Tap Waterless urinal system
Roto-Loo Composting Toilets. (2002). The Waterless Advantage. New South Wales, AUS: Author.

Cost of waterless urinal	$______	(1)
Cost of water per kilolitre	$______	(2)
Cost of sewer service per kilolitre	$______	(3)
Number of student in school	#______	(4)
Number of urinals to be replaced	#______	(5)
Litres per flush of current urinals	#______	(6)
Number of school days in a year	#______	(7)
Estimated number of times a urinal is flushed per day	#______	(8)

(2) + (3) = Current cost per kilolitre of water	$______	(9)
(6) x (9) x .001 = Current costs per flush	$______	(10)
(1) x (5) = Total initial cost	$______	(11)
(5) x (7) x (8) x (10) = Cost savings per year	$______	(12)
(12) / (5) = Savings per student per year	$______	
(11) / (12) = Number of years to recover initial costs	#______	years

Companies:
Environment Equipment Pty Ltd

41a Jarrah Drive
Braeside 3195
Tel 03 9587 2447
Fax 03 9587 6522
Free Call 1800 250 950
Website: www.waterless.com
Email: enquiry@rotaloo.com

Recycling **Reference # R1**

Glass

According to the environmental organisation, EcoRecycle (1999), recyclable glass makes up 3.4 percent of household garbage in Victoria. Recycling glass saves 74 percent of the energy it takes to make glass from raw materials (EcoRecycle Victoria, 1999). Presently, the major raw material for glass manufacturing in Australia is crushed glass, or cullet. Using cullet in glass manufacturing contributes to reduced resource use. In fact, EcoRecycle (1999) stated that each ton of cullet used saves 1.1 tons of raw materials. Figure 35 illustrates examples of types of glass that can and cannot be recycled.

Types of glass that can be recycled:

- All clear, green and amber glass bottles -soft drink, mineral water, wine, beer
- All glass jars
- Sauce bottles

(EcoRecycle Victoria, 1999)

Figure 35. Examples of glass that can and cannot be recycled.
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Types of glass that cannot be recycled (through kerbside collection):

- Broken window glass and broken windscreen glass.
- Heat-treated glass (for example Corning Ware, Pyrex or Vision Ware).
- Light globes.
- White opaque bottles (cannot see through them).
- Laboratory and medical glass.

(EcoRecycle Victoria, 1999)

Glass should be prepared for recycling by:

- Removing lids or caps.
- Rinsing bottles and jars.

(EcoRecycle Victoria, 1999)

If glass is allowed on a school's grounds, the school's kerbside council should be contacted to arrange for glass pickup.

Resources:

ACI Glass Packaging

(Glass recycling)
PO Box 8 Newport Vic 3015
Tel 03 9235 6211
Fax 03 9399 1392

Recyclers of Australia

(Glass recycling)
PO Box 388
Altona Vic 3025
Tel 03 9369 7477
Fax 03 9369 6350

Paper

In 1998/99, Australians used almost 3.5 million tonnes of paper, with only about 1.8 million tonnes of waste paper collected for recycling. Most of the waste paper was packaging materials, with smaller amounts being newspaper, magazines and writing paper (EcoRecycle Victoria, 1999). EcoRecycle Victoria et al (1996-2000) stated that at least half of the waste generated by schools is paper and cardboard, most of which is recyclable. The waste paper may need to be separated into two types - mixed paper/cardboard, and clean white paper - as some companies collect these two separately (Visy Recycling). If schools are provided with a choice of collection method, it is often more convenient to have all the paper collected together. Teaching pupils to distinguish between the two types, however, may increase their awareness of recycling.

Each time used paper is recycled, the fibres from which it was composed are degraded, or "down graded". Consequently, there is a limit to the number of times a paper fibre can be recycled (EcoRecycle Victoria,1999).

Local council should be contacted, as there are a variety of differences in the types of paper accepted, as well as the preparation require by recycling contractors.

Resources:

AMCOR Paper Recycling

(Paper recycling)
626 Heidelberg Road
Alphington Vic 3078
Tel 03 9490 3130
Fax 03 9490 3211

Visy Recycling

(Paper recycling)
13 Reo Crescent
Coolaroo Vic 3048
Tel 03 9247 4400
Fax 03 9247 4444

Publishers National Environment Bureau

(Newspaper recycling)
PO Box 5359
Sydney NSW 2001
Tel 02 262 1164
Fax 02 262 6767

Aluminium Cans

In 1997, 0.2 percent of waste dispensed by Victorian households consisted of aluminium cans (EcoRecycle Victoria, 1999). Aluminium is a metal made of an ore called bauxite. Australia has large reserves of bauxite and is one of the world's leading producers of aluminium. The energy needed to make one new aluminium can is the same as the energy gained by recycling twenty aluminium cans, as illustrated in Figure 36.

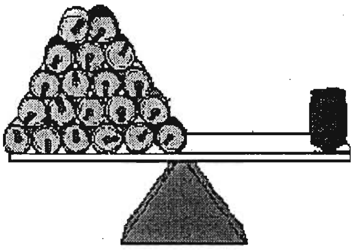


Figure 36. Energy needed to make one-can verses recycling cans
Ecorecycle Victoria. (1996). About Ecorecycle. Retrieved from the World Wide Web on the 25th of March, 2002, at http://www.ecorecycle.vic.gov.au/frames_about.asp

Aluminium that can be recycled:

- Aluminium soft drink and beer cans (not those with steel ends).
- Aluminium cooking foil.

(EcoRecycle, et al., 1998)

Preparing aluminium cans for recycling:

- Rinse and crush the cans. (If you collect cans from public places to sell at buy back centres, then before you crush the can, check that no sharp objects, such as syringes, have been placed inside the can.)
- Don't add foreign objects, such as stones, to the cans. These can interfere with the recycling process

(EcoRecycle Victoria, et al., 1998)

There are different options a school has when recycling aluminium. The cans may be collected and sold back at a buy-back centre, deposited at a 'cash for cans' centre school, or placed in recycling bins in public areas. Two alternative options are that the school can arrange a tailored collection program or contact a local scrap merchant who will arrange a collection and payment system.

Resources:

KAAL Australia

(Aluminium recycling)
Point Henry Road
Point Henry Vic 3220
PO Box 460 Geelong Vic 3220
Tel 03 524 51 440
Fax 03 524 51 153

Steel Cans

Recycling steel cans saves 87 percent of the energy it takes to make them from raw materials (EcoRecycle Victoria, 1999). As EcoRecycle Victoria stated (1999), in 1997, 2.3 percent of household garbage was made up of recyclable steel. Two years later, on average, each Australian threw away 6.5 kilograms of small steel products and steel cans.

Steel cans from kerbside collections are taken to recycling sorting centres where they are separated either by hand or with magnets. The cans are then baled and sent to the Broken Hill Propriety (BHP) steel works at Newcastle or Whyalla, which use the cans to make new steel, or a de-tinning plant at Port Kembla in New South Wales, where the cans are de-tinned before being made into new steel in an integrated steel plant (EcoRecycle Victoria, 1999). Figure 37 depicts the process that steel cans go through during recycling.

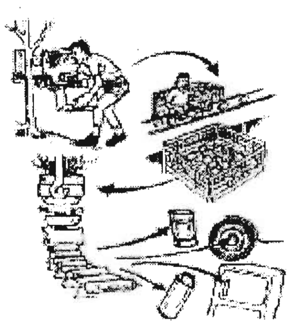


Figure 37. Diagram of steel can recycling
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Types of steel cans that can be recycled:

- Food and pet food cans.

- Coffee cans.
- Oil cans.
- Paint cans.
- Aerosol cans.
- Bottle tops.
- Jam jar lids.

(EcoRecycle Victoria, 1999)

Preparing steel cans for recycling:

1. Remove the lid completely.
2. Rinse the can
3. Place the lids inside the can. (Place bottle tops and jam jar lids inside as well)
4. Press the can flat near the top of the can. (This saves space)
5. Place the cans out for collection.

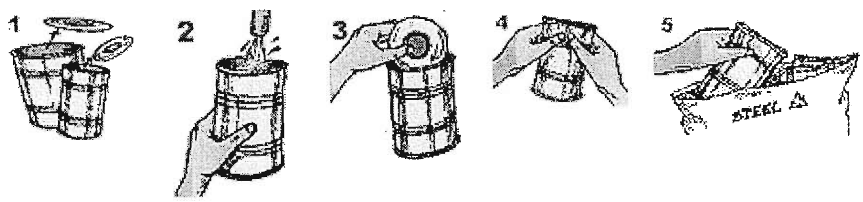


Figure 38. Example of preparing a steel can for recycling
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at **http://203.202.189.6/waste_stop/act_intro.htm**

Steel containers may be collected and recycled by most schools through their local recycling service providers or scrap merchants. The local Council should be contacted with inquiries. If these options are not available for a school, the steel cans can be taken home by staff and left out in their home kerbside container.

Resources:
BHP Packaging Products

(Steel can recycling)
PO Box 1854
Woolongong NSW 2500
Tel 04 2 753 260
Fax 04 2 753 201
Freecall 1800 064 384

Beverage Cartons

According to EcoRecycle Victoria (1999), about 0.5 percent of household garbage in 1997 consisted of recyclable, liquid paperboard that could have been recycled. Just one carton could have been used to produce five new sheets of white paper. Beverage cartons are commonly used to package milk and juice, as well as cream, custard, flavoured milks, sauces, detergents, soups, wine, oil, and cereal grains. There are two basic types of cartons: gable top and aseptic brick (EcoRecycle et al, 1998).

Gable top cartons (Figure 39) are made from a layer of paperboard sandwiched between two layers of very thin plastic. Some gable top cartons that are used for packaging fruit juice have an additional layer of foil and a third layer of plastic. This is to further improve the shelf life and retain flavour (EcoRecycle Victoria, et al., 1998).

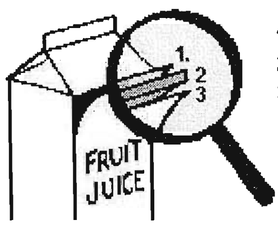


Figure 39. Example of gable top cartons
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Aseptic bricks/UTH or longlife packs (Figure 40) - are a newer type of carton and are made from five layers: three of plastic, one of foil and one of board. The products in the cartons are sterilized before being packaged and, as the cartons fully seal the contents, they do not need to be refrigerated before opening. This results in savings in energy during storage and transport (EcoRecycle Victoria, et al., 1998).

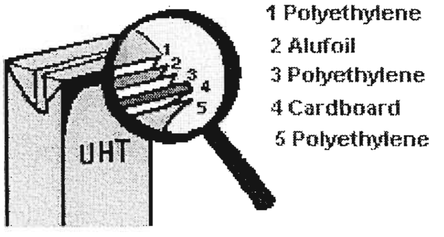


Figure 40. Example of aseptic bricks
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Types of cartons that can be recycled:

- All gable top milk and juice cartons. j
- Brick shaped cartons (for example long life milk and juices).

(EcoRecycle et al., 1998)

Preparing cartons for recycling:

1. Rinse and flatten the cartons.
2. Place flattened cartons inside an open carton.

You should be able to insert at least six one-litre cartons inside an open one, even more if you top and tail them.

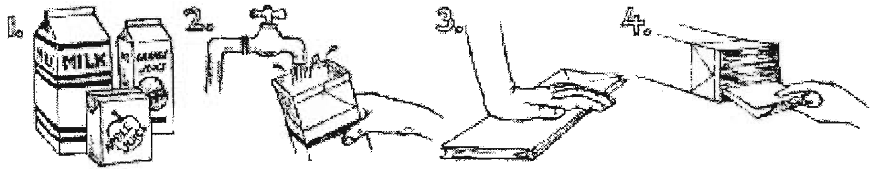


Figure 41. Example of preparing cartons for recycling
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Other uses for cartons:

Composting:

Cartons can also be composted as an alternative to recycling. Ideally, the cardboard should break down within three months, and the plastic, being very thin and un-stabilized, breaks into small pieces.

Reused for:

- For growing seedlings
- As tree guards
- For craft activities
- As pencil holders (try decorating with stickers or wrapping paper)
- For storing waste cooking fat.

(EcoRecycle et al., 1998)

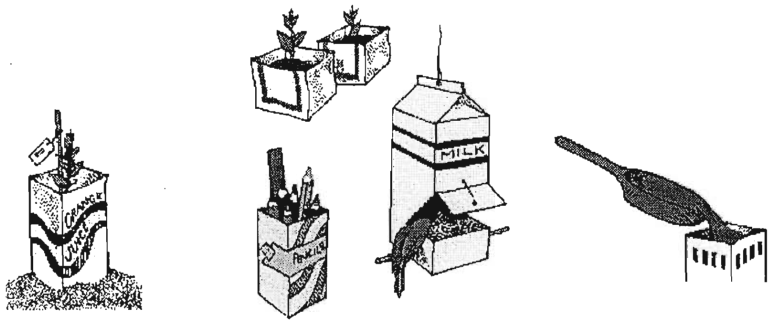


Figure 42. Examples of composting
EcoRecycle Victoria, Environs Australia, & Gould League. (July, 1998). Waste Stoppers. Retrieved from the World Wide Web on the 31st of March, 2002, at http://203.202.189.6/waste_stop/act_intro.htm

Storing cartons present a hygiene problem if they are not emptied, opened, and cleaned before being stored for recycling. Based on the pickup schedule of recyclables, schools should be prepared to set up a cleaning system or a suitable storage area for these cartons. The local Council should be contacted for information on local recycling systems.

Resources:

Association of Liquid paperboard Carton Manufacturers

(Milk and fruit juice carton recycling)
Level 3, 15-17 Park Street
Melbourne Vic 3004
Tel 03 9698 4484
Fax 03 9698 4485

Plastics

In 1998/99, 4.4 percent of garbage from the average household in Victoria was made up of plastics that could have been recycled (EcoRecycle Victoria, 1999). Table 8 lists many types of recyclable plastics, and provides a brief description of their uses, both before and after recycling. Three familiar types of plastics that are economically feasible to recycle are: PET (code 1), consisting of soft drink and some fruit juice bottles; HDPE (code 2), including white milk, cream and some juice bottles; and Vinyl (code 3), comprising some juice containers and cordials (EcoRecycle Victoria, 1999). Each plastic must be sorted, and then returned to the factory for reprocessing. During the reprocessing procedure, the following steps are taken:

- Large contaminants are removed manually.
- The plastics are shredded, chopped, or ground, and then washed to remove further contaminants.
- The material is dried and formed into pellets or powder, ready for remaking into new plastic products.

(EcoRecycle Victoria, 1999)

Table 8. Recyclable plastics and their uses

Plastic Identification Code	**Name of plastic**	**Description**	**Some uses for virgin plastic**	**Some uses for plastic made from recycled waste plastic**
1 PETE	polyethylene terephthalate PET	Clear tough plastic, may be used as a fibre.	Soft drink and mineral water bottles, filling for sleeping bags and pillows, textile fibres.	Soft drink bottles, (multi-layer) detergent bottles, clear film for packaging, carpet fibres, fleecy jackets.
2 HDPE	High density polyethylene HDPE	Very common plastic, usually white or coloured.	Crinkly shopping bags, freezer bags, milk and cream bottles, bottles for shampoo and cleaners, milk crates.	Compost bins, detergent bottles, crates, mobile rubbish bins, agricultural pipes, pallets, kerbside recycling crates.
3 V	unplasticised polyvinyl chloride UPVC	Hard rigid plastic, may be clear.	Clear cordial and juice bottles, blister packs, plumbing pipes and fittings.	Detergent bottles, tiles, plumbing pipe fittings.
	plasticised polyvinyl chloride PPVC	Flexible, clear, elastic plastic.	Garden hose, shoe soles, blood bags and tubing.	Hose inner core, industrial flooring.
4 LDPE	low density polyethylene LDPE	Soft, flexible plastic.	Lids of icecream containers, garbage bags, garbage bins, black plastic sheet.	Film for builders, industry, packaging and plant nurseries, bags.
5 PP	polypropylene PP	Hard, but flexible plastic - many uses.	Icecream containers, potato crisp bags, drinking straws, hinged lunch boxes.	Compost bins, kerbside recycling crates, worm factories.
6 PS	polystyrene PS	Rigid, brittle plastic. May be clear,glassy.	Yoghurt containers, plastic cutlery, imitation crystal "glassware".	Clothes pegs, coat hangers, office accessories, spools, rulers, video/CD boxes.
	EPS	Foamed, lightweight, energy absorbing, thermal insulation	Hot drink cups, takeaway food containers, meat trays, packaging.	
7 OTHER	Other	Includes all other plastics, including acrylic and nylon.		

EcoRecycle Victoria. (1999). Information Sheet 7: Glass Recycling. Retrieved from the World Wide Web on the 1st of April, 2002, at http://www.ecorecycle.vic.gov.au/aboutus/infosheet_glass.asp

Types of plastics that can be recycled:

- For plastic bottles, check with your local Council. Save only these for kerbside collection.
- Return plastic supermarket bags to those supermarkets that collect them.

(EcoRecycle Victoria, 1999)

Preparing plastics for recycling:

- Wash and squash bottles.
- Remove lids or caps from bottles. Check with your local Council for details about plastics recycling in your local area.

(EcoRecycle Victoria, 1999)

Resources:

ACI Petalite

(PET recycling)
19 Maloney Drive
Wodonga Vic 3630
Tel 02 6056 2344
Fax 02 6056 2388

Australian Vinyls Corporation

(PVC recycling)
Leakes Road
Laverton Vic 3028
Tel 03 9360 0899
Fax 03 9368 4888

Full Cycle Plastics

(HDPE recycling)
8 Brixton Road
Cheltenham Vic 3192
Tel 03 9584 5211
Fax 03 9583 6391

Kemcor (Plastics)

(HDPE recycling)
471-513 Kororoit Creek Road
Private Bag 3
Altona Vic 3018
Tel 03 9258 7333
Fax 03 9258 7451

Plastics and Chemicals Industries Association (PACIA)

(Plastics recycling)
GPO Box 1610M
Melbourne Vic 3001
Tel 03 9699 6299
Fax 03 9699 6717

Vicfam Plastics Pty Ltd

(LDPE, HDPE and cling recycling)
20-22 Somerleigh Road
Laverton North Vic 3026
Tel 03 9315 3421
Fax 03 9315 3485

Inkjet and Toner Cartridges

According to Carleton (2002), empty inkjet cartridges are, kilogram for kilogram, the most valuable post-consumer item in the recycling market. They are one of the newest and least-known recyclable products, and as a result, approximately three hundred million empty inkjet cartridges are thrown into US landfills annually, the equivalent of 30,500 African Elephants (Funding Factory and the Environment). With the average recycled value of a cartridge, minus its initial cost, being $2.50 (USD), roughly $500,000,000 (USD) is wasted each year.

Oil is a non-renewable fossil fuel:

- 77.8 grams of oil are used for every inkjet cartridge produced.
- 3.85 litres of oil are used for every laser cartridge produced.
- 2.2 litres of oil are conserved for every laser cartridge returned.
- The plastics that are used to manufacture computer cartridges take more than ten centuries to decompose.
- In most cases, computer cartridge recycling saves up to seventy percent on printing costs.

(Funding Factory and the Environment/Money-Back Secrets, 2001-2002)

There are two methods that should be considered when recycling cartridges:

Refilling – the process of adding ink to an empty cartridge. A cartridge can be refilled anywhere from five to nine times before it needs to be replaced (Inkhero Inkjet Printer Cartridge Information, 2002).

Remanufacturing – the process in which the cartridge is pulled apart and serviced before being reassembled and filled with ink. Remanufactured cartridges can be operated to the same standard as a new one, and should not affect the warranty of the printer as refilled cartridges can do (Inkhero Inkjet Printer Cartridge Information, 2002).

Recycling ink cartridges saves money by eliminating the costs of buying new cartridges each time they run out of ink. It can also be a source of income since most dealers exchange cash for good empty cartridges.

Resources:

ALC IT Solutions

(inkjet, laser, and toner cartridge recycling)
131 Adderley Street
West Melbourne Vic
Tel 03 9249 9249
Fax 03 9249 9866
e-mail: ian.smith@alcit.com.au

ATC I.T. Supplies

(laser toner, and toner cartridge recycling)
152-160 Miller Street
West Melbourne Vic
Tel 03 9329 9099
Fax 03 9329 9033
e-mail: peter.costa@atcitsupplies.com.au
website: www.atcitsupplies.com.au

Cartridge World Victoria (Head Office)

(inkjet, laser, and toner cartridge recycling)
39 Charles Street
Norwood Vic
Tel 61 08 8333 9800
Fax 61 08 8333 9811
Email: Trevor@cartridgeworld.com.au

Close the Loop

(inkjet, and toner cartridge recycling)
Unit 2, 19 Macquarie Drive
Thomastown Vic
Tel 61 3 9465 4855
Fax 61 3 9465 8722
free call: 1 800 2424 73
e-mail: info@closetheloop.com.au

Empties R Us

(drum units, toner bottles, fax, inkjet, laserjet, and photocopier cartridges)
200 Alexande Parade
Fitzroy Vic
Tel 03 9857 027
Fax 61 3 9859 8727

Greenworld Office Products

(laser cartridge recycling)
13/14 Miles Street
Mulgrave Vic
Tel 03 9545 0700
Fax 03 9545 0211
e-mail: Michaelc@greenworld.com.au
website: www.greenworld.com.au

Laser Rib Pty Ltd

(copier, inkjet, and laser toner cartridge, and dot matrix cassette recycling)
6D Aristoc Road
GlenWaverley Vic
Tel 03 9574 9499
Fax 03 9574 9890
e-mail: stevenklotnick@laserrib.com.au
website: www.laserrib.com.au

Print Saver

(inkjet, and laser cartridge recycling)
224 Charman Road
Cheltenham Vic
Tel 03 9583 5200
Fax 03 9585 6020
e-mail: steve@printsaver.com.au
website: www.printsaver.com.au

Toner Express (A'Asia) Pty Ltd

(laser and toner cartridge recycling)
428 Johnson Street
Abbotsford Vic
Tel 03 9417 5255
Fax 03 9419 8922
e-mail: haresfield@ozemail.com.au
website: www.tonerexpress.com.au

Westbury Office Supplies

(laser toner cartridge recycling)
22 Pakington Street
Saint Kilda Vic
Tel 03 9534 6644
Fax 03 9537 0744
e-mail: budz@bigpond.com

National Toner and Ink

(drum unit, fax, inkjet, photocopier, and toner cartridge recycling)
62 Korong Road
West Heidelberg Vic
Tel 03 9459 9055
Fax 03 9459 7992
e-mail: ian@toner-ink.com.au

Retoners

(inkjet, laser, and toner cartridge recycling)
1 Oxley Court
Langwarren Vic
Tel 03 9775 6561
Fax 03 9775 8362
e-mail: retoners@netscape.net

TonerFast

(laser and toner cartridge recycling)
19 Thompson Circuit
Mill Park Vic
Tel 03 9436 9981
Fax 03 9436 9957
e-mail: ssmith12@bigpond.net.au

About half the household waste in Australia is made up of kitchen and garden waste, which can be composted instead of thrown away (EcoRecycle Victoria, 1999). There are two types of decomposition that can occur in a composting heap: anaerobic and aerobic.

Anaerobic decomposition - Anaerobic decomposition occurs without oxygen, and, as a result, presents several disadvantages. It occurs slower than aerobic and produces unpleasant odours such as methane gas.

Aerobic decomposition - Aerobic decomposition occurs relatively quickly, through the action of microorganisms that thrive in oxygen, and does not usually produce unpleasant odours. Composting worms can be added to aerate the organic material and to reduce anaerobic breakdown (EcoRecycle et al., 1996-2000).

Creating a composting heap:

The following guiding principles should be adhered to in order to successfully develop and operate an aerobic composting system:

- Approximately equal amounts of 'greens' (kitchen and fresh garden waste) and 'browns' (fallen leaves and shredded paper) should be added to the heap.
- The heap should be kept damp and on well-drained soil to improve drainage.
- The organic material should be kept aerated by either frequently turning the container of compost or by inserting a piece of plastic pipe—with slits in the side—into the centre of the heap.

- If a closed bin is used to collect and store compost, small holes can be drilled into the sides of them to improve aeration.

  (Eco-recycle et al., 1996-2000)

Types of composting systems:

Three of the more commonly existing composting systems are the layering method, the 'all in together' method, and the compost worm method.

The **layering method** takes place rather slowly and does not give off much heat. 'Browns' and 'greens' are added to the composting heap in layers that are roughly ten centimetres deep, with a handful of fertilizer between each layer. This type of compost should be ready in between three and six months, however, the process can be accelerated if the heap is turned occasionally (EcoRecycle Victoria, 1999).

The next method is the **'all in together' method**. Unlike the layering method, this method occurs quickly and produces more heat. The container being used to hold the compost should be about one cubic meter. Kitchen and garden waste should be added to the bin. In order to create a rise in temperature, and accelerate the decaying process, the compost should be turned several times per week. In this case, the compost will be ready in one to six weeks (EcoRecycle Victoria, 1999).

The **compost worm method** (see wormeries section below) is moderately fast and does not produce much heat. The temperature of the heap is raised slowly through use of the layering method. Before the heap has exceeded thirty degrees Celsius, worms are added. The number of worms to be added will vary with the size of the compost heap. The worm population should double, roughly, every two to three months, and every ten thousand worms will eat about ten kilograms of waste per week (EcoRecycle Victoria, 1999). Again, the heap should be kept damp, and turning is not necessary because of the worms mix the soil. Compost produced through this method should be ready in about three months (EcoRecycle Victoria, 1999).

Worms will eat nearly any type of fruit or vegetable scrap, as well as leaves and damp cardboard, so ideally, a mixture of different materials should be added. However, onions, acidic foods (citrus fruits, etc.), and chemically treated foods should be avoided (EcoRecycle Victoria, 1999). Table 9 contains a list of suggestions of some of the different materials that should or should not be added to a composting heap.

Table 9. Ideal materials for a composting heap

What To Add	What NOT To Add
Vegetable and fruit scraps	Meat and dairy products
Fallen leaves	Diseased plants
Tea leaves	Metals, plastics, glass
Coffee grounds	Fat
Vacuum cleaner dust	Magazines
Soft stems	Large branches
Dead flowers	Weeds with seeds
Used vegetable cooking oil	Bread or cake
Old newspapers	Bones
Lawn clippings	Animal manure
Sawdust from treated timber	Sawdust from treated timber
Wood ash	

EcoRecycle Victoria. (1999). Information Sheet 7: Glass Recycling. Retrieved from the World Wide Web on the 1st of April, 2002, at http://www.ecorecycle.vic.gov.au/aboutus/infosheet_glass.asp

Composting bin containers:

Various types of containers may serve as a bin for a composting heap. A few possibilities are:

- Plastic bins with ventilation holes or slits
- Plastic bins without ventilation
- Metal drums with holes punched in the side and with the base removed

- Rotating drum units (tumblers)
- Enclosures made from timber (planks or sleepers), bricks, or chicken wire
- If an open composting heap is desired, they should be covered with either a plastic sheet or some hessian, so they do not dry out
- An alternative option would be to bury compost in small holes in the garden bed. (EcoRecycle Victoria, 1999)

Precautions

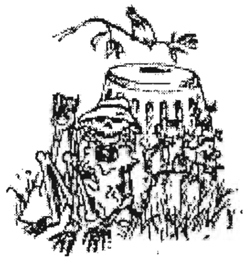
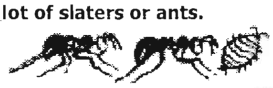
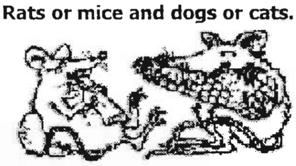
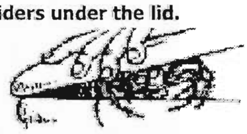
Since compost is made up of organic waste, it contains many living organisms, some of which have the potential to cause illness. Therefore, there are certain precautions that should be followed while handling compost:

- Wash hands after handling compost or soil materials.
- Protect broken skin by wearing gloves.
- Avoid confined spaces while handling compost.
- Keep compost moist to prevent the spores or bacteria in compost from becoming airborne.
- Gently wet dry compost to allow dust-free handling and avoid direct inhalation of dry compost.
- Facemasks may need to be worn to minimise allergic reactions.
- Elderly should take extra precaution when working with compost.

(EcoRecycle Victoria, 1999)

Composting Problems and Solutions:

Table 10. Examples of composting problems and solutions

PROBLEM	CAUSE(S)	SOLUTION(S)
Compost takes too long to break down. 	Too dry. Not right mix of 'greens' and 'browns'. Not enough air.	Add water. Add equal amounts of 'greens' (eg, vegetable scraps or fresh lawn clippings) or 'browns" (eg, fallen leaves or straw). • Either turn more frequently or add about 2,000 compost worms to the heap. • Punch some holes in the container. • Place a length of slotted agricultural pipe in the heap.
Smelly. 	Too wet. Too acidic. Insufficient air.	See below. Add some wood ash or dolomite to neutralise the heap. • Turn more often. • Rebuild with some dry materials.
Flies. 	Most of the flies in and around a compost heap are small vinegar flies which are quite harmless. If the flies are house flies or blowflies, then they are being attracted by meat or dairy foods.	Cover organic waste with a thin layer of soil, grass or leaves. Avoid adding meat or dairy products.
Too wet. 	Too much water has been added. Organic waste is too moist. Inadequate drainage.	Improve the drainage under the heap. Mix in some dry material such as dry grass clippings or shredded newspaper. Improve the drainage under the heap.
A lot of slaters or ants. 	Heap is too dry.	Add water or some moist organic materials.
Rats or mice and dogs or cats. 	Attracted by uncovered food and/or warmth of heap.	Cover each addition of food with a layer of soil. Place the bin on a layer of fine wire mesh. Set traps around the bin.
Spiders under the lid. 	Attracted by invertebrates, most likely small flies.	Have a handle on the top of the lid. Check for spiders before placing your hand under the lid. Wear gloves. Cover each addition of food with a layer of soil.

EcoRecycle Victoria. (1999). Information Sheet 7: Glass Recycling. Retrieved from the World Wide Web on the 1st of April, 2002, at http://www.ecorecycle.vic.gov.au/aboutus/infosheet_glass.asp

Mulch:

Mulch is chopped, composted, or shredded organic material that may be spread over soil to prevent water loss, while still allowing water to penetrate. It also suppresses weed growth and reduces the need for chemical sprays.

Mulch is used for many reasons, including to:

- Suppress weed growth
- Provide an alternative to land filling the plant material
- Reduce water loss from the soil and so reduce the need to watering
- Encourage a diversity of fungi and invertebrates and so reduce the need for chemical sprays
- Create a natural appearance
- Provide a soft surface for play grounds and paths
- Reduce soil erosion.

(EcoRecycle Victoria, 1999)

There are many types of organic mulch to choose from.

Some of these are:

- Pine or eucalypt chips
- Straw or hay
- Fallen leaves
- Sawdust
- Chipped tree pruning
- Grass clippings
- Compost

(EcoRecycle Victoria, 1999)

Wormeries:

An alternative to the composting methods described above would be to keep a container full of worms and feed them fruit and vegetable scraps. Worms could also be added to a composting heap (which, when properly aerated, would accelerate the decaying process). This is a simple way to cut down on garbage, and the worm castings provide a useful garden fertiliser.

Containers for keeping worms:

- Wooden boxes
- Stackable worm farms
- Stackable plastic worm factories
- Standard compost bins or heaps of compost (in this situation, knowledge of properly keeping after worms is required)

(EcoRecycle Victoria, 1999)

To contact a company that sells worm farms and composting worms, consult the 'yellow pages' of the telephone directory under 'Worm Farms.'

Resources:

CERES

(Composting and wormeries)
8 Lee Street
East Brunswick Vic 3057
Tel 03 9387 2609, 9387 4472
Fax 03 9381 1844

There are many reasons to **reduce and reuse** waste. Not only does reducing and reusing assists the environment by reducing the need for resources, but purchasing less materials and fully utilizing products also saves money. As a result of reducing the resources used in everyday life and living more carefully, there is a reduced amount of waste to dispose of. By reusing the same item numerous times, rather than disposing of it after one use, energy and resources that would have been used to make a new product are conserved. These are small but worthwhile changes that will contribute to decreasing the amount of waste generated by the people of Victoria.

Reduce:

Reduce means to live more carefully, producing less rubbish.

This includes:

- Shopping more carefully.
- Making more foods at home instead of buying takeaways or convenience foods.
- Making gifts and cards for family and friends, rather than buying them.
- Growing your own vegetables and flowers.
- Repairing clothes, toys, tools, and appliances rather than replacing them with new ones.
- Hiring, sharing, and borrowing things rather than buying new ones where possible.

When shopping, the following actions help reduce unwanted garbage:

- Take a bag, basket or box with you when you shop.
- Buy only what you really need.

- Avoid goods that have excessive packaging.
- Choose products that come in concentrated form (for example: kitchen detergents) or that have refills (for example: certain ballpoint pens and laundry detergents).
- When you buy packaged goods, choose packaging that is either made from recycled materials or that can be refilled, reused or recycled.
- Buy products made from recycled materials (examples include: paper and compost bins).
- Do not buy disposable products, such as tissues and nappies.
- Buy products that are durable and long lasting.
- Buy products that will not go out of fashion.
- Buy fresh foods and compost the scraps.
- Buy food from bulk stores or markets, and take your own bags to be refilled.
- Where there is a range of sizes available, choose the largest without being excessive.

(EcoRecycle Victoria, 1999)

Reuse:

Reusing an item means that energy and resources are saved, that would have been used to make a new product. Reusing also means that the item does not end up in a landfill.

There are many ways to reuse items around the home:

- Reuse empty glass jars for jams, and sauces.
- Open old envelopes carefully so that they can be reused.
- Use small, empty plastic soft drink bottles as drink bottles for school or outings.
- Buy second-hand books for school and pleasure.
- Arrange a garage sale and allow others to reuse unwanted items.
- Save old margarine, ice cream containers, and egg cartons to donate them to a school.

(EcoRecycle Victoria, 1999)

Resources:

Alternative Technology Association
(Recycling Technology Education)
PO Box2001,
Lygon St. North East Brunswick Vic 3057
Tel 03 9388 9311
Fax 03 9388 9322

Australian Conservation Foundation
(Waste minimisation)
340 Gore Street
Fitzroy Vic 3065
Tel 03 9416 1455
Fax 03 9416 0767

Beverage Industry Environment Council
(General recycling, litter)
Level 15, Como
644 Chapel Street
South Yarra Vic 3141
Tel 03 9826 4895
Fax 03 9826 6385

Classic Everwood Profiles Pty Ltd
(Polystyrene recycling)
PO Box 543
Warners Bay NSW 2282
Tel 02 4956 9749
Fax 02 4954 4175

Cleanaway
(Tour of recycling depot)
8-14 Havelock Road
Bayswater Vic 3153
Tel 03 9729 1500
Fax 03 9729 4498

EcoRecycle Victoria
(General recycling)
Level 4, 478 Albert Street
East Melbourne Vic 3002
Tel 03 9639 3322
Fax 03 9639 3077

Environment Protection Authority
(General recycling for industry)
Ground Floor, 477 Collins Street
Melbourne Vic 3000
Tel 03 9628 5622
Fax 03 9628 5391

Friends of the Earth
(General recycling, waste minimisation)
312 Smith Street
Collingwood Vic 3066
Tel 03 9419 8700

Gould League WasteWise and Environment Education Centre
(Recycling, waste minimisation, composting, litter)
Genoa Street (PO Box 1117)
Moorabbin Vic 3189
Tel 03 9532 0909
Fax 03 9532 2860

Hi-Cone
(LDPE recycling)
160 Bernard Street
Cheltenham Vic 3192
Tel 03 9585 0633
Fax 03 9583 5935

Keep Australia Beautiful Victoria
(Litter)
Ground Floor, Hanover House
158 City Road
South Melbourne Vic 3205
Tel 03 9682 9009
Fax 03 9682 9177

Packaging Council of Australia Inc.
(Packaging)
15-17 Park Street
South Melbourne Vic 3205
Tel 03 9698 4278
Fax 03 9690 3514

PBD Recycling

(Education room on recycling, tour of recycling depot)
426 Barry Street
Coolaroo Vic 3048
Tel 03 9302 2255
Fax 03 9302 1373

Building a Habitat **Reference # B1**

One of the most important actions a school can take in being active with regards to biodiversity, is to preserve the natural habitats that exist around the school. With many schools, however, large areas of habitats have already been disturbed or altered through the activities of the school. Often, the construction of new habitats will result in the re-emergence of species to the damaged area. It is for this reason that schools should work to construct habitats so that indigenous species may once again be diverse through the area.

Creating a habitat to attract native species requires the careful selection and layout of different types of vegetation and landscape. The following are a few guidelines for planning the creation of a habitat:

- Find out more about the different types of trees and other vegetation that occur naturally in your area.
- Plant local, native trees, shrubs, and grasses that attract native birds and other animals.
- When planting, try to recreate the layers of trees, shrubs, and ground covers found in the bush. Natural mulch (leaf litter and twigs) rather than just open lawn saves water and provides homes for beetles and worms, and in turn food for birds, lizards and other animals.
- Attract frogs to your garden by creating wetland habitat, including a frog pond surrounded by native plants that provide hiding spots for frogs to shelter and attract insects for frogs to eat
- Make hiding and sunning spots for lizards by using mulch, half buried stones, and placing sunning sites close to shelter and food sources (such as your compost bin).

Do not use 'bush rock' unless you are sure it did not come from the wild, as its removal threatens the survival of several native lizards.

- Remove weeds either declared noxious or unfriendly to bushland. Herbicides such as *Round-Up* should be used with great care when treating weeds.

Source: Community Biodiversity Network
More Information: http://nccnsw.org.au/member/cbn/projects/earthalive/habgard.html

Resources:

Australian Plants Society

Blacktown, N.S.W.
2148 P.O.Box 744
Tel 02 9621 3437
Fax 02 9676 7603
Website: http://farrer.csu.edu.au/ASGAP/

Australian Plant Guide from the Society for Growing Australian Plants

Website:
http://farrer.csu.edu.au/ASGAP/index.html
"Plant Guide" Website:
http://farrer.csu.edu.au/ASGAP/sgap1a.html

Creating an Australian Garden from the Department of Natural Resources and Environment

Tel 136 186
Website: http://www.nre.vic.gov.au/

Creating Wildlife Friendly Gardens from WIRES Rescue

PO Box 260
FORESTVILLE, NSW 2087
Tel 02 8977 3333
Fax 02 8977 3399
Website: http://www.wires.com.au/
"Creating Wildlife" Website:
http://www.wires.au.com/docs/garden.pdf

Let Nature Feed Itself, Natural Food for Wildlife from WIRES Rescue

PO Box 260
FORESTVILLE, NSW 2087
Tel 02 8977 3333
Fax 02 8977 3399
Website: http://www.wires.com.au/
"Let Nature Feed Itself" Website:
http://www.wires.au.com/docs/feeding.pdf

Another method of preserving biodiversity is to increase the awareness of everyone that may affect it, including teachers and students. Biodiversity should be integrated into the curriculum, with students striving to understand what it is, how it works, and why it is important.

The Gould Group has developed a number of curriculum resources that can be used on their own or in combination with their Wildscapes website. All of the available teaching activities can be downloaded in pdf format from their website (http://www.wildscape.com.au/curriculum/.) The site also includes an interactive habitat builder.

Schools can also benefit from biodiversity by using it to monitor the environment around the school. Indicator species are species that have a reaction to natural and man-made toxins that may occur in the environment. By carefully monitoring these species, a great deal can be learned about the level of potential toxins in and around the school.

One of the most well noted cases of an indicator species is that of frogs. Frogs depend on water in the first stage of their lives before moving to land for the latter. Their dependence on both eco-systems leaves them very vulnerable to changes in the environment. This susceptibility is even more pronounced due to frogs absorbing both gasses and liquids in the environment through their skin (The Academy of Natural Sciences). The creation of a secure frog pond on the school grounds can serve as an early warning system for increasing levels of dangerous toxins.

V. CHECKLISTS

The following pages contain the checklists, designed to present options that the staff of the schools may undertake to become more sustainable. These lists are divided into the four main aspects of sustainability: energy, water, waste, and biodiversity. Each section is further divided into subsections based upon the area in which the actions take place, such as general, classroom, and outdoors. Some of the actions contain a technology reference number corresponding to an existing number in the technology review that goes into more detail on the particular subject.

Energy

General

- O Create a committee and an energy plan for reducing energy usage, acknowledging all those areas that need to be improved
- O Encourage faculty and staff to turn off heaters, air conditioners, and fans in areas when those areas are not in use
- O Encourage school community members, including parents, to contribute suggestions to improve the school's energy policy
- O Establish a monitoring system for overall electricity, gas, and/or oil use
- O Provide feedback on school's success such as a newsletters to parents
- O Turn lights, appliances, and computers off when they are not needed
- O Install automatic lighting controls (see reference # E8)
- O Use one light instead of two in double light bulb fixtures
- O Use energy efficient light bulbs (see reference # E2)
- O Install energy efficient windows (see reference # E15)
- O Keep curtains, blinds, and shades open to allow natural light to enter rooms[1]
- O Install skylights and large windows to allow natural light to enter rooms (see reference # E4)
- O Install light shelves (see reference # E5)
- O Paint rooms light colours to allow for reflection of light (see reference #E6)
- O Use passive heating and cooling techniques (see reference #s E9, E10, E11, E12)
- O Paint the outside of the building a light colour to reflect the sun's radiation (see reference # E13)
- O Use energy from renewable energy sources (see reference #s E19, E20, E21)
- O Use only those devices that have a high-energy rating (see reference # E1)

- O Keep hot water taps free of drips and leaks
- O Be sure hot water pipes and tanks are properly installed
- O Keep the temperature of hot water less than 43°C except in the Canteen and Cleaner's room
- O Install solar water heaters (see reference # E18)

Space Heating and Cooling

- O Install insulation in walls, ceilings, crawl spaces and floors (see reference # E17)
- O Add chalking and weather-stripping around windows and doors.
- O Install outside doors that close automatically
- O Install entryways with doors on both ends, to create a space of stationary air (air lock)
- O Install double-glazed and multi-pane windows (see reference # E15)
- O Install setback thermostats (see reference # E14)

In the winter months

- O Fit curtains to windows; be sure there is plenty of width and full length, and well sealed.
- O Keep curtains closed at night
- O Keep windows and doors free of drafts – use seals and draft stoppers
- O Install carpeting to insulate floors and reduce draft
- O Use shelves above radiators or space heaters to direct warm air into the room
- O Fit reflectors behind heaters and radiators
- O Keep space around radiators and space heaters clear for good circulation

In the summer months

- O Keep windows and skylights open to allow a natural breeze to enter the room
- O Place insulation around air conditioning units to maximize efficiency
- O Use energy efficient fans when possible instead of air conditioners
- O Install awnings and plant trees and bushes outside to allow shading of windows and walls (see reference # E16)

Classroom

- O Introduce energy efficiency issues into curriculum
- O Encourage students to review their actions and find ways in which they can reduce their personal energy usage
- O Turnoff computers when they are not being used
- O Have students work in areas lit by sunlight when possible (see Appendix 1)
- O Open windows to increase passive ventilation, instead of using fans
- O Remind staff and faculty to switch off the lights and other electric devices at the end of the day / sessions / lunchtime / etc.

Transportation

- O Encourage students and staff to take a tram, walk or cycle to school
- O Provide secure and dry place for bicycle storage during the hours of operation
- O Provide buses for those who live at a great distance from the school
- O Use bio-diesel fuel in buses
- O Encourage carpooling when parents drop their children off at school
- O Encourage community to develop at a network of safe routes to the school

- O Encourage parents and staff that own diesel vehicle to use bio-diesel fuel
- O Provide adequate information on travel programs and policy the school indorses to new families.
- O Hold regular events that encourage cycling and walking

[1]Blinds, shades, and curtains should only be left open in the winter months if energy efficient double glazed windows are installed.

Water

General

- O Establish water-saving policy and goals
- O Establish an overall water usage monitoring system
- O Encourage students to use reusable cups with water fountains (bubblers)
- O Minimize leaks thru proper maintenance, monitoring, and replacement of pipes and fixtures
- O Fix dripping taps and leaks quickly
- O Adjust every buildings water pressure so that it is appropriate
- O Publicize goals and progress regularly possibly on a bulletin board or a school News Letter
- O Encourage feed back from all of the school community to continuously improve the school's water-saving efforts and policy
- O Involve staff and students in the development of water-saving policy
- O Encourage everyone to review their own practices of water consumption to determine the most feasible means to reduce water use on an individual basis
- O Promote policies and programs to parents and community to encourage their support
- O Install rainwater collection system (see reference # W5)
- O Install a water recycling system (see reference # W7)

Canteen

- O Install 5A rated low-flow taps and dishwashers
- O Hand wash dishes or cookware when possible
- O Use the same wash water as much as possible
- O Encourage costumers to reuse silverware and dishes for seconds or dessert
- O Post canteen policy and etiquette prominently and understandably

Staffroom

- O Install 5A rated low-flow taps
- O Do not use dishwashers or install those with a 5A rating
- O Encourage staff not to run water unnecessarily
- O Use dry-erase boards for messages/notices rather then wet-erase boards
- O Post signs giving suggestions and direction on water conservation

Classroom

- O Encourage students to be mindful of leaving taps open unnecessarily
- O Install 5A low-flow taps
- O Use a broom to clean messes on the floor instead of a hose

- O Hand wash dishes in home economic classes
- O Install 5A rated front-loading washing machines for home economic classes
- O Use recycled greywater in washing machines
- O Encourage students to take only the water needed for the task
- O Use dry-erase boards, instead of using wet-erase or chalkboards

Toilets

- O Install 5A taps and showerheads
- O Modify taps and showers to comply with 5A low-flow standards using pressure reducing caps and water saving values
- O Install dual flush or composting toilets (see reference # W2)
- O Install waterless or composting urinals (see reference # W8)
- O Install water hippos in toilet and urinals (see reference # W6)
- O Use tap timers to automatically shut-off after a given length of time
- O Install automatic urinal flush controls
- O Post reminds for users to turnoff tap or shower when finished
- O Use recycled or greywater to supply water for toilets (see reference # W7)
- O Inform users of greywater use and of any precautions that should be taken by posting informational signs

Grounds

- O Landscape with vegetation appropriate to the climate, so that, extra irrigation will not be required
- O Irrigate at night or early in the morning to minimize evaporation
- O Water only areas where it is necessary
- O Install underground irrigation system to minimize water lose (see reference # W4)
- O Mulch gardens to reduce evaporation
- O Inform groundskeepers of proper greywater use and the hazards
- O Properly and prominently label all the taps where greywater is accessible
- O Inform the public of greywater use and provide any safety information required
- O Use greywater or collect rainwater to irrigate vegetation (see reference # W5)
- O Let the turf in unused areas dry out during the dry season
- O Direct rainwater from the roof to help irrigate the maximum area possible
- O Do not use a hose to clean leaves or dirt from walks, or gutters, instead use a broom or rake

Waste and Litter

General

- O Form a planning committee
- O Research current practices, and conduct a waste audit.
- O Write a waste minimisation and litter reduction policy for the school.
- O Develop an action list.
- O Prepare a draft strategy.
- O Present the draft strategy.
- O Finalise and publicise the strategy

- O Implement/launch the strategy.
- O Monitor progress, keep careful records and modify your strategy.
- O Give feedback, incentives/recognition.

Reduce (reference # R3)

- O Do not use disposable cups, plates, serviettes for any school functions.
- O Encourage the use of non-disposable items e.g. hankies rather than tissues (first inquire as to whether this is acceptable for parents and teachers due to health reasons), or a fountain or refillable pen rather than single-use pens.
- O Encourage students to use recycled paper products.
- O Encourage all members of the school community to contribute suggestions to continuously improve the school's efforts to minimise waste and reduce littler.
- O Provide feedback on the school's successes in minimising waste. Include this information in family newsletters.
- O Give spot prizes for good practices, e.g. having a hankie, picking up litter unprompted, using a fountain pen or a refillable pen.

Reuse (reference # R3)

- O Have a reuse bin in all work places (offices, classrooms, staffroom, library, etc.) for paper that can be used for scrap, drafts, etc. Organise a system for collecting this paper so that the boxes do not overflow.
- O Encourage the use of clean waste materials in the art rooms and classrooms – materials from Reverse Garbage Truck, used margarine and ice cream containers, etc.

Recycling (reference # R1)

- O Have separate containers in all rooms for materials to be recycled, e.g. cans, plastic milk bottles, and glass. Have a system for regularly emptying these containers and returning the materials for recycling.
- O Have a bin in all rooms for clean white paper that has no further use and can be recycled. Organise a system for collecting this paper.
- O Have regular 'garbage-free lunch days'. Only put out bins for recyclables and compost. Promote the day to parents and seek their support.
- O Have a container in all rooms for fruit and vegetable scraps. Organise a system for collecting these scraps and placing them into the compost bin. Link this system to the curriculum.

School Administration/Office Procedures and Purchases

Reduce (reference # R3)

- O Design newsletters or other materials to be posted that do not use envelopes. Use the back of the newsletter for postage details. Simply fold the sheet(s) and tape or staple closed.
- O Encourage the bookshop to stock fountain pens and refillable pens and pencils.
- O Photocopy double-sided.
- O When purchasing new photocopiers, choose ones that will accept recycled paper and copy double-sided.
- O Tailor the size of the paper to the size of the message.
- O Send home one notice per family.

- O Review school newsletter, magazines and course description booklets. Do they make efficient use of paper?
- O Set targets to reduce the amount of paper use.
- O Market your waste minimisation program to the school community. Provide regular feedback on successes and progress.

Reuse (reference # R3)

- O Reuse envelopes.
- O Make note pads from used paper.
- O Only use new white paper for final copies. Use pre-used paper for drafts and rough copies.

Recycle (reference # R1)

- O Encourage the bookshop to stock recycled paper.
- O Use recycled stationary only. If recycled paper costs more, write to the suppliers and paper manufacturers asking why this is the case, and urge them to provide recycled paper at a competitive price.
- O Purchase recycled products when available, e.g. stationary, plastic containers, and toilet paper towels.

Classroom

Reduce (reference # R3)

- O Use the chalkboard/whiteboard more often to reduce paper use.
- O Use overhead projectors (or a computer and a computer projection screen if the school can afford one) to save paper.
- O Encourage all students to use both sides of a sheet of paper.
- O Place more emphasis on oral work.
- O Make sure that handouts make best use of a sheet of paper, i.e. double-sided, single-spaced and paper of a size to match the length of the information provided.
- O Don't provide additional copies of handouts. Encourage students to value the copies they are given. (Consider charging for extra copies, with the proceeds going to charity).
- O Where possible, encourage students to share handout sheets. Collect these at the end of the class/unit for reuse for another class. Appoint monitors to collect and check number of handouts.
- O Encourage students to complete a sheet of paper before starting a new one.

Reuse (reference # R3)

- O Laminate commonly used worksheets. Have students use water-soluble felt pens and clean the worksheets after use. Alternatively, use clear plastic envelopes.
- O Have a 'swap box' for the class to deposit items that they no longer want, but are not broken or damaged.

Compost

- O Have a worm factory in each classroom for students' fruit scraps.

Staffroom

Reduce (reference # R3)

- O Use a staffroom noticeboard/whiteboard for messages/notices rather than provide individual copies.

- Introduce a system of coloured folders for distribution of information/notices around year levels/department staff. (The folders help keep things together and prevent things from being lost).
- Buy in bulk, e.g. tea, coffee, milk, and sugar.

Reuse (reference # R3)

- Fill one tray of the photocopier with used paper and run off single-sided copies and drafts with that tray.
- Have a box near the photocopier to place paper for reuse.

Department Practices

Reduce (reference # R3)

- Develop and implement a system for filing class sets of materials.
- Encourage more sharing of materials among staff and teachers.
- Offer unwanted class set books to other schools or to students, rather than throwing them out.
- Set a goal of ten per cent reduction in paper use over a year and see if you can reach the goal, even exceed it.

Cleaning Staff

Reduce (reference # R3)

- Encourage staff to review their work practices and products to see whether they can cut down on waste/use of resources and use more environmentally friendly products.
- Involve cleaning staff in the setting up of composting and recycling programs.

Garden/Maintenance Staff

Compost (reference # R2)

- Involve staff in the design, construction and management of the school's composting system.
- Investigate ways to either mulch or compost all green waste produced in the school.
- Encourage the staff to use the mulch produced from the school's green waste, rather than buy mulch.
- Encourage the staff to use the compost produced from the school's food waste on the school's gardens.
- Provide opportunities for staff to attend seminars/workshops on the correct ways to prepare mulch and compost.

Canteen

Reduce (reference # R3)

- Examine ways to reduce packaging of food and drinks sold at the canteen.
- Examine possibilities of selling more foods that have been purchased in bulk, rather than foods that are individually wrapped.
- Develop and implement a plan to educate canteen users about the changes to the canteen, the reasons for these changes, and seek their support.
- Review types of drinks sold in containers at the canteen. Consider the nutritional value of contents and the attributes of the containers: safety, recyclability of materials, and lifespan in the environment should they become litter.

Reuse (reference # R3)

- O Encourage students to bring their own mugs for soups and drinks.
- O Encourage staff to bring plates and mugs for the staffroom.
- O Encourage students to provide a lunch box for their canteen lunch orders.

Recycle (reference # R1)

- O Develop a system for the return of paper and cardboard and drink containers for recycling.

Compost (reference # R2)

- O Develop a system for the collection of fruit and vegetable scraps for composting.

Other School Activities – Excursions, Fetes, Open Days, Parent-Teacher Nights

Reduce (reference # R3)

- O Rationalise use of paper, notices and decorations for special events: produce or purchase reusable, quality materials instead of creating waste.
- O Take students on excursions to landfill sites, recycling depots, and education centres on waste minimisation so they can learn new ways to minimise waste.

Reuse (reference # R3)

- O Raise money with a 'trash and treasure' stall.
- O Encourage sale or exchange of unwanted uniforms

Recycle (reference # R1)

- O Encourage students to bring home all rubbish generated on excursions, separating out the recyclables. Take two bags on excursion: one for rubbish, one for recyclables.

Biodiversity

General

- O Set up a committee to lead the biodiversity actions
- O Have a biodiversity audit performed, identifying areas for potential habitats
- O Establish a biodiversity policy
- O Set goals and progress targets to be reached by a certain date
- O Devise an action plan
- O Implement the plan
- O Evaluate the results
- O Continuous Improvement

Outside

- O Preserve the natural habitats that exist on the grounds
- O Create new habitats to encourage the return of species (reference #B1)
- O Locate outside influences affecting the school's habitats
- O Take action to reduce the outside influence on the school's habitats

Inside

- O Integrate biodiversity into the curriculum (reference #B2)
- O Use biodiversity to naturally monitor the school's environment for potential dangers (reference #B3)

VI. ANALYSIS OF RESULTS

Through observing the meetings of our liaison with the pilot schools, we gained a better understanding of CERES' Sustainable Schools project and the variety of environments it was to be implemented into. Before these visitations were conducted, we had little knowledge of what CERES wanted from our project, but having the opportunity to listen to the entire project explained to a school, allowed us to gain insight into the larger picture and view our project in the context of whole program. One of the main points we found in common among all four schools we visited, primary and secondary alike, was the desire for a well-structured, step-by-step program that could be easily followed. The Sustainable Schools program is in its infancy and being developed as it progresses. An example of this is the five star reward system, which is still in the design phase.

Currently, schools are meeting with one of the program coordinators and being presented with large amounts of information regarding the Sustainable Schools Program. These meetings have been casual and somewhat unstructured, serving the purpose of providing the schools with a basic background of the program, the methods, and the goals involved in achieving success in the program. Information is not presented to the school staff in a manner that allows them to quickly and easily grasp what they are being told. This leads to lengthy discussion that might be better spent assessing the details of how the program will be integrated into the school. If a more organised and consistent presentation was given, it could streamline the process. In order to accomplish this, a set of frequently asked questions could be generated, which allows for a comprehensive reworking of the presentation to answer those commonly asked questions upfront. This could potentially reduce the amount of time needed by the schools and the coordinator, as well as allowing for a more in-depth discussion from the beginning.

Half of the schools had already generated ideas for the execution of this program, but the other two seemed very reserved and somewhat reluctant about participating. All of the schools also seemed to be concerned about their budgets and possessed certain common factors that gave them immediate opportunity for action. Lights are being left on in empty rooms, shades are drawn when the sunlight is shining, and some of the taps are leaky. Therefore by fixing these pervasive problems, schools can easily become more sustainable and begin saving money. Not only does this demonstrate the need to include such suggestions in our checklists and technology reviews, but this information could be used to motivate schools to participate in the program because it shows them that they can start saving money while becoming a Sustainable School.

All four schools were also concerned with self-promotion, and three of the four schools seemed to latch on to any ideas that were presented, which could generate good publicity or interest potential students. Therefore once a promotional system is chosen for the program, spending some time and money to promote the system and the Sustainable Schools concept to the general public would make any display by a school more meaningful. Instead of developing a unique rating and promotional scheme, however, it might be better to piggyback on the EPA's Eco-footprint Program and promote the progress of schools as the reduction in size of their eco-footprint. This could mean a reduction in the amount of marketing that would be necessary to raise public understanding and interest compare to a 'Five-Star Sustainable School' because the EPA is already promoting the eco-footprint concept to the public.

None of the schools visited had state-of-the-art or noticeable energy star rated appliances, which could be due to one of two things. That budgetary constraints drive the product selection, or that those who choose the appliances are unaware of the energy star or water conservation rating systems. Which could mean that staff need to be educated about the energy star and water conservation rating systems, and thus, this data needs to be included in the information provided to schools. That way schools will at least be aware of other things to look for in their purchases other than the up-front price.

Two of the schools revealed other ideas that could be used to motivate schools already in the program, to develop effective strategies in implementing the overall Sustainable Schools program. The schools were enthusiastic about the idea of owning or being recognised for specific strategies they invented or developed, which are subsequently used or adapted by other schools. By allowing a school to attach its name to a specific method or system, it encourages the development of new ideas while keeping the strategy within the Sustainable Schools program. No matter how the issue is addressed, CERES and the Gould Group should develop a standard policy that all the schools understand from the outset.

VII. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There are technologies that exist and that are available to schools that will help them to become more sustainable. Photovoltaic cells, dual flush and composting toilets, automatic thermostats, photocell light controls, water hippos, and pressure reducing valves are just a few of the numerous technologies that our group identified while conducting our research. There is equipment that lowers electricity consumption, decreases the need for heating and cooling, composts organic waste, reduces water demands, and encourages the return of indigenous species. Some of these sustainable technologies and practices, however, are less apparent and well known. Painting a room gloss white to reflect sun light, thus increasing the natural light levels of the room, as opposed to installing skylights, is only one example of this.

The information on these technologies, however, is widely scattered and hard to locate. Books, pamphlets, reports, websites, and organizations are just some of the many sources of information on these technologies. Despite the variety of sources, the relevant information was obscured by the extraneous topics surrounding it, and much time and energy was devoted to deciphering the research and transforming it into simple to understand, useful knowledge for the report. Therefore, schools could find it difficult to identify all of the options available. It took our group several weeks to compile the technology review and checklists, time that most schools cannot afford to spend.

Therefore, through the use of our packet, schools will be able to save themselves the cost of time and effort that would be spent in both identifying the technologies and gaining a basic understanding of them. For example, the water conservation rating scheme provides an excellent way of initially identifying water efficient technologies, because it grades appliances against a standard. However, this rating scheme is not mandatory, and it is in the stages of changing to a five A system. Therefore, if appliances with the highest efficiency do not take the time to receive one of these ratings they could be completely ignored by a consumer relying completely on the labelling scheme. Our packet informs consumers of these details that can only be found from a particular source, which schools may be unable to find with limited resources for research.

By implementing these technologies schools will save money and will be able to educate their students on sustainability and the environment. By installing composting toilets or Photovoltaics, schools must initially invest more money, but will make back their initial investment over time with savings from their water, sewer, or energy bills. Other, simpler actions can be taken, such as teaching staff and students to turn off the lights when they leave a room or to not run a tap unnecessarily. This saves natural resources and reduces the school's energy bills. At the same time, with sustainability integrated into the curriculum, the students are learning about the environment, sustainability, and its benefits while experiencing it first hand.

Future Projects and Research

The project group recommends that further research projects be conducted once the Sustainable Schools program has been fully established and has been integrated by several schools. These research projects should entail evaluating the effectiveness of the program and identifying changes that need to be made to assure the program continues successfully. In order for the review to be objective, guidelines for the evaluation should be developed before the pilot program is fully implemented. Once completed, if the research shows that there are specific areas posing significant problems for schools, a second project should examine the reasons behind these and identify methods to remedy them. A third research project should investigate the effects of sustainable technologies on students, and their ability to learn and function in the school environment. Are sustainable technologies that save the most money and resources always the best choice for the school community?

Macro Implications

Implementing technologies to increase the sustainability of Victorian schools can have wide ranging effects. Between the students taking the lessons that they learn home with them, and the schools serving as leading examples of environmental responsibility, sustainability practices could spread throughout the community. The possibility to simultaneously save money, while working towards the preservation of the environment, will become much more apparent.

Community implementation of water technologies will have a significant impact on the local water infrastructure. Figure 43 shows the number of years that the lifespan of the current infrastructure system will increase with the implementation of a specific water technology across Victoria. For example, installing 'AAA' rated shower roses add 3.5 years to the lifespan of the system and the use of tap timers will add 1.5 years. The incorporation into the community of the six technologies and three behavioural changes listed below will, alone, add seventeen years onto the lifespan of the water infrastructure.

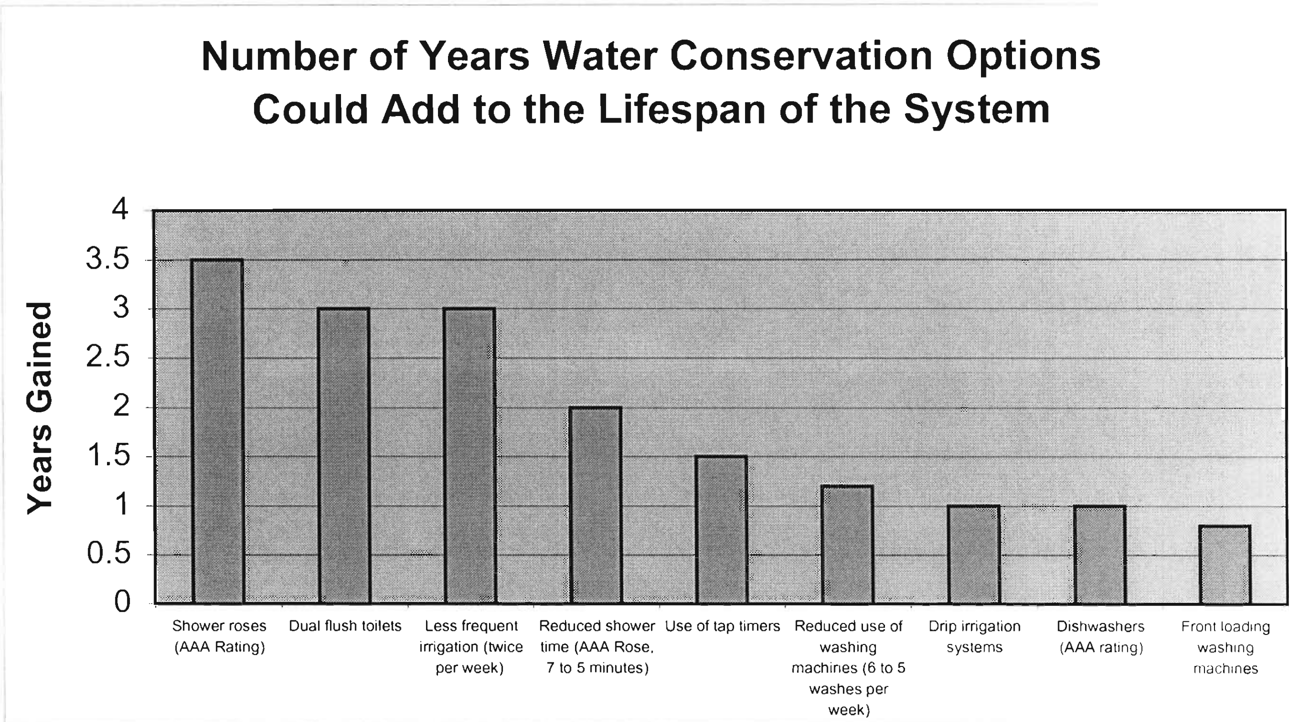


Figure 43. Years Conservation Options Could Add to the System's Lifespan
Water Resources Strategy Committee for the Melbourne Area. (June 2001). Planning for the future of our water resources: Discussion Starter. Melbourne, VIC: Author.

Human progress is affecting every corner of the globe. Increased awareness of biodiversity and the construction of new habitats, to encourage the return of indigenous species, will also have a major impact on the future of the world. Seventy percent of biologists from around the world believe that the Earth is in the middle of its sixth mass extinction—the only one that has been caused by a single species, humans (Public Broadcasting Station). It is agreed on by most biologists that at the current rate of extinction, approximately half of the world's plant and animal species will become extinct within the next fifty to one hundred years (CNN Insights). The extinction is being caused by the population growth and expanding lifestyles of humans (CNN Insights).

One of the major concerns is the rapid disappearance of natural habitats. Scientists believe that there is still a chance to prevent this mass extinction in the next fifty years if there are drastic changes made by governments, businesses, and communities (CNN Insights). Societies and schools working together and constructing habitats will help the diversity of life on earth to survive, as well as leading the way to preventing what could result in the end of our species.

The changes discussed throughout this report are small when viewed in isolation, but with wide spread use their impact could be dramatic. Seemingly small and unimportant alterations on a micro-scale may lead to a wide-scale shifts in thinking and decision making. Similar to the ramification of water and biodiversity conservation, discussed earlier, there are many other wide-ranging consequences of a commitment to sustainability.

Recommendation 1

We recommend the steps established in the Gould Group's Waste Wise program—designed to help schools to reduce waste—be expanded and integrated into the Sustainable Schools program. These steps have proven to create long-lasting, successful programs in schools. They include appointing a leader, developing a school policy, and getting every member of the school community involved. The appointed leader should be an individual in the school who is enthusiastic, respected by the school community, and has the ability to motivate both the students and the faculty. It is important that the person is accountable to a higher authority, so there is no intersubjectivity created through ascension of ranks. The Vice Principal is the ideal person to report to because they are the authority who is in charge building infrastructure, which sustainable technology should be integrated into. The purpose for implementing a school policy is that it creates an official set of guidelines to organise the steps that the students and faculty must take to become more sustainable. Having the policy written down ensures that everyone understands it clearly and with less ambiguity. The entire school community should be involved in the composition and implementation of the school policy. With this open forum, everyone's ideas are considered for integration into the policy, as it is not just an individual imposing rules on others. A newsletter, including details on the steps the schools is taking and the status of the school's policy, should be sent to parents and community leaders, keeping them informed and further encouraging community participation. By integrating these steps into the program, schools will have a solid foundation and strategy for attaining their goals.

Recommendation 2

We recommend that CERES present the program and its guidelines to schools in a more organised manner. By clearly stating the goal of the program, the cost and benefits to the schools, what CERES provides, a typical implementation processes, as well as successful examples, schools will better understand the program. With a deeper and clearer understanding, schools will be more comfortable and more willing to participate in the program. Schools will be able to develop and integrate the steps of the program into their school without the constant support from the program coordinators. A list of frequently asked questions should be created and used to alter the presentation of information. This would eliminate constantly repeated questions and allow for concentration on the implementation of the program into the school.

Recommendation 3

We recommend a system of communication be established among schools that are participating in the program. The schools involved, as well as the program itself, will benefit from the ability to share stories of success and failure within different aspects of the projects and choices that were made. By encouraging schools to communicate, the schools will be able to pool resources and assist one another without needing to contact the Sustainable Schools coordinator, who might be busy with other projects. Along with establishing the communication system, the feasibility of such a system with schools in other regions of the world that have similar goals should be examined.

Recommendation 4

We recommend a method for recognizing innovation from schools involved with the program needs to be created. While working on a specific aspect of the program, a school may develop an alternative method or strategy for accomplishing a specific goal. Developing this method will create more interest and enthusiasm by the schools to be a part of, and continually improve the program. This also creates another opportunity for schools to promote themselves by having their name attached to their innovations.

other schools abroad. These programs connects teachers from different areas of the world and induce communication between individual students or entire classes. Schools with internet access can also utilize video conferencing and other advances in communication in order to communicate with multiple schools.

In addition to establishing a communications network, a system that recognises schools for their individual creativity should be developed. During the course of the program, schools will use various schemes and methods to implement sustainability. While going through the program, schools may find alternate methods or strategies that are more successful than other. Schools should gain recognition for their innovations in order to promote improvements.

The project group also recommends that a recognition program be established and marketed to the public to increase their understanding of the Sustainable Schools program. If the phrase "Five-Star Sustainable School" achieves recognition from the general public, then its impact will be more effective and meaningful.

Future Projects and Research

The project group recommends that further research projects be conducted once the Sustainable Schools program has been fully established and has been integrated by several schools. These research projects should entail evaluating the effectiveness of the program and identifying changes that need to be made to assure the program continues successfully. In order for the review to be objective, guidelines for the evaluation should be developed before the pilot program is fully implemented. Once completed, if the research shows that there are specific areas posing significant problems for schools, a second project should examine the reasons behind these and identify methods to remedy them. A third research project should investigate the effects of sustainable technologies on students, and their ability to learn and function in the school environment. Are sustainable technologies that save the most money and resources always the best choice for the school community?

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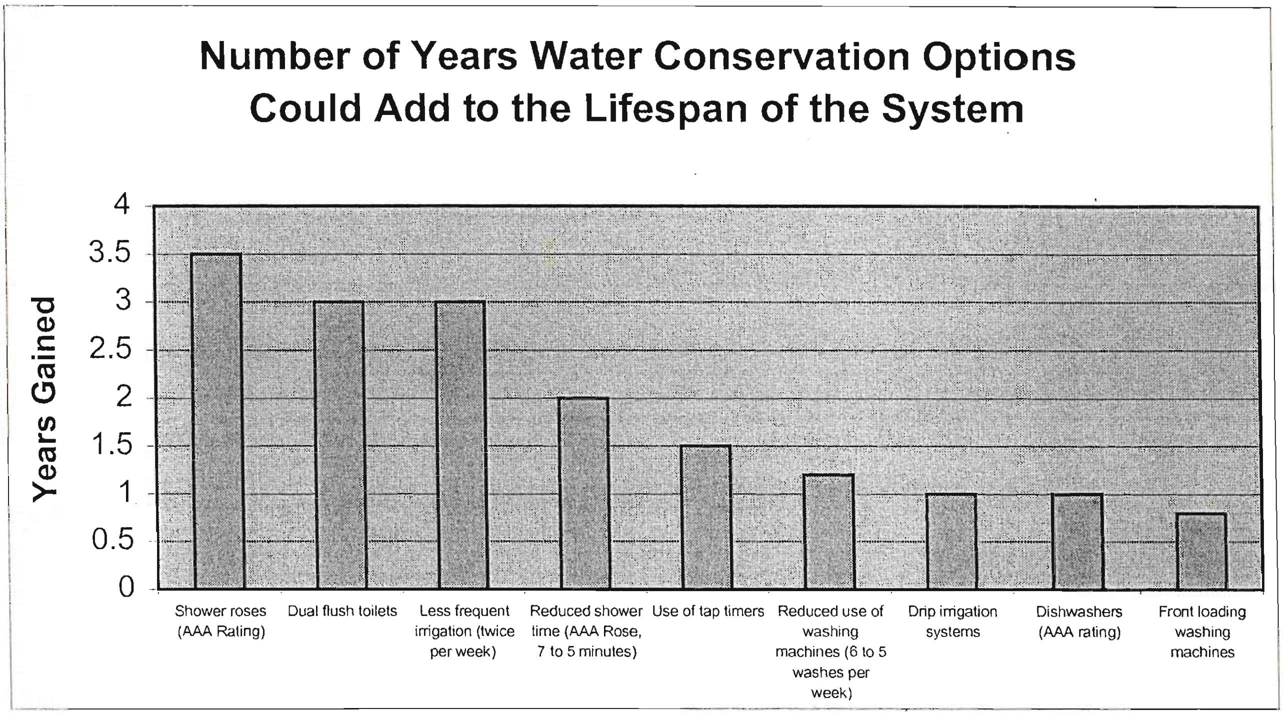

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VIII. APPENDICES

Appendix A: Mission and Organisation of CERES

The Centre for Education and Research in Environmental Strategies (CERES) is a non-profit organisation that helps to initiate and support ecological sustainability and active recognition of cultural diversity on all levels of society (CERES Community Environmental Park, 2001). It promotes environmental and social awareness through a wide variety of community activities in urban areas.

Located in Brunswick, along side the Merri Creek, the CERES Community Environment Park serves as a model and example of the issues they promote. A *permaculture* and bushfood nursery, community gardens, renewable energy systems, an animal farm, the largest display of household composting systems, the CitiPower sustainable energy house, African and Indonesian villages, and a *vermiculture* and worm farm are just a few of the functional examples displayed on their four hectare site (CERES Community Environmental Park, 2001).

Soon after the site was first occupied, a mural was commissioned to commemorate not only the past history of the site but to present a vision for the future, as well. The mural depicts the site when it was simply pasture land, then the site as a rubbish tip, and finally some visions of what the site was to become.

Originally in 1982, the location only contained the Low Energy House, community gardens, composting sites, the office, beekeeping, and animal pastures. By 1990, CERES had expanded by adding a train car classroom, the first of three wind generators, the education centre, and an animal enclosure. During the following three years CERES underwent an explosive expansion adding the CitiPower solar display, the solar workshop, the wind pump, African village and classroom, the Working for the Dole Program, organic gardens, weeroom gardens, as well as the stables and nursery. The Working for the Dole is a skill share program that is part of a larger Australian system that provides work for people who don't have a steady job. Presently the Alternative Technology Association (ATA) is occupying the solar workshop while publish a bimonthly magazine called "ReNew," and CERES uses their library for research.

In addition to the wide variety of working displays, CERES offers a range of educational programs to the fifty thousand students that visit their site every year. Students may take part in learning about environment concerns, renewable energy and conservation, waste recycling and minimization, aquatic eco-systems, Aboriginal heritage, third world development, as well as Indonesian and Maori culture. Adults who wish to benefit from the CERES experience have the opportunity to become accredited in horticulture, *permaculture*, and environmental design (Waldenstein, 2002).

In an effort to increase community participation and awareness, CERES is heavily involved in a number of festivals and other community events. The Kingfisher Festival, "Music under the Stars over summer," the Bushfood Festival, the African Festival, Spring Equinox Planting, and Autumn Equinox Harvest Festivals are just some of many events in which CERES plays a large role. (Waldenstein, 2002). The Kingfisher Festival is the largest of those mentioned, and it is held in the autumn each year in celebration of the kingfisher's return to the Merri Creek, in 1994. Kingfishers originally stopped returning to the creek annually due to pollution. It was only through dedication and hard work of CERES and several other organisations that the creek was again made habitable to the kingfisher. The festival incorporates a plethora of cultural activities and cooking, which culminates in a feast at the end of the day, as well as promoting environmental awareness throughout.

CERES has expanded from its meagre beginnings of three fulltime coordinators in 1981 to over forty fulltime employees, who work between one and four days a week, and thirty volunteers who donate varying amounts of time per week. The organisational structure of CERES is headed by a group of elected representatives who oversee a number of focused committees. These committees are separated into teams that undertake projects as shown in Figure 5.

CERES Structure

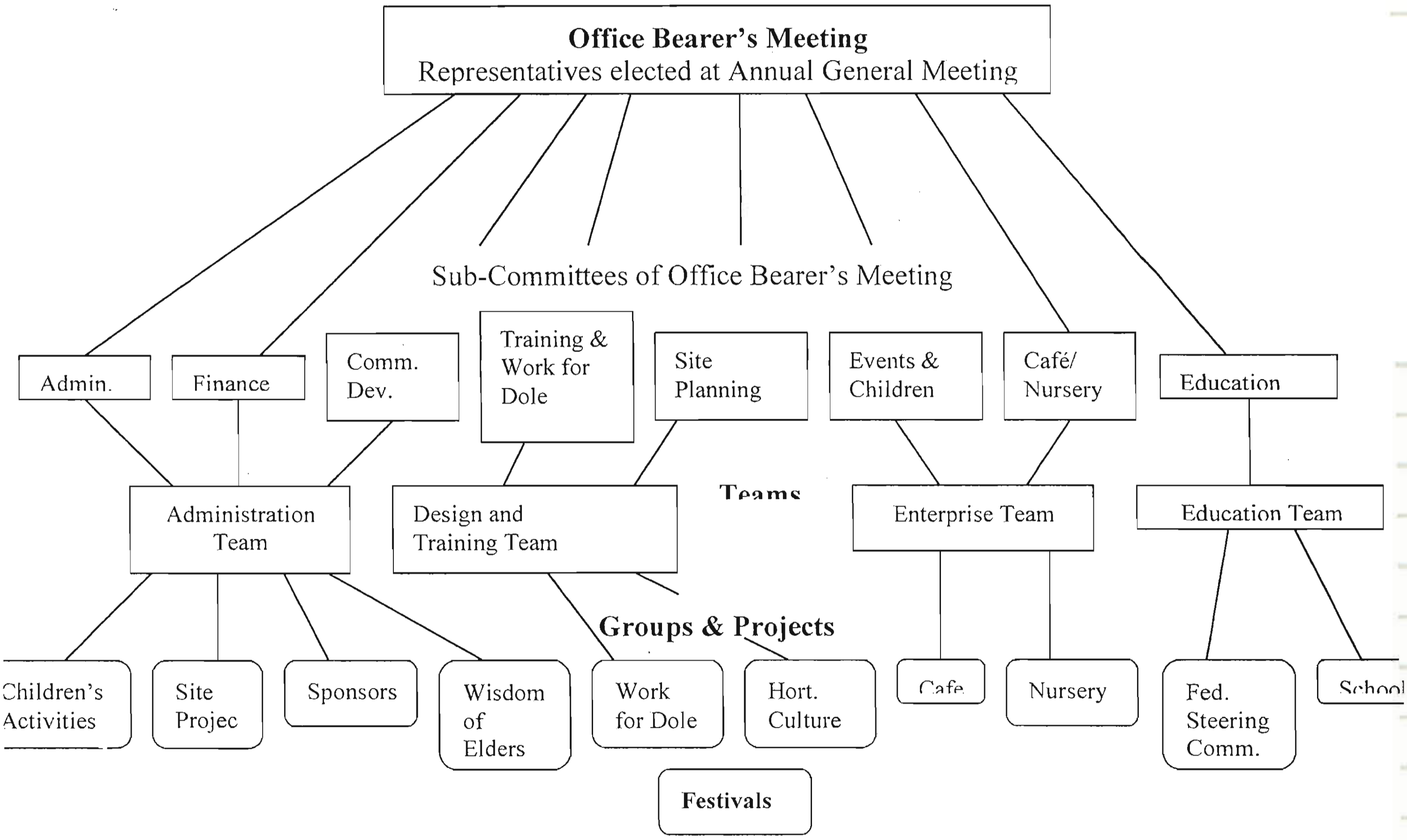

Figure 45. Chart of CERES organisation
Waldenstein, Z. (2002). Social Change in Action. A paper present to the WPI CERES project group.

CERES was initially conceived as one of five solutions to youth employment problems at a RMIT conference in 1977. It was originally planned as more of an intellectual institution that would coordinate the efforts of other organisations, but under local control this soon changed, and the beginnings of the current CERES ideology were put in place. By this time Dr. St. Barbe Baker, a founding member, had established CERES on a piece of land adjourning Brunswick East High School. As the scope and magnitude of the projects that were being undertaken increased, the centre was moved in 1982 to its current location–a site that was originally a "polluted, lifeless, wasteland dominated by piles of rubbish and high tension powerlines" (Waldenstein, 2002). The new site is also a home to other semi-independent community projects that operate on site. These include the Alternative Technology Association, the CERES Community Gardens Group, the Chook Group, the Baking Group, Moreland LETS (Local Exchange & Trading System), and the Bicycle Recycle shed (Waldenstein).

Early funding came from the Brunswick City Council, but now donations stem from a number of different source. A portion of it is through grants from organisations listed in Table 11. The Community Environment Park also generates funding by

Table 11. CERES' sponsors

• Moreland City Council	• CitiPower	• EcoRecycle Victoria
• Dep't of Education, Victoria	• VISY Recycling	• Environment Australia
• The Besen Family Foundation	• Federation Projects	• Department of Human Services & VicHealth
• VicHealth	• Earth Graphic Design	• Australian Greenhouse Office
• Darebin City Council	• Rotary Club of Brunswick	• Festivals Australia
• Parks Victoria	• EPA – Victoria	• Avant Card
• James Simpson Love Trust	• The RACV Foundation	• Kingfisher Bay Resort
	• Mullum Trust	

CERES & Gould League. (2001). Sustainable Schools Victoria: Business Plan 2001-2006. Victoria, AUS: Author.

collecting donations from visitors, membership fees, vendors in their organic market, and a café that serves a variety of culinary delights.

The Sustainable Schools Victoria, a current project that CERES is coordinating in conjunction with the Gould League, has a four-year budget of approximately $1,200,000 AUS. Many of their programs rely on volunteers to see them through their final goal (CERES & Gould League, 2001).

Appendix B: What is an IQP?

An Interactive Qualifying Project (IQP) is a project dealing with the social issues of technology. The project qualifies as an IQP because it takes a social problem, in this case the lack of sustainability in the Australian school system, and shows how technology can be used to help. The way in which this is going to be accomplished involves: interviews, shadowing, archival research, and other social science methods used to identify individuals' needs. Once those needs have been determined, the appropriate technology can be selected to best fit those needs. Since this project is dealing with sustainability in the Australian school system, the technology that will be implemented is a computer program, similar to those offered by the United States Department of Energy, designed to help with the reduction of resource consumption.

Appendix C: CERES' Sustainable School Program

One of the numerous challenges that CERES is currently involved in to help the environment is the implementation of a five-star sustainable school program. A sustainable school is a school that is designed to reduce the amount of negative impact it has on the environment.

Over the past couple of years, the Gould League and CERES has designed an implemented the Waste Wise program in schools across Victoria. The program is designed to help schools manage their waste more effectively, by reducing the amount of rubbish they produce. The program has met with so much success that CERES and the Gould League has decided to use it as a model for the units in the Sustainable Schools Victoria program–water, energy, waste, and biodiversity.

The five-star aspect of the program is a motivational tool used to provide incentives for schools to continue to progress through the program. A school receives its first star for completing the introduction workshop on sustainability, involving defining sustainability, identifying the school's needs, establishing a school policy, and developing an action plan. A school then earns a star for each aspect of the units it completes–Waste, Water, Energy, and Biodiversity. These stars can become publicity tools for the schools, making known that they are a three, a four, or even a five-star sustainable school.

While in its initial stage, the program is recruiting pilot schools to be the first ones to implement the program. These pilot schools will be used to identify problems with the program, potential areas for improvement, and establish its successfulness. In return, these schools are fully sponsored and do not have to pay for any of the workshops that will normally be sold to the schools.

Appendix D: Summaries of Meetings Between CERES and Schools

School 1

Grades 1-6
Approximately 250 students

We arrived about thirty minutes before our liaison, which allowed us to take a careful look at the toilets and staffroom. In the staff room there were no visible fliers or bulletins, among the many on the walls, about environmental issues. Most were of professional practice or social issues.

There was, however, a recycling bin next to the photocopier. Two students came in to copy something for their class. Extra large sheets of paper came out when the students were trying to copy a standard size paper. One student was satisfied with those copies, but the other then adjusted the copier and printed the copies on the proper size paper. On their way out they dropped all the unsatisfactory copies into the recycling/reuse bin.

The appliances in the staff room were not state of the art, but most appeared to be five to ten years old. We noted no energy star ratings on these appliances. There was a dishwasher, water heater, hot water dispenser, and a sink that was not leaking.

While waiting, we overheard the makings of Event Bias—the teachers and assistant principal were preparing for Mr. Bottomley's arrival by discussing what they would do and say. We were unable to hear clearly what was discussed other than that it was about that morning's meeting with Mr. Bottomley and ourselves.

We started at the front of the school and got a tour of the grounds with two teachers and the Assistant Principal. First, they explained to us the extensive remodeling the school would be undergoing after this year. They said the plans had just been seen in for final approval. We questioned the environmental considerations that were taken into consideration for the design. They informed us that any building project over one million dollars had to complete an environmental review. This information was new to our liaison and us, and subsequently verified by the Department of Education and Training. The school had a piece of undeveloped land, and both our liaison and the faculty thought it was a perfect place for an outdoor classroom where students could learn about nature and biology. Mr. Bottomley suggested that he might have someone come in and take a count of the species that are presently there, so they could be utilized fully, as part of the schools participation in the program.

Next, we moved to the new chicken coop and goat house. There were three chickens in a fairly roomy enclosure. We were told that they were let out daily and that a different family was placed in charge of their care each week. A photo opportunity the school was taken, and two chickens were brought out for a picture with a group of student, Mr. Bottomley, the Staff, and us. The animals seemed to be more to promote the school than to educate the students, however, simply by their presents the students get exposure to animals.

The goat had not arrived yet, but the leading teacher had the idea of it being able to be chained on the school field which was just next to and up hill from the "nature preserve." It was obvious that little thought had been put into the containment of the goat when it was grazing or how it might affect the "nature preserve." The goat was being highly touted the entire time we were there, again more as a promotional tool than one of sustainability. We also were told here that the community was very into environmental issues and supported the school wholeheartedly.

Next, we went inside where the details of the Sustainable Schools program were discussed. We sat in an art classroom with two computers and monitors running while not being used. There was minimal insulation in the old building and no double glazed windows or spaces that created died air at entryways. The building was designed to harness natural light and passive ventilation with north facing vertical skylights that could be opened. The meeting consisted of Mr. Bottomley presenting the basics outline of the pilot program and fielding questions from the staff. They discussed the triple bottom-line and the eco-footprint kick off, along side the project details. When Mr. Bottomley presented his five star sustainable school idea for the schools to promote themselves as an *n* number star sustainable school, they seemed very excite about being able to prominently display their participation in the pilot program.

They even had groups set up in advance to take up all the different part of the sustainable schools program thinking they would have to implement it in a year or two, however, they considered altering this set up as Mr. Bottomley presented how he saw the program working. The biodiversity unit was chosen as the initial unit to be dealt with at the school. Due to timing, the introductory unit was initially was going to be taught as a conclusion unit, but eventually time was made to do it as the introduction, on one of the curriculum days. They also all felt it important that everyone be involved or at the very least be kept informed.

Mr. Bottomley felt going in that this school was ahead of the game, very motivated, and going to be easy to work with.

<u>School 2</u>

Grades 1-6 (grouped 1-2, 3-4, 5-6 by buildings)

Approximately 135 students

Initially, we were given a tour of the grounds. The school was made of several buildings some of which were old and originally built for other purposes, and some were built as classrooms. The school was planning to build a new, larger building to accommodate more incoming students, while removing one of the oldest buildings. The principal was very keen on us seeing all the things she felt made the school unique.

As we reached the rear of the grounds, a local teams oval was pointed out to us that the students were allowed to use, while being maintained by the team, hence, costing the school nothing. A hedge maze, next to one of the buildings, was pointed out as a feature of interest. The soccer field, next to and up hill from the administrative building, will be the site of the building which will be erected next summer.

The town-recycling depot was approximately thirty meters from the back of the school. Mr. Bottomley thought that was wonderful, but the principal told him that she was left monitoring it most of the time, and it could be a sanitation hazard.

Mr. Bottomley then gave pretty much the same talk that he did at School 1. The principal and teacher seemed very interested in the direct education of the students in the program, so the children then could go home and teach the parents. They were also interested in having contact with other schools in the program and seeing what worked or did not for the different things they tried. The idea was new to Mr. Bottomley, and he noted it as a possibility for the program. They said the local community was very cooperative and that there might be some parents that would take an interest in the school's participation. As an example, the editor of "Earth Garden," what Mr. Bottomley called a "prominent Australian environmental magazine", is the father of one of the school's students and would most likely be interested in becoming involved with the school program. They also suggested involving local "land care" groups in the school activities and as sources of information. This demonstrated to us that there are a good number of local resources that schools should be able to contact to support them in the sustainable schools program.

Both school representatives seemed much more interested in the curriculum side of the program than the technology side. When we inquired about the cost of the renovations and if it had undergone an environmental review, they said the design had not undergone that review. The principal also seemed mildly relieved that that wasn't required.

They had started a small vegetable garden and were interested in raising chickens, as well. It appeared however, that neither of these ideas was focused on sustainability, but they were viewed as good hands-on learning tools. They also said they encouraged all the students to bring reusable cups from home to drink from.

The principal was in charge of the watering the grounds and said she tried to water first thing in the morning to avoid water loss, however, the sprinkler was still going when we arrived at 10 AM.

They turned off the lights when the clouds cleared and the sun came out. We weren't taken into any rooms with computers, but through the windows several computers that were not being used appeared to be on. The art room had a forced ventilation system and the room got rather warm during the meeting. Warm enough, so that, the principal turned the heat off at the same time that she turn off the lights. The heating system was a gas system. All the windows were single glazed, while other insulation was minor. None of the entryways created dead air spaces that reduced the amount of heat transfer through them.

School 3

Grades 7-10
Approximately 350 students

We arrived thirty minutes early which allowed us to examine the staff room with Mr. Bottomley. Similarly to the first school, most of the fliers posted on the walls were of occupational hazards and social issues. There were four computers running in a corner for the staff to use. Only one was in use, however. The staff room had a refrigerator, dishwater, hot water dispenser, and a sink without leaks. The bathroom taps were leak free and everything seemed to be in good working order, which suggests an adequate maintenance plan.

Mr. Bottomley started his talk on the Sustainable Schools Victoria program with the deputy principal and the head of the SOSE and Science departments. As Mr. Bottomley went over the specifics of the introductory unit the science teacher mentioned that he had done one of the exercises with a class of his. The staff was very reserved until the very end of the meeting and they seemed very apprehensive about the program during the entire meeting.

They all felt that in order for the program to be a success at their school, it was necessary for it to be "student owned" and run. Thus, the teachers would only be the initial catalyst. The deputy principal also had thoughts with regards to improving the gardens (grounds) to their former beauty, but, apparently, has not given thought to biodiversity issues and was concerned only with aesthetics.

Mr. Bottomley was very open to suggestions of how the program would work best in a secondary school, which implied more work would be needed here to develop an effective program. It seemed the staff expected more of a structured program, where all they had to do was follow a list of steps. They all were very concerned with funding of the program and with what the school would receive in return if they participated. The deputy principal flatly stated that integrating the entire school in one shot was impossible and that a slow step-by-step integration would need to be used.

We received no tour of the school or its grounds.

School 4

Grades 1-6
Approximately 250 students

The fourth and final school that we visited with Mr. Bottomley was a primary school. From its exterior, it was evident that the building that housed the school was fairly old. The interior revealed classrooms with high vaulted ceilings that seemed to be ignored. Although the lower walls of the room had rows of windows, the shades that were drawn and left the vastness above lit only by the constant humming of the electric bulbs. The school is fortunate to have such high ceilings to allow the heat of the day to rise far above the chairs and desks, reducing the need for cooler air, and yet the ceilings are greatly under-utilised. Skylights in those particular classrooms have the potential to eliminate the need for electric light sources altogether.

Our meeting was to be with the Acting-Assistant Principal, a woman who had read over the summary of the Sustainable Schools program, but had little real knowledge or understanding of any part of it. We pored over the colourful barrage of posters plastering the walls: calendars, meetings and events, safety tips, and policies. There was not one visible sign, bulletin, or announcement regarding sustainability; nothing on waste, lights, or water. If it was a concern amongst the teachers at the school, it did not appear to be of high priority.

The meeting itself went fairly well. By the end of the session, she sounded very positive about their participation in the program, but didn't have a firm grasp on the process involved. As described in Appendix I, the first step in the program is a full-day workshop with the majority of the staff to explain the concepts behind sustainability, discuss the specifics of the schools needs, develop a school policy, and identify the program for the school to begin with. She didn't feel like the program was something she wanted to reserve a full day for and asked about sending a single teacher to sit in on another school's workshop. With more explanation and concessions on both sides, an agreement was reached where the workshop would be conducted with the entire staff in short segments over a span of weeks.

The meeting was interrupted only once, with an office assistant running in to inform the Assistant Principal of a water leak in the library. While the Acting-Assistant Principal dealt with the problem, we took advantage of this unexpected free time to examine the different appliances around the room. There was a refrigerator, coffee maker, microwave, and dishwasher. All appeared to be older and there was no energy-rating sticker visible on any of them.

The school seemed very open to new ideas and willing to experiment with unconventional methods. During the meeting, we learned of their work with teaching students from different grade levels in the same classroom at the same time. This willingness showed promise for the implementation of the Sustainable Schools program.

Appendix E: Summaries of Interviews

Interviewees were assured their names would not be associated with the data collected during the course of each interview, therefore their names and organisations have been omitted.

Water authority

While describing the working of the company:

The department does audits on itself in the areas of water, while another department completes waste audits, in order to not only monitor themselves. This way when the company goes to a school or other company they can use their work as a successful example. It was indicated that schools should do the same.

When asked what the most important thing to do to conserve water:

Policy is most important and that most of the water usage comes from toilets and irrigation. The interviewee felt that reducing the amount of water used on the garden could dramatically reduce overall consumption, and point to statistics in "Planning for the future of our water resource," which showed that most of residential water consumption is due to irrigation. She felt that this would hold true for schools, as well.

Next, different watering systems were discussed. The company used to have problems with their time watering system, which would operate even during the rain. Their system has now be redesigned to water only when needed by using rain gages, and water consumption was said to be lower. Here they pointed out that without a metering system it would have been difficult to know exactly what the water savings amount to. There are new devices that operate using satellite technology to talk to the weather satellites to determine when to apply irrigation.

As for the toilets, the problem comes with the system currently being used is one that has the tank installed directly into the wall and it would be costly to remove the tanks and install dual flush systems. One idea that was investigated was placing a brick in the system to lesson the volume of water being used. Problems arise, however, if the reduced volume is inadequate to clean the bowl. If not then this can cause sanitation issues. Pressure reduction could also be applied to an entire household or to specific sources of use.

When questioned about the major issues people should be aware of concerning water conservation:

The major issue of water conservation is behavioural, so teaching students and staff what to do has much more potential to reduce water consumption than any new technology. Money is an issue for schools, so they may not be able to institute some technologies. Therefore, the report should highlight some low cost alternatives such as the brick in the tank, as long as the schools know of the issues associated with those ideas. Technical questions were directed to another employ that was absent that day.

While reviewing the Literature Review:

The interviewee took the time to skim over all the material presented. Gardens are the major consumers water domestically and probably for schools, as well. A possible solution would be for schools to refrain from watering those areas that are not utilized in the summer months. Toilets were also indicated as big water user. Metering is a good way to quantify the results of steps to water conservation.

The company is also working on a Sustainability CD involving all the areas that are being looked at in the Sustainable Schools program. For information on water conservation and curriculum resources www.h2ouse.org and www.cuwcc.org were recommended. The Californian website, www.h2ouse.org, was thought highly of by the interviewee and others in the department. In the opinion of department staff this site is easily adaptable to Australia.

Rainwater collection tanks used to collect rain water need a lot of surface area and may not be feasible for schools that have a small roof area. It may also be expensive for schools with multiple buildings because of the expenses involve–i.e. either multiple tanks or an elaborate guttering system. Schools however, should have at least one to use as an educational tool.

Basaltica is a company using natural plants and traditional plants to show how natural plants are better and use less water. They have developed a system of hard data to better compare the two types of gardens, and this material may be of interest to schools. Basaltica has partnered with several local nurseries in order to increase public awareness and understanding of what individuals can do.

It was recommended, CERES should use any resources they can for this project, Yarra Valley Water, Gould League, the Sustainable House, Basaltica, SEAV, etc.

When Reviewing the Technology Review:

Envirohouse, located in Seddan (Western suburbs), is similar to the Lower Energy House at CERES and has educational lessons. It is run by Roger Chitman, 9689-0282.

Focusing on behavioural and cultural aspects was emphasized along with the need to talk to ground people and maintenance staff to see what they do and ensure they know the best method for completing a task while conserving water.

When asked, should anything should be added:

Add a Pressure Reduction section and discuss flow reduction valves and more diagrams. Showerheads and taps should have more detail about retrofitting appliances in order to "keep the look"

When asked about clarity of format:

Format looks good but add an index at the back with a break down of each section and what is in each one.

When asked, if they were a principal, what information would be most influential in convincing you to implement water conservation measures:

Economics would be the Big One, and then feel good

Ross Young might know interesting products, name should be in blue book, if not Rosemary has it.

Follow up telephone interview with person referenced in interview

When asked about the timing of the 5A rating scheme's implementation:

No, specified date yet due to changes that must be made in the quality standards.

Waste Authority

When asked about other recyclables:

Cork should be recycled in small quantities. There are places that will buy the material and sell it back to other companies.

When looking at the technology review and checklist:

It is important to see where this part of the project fits in to the program. The program consists of ten major steps.

Step 1) A committee should be formed in order to be the driving force in integrating this specific part of the program.

Step 2) The entire school community must be involved. The plans of the committee will be met with more enthusiasm if everyone is involved with its design. It also means that there is a much better chance of it surviving through times of change.

Step 3) An audit should be performed. In the case of waste, the Gould League completes a waste audit for the schools.

Step 4) A policy must be established. Having the policy in writing ensures that it will be followed by more people for longer. It also makes everything clear and helps everyone to be on the same wavelength.

Step 5) Targets must be set. It is easy for a school to look at a checklist and pick actions that they will do, but without specific targets and long-term goals in mind, there isn't a lot of meaning or purpose behind it. A school should set specific goals they want to achieve and then a series of targets and dates for each goal.

Step 6) A school should then create action plans. This is where our checklist and technology review fits in. It provides the school with a basic understanding on the way that they can achieve the goals.

Step 7) A school then integrates the plan into the curriculum.

Step 8) A school should implement the plan.

Step 9) Evaluation should take place.

Step 10) A school should continuously work towards more improvement.

When asked about challenges of getting the program to work in Secondary Schools:

There have been hundreds of success cases in primary schools, but there have only been about ten or fifteen secondary schools that have been truly successful.

When asked about characteristics that the successful Secondary Schools shared:

For secondary schools, it usually takes a school with a faculty member that is very passionate about the environment and bringing about change. A school needs someone who will continue to motivate and push the group forward, at times taking a lot of it upon themselves.

A school also needs to have a very supportive principal who backs the program and makes it both a policy and priority. Secondary schools should approach such a program and the creation of a policy in a democratic manner and involve the students. One secondary school that met with great success went through a number of negotiations with the students on establishing a policy. When it was finally accepted by both sides, the students supported it instead of working against it.

Awards are also very motivating factors for secondary schools, especially when the award is something the school can share with students.

Biodiversity Researcher

I am concentrating on biodiversity in schools by getting schools to establish habitats. The habitats should be built in order to sustain indigenous species. It is not necessary to reintroduce them physically. Building the habitats will result in the species introducing themselves.

Schools should work on building grasslands, wetlands, and forests. There should also be an attempt to grow food on the site.

Biodiversity also helps in the education aspect of schools as it is much easier for children to learn by looking out the window at the subjects than by simply reading about them.

Appendix F: Day lighting in Schools: Improving Student Performance

IX. GLOSSARY

altruistic- unselfish regard for or devotion to the welfare of others

anthropocentric- human centred

cause celebre- a celebrated legal issue

coagulate- to come together into a mass or group

en masse- in one group or body

indigenous species- species that originate and live in area or environment; native species

invasive species- a species originating else where, which displaces indigenous or native species

indicator species- species that show the first signs of a changing environment

monoculture- a group of things that are all the same species and have similar genetic dispositions

permaculture- an idea that landscapes change in time and their for people must learn to adapt and be accommodating to those changes in order to keep the land productive

potable- suitable for direct human consumption

vermiculture- worm cultivation

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