Skills for Sustainability

Manufacturing Skills Australia

Sustainability issues in cement & concrete

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Contents

About the guide

This guide presents an outline of the social, economic and environmental sustainability issues that typically arise in the cement and concrete sectors. This guide focuses on the manufacture of cement and concrete products, typically through the processes such as kilning, grinding, mixing, compaction and curing.

Examples of products include:

- Cement, including hydraulic and Portland cement
- Lime
- Pre-mix or ready-mixed concrete slurry
- Concrete pipes and box culverts
- Other concrete products, such as pavers.

The guide shows some of the processes that are common across the sector and how sustainability issues relate to different parts of the process. These issues will vary depending on the inputs and activities in each process step.

The guide will assist Registered Training Organisations (RTOs) to identify the sustainability issues in a sector and/or business. It provides a high-level snapshot of sustainability in the sector. This can be used as a basis for the RTO to undertake its own research in order to:

- Consult with clients and understand their business and skill needs
- Develop their training and assessment strategy
- Contextualise training and assessment materials and activities.

The guide is not intended as learning material for students, however, it may be useful as part of a suite of information resources. It may also provide a model which an RTO can adapt, expand and/or contextualise for use in its own materials.

The Skills for Sustainability website provides further support for RTOs including links to more information about this sector and guides to identifying the sustainability issues in five other manufacturing sectors. See http://www.sustainabilityskills.net.au.

What is in the guide?

The guide includes:

- An overview of sustainability issues
- Simple process flows
- Risk ratings tables for sustainability issues at various points in the processes
- Examples of possible *high impact* issues and their causes.

The guide provides a 'map' of where sustainability issues are likely to arise in a particular manufacturing process, and what the impact of these issues might be. It uses a risk rating system and explains the potentially *high impact* issues in more detail. Brief and simplified examples are provided, which do not cover all of the possible sustainability issues and variables within the sector.

The process steps and sustainability issues in the sector have been identified through discussions with stakeholders and desktop research. Sources include IBIS World Industry Research Reports, International Finance Corporation (IFC) Environmental Health Guidelines, the MSA Environmental Scan 2012 and the National Pollutant Inventory Emission Estimation Technique (EET) Manuals.

Overview of sustainability issues

This section provides an overview of sustainability issues that are likely to affect enterprises in cement and concrete products manufacture.

Sustainability issues	
Economic sustainability	• Energy intensive industry – high and increasing cost of coal, electricity, gas and oil resulting in exposure to the Carbon Price and possible future threats to supply. • Labour intensive industry – exposure to high labour costs, out-dated manual technology and risk of industrial action. • High freight costs – limits access to global markets and creates reliance on local markets. • Local market volatility (e.g. heavy reliance on the civil construction industry) which is variable. • Pressure to innovate and import 'best practice' technology – cost of technology and managing workforce/skill needs.
Environmental sustainability	• Significant electricity use to run equipment, currently reliant on non-renewable resources (gas and black and brown coal in Queensland, NSW, Victoria and South Australia). • High use of fuels for combustion in kilns, although use of alternative fuels from commercial waste is increasing. • High use of non-renewable resources as raw materials, including limestone, shale, clay, sand and iron ore, although use of alternative raw materials and different mixtures is increasing. • A wide range of chemicals and other substances are used as admixtures (to increase the workability and strength of concrete), accelerators (to reduce setting time), set-retarders (to delay concrete setting), and aerators – these may affect land, air and water quality if they enter the environment. • Large amounts of mostly potable (drinking quality) water used as a coolant, cleaner and dust suppressant and for making cement and concrete. • Packaging may use renewable or non-renewable resources, and generate recyclable or non-recyclable waste.
Social sustainability	• Significant regional employer. • Employees across a wide range of skill sets at a variety of levels, from low to high skills. • Contraction and innovation in the sector – leads to skill development needs and risk of redundancies of lower skilled workers who would benefit from a planned transition process. • Workplace health and safety issues are significant given the level of heat, heavy machinery and the manual nature of the work. • High risk of impact on local communities – from GHG and particulate emissions, waste, visual amenity, and noise and traffic entering and leaving the site.

Process flows

This section provides two simple process flows of some common steps in cement (Figure 1) and concrete product (Figure 2) manufacture. It gives a broad indication of the inputs (such as materials, energy, labour and equipment) and outputs (such as greenhouse gas (GHG) emissions, particulates, waste materials and products). This defines a focus area so that specific sustainability interactions can be identified.

Value chain issues

These process flows focus on a 'gate to gate' section of cement and concrete product manufacture. Process flows for this sector could also be developed for concrete slurry ('ready mix') and specialist manufacturing.

While they are not the focus of these process flows, the supply of raw materials and distribution of products can contribute significant sustainability impacts to the value chain and businesses can have some influence over them. For example, many enterprises include environmental and social sustainability criteria in tenders and contracts.

Other parts of the value chain that are excluded from this production-focused flow can influence the mix of sustainability issues that are identified. For example, the flow could include management or customer service processes. This would be likely to show more social sustainability issues in areas such as governance, ethics or customer complaints.

For more information about sustainability in practice and sustainable supply chain see http://www.sustainabilityskills.net.au.

Raw materials	Crushing	Grinding and blending	Pyro-processing or kilning	Finishing grinding
INPUTS • Mined limestone, sand, shale, clays and iron ore • Transport **OUTPUTS** • GHG emissions • Dust • Storage	**INPUTS** • Limestone and sand • Energy for crushers and grinders • Transport **OUTPUTS** • Dust • Storage	**INPUTS** • Limestone • Chemical additives • Water (wet process) • Energy for rotating ball or vertical roller mill • Blending tanks **OUTPUTS** • Wet process: homogenised slurry • Dry process: blended kiln feed • Waste (e.g. water and dust)	**INPUTS** • Kiln feed or slurry • Energy to heat rotary kilns (e.g. 2500 °C) **OUTPUTS** • Heat • Dust • GHG emissions • Clinker	**INPUTS** • Clinker • Gypsum • Additives (e.g. fly ash, minerals and slag) • Energy for ball mill **OUTPUTS** • Cement – range of grind and content • Storage in silos • Waste (e.g. metal, dust, chemical and water)

Figure 1: Cement manufacture process flow

Concrete slurry	Moulding	Compaction and vibration	Curing	Stripping and finishing
•INPUTS •Cement •Aggregates and admixtures (e.g. fibres, minerals, fly ash and slag) •Sand •Water **•OUTPUTS** •GHG emissions •Storage	**•INPUTS** •Prepared moulds, fittings and templates •Chemical or oil based release agents •Reinforcement •Labour **•OUTPUTS** •Green products (uncured) •Waste (e.g. slurry and reinforcement)	**•INPUTS** •Green products •Machinery for vibration or pressure **•OUTPUTS** •Green products for curing	**•INPUTS** •Green products •Water and/or steam •Curing agents (chemical and/or physical) •Managed curing conditions (e.g. space and time, moisture and heat) **•OUTPUTS** •Cured products •Waste (water and particulates)	**•INPUTS** •Cured products in moulds •Energy for finishing processes (e.g. polishing, smoothing, patterning and etching) •Chemicals and cleaning agents •Labour **•OUTPUTS** •Waste (e.g. chemicals/oils as release agents, and cleaning agents) •Clean moulds and fittings •Finished products

Figure 2: Concrete product process flow

Risk rating of sustainability issues in the process flows

This section looks at each step in the process flows (above). Typically, each step in a process will apply different techniques, use a range of equipment and require various inputs. These can result in very different sustainability issues at each step. This risk assessment investigates the risk of a particular sustainability issue occurring at each step and estimates the potential level of impact.

Risk assessments are subjective and require interpretation of information. In this instance the risk assessment will also depend on local and enterprise variables, for example, physical location, management systems, the economy, the skill level of the workforce, external events and available technologies.

This risk assessment is against a number of issues within economic, social and environmental sustainability. This list of issues is not exhaustive and there are many different ways that sustainability issues can be described and categorised. This list draws on a number of sources, including the Global Reporting Initiative (GRI), ISO 14001 Environmental management systems, ISO 26000 Guidance on social responsibility and the Skills for Sustainability website.

The risks have been rated using a scale for **likelihood** (probability) and **impact** (consequence).

Likelihood – the probability of occurrence	Impact – the consequences of occurrence
H = highly likely	H = high impact
M= might happen	M = moderate impact
L = less likely	L = limited impact

In the following tables the probability is listed first followed by the likely level of impact. So ‘H/M’ would be highly likely to happen and, if it did happen, would be expected to have moderate impact. *High impact* risks are discussed in further detail, as an example. However, this does not imply that other risks do not need to be considered in analysing the sector or in delivering training and assessment.

Cement manufacture risk rating table

Sustainability issues	**Process flow elements and sustainability risks** (Cement manufacture)				
Economic	**Raw materials**	**Crushing**	**Grinding and blending**	**Pyro-processing or kilning**	**Finishing grinding**
Political/economic • AUD (exchange rate) • Cost of capital and taxes (including Carbon Price) • Competition with developing countries	**M/H**	L/L	**M/H**	**H/H**	L/L
	• Exposure to increased electricity costs due to Carbon Price. • Cement imports are typically low. However, the high AUD exchange rate and excess global production increase the viability of imports.				
Markets • Global and local	L/L				
	• Demand is predominantly local and largely driven by infrastructure projects and civil construction.				
Value • Costs and financial risks • Value add and intellectual property • Efficiency	L/L			**H/H**	
	• High cost of energy for intense heat processes. • Exposure to increased electricity costs due to Carbon Price.				
Environmental	**Raw materials**	**Crushing**	**Grinding and blending**	**Pyro-processing or kilning**	**Finishing grinding**
Materials (and packaging) • Consumption/reduction • Source – recycled/renewable	**L/L**		M/M	**H/H**	L/L
	• Traditional 'recipes' for clinker and cement require intense heat, typically from fossil fuels (coal combustion, gas and electricity). The use of waste products in the recipes (e.g. fly ash from electricity generators) can reduce the heat required as well as diverting and using those wastes.				

<table>
<tr><th>Sustainability issues</th><th colspan="5">Process flow elements and sustainability risks
(Cement manufacture)</th></tr>
<tr><th>Environmental</th><th>Raw materials</th><th>Crushing</th><th>Grinding and blending</th><th>Pyro-processing or kilning</th><th>Finishing grinding</th></tr>
<tr><td>Energy and fuels
• Consumption/reduction
• Source – renewable/non-renewable</td><td colspan="5">H/H
• Consumption of electricity for machinery and combustible fuels for kilns is high in the processing of raw materials into clinker, clinker into cement and cement into products. Traditionally these are non-renewable (finite) resources, however, the use of alternate combustible fuels is increasing (e.g. scrap tyres).
• Significant fuel consumption transporting materials in and product to customers.</td></tr>
<tr><td>Water
• Consumption/reduction
• Source – captured, recycled and potable
• Impact on local waterways</td><td colspan="2">M/H</td><td>L/M</td><td colspan="2">H/M
• Water consumption is high in cement manufacture – as an ingredient, a coolant and as a dust suppressant. Water capture and re-use systems can reduce reliance on potable and unpredictable water supply.
• High risk of water run-off to local waterways and other environments, with contaminants.</td></tr>
<tr><td>Emissions, effluent and waste
• GHG and ozone depleting emissions
• Trade and solid waste
• Toxins and hazardous substances</td><td colspan="5">H/H
• Potentially significant emissions from mining and processing of raw materials (depending on materials and processes used).
• GHG emissions, pollutants, odours, dust and waste from grinding and blending processes may enter the local environment (air, water and land).
• Admixtures, accelerators, set-retarders and aerators and non-degradable waste may contribute to pollution risk.</td></tr>
<tr><td>Habitat
• Risk management and mitigation
• Vulnerable area impacts</td><td colspan="5">M/M
• Impact of issues in the supply chain, such as mining activities, which impact local habitats.</td></tr>
</table>

Sustainability issues	Process flow elements and sustainability risks (Cement manufacture)				
Social	**Raw materials**	**Crushing**	**Grinding and blending**	**Pyro-processing or kilning**	**Finishing grinding**
Worker health and safety • Operation of heavy machinery • Handling of heavy, hot or hazardous materials • Safety training, equipment handling and drills	M/M	**M/H**			M/M
	• Worker exposure to heat, chemicals, dust and pollutants can cause serious health issues. • Operation of heavy equipment requires specialised training and monitoring. • Handling of potentially hazardous materials requires specialised training and monitoring.				
Workplace culture and workforce development • Worker engagement, job design and working conditions • Diversity and equal opportunity • Training and development	M/M	**H/H**			M/M
	• Innovation may lead to redundancies for lower skilled workers – managed redundancy and transition processes may be required.				
Heritage and amenity • Cultural heritage • Visual amenity, noise and pollution from plant/site • Impact on pedestrian movement and resident privacy • Traffic entering and leaving the plant (noise, pollution and hazards)	M/M	L/M	M/M		L/M
	• The delivery of supplies or the distribution of finished product may generate traffic and associated pollution and emissions. This can have a detrimental effect on community amenity and lead to complaints and poor profile in the local community.				
Community • Engagement • Local programs • Complaints	M/M	L/L	M/M		L/L
	• A poor reputation in the community can result in negative media coverage and community complaints. These can be costly, time-consuming and threaten the 'social license to operate' of the business.				

Sustainability issues	**Process flow elements and sustainability risks** (Cement manufacture)
Ethical practice • Governance and compliance • Management of contracts and transactions • Treatment of workers, suppliers, customers, competitors, locals and Indigenous persons	**M/H** M/M • The risk of collusion or unethical practice in supply chain contracts, which may cost the business through fines and/or negative media coverage. • Poor practices in the supply chain may generate negative media coverage. • Effective management of these issues requires staff training and monitoring processes.
Product responsibility • Safety and sustainability of products • Labelling, stewardship and transparency • Ethical marketing	**M/H** • Product safety – poor quality practices and/or materials in any step in the process can affect the safety of products. • Effective management of these issues requires systems and procedures, staff training and monitoring processes.

Concrete products risk rating table

<table>
<tr><td>Sustainability issues</td><td colspan="5">Process flow elements and sustainability risks
(Concrete products)</td></tr>
<tr><td>Economic</td><td>Concrete slurry</td><td>Moulding</td><td>Compaction and vibration</td><td>Curing</td><td>Stripping and finishing</td></tr>
<tr><td>Political/economic
• AUD (exchange rate)
• Cost of capital and taxes (including Carbon Price)
• Competition with developing countries</td><td>M/H</td><td colspan="4">L/M</td></tr>
<tr><td></td><td colspan="5">• The impact of the Carbon Price on mining and fuel in the supply chain will flow through to raw materials and transport costs, and is a significant liability unless alternative fuels and materials can be sourced.
• Competition from global markets is low due to the high cost of transporting concrete products.</td></tr>
<tr><td>Markets
• Global and local</td><td colspan="5">L/L</td></tr>
<tr><td></td><td colspan="5">• Demand is predominantly local and largely driven by infrastructure projects and civil construction.</td></tr>
<tr><td>Value
• Costs and financial risks
• Value add and intellectual property
• Efficiency</td><td colspan="2">M/H</td><td colspan="3">L/L</td></tr>
<tr><td></td><td colspan="5">• Innovations in concrete strength and weight (e.g. use of glass fibres) and design features (e.g. hollow core wall and floor panels, and insulated ‘sandwich’ panels) are helping concrete compete in the ‘green’ market. These provide value add and sustainability features, such as reduced heating and cooling costs and reduced transport costs.</td></tr>
</table>

Sustainability issues	**Process flow elements and sustainability risks** (Concrete products)				
Environmental	**Concrete slurry**	**Moulding**	**Compaction and vibration**	**Curing**	**Stripping and finishing**
Materials (and packaging) • Consumption/reduction • Source – recycled/renewable	M/H	L/L			
	• Reliance on non-renewable resources is being reduced by using waste products from other industries (e.g. fly ash from electricity generation and slag from iron production) to modify clinker and cement 'recipes'. These can also be used to manage the water requirements, strength, durability and other features of the concrete and may deliver other sustainability benefits and cost savings.				
Energy and fuels • Consumption/reduction • Source – renewable/non-renewable	**L/L**			**M/H**	**L/L**
	• Significant amounts of energy may be used to manage the curing environment (e.g. humidity or heat/steam curing).				
Water • Consumption/reduction • Source – captured, recycled and potable • Impact on local waterways	**H/H**	L/L		**H/H**	L/L
	• Potable water consumption is high as an ingredient, coolant and dust suppressant. Use of recycled and reclaimed water is being investigated for the effects on concrete strength, curing properties and durability. • High risk of water run-off to local waterways and other environments, with contaminants.				
Emissions, effluent and waste • GHG and ozone depleting emissions • Trade and solid waste • Toxins and hazardous substances	M/M	L/L		**H/H**	M/M
	• GHG emissions, pollutants, odours, dust and waste from manufacturing processes may enter the local environment (air, water and soil). • Chemicals used or released during production may affect workers and soil, air and water quality.				

Sustainability issues	**Process flow elements and sustainability risks** (Concrete products)				
Environmental	**Concrete slurry**	**Moulding**	**Compaction and vibration**	**Curing**	**Stripping and finishing**
Habitat • Risk management and mitigation • Vulnerable area impacts	L/M				
	• Impact of issues in the supply chain, such as emissions, odours, dust and waste which are released into local habitats.				
Social	**Concrete slurry**	**Moulding**	**Compaction and vibration**	**Curing**	**Stripping and finishing**
Worker health and safety • Operation of heavy machinery • Handling of heavy, hot or hazardous materials • Safety training, equipment handling and drills	**M/H**			M/M	
	• Worker exposure to chemicals, dust and pollutants can cause serious health issues. • Operation of heavy equipment requires specialised training and monitoring. • Handling of chemicals and/or hot materials requires specialised training and monitoring.				
Workplace culture and workforce development • Worker engagement, job design and working conditions • Diversity and equal opportunity • Training and development	M/M				**H/H**
	• This is a labour intensive process, exposed to the high costs of a large but low skilled workforce.				
Heritage and amenity • Cultural heritage • Visual amenity, noise and pollution from plant/site • Impact on pedestrian movement and resident privacy • Traffic entering and leaving the plant (noise, pollution and hazards)	M/M				
	• The delivery of supplies or the distribution of finished product may generate traffic and associated pollution and emissions. This can have a detrimental effect on community amenity and lead to complaints and poor profile in the local community.				

Sustainability issues	Process flow elements and sustainability risks (Concrete products)				
Social	**Concrete slurry**	**Moulding**	**Compaction and vibration**	**Curing**	**Stripping and finishing**
Community • Engagement • Local programs • Complaints	M/M • A poor reputation in the community can result in negative media coverage and community complaints. These can be costly, time-consuming and threaten the 'social license to operate' of the business.				
Ethical practice • Governance and compliance • Management of contracts and transactions • Treatment of workers, suppliers, customers, competitors, locals and Indigenous persons	**M/H**			M/M	
	• The risk of collusion or unethical practice in supply chain contracts, which may cost the business through fines and/or negative media coverage. • Poor practices in the supply chain may generate negative media coverage. • Effective management of these issues requires staff training and monitoring processes.				
Product responsibility • Safety and sustainability of products • Labelling, stewardship and transparency • Ethical marketing	**M/H** • Product safety – poor quality practices and/or materials in any step in the process can affect the safety of products. • Incorrect or inadequate labelling and product information may result in significant safety breaches/accidents. • Effective management of these issues requires systems and procedures, staff training and monitoring processes.				