

Building and Construction

Work effectively and sustainably in the construction industry

Learner Guide



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Sustainability

Caring for the environment

It's easy to forget about where the stormwater is going once it disappears down the drain. But you need to remind yourself that eventually it will rejoin an ecosystem that supports a whole network of plants and animals.

When stormwater runs off roofs and driveways, it generally travels via gutters and drains to the local creek. From there, it eventually it ends up in a river or coastal waterway.



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If stormwater is contaminated with litter, wastes, grease, oil or other chemicals it can kill fish and other water life, and seriously pollute the environment.

That's why it's an offence to allow stormwater to become polluted. This includes placing substances in a position where they can fall or be blown into a drain, gutter or local waterway.

Keeping stormwater clean

Here's some simple things you can do to stop the rainwater running off your premises from becoming polluted before it goes into the stormwater drains:

- keep driveways and yard areas free of litter
- sweep up rubbish and put it in waste bins, don't hose it into the gutter or drain
- provide containers for cigarette butts
- keep drains clear, so that muck isn't allowed to build up over time and stop the free flow of water when it rains.



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One example of a treatment process is an oil water separator. This unit directs the wastewater into a tank, where it skims off the oil, which is pumped out separately, and then discharges the treated water into the sewer.

Dealing with trade wastewater

Trade wastewater is any wastewater produced by a commercial or industrial activity. It includes the runoff from industrial sprays and cooling systems, especially when it contains contaminants like cutting compounds from grinders, tannins from logs, and oil or grease from the workshop floor.

Before you let wastewater go into the sewerage system, you need to remove the contaminants, and your company needs to get a wastewater permit from the local water authority. This permit will specify the treatment process required and any other standards that may apply.

Not all businesses need to put their wastewater into the sewerage system. Some companies recycle the wastewater on-site, and treat it so it can be used in other production processes, or for watering the garden. Other companies collect the wastewater in drums, and have it taken to a waste disposal station.

Remember that if you're sending wastewater to a waste facility, the transporting must always be done by a licensed contractor.



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This on-site diesel tank has a concrete bund around its base and a corrugated iron roof to keep the rainwater out.

Bunding

One of the best ways of stopping hazardous substances from escaping and getting into the stormwater system is to use *bunding*. A bund is a barrier, like a low wall, built to contain spills or leaks.

Where possible, storage bays should also have a roof overhead to stop rainwater from filling up the banded area and also from rusting the drums. However, if there are hazardous chemicals involved, there may be special WorkCover requirements to comply with when the roof is installed.

Bunding and a roof covering is also a good idea around plant and machinery that's housed outside the factory walls, such as compressors, generators and oil-water separators.

Waste disposal

If you're disposing of waste or storing it on-site while its waiting to be picked up, you need to make sure that its managed correctly. There will be different requirements for different materials, depending on their make-up. For example, copper chrome arsenate (CCA) treated timber must only be disposed of in certain landfills, approved by the EPA.



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If you don't store waste securely prior to being collected, it may escape, particularly into the storm water system, and your company could face a fine. You must not bury waste on-site either - this constitutes a landfill activity and is illegal unless your company has an EPA waste licence.

Don't put liquid wastes into the waste bin. Materials in the waste bin generally go to landfill, so it should only ever be used for dry, solid wastes. Always drain and clean anything containing leftover fluid before you put it in the bin. Depending on the type of liquid it is, you can then either recycle it on-site, treat it and discharge it, if your company has a permit, or put it aside for removal by a waste disposal contractor.

CCA treated pine typically has a greenish colour. It needs to be kept separate from other timber offcuts, so that it doesn't accidentally get included in firewood or used for other purposes that may be hazardous.

CCA treated timber should never be burnt, because the arsenic is not only given off in the smoke, it also concentrates in the ashes.

Reduce



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- Reducing the level of waste you generate in the first place is the best way to deal with it.
- Always try to use raw materials as efficiently as you can, and minimise the amount of reject stock you produce.

This frame and truss component cutter is monitoring the lengths of the off-cuts, so that only the shortest pieces go to waste.

Reuse



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- Reusing waste is another way of minimising the amount that needs to be thrown away.

- Ask your suppliers whether products can be delivered in returnable packaging, such as crates, pallets, and containers. Their delivery trucks may be able to pick up these items when they drop off your next order.

Recycle



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Recycling waste products is now a very organised business.

Recycling companies offer commercial services for many different products, including:

- glass
- aluminium
- steel
- plastic
- paper and cardboard
- toner cartridges.

Timber shavings and sawdust are also often collected by composting operations, pet shops, or horse stables.

Waste minimisation strategies¹

Approximately 32.4 million tonnes of solid waste was generated in Australia in 2002–03, an estimated 42% of which was building waste (Productivity Commission 2006). Minimising and recycling this waste can have significant social, economic and environmental benefits.

A number of states, including Victoria, South Australia and Western Australia, have 'towards zero' waste strategy documents. The strategies set state-wide targets for waste reduction, resource recovery and littering, and specific targets and actions for the municipal and business sectors to deliver more sustainable use of resources. See for example Victoria's *Sustainability in action — towards zero waste strategy* or South Australia's *waste strategy 2011–2015*.

The three Rs of waste minimisation: reduce, reuse, recycle.

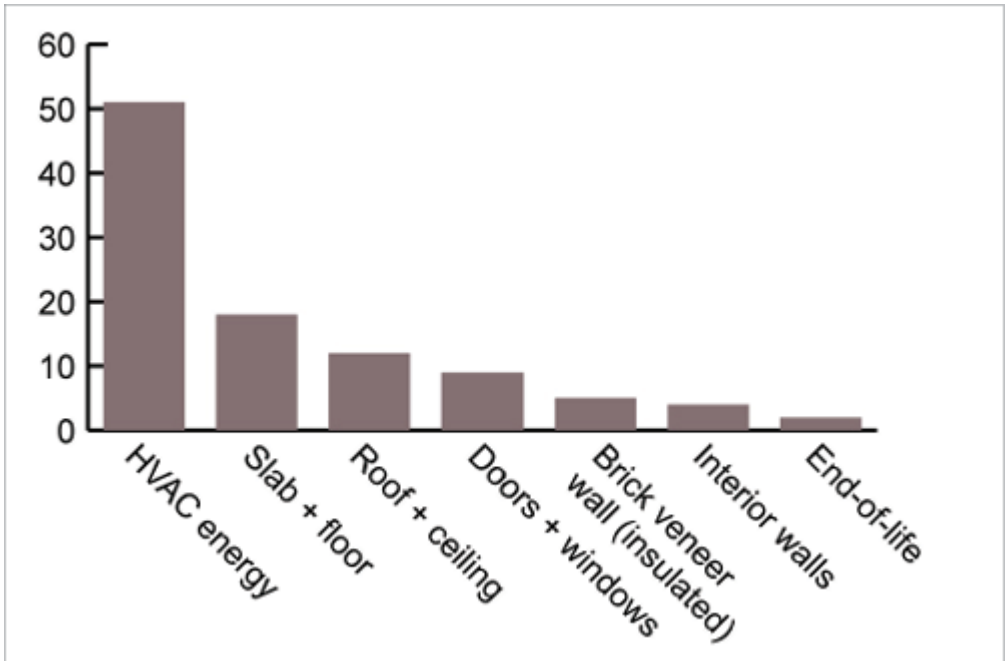
Reduce consumption of resources by building smaller houses that are better designed for your needs. This is the most effective way to conserve precious resources for use by future generations and reduce waste. It also lowers costs.

Improve the accuracy of your ordering so that materials are not wasted nor sit around a site for long periods where they can become damaged.

Reuse existing buildings and materials in order to reduce demand for resources, lower waste volumes and save money. A lot of energy and resources go into the materials used to construct a home and due to the mixed nature of these materials most end up in landfill. The following graph shows that the emissions from the energy of the materials required to construct a typical house are nearly equal to the emissions from the energy required to heat or cool that house over a typical 50 year life. Consider renovating an existing house, rather than demolishing the old and building from scratch as very little of the demolished house is recycled or reused.

Recycle resources that are left over or have reached the end of their useful life. This reduces demand for new materials and lowers the volume of waste going to landfill. Use materials with high recycled content to create a market for recycled resources. It raises the price paid by recyclers for recovered resources and increases the viability of recycling.

¹ Source: Your Home, as at <http://www.yourhome.gov.au/materials/waste-minimisation>, as on 14th May, 2014; https://nationalvetcontent.edu.au/alfresco/d/d/workspace/SpacesStore/46533bf3-db71-4495-a6e6-38ff09372e2d/ims/content_sections/cpcbc4021a_minimise_waste/01_plan/003.htm, as at 14th May, 2014.



Source: Rouwette 2010

Emissions from typical brick veneer house over 50 year life.

Sending building materials to landfill is like throwing money away. You have already paid for the material, paid someone to deliver it and then paid someone to collect it and throw it away.



Landfill

Our traditional means of waste disposal to landfill is uneconomic. Costs to communities for operating and maintaining landfill sites are high and the availability of suitable land is limited. Reuse options for landfill sites are limited due to potential health hazards. Remedial action is often prohibitively expensive. Emissions and leachate from landfill sites can be

highly toxic due to concentrations of heavy metals and toxic chemicals. These toxins find their way into the watertable or waterways, often with disastrous consequences.

Tipping fees are increasing rapidly to reflect the true cost of disposal. This increases the cost competitiveness of recycling options and rewards waste minimisation efforts.



What is building waste?

Percentage weight of typical building waste materials	
Waste description	Waste quantity (% of total weight)
Source: Extrapolated from NSW EPA Waste Census Data 1997	
Paper/cardboard	1
Garden/vegetation	3
Wood/timber	10
Textiles/rags	1
Hard plastic	1
Ferrous	2
Soil rubble (<150mm)	34
Soil rubble (>150mm)	2
Concrete-based masonry	16

Clay-based (e.g. bricks, tiles)	16
Plasterboard	2
Other/unknown	11
Total	100

Life cycle and waste

Life cycle assessment of waste streams indicates that significant energy savings can be achieved at little or no cost by considered construction and demolition waste management and planned recycling.

Materials with high embodied energy (e.g. metals, especially aluminium) or with high environmental cost in extraction can have their life cycle impact reduced by end use recycling. The environmental impact of most materials can be substantially reduced with each reuse.

Recycling — who to contact

- local councils
- regional waste authorities
- local waste station or landfill operator
- waste recycling contractors (see www.recyclingnearyou.com.au for a list of recyclers searchable by location or product)

What can be recycled?

Most materials can be recycled. The following list demonstrates some reuse options. There are many more and the list is growing rapidly.

Steel — Electric arc furnaces produce reinforcing bar, mesh and sections from 100% steel scrap. Conventional blast furnaces can incorporate up to 30% steel scrap. Recycling steel reduces embodied energy by 72%.

Aluminium — Aluminium is 100% recyclable; recycling aluminium reduces embodied energy by 95%.

Gypsum plasterboard — CSR recycles clean plasterboard offcuts from material ordered from them; other companies are considering doing so. Check with your supplier to see if they offer this service. Plasterboard disposed of in landfill produces poisonous hydrogen sulphide, which has a foul odour.

Timber — Most timber (except treated timber) can be reprocessed into horticultural mulch. A particleboard manufacturer in Australia is developing a recycling facility that requires little or no pretreatment of the waste.

Concrete — Un-set concrete can be ‘washed’ out at the plant to remove cement. Sand and stone can be reused. Set concrete can be crushed and recycled as aggregate for new

concrete or road base and fill. Rapidly developing markets for this product mean the material is now in demand and disposal costs are significantly reduced.

Glass — Most glass can be recycled. Construction glass must be separated from other glass such as drink bottles. Glass may be cut and reused or recycled as aggregate for concrete. Some patterned glass incorporates all types of recycled building glass. Recycling glass reduces embodied energy by 20%.

Carpet — In good condition, carpet can be sold and reused. It can also be recycled into secondary carpets. Some manufacturers offer a recycling or take-back service on their products. Some carpet can be recycled as a weed barrier or a covering and food for worm farms.

Bricks and tiles — These materials can be reused where appropriate or crushed on site for backfill, aggregate and gravel with portable crushing plants.

Plastics — Many plastics can be granulated and reused to make new plastic products and include:

- high density polyethylene (HDPE): rubbish bins, buckets and traffic cones
- low density polyethylene (LDPE): shrink wrap and bubble wrap
- polystyrene containers, insulation, PVC pipes, fittings, and vinyl flooring.

Making it happen

To be cost effective, waste minimisation strategies must be agreed to and implemented by all parties involved in building the home at the design, construction and operation stages.

A team approach by the owner, builder and designer is the most effective way to reduce waste.

Research has shown that opportunities for cost effective inclusion of sustainable features decline exponentially throughout the design process. Up to 90% of critical decisions, including waste minimisation, are made during the design stage. Many good household recycling and waste minimisation guides are available. Consult your local council.

The design stage

Plan ways to reduce waste before you start the job.

Designers are responsible for introducing and planning waste minimisation strategies from the earliest stages of design through to completion. This includes deciding what to build, whether to demolish, what materials to use and how they might be recycled.

The initial consultation

- Lasting decisions about whether to renovate or demolish are often made at this stage.
- Consider waste streams and life cycle benefits.

A commitment to reducing waste at the initial consultation is more likely to endure throughout the project.

Concept design

- Choose construction to minimise cut and fill.
- Plan for end use and deconstruction.
- Select building systems with low waste rates.
- Choose prefabricated products.
- Identify recycled materials that can be used.
- Source recycled materials.

Early decisions have a major impact on waste stream quantity and quality.

Design development

- Dimension to suit standard modular construction sizes and minimise waste — and create fewer plasterboard and wall lining offcuts.
- Select materials with known minimum waste rates; consider manufacturers' waste recycling schemes and recycled content or other life cycle benefits.
- Engage like-minded design professionals (e.g. engineer, interior designer).
- State and agree key waste goals before engagement (team building).

Working drawings and detailing

- Design operational waste handling facilities.
- Select energy efficient appliances (washing machine, refrigerator, dishwasher).
- Plan for waste separation and sorting on site during construction.
- Prepare accurate working drawings and nominate waste-wise fabricators.

Off-site fabrication can reduce waste, facilitate separation of waste streams and improve recovery rates.

Specification

Specify:

- materials with known minimum wastage rates, e.g. plywood, finger-jointed timber
- materials with known recycled content, e.g. paper and polyester insulation
- durable materials and finishes
- waste handling and recycling contractors
- waste streams to be recycled.

Contract documentation

- Prepare a waste minimisation plan. Identify the possible types of waste produced (e.g. bricks, timber, plasterboard), potential recyclers and methods to reduce or avoid the waste before you begin. An example of a waste minimisation plan can be found at www.mbav.com.au
- Agree which party or parties receive financial benefits of recycling.
- Provide economic incentives for recycling.
- Include waste minimisation and recycling performance clauses in the contract.

Tendering period

- Promote the economic benefits of waste minimisation and recycling to tenderers.
- Familiarise tenderers with recycling, waste management and waste minimisation strategies.
- Answer questions and allay concerns (costs).
- Engender a spirit of cooperation to achieve waste minimisation objectives (team building).

The construction stage

Site operations generally

- Plan locations for depositing and stacking of materials before delivery.
- Separate waste for recycling wherever possible. Provide recycling skips and ensure compliance with waste stream sorting by all trades.
- Where this is not possible engage a reputable waste disposal contractor who will take mixed waste bins, sort it on their site and provide you with a report.
- Form a compound to contain plastic film, cardboard, glue and paint tins.
- Use bins with lids to reduce windblown litter.
- Use reputable waste service providers.
- Negotiate recycling paybacks with local resource recovery firms.
- Use waste aware subcontractors.
- Use written contracts with all trades including clauses requiring waste minimisation practice.
- Require trades to dispose of their own waste.
- Back charge for sorting of waste streams not sorted by each subcontractor.
- Colour code or label waste skips and protect them from contamination, rain and wind.
- Provide regular waste bins for food scraps and household waste during construction.
- Lock special skips at night and weekends to prevent others dumping rubbish in them.
- Tidy up the site often. This encourages your trades to do the same and reduces the potential for windblown litter and safety hazards on site.



Supervision

- Monitor recycling rates and on-site sorting and storage of various waste streams.
- Verify contractor performance or certification.

Materials storage and handling

- Minimise the time between delivery and installation to reduce the risk of damage or theft.
- Does packaging adequately protect goods? Is there too much? Can you eliminate some?
- Ask suppliers to collect or recycle packaging.
- Have fragile materials and fixtures delivered and installed close to completion date.
- Use prefabricated framing and trusses to reduce time on site before installation.

- Check quantity, condition and quality of goods on delivery. Report discrepancies immediately.
- Reject inferior goods or materials if their quality will result in additional waste.
- Refuse oversupply as compensation for inferior quality or condition.
- Report careless delivery staff to the supplier.

Concreting

- Use concrete with recycled aggregate in all viable applications.
- Use reinforcement made from recycled steel.
- Form up accurately and fine-tune estimating to minimise waste. Up to 10% is often wasted.
- Return surplus to the plant for recycling.
- Buy from plants that wash out cement to allow recycling of sand and aggregate.
- Break remnants into small pieces before final set to allow later use as backfill or recycling.
- Always form up a small area of path or low grade slab ready to accept remnants.



Carpentry and joinery

- Use engineered timber products that make efficient use of materials where possible.
- Use sustainably sourced timber.
- Encourage your supplier to find sustainable sources.
- Prepare accurate cutting lists before ordering.
- Give joiners a copy of the cutting list.
- Ensure that carpenters have a complete cutting list to allow efficient timber use.
- Use joinery profiles that can be easily and invisibly joined to reduce offcuts.
- Use offcuts wherever possible.

Measure it twice — cut it once.

Bricklaying

- Have bricks delivered around the perimeter to minimise the chance of damage from subsequent movement to place of use.
- Use mortar to produce masonry of appropriate strength and durability as required by AS 3700-2001, Masonry structures. Mortars with lower cement content are usually softer, thus helping in recycling as well as saving on cement.



Electrical services

- Use sub-boards and plan wiring to reduce wiring distances, quantities, waste and cost.
- Recycle offcuts. Strip insulation from copper.
- Consider pulse switching and intelligent controls to reduce cabling and energy use.

- Use cable products that are highly recyclable and be aware that some PVC coatings used to contain heavy metals.

Plastering

- Buy plasterboard from suppliers who recycle.
- Sort offcuts and store on site for return to recycler. Keep offcuts clean and dry.
- Carry useful sized offcuts to the next job.

Glazing

- Separate construction glass from other glass such as drink bottles. Most glass can be melted down and recycled but requires sorting.
- Glass can also be recycled as aggregate.

Waste management plans

Many local councils require waste management plans before granting development consent. They usually require the builder or designer to estimate the total waste stream volumes from both demolition and construction and nominate the means of disposal including the recycling contractor, recycling waste station or landfill site.

The site plan is often required to show waste storage facilities on site during construction and provide a schedule for delivery or pickup.

The time and cost of waste plan preparation is usually recouped through reductions in waste disposal costs or dividends from the sale of salvaged resources. If this is not possible (low tipping fee areas), charge a fee for the service to ensure that plans are properly prepared.



Calculating the relative costs and savings of your waste minimisation strategy is an important part of the planning process. You can calculate your relative costs and savings by

comparing the cost of an **existing work practice** against an **alternative sustainable work practice**.

The new strategy specifies the purchase of building materials with minimal or no packaging. As part of your research into the new purchasing strategy, you will need to compare the cost of the building material with minimal packaging against the cost of disposing of the packaging waste to landfill. For example, your organisation is planning to introduce a new strategy to minimise waste on the construction site.

Once you have calculated the relative costs and savings of your proposed waste minimisation strategy, you will be able to demonstrate the economic and environmental benefits of your strategy to your client.

It is important that you involve other building and construction industry professionals during the planning stages of your waste minimisation strategy. Their involvement will help you to calculate material reuse costs, identify and specify building materials based on Australian Standard sizes in your plans and specifications. This will help you to reduce project costs and minimise waste. Involving other building and construction industry professionals may be more common on large commercial projects, but it's one example of how waste minimisation can be integrated into the planning stage of the construction process.

How to calculate the costs and savings of waste minimisation strategies

Calculate the cost of your existing work practice



You need to calculate the cost of your existing work practice, before you can determine the costs and savings of your waste minimisation strategies. Once you know the cost of your existing work practice, you can compare this against the cost of alternative work practices. Consider the following building and construction problem:

A subcontractor has finished planning a demolition project. The contractor determined the demolition will generate **5 tonnes of brick and concrete waste**. The subcontractor's existing work practice is to dispose of brick and concrete waste to landfill.

The local landfill charges **\$150** for a truck to **dispose of 1 tonne** of acceptable general rubbish. Acceptable general rubbish includes building materials such as brick and concrete waste.

You can **calculate the cost** of disposing of brick and concrete waste to landfill by multiplying the **quantity of building waste** by the **cost per tonne**.

For this example, it will cost the subcontractor **\$750 to dispose of 5 tonnes of brick and concrete waste** to the local landfill. Regardless of the work practice, the calculation method is the same. **Multiply the quantity** by the **cost per unit**.

Types of waste minimisation strategies

Once you have calculated the cost of your existing work practice, you can identify a strategy that will minimise waste generated by your current work practice. Some strategies you could implement to minimise waste on your work site are:

- **purchasing materials in standard sizes** – companies manufacture building materials in standard sizes; by purchasing and building to these sizes you can minimise building material waste
- **green purchasing strategies** – specify that suppliers deliver building materials with minimal packaging or packaging that can be recycled or reused
- **deconstruction practices** – that combine hand and machine can be used to increase the recovery of building materials for reuse and minimise on-site waste
- **litter reduction or prevention** – site fencing and litter bins can be installed on site to reduce litter or prevent it from being released into the work site, landfill or the environment
- **storage and separation** – recycling bins can be installed on site to store and separate building material waste.

Identify a waste minimisation strategy



Consider how the subcontractor could apply a waste minimisation strategy to their existing work practice of disposing of brick and concrete to landfill. The contractor could specify that brick and concrete waste be **separated and stored in on-site storage bins or skips**. Once the on-site storage bins or skips are full, they would be collected by a recycling company for recycling or resale.

This kind of strategy would minimise the amount of brick and concrete waste disposed of to landfill and create a potential revenue stream, through the sale of second-hand bricks.

You can communicate your waste minimisation strategies to your subcontractors by including them in the initial design stage of the project. This increases their awareness of the goals of your strategy and encourages them to identify opportunities to save resources and minimise waste.

Calculate the costs and savings of your strategy



Once you have identified your strategy, you can calculate the costs and savings. You can do this by **multiplying the quantity of waste** by the **cost of the waste minimisation strategy** and then **subtracting the result** from the **cost of the existing work practice**. Consider how the subcontractor could calculate the costs and savings of their waste minimisation strategy.

The subcontractor has determined that hiring **on-site recycling bins** from a local recycling company is the best way for them to minimise building waste. The recycling company charges customers a **flat rate of \$420 to collect recycling bins** from a construction site. The subcontractor can now calculate the savings of their waste minimisation strategy. The subcontractor has already determined that the cost of **disposing of building waste to landfill will be \$750**. The subcontractor will need to subtract the **recycling bin charges of \$420** from the **landfill fee of \$750** to calculate the savings of the waste minimisation strategy. The subcontractor **saved \$330** by hiring recycling bins for their construction site.

Remember, the costs and savings of your strategy will be determined by your project.

Negotiate costs and savings with your client

Once you have calculated the costs and savings of your waste minimisation strategy, you can record your calculations on your waste minimisation plan. You can then use the plan to show your client the financial benefits of implementing a waste management strategy.

Sometimes your strategies may cost more than the existing work practice. This is where you need to demonstrate how your strategies will benefit your client. For example, your strategy may specify that recycling bins be installed on site. The bins are used to prepare bricks for recycling. The cost of the bins is more than the cost of disposing the bricks to landfill.

You can demonstrate to the client how the cost of the bins can be offset by the reuse of the bricks in another stage of construction. The bricks could be used in the construction of the garage. The client may no longer need to purchase new bricks and could make a saving.

This waste minimisation plan shows the cost of the subcontractor's waste minimisation technique, the cost of their existing work practice and savings generated from their waste minimisation strategy.



Waste minimisation plan				
Building materials	Cost of existing work practice	Waste reduction technique	Cost of waste reduction technique	Savings
Bricks	Landfill charges \$750	Bricks are to be sorted and separated into on-site bins and then sent to a recycling company	Hire of on-site recycling bins \$420	\$330

Communication strategies



You can communicate your waste minimisation strategies with project stakeholders through your project plans and waste minimisation plan.

These documents usually describe the materials to be used and the type and quantity of waste materials to be generated. These documents can also describe waste reduction techniques to be followed during the project or how waste is to be reused or disposed of to landfill.

You could also develop a building material reuse strategy for deconstruction projects. The strategy estimates the amount of materials that can be salvaged and how long it would take to prepare the materials for reuse in the construction of a new building. You would then compare the cost of preparing the materials against the cost of purchasing new materials.

This strategy is useful for commercial building developers who are applying for Leadership in Energy and Environmental Design (LEED) certification through the Green Building Council of Australia (GBCA).

That completes our demonstration of how to calculate the cost of waste minimisation strategies.

Sustainable Construction²

In the past decade the awareness of the importance of ecology and environment protection has risen to a very high level. People are being educated more on the environment protection and are always trying, together with experts, to find new ways of being green. With that in mind sustainable construction has been invented.

Basics

Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.

While standard building practices are guided by short term economic considerations, sustainable construction is based on best practices which emphasize long term affordability, quality and efficiency. At each stage of the life cycle of the building, it increases comfort and quality of life, while decreasing negative environmental impacts and increasing the economic sustainability of the project. A building designed and constructed in a sustainable way minimizes the use of water, raw materials, energy, land ... over the whole life cycle of the building.

The evolution of the concept of sustainable development is used as a basis for advancing understanding of sustainable construction. Principles of sustainable construction are developed and divided into four 'pillars' – social, economic, biophysical and technical – with a set of over-arching, process-oriented principles, to be used as a checklist in practice. A multi-stage framework is proposed which requires the application of Environmental Assessment and Environmental Management Systems for construction projects.

Sustainable or "green" construction is a type of construction which is concerned with environmental impacts in addition to the creation of a usable structure. When people build sustainably, it means that they are building in a way which is considered sustainable, meaning that the building practices used can be utilized in the long term without causing damage to the environment. There are a number of aspects to sustainable construction, and such construction is often overseen by a firm which specializes in sustainable construction and is familiar with the complexities of this type of work.

Sustainability is a complex issue. One critical facet is environmental sustainability, but it can also include social and economic sustainability. Good sustainable construction thinks about the environmental impacts of construction and long term building use, in addition to considering whether or not a structure is economically sensible to build and maintain, and whether or not a structure fits sustainably into the social structure in the area where it is being built.

² Source: Australian Science, as at <http://www.australianscience.com.au/industry/sustainable-construction/>, as on 15th May, 2014.

Construction has been accused of causing environmental problems ranging from excessive consumption of global resources both in terms of construction and building operation to the pollution of the surrounding environment, and research on green building design and using building materials to minimise environmental impact is already underway. However, relying on the design of a project to achieve the goal of sustainable development, or to minimise impacts through appropriate management on site, is not sufficient to handle the current problem. The aim for sustainability assessment goes even further than at the design stage of a project to consider its importance at an early stage, before any detailed design or even before a commitment is made to go ahead with a development. However, little or no concern has been given to the importance of selecting more environmentally friendly designs during the project appraisal stage; the stage when environmental matters are best incorporated. The main objectives of this paper are to examine the development, role and limitations of current environmental building assessment methods in ascertaining building sustainability used in different countries which leads to discuss the concept of developing a sustainability model for project appraisal based on a multi-dimensional approach, that will allow alternatives to be ranked is discussed in detail in the paper.

Sustainable construction faces economic challenges at different levels. On the macroeconomic level, the goals of sustainable construction are being implemented most actively in industrial countries in which the share of construction output is decreasing. However in both less developed and newly industrialized countries, the share of construction output is increasing, but the goals of sustainable construction are more difficult to implement. On the mesoeconomic level, the construction sector depends on the implementation of the goals of sustainable development across the national economy as a whole. Supply chains feeding the construction sector are long and intertwined, making it difficult to assess the effect of different materials, components and procedures. On the microeconomic level, buildings are created with shorter time horizons in response to being a demand-derived commodity and increasingly dominated by mechanical, electrical and electronic equipment. Their finance is being adjusted to the short and medium term which is in conflict with sustainable construction, whose goals rely upon the long term. Two broad approaches for meeting the economic challenges of sustainable construction are considered: governance through standards, legal and regulatory practices; market-oriented policies which influence the costs of particular forms of construction. Both approaches have a role, but it is argued that the market-oriented measures will be more effective at the strategic level.

The construction industry makes a vital contribution to the social and economic development of every country, but, at the same time, its building sector has major impacts on the environment. Construction is a major consumer of non-renewable resources (energy in particular), a substantial source of waste, a polluter of air and water and an important contributor to land dereliction. This paper focuses specifically on the growing lack of focus on construction sustainability in the Southern Africa Development Community (SADC) public building sector. It indicates some salient issues on sustainable construction and the need for appropriate procurement systems, using the Botswana public building sector as a case study. It addresses two propositions. First that lack of appropriate focus on sustainable construction is primarily due to an inappropriate project organizational structure. Second that a default traditional construction procurement system (TCPS) provides a poor

relationship management system incapable of dealing with sustainability parameters. Information is obtained through questionnaires on the dominant procurement system used. The primary conclusion is that the building procurement system apparently in use in the SADC public building sector differs significantly from that recommended in the theory, resulting in insignificant focus on construction sustainability. Salient steps are proposed with a proviso that the SADC public building sector should establish appropriate methods of selecting building procurement systems and formulate appropriate project organizational structures that will embrace an environmental management system.