SUSTAINABILITY AND THE BUILT ENVIRONMENT

A Submission to the State Sustainability Strategy

April 2002

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The scope of this analysis of the built environment is limited to buildings and construction projects and does not extend to planning and other built environment sustainability factors.

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Sustainability centres on meeting three objectives simultaneously, commonly known as the triple bottom line – social, economic, and environmental.

3. The Built Environment

- Buildings define how resources flow from the environment and how people feel and perform, and therefore deliver a significant impact on their surrounding environments.
- Sustainable buildings can be defined as those buildings that have minimum adverse impacts on the built and natural environment and the humans who occupy them.
- Buildings have a large impact on the environment and are responsible for approximately 30% of raw material use, 42% of energy use and 40% of air emissions. Therefore, the industry has a huge contribution to make to improving the quality of life.
- Sustainable construction may be defined as building practices that strive for integral quality, including economic, social and environmental performance and issues.

4. Relationship with Other Themes

Built environment sustainability can clearly be linked with other significant State Government themes:

- State Strategic Plan
  - Sense of place
  - Community building
  - Resilience
  - Wealth creation
- Building WA Strategy
  - Quality built environment
  - Vibrant industry
  - Regulatory protection and enablement
  - Best practice works procurement

5. Targeting Effort

- Components that make up the built environment:
  1. Residential Housing
  2. Non-residential/Commercial Buildings
  3. Infrastructure
- Built environment sectors and influence mechanisms:
  1. Built Form – All Public and Private Assets: Legislation, Incentives, Regulation
  2. Built Form – All Public Assets: Mandated Government Policy/Legislation
  3. Built Form – State Government Public Assets: Control and Processes applied through the relevant State Government Departments.

- Issues for the non-residential/commercial works industry fall under five different areas, which represent the life of a built asset:
    1. Pre-design/Planning/Land Development
    2. Design
    3. Construction
    4. Operating/Maintaining
    5. Disposal/Renewal
- Future development in a sustainable manner represents new ways of thinking in planning, designing, building, operating and maintaining the built environment.

6. Specific Priorities

There is a need to develop built environment priorities in consultation with all parties involved in the WA built environment. Some suggestions of suitable priorities include:

1. Environmental:
- Improved energy efficiency and use of renewable energy resources
- Reduced overall environmental impact
- Increased resource conservation
- Enhanced indoor air quality

2. Economic:
- Increased efficiency/productivity of the construction process
- Better working conditions for employees and contractors
- Improved business relations

3. Social:
- Increased consideration of community issues
- Contribution to safe, viable and cohesive communities
- Increased responsiveness to customers, end users and other stakeholders.

7. Barriers

It is possible to identify several broad areas that may present barriers to a more proactive approach to sustainability in the built environment:

1. Industry Culture
2. Economic
3. Educational/Awareness
4. Institutional/Process

8. Mainstreaming Sustainability: Facilitating Change

It is possible to identify a number of key areas that represent the key to bringing about change and facilitating a more sustainable built environment:

1. Market Demand: Community, clients and investors creating market demand for sustainable practices.
2. Affordability/Delivery: Building and Construction Industry achieving and delivering affordable sustainable practices.
3. Regulation/Facilitation: Government providing a regulatory environment and acting as the driver and facilitator of sustainable practices.

9. Research and Development Requirements

- Improvements in environmental quality – providing convincing evidence of business benefits.

- Sustainable building and construction industry – transform the market to one receptive to sustainable buildings.
- Delivering a sustainable built environment and contributing to sustainable communities.
- Specifics in relation to building performance and construction.

10. Options for Action

- Sustainable Asset Management Lifecycle Strategies: A framework for achieving sustainable outcomes in the asset management process should be developed by linking Strategic Asset Management principles with sustainability principles.
- Capital Works Project Approval and Funding Process: An approach based around a new capital works project approval and funding process. The sustainability star rating system would be linked to funding incentives for Government agencies to encourage sustainability initiatives in works projects.
- Fiscal Incentive Schemes:
  - Incentive Schemes for Business/Private Sector: price preferences in Government tendering processes for those organisations that incorporate built environment sustainability principles.
  - Incentive Schemes for Government Agencies/Public Sector: higher funding incentives for those agencies who incorporate sustainability objectives in their capital works project planning.
- Educational and Awareness Programs:
  - Education Centre for the Built Environment: an education centre for the built environment could be established to promote sustainability concerns and initiatives.
  - Promote Sustainable Buildings and Infrastructure
  - Promote the Business Benefits of Sustainable Construction
- Rebuild Public Service Expertise: Rebuilding of expertise in the relevant public sector departments to oversee the works design and construction processes to ensure sustainability principles are implemented.
- Built Environment Sustainability Research and Policy Unit: Creating a research unit consisting of representatives from all Departments operating within the built environment to enable the coordination of policy efforts.
- Improve Existing Built Facilities: Renewal programs and the improvement of renovation and repair methods and practices.
- Forming Alliances and Partnerships: Partnerships with business, Government organisations/agencies, and non-government organisations.
- Implementing Legislation: To achieve maximum sustainability benefits with a minimum of regulation.

11. Case Studies – Sustainability in Action

- Five case studies are included in this paper:

  1. Rat Island Research Camp – Abrolhos Islands
  2. Shenton College
  3. Energy Efficient Design of Schools in WA
  4. Fremantle Prison and Heritage Precinct
  5. Percent for Art Scheme

2 Introduction

2.1 State Sustainability Strategy

The Western Australian Government has placed sustainability as a top priority to re-examine its future vision, making a strong commitment to sustainability and the development of a State Sustainability Strategy when coming into office in February 2001. Professor Peter Newman, seconded from the Institute for Sustainability and Technology Policy at Murdoch University, has been driving sustainable thinking in Western Australia as the Director of the Sustainability Policy Unit in the Department of The Premier and Cabinet.

Consequently, the Western Australian Government recently released a consultation paper for the development of a State Sustainability Strategy, inviting widespread participation in this development process via written submissions to the Sustainability Policy Unit.

The Department of Housing and Works welcomes this opportunity for State Government Departments, Industry and the general community to come together to translate the vision of sustainability into a reality. We commend the Gallop Government and Professor Newman's Sustainability Policy Unit for their concern and efforts to end the current trend of borrowing heavily from the future.

Accordingly, what follows is the Department of Housing and Works, non-residential works component, response to the Western Australian Governments consultation paper "Focus on the Future: Opportunities for Sustainability in Western Australia".

2.2 Department of Housing and Works (DHW)

The Department of Housing and Works (DHW) is the State Government Department responsible for the public sector's buildings component of the built environment (i.e. housing and non-residential buildings), and the Government's assets and project management. The Department builds homes, develops land, undertakes joint venture projects with other housing providers, and delivers and manages non-residential buildings and some infrastructure assets across the State.

With the recent merger of Ministry of Housing and the Asset Management Services section of Department of Contract and Management Services (CAMS), DHW is effectively split into two sections. The main bulk of the Department is concerned with the residential housing and rental market (referred to as DHW Housing). In these works the Department is its own client and does not provide services to other Government agencies in relation to housing.

The other side of the departmental split focuses only on non-residential public works (referred to as DHW Works). These works are carried out on behalf of other Government agencies as a "client" of DHW Works, and the role of the Department here is more of a project management/contract management one. Whilst the client agency ultimately has the final decision on project matters, and therefore greatest control over implementing sustainability initiatives, DHW Works could play a significant role in assisting clients to recognise and pursue sustainability in their built assets.

2.3 Scope of Submission

The scope of this analysis of the built environment is limited to buildings and construction projects and does not extend to planning and other factors affecting the sustainability of the built environment. While concentrating on issues under the direct control of the building industry, the narrow focus in most cases precludes consideration of the broader impacts of construction on sustainability and sustainable development. In this way several key issues are excluded which need to be addressed in partnership with other actors for the industry to optimise its contribution to sustainability. These include land use and land development, transport, community safety and health, and access to employment and local services.

Given the fundamental differences in the operation of the two sections of the Department of Housing and Works (Residential Housing / Non-Residential; Commercial), this paper primarily attempts to focus on non-residential/commercial public works (particularly so with respect to the options for action in Section 10), although there are many sustainability issues that permeate all areas of the built environment. The general residential housing market is covered under a separate paper prepared by DHW Housing.

3 Sustainability

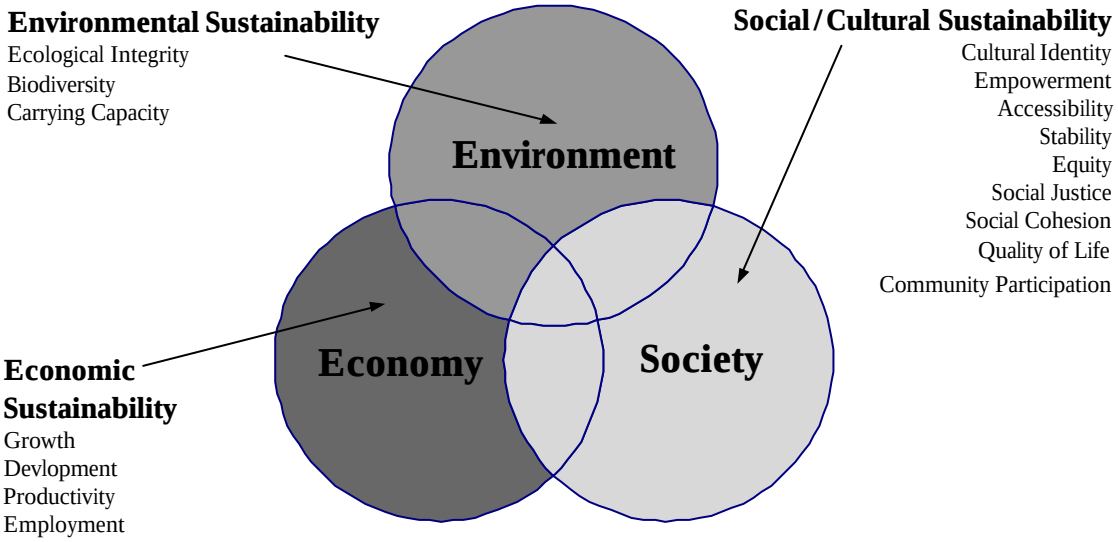
For many years the pursuit of economic, environmental and social goals have been in isolation from each other. The realisation has emerged that our long-term well-being depends as much on the promotion of a strong, vibrant society and the conservation of our environment, as it does on economic development.

At the heart of sustainability is the simple idea of providing a better life for everyone, now and for future generations. Although the idea appears simple, the task is far more substantial. It centres on meeting three objectives simultaneously, both in Western Australia and indeed around the world. These dimensions of sustainability are now commonly known as the triple bottom line – social, economic, and environmental – and the objectives are as follows:

1. **Social** progress that recognises and incorporates the needs of all, especially indigenous people and other disadvantaged groups – building a sustainable society and communities.
2. Effective protection, and where possible enhancement, of the **environment** to limit global environmental threats and prudent use of our natural resources to ensure they are not depleted, including the development of alternatives – building a sustainable environment with sustainable natural resources.
3. Maintenance of high and stable levels of **economic** growth and employment – building a sustainable economy.

Future development must consider these three dimensions and their objectives. In order to achieve sustainable development there is a need to integrate social, environmental and economic objectives in all policy-making and decision taking. A sustainable approach is a balanced approach.

Three Dimensions of Sustainability



4 The Built Environment

The built environment is that part of the natural environment that has been altered by humans with the introduction of man made structures. It is everything humanly created, modified, or constructed, arranged, or maintained that is developed to fulfil human purpose (to satisfy human needs, wants and values). It is developed to protect us from the overall environment, to mediate or change this environment for our comfort and well-being, with results that affect the environmental context.

"The built environment refers to the totality of all that humans have changed or rearranged within the natural environment." (Bartuska & Young, 1994, p. 7.)

The increased desire for people to achieve a more harmonious relationship between the built and natural environment is stimulating communities and local governments to explore new patterns for human settlement and to utilise the skills of artists and designers innovatively in this process. These issues have also pressured industry to aim for ecologically sustainable development and to deal with polluting waste products.

The characteristics of a sustainable built environment, along with the benefits that would ultimately accrue, are as follows:

- Cities/suburbs would be planned with input from the community and would be built around liveable centres linked by quality public transport, ultimately reducing reliance on motor vehicles (and hence reducing pollution/noise etc), and producing more opportunities for socialisation, greater social justice, less crime, improved quality of life, increased community participation, all leading to a strengthened sense of community and social cohesion, and
- Houses/commercial dwellings would be planned with community input and built on sustainability principles – analysis of location, analysis of actual need for the asset, alternative delivery strategies such as co-housing, and environmentally friendly principles such as solar based, ecological in design and interior health – all leading to the greater protection of the environment and reduced resource depletion, to ensure a workable, healthy future for generations to come.

Some key sustainability issues for the built environment are set out in the table[1] below:

Sustainability objective	**Theme**	**Specific Issue**
Economic	Competitiveness	• Efficiency, productivity and profitability of the industry • Employment
Environmental / Resource Use	Energy	• Energy efficiency • Use of renewables vs non-renewables
	Materials	• Efficiency of use • Use of renewables vs non-renewables • Embodied energy
	Water	• Efficiency of use

[1] Table borrowed from the following source: CRISP Sustainable Construction Theme Group, 1999 http://www.crisp-uk.org.uk/reports/isrt_fr.pdf

		• Pollution of surface and groundwater
	Land	• Use of brown-field vs green-field sites • Degradation / pollution
	Air	• Local air pollution
	Nature conservation	• Protection of wildlife habitats
Social	Building occupants	• Quality of built environment • Equity of access
	Employees	• Health and safety • Training and development
	Community	• Construction impacts (nuisance, noise etc) • Contribution to viable, safe and cohesive communities
	Wider Society	• Industry accountability

4.1 Buildings[2]

As society becomes more complex and technologically sophisticated, the concept of buildings seems relatively simple. Yet the environmental and social impacts of buildings are only partly realised and understood. Buildings define how resources flow from the environment and how people feel and perform, and therefore deliver a significant impact on their surrounding environments.

Buildings shape the lives of individuals. In Australia people spend a large amount of their life inside a building. Consequently, building design has a large impact on our lives and how we feel. Poor building design incurs high operating costs, including lower occupant productivity. Yet in Australia, design costs are seen as a burden on capital budgets. This is due to the fact that life cycle costs of buildings are not generally considered – the industry is based around short term cost decisions rather than long-term costs and affects. Design costs are minimal compared to life cycle costs, and operating costs are quite significant and should therefore be a major consideration of building design. Built asset life cycle issues are raised further throughout this paper.

Buildings are also an integral part of the wider general community. Planning and infrastructure impact on the life cycle, and economic and environmental performance of individual buildings. In Australia, large cities are spreading because of car use, causing high social, environmental and economical costs for new development.

Buildings mark a change in the relationship between humans and the environment. Unlike nomadic communities, which respond to the capacity of the surrounding environment, a settled community draws resources from beyond its immediate area. Consequently, nature does not impose an immediate limit on the resource use of settled communities. When presented with local environmental degradation, the settled community searches further afield for its resources. Modern production systems now extend throughout the world. The search for resources barely

[2] Please note this Section has borrowed from the following source: Environmental and Energy Services of the NSW DPWS, 1998, Page 4-7 http://www.industry.gov.au/industry/building/LCReport.pdf

enters the consciousness of building dwellers - resources are consumed unaware of the distant location and impact they carry.

4.1.1 The environmental impact of buildings

Not only are building products and activities a large part of the Australian economy, they also have a large impact on the environment. Over their life, from construction through to disposal, they consume large amounts of natural resources and energy and produce significant quantities of pollution. Therefore, the design and environmental performance of our buildings is a key factor in the health of our environment.

Buildings are a collection of products and services, which consequently contribute to problems such as habitat destruction, global warming, depletion of natural resources, ozone depletion, soil erosion and so on. The impacts extend beyond the local area of the building to the source of all the products and services provided to a building over its life-time. Therefore, we can clearly see that contemplation of the life cycle of a building is integral when considering sustainability of the built environment.

4.1.2 Sustainable Buildings

Sustainable buildings can be defined as those buildings that have minimum adverse impacts on the:

- built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting; and
- the humans who occupy them, in terms of comfort of the building, health and safety, accessibility, and other broader social issues.

Ideal sustainable buildings:

- Harvest all their own water and energy needs on site.
- Are adapted specifically to site and climate and evolve as conditions change.
- Operate pollution-free and generate no wastes that aren't useful for some other process in the building or immediate environment.
- Promote the health and well-being of all inhabitants, as a healthy ecosystem does.
- Are comprised of integrated systems that maximize efficiency and comfort.
- Improve the health and diversity of the local ecosystem rather than degrade it.
- Are beautiful and inspire us to dream.

4.2 Building and Construction Industry[3]

The building and construction industry provides the built environment within which the nation undertakes social and economic activities. The industry is defined as all who produce, develop, plan, design, build, alter, or maintain the built environment, and includes building materials manufacturers and suppliers as well as clients and end use occupiers.

The building industry is a major component of the Australian economy. Buildings also have a large impact on the environment and are responsible for approximately 30% of raw material use, 42% of energy use and 40% of air emissions (Environmental and Energy Services of the NSW DPWS, 1998, page 1, http://www.industry.gov.au/industry/building/LCReport.pdf). Therefore, the industry has a huge contribution to make to improving the quality of life; both directly by providing safe, secure buildings for people to live and work in, and by ensuring that the industry

[3] Please note this Section borrowed from the following sources: Environmental and Energy Services of the NSW DPWS, 1998, http://www.industry.gov.au/industry/building/LCReport.pdf; and Construction Best Practice Program, Sustainable Construction, http://www.cbpp.org.uk/cbpp/themes/suscon/intro_1.jsp

itself works in a sustainable way, husbanding resources, reducing pollution and waste and valuing its workforce.

The industry is central to the delivery of any Government sustainability policy or initiatives, in areas such as:

- Regeneration of housing, particularly to revitalize town centres (social/economic)
- Planning communities to reduce car use (social/environmental)
- Using energy and water more efficiently (economic/environmental)
- Minimising mineral extraction (economic/environmental)
- Protection of the countryside (environmental)
- Provision of training (social)

Through its activities, whether it is the provision of buildings, infrastructure development or contaminated land reclamation, the construction industry has a major role to play in the delivery of sustainability of the built environment. The industry must play an integral part in providing a better quality of life through its activities, whilst minimising impacts on the environment and local communities. By shifting its culture to embrace sustainable thinking at every level, the industry can save energy, reduce waste and pollution and cut the lifetime costs of property ownership.

The challenge facing the industry is to provide affordable, safe, functional buildings and communities whilst minimising the impact of their design, construction, renovation, re-use and demolition on the natural environment. Through more efficient use of limited resources, costs can be reduced while delivering better outcomes for builders and consumers. Therefore, there must be a concerted effort to work toward advancing more sustainable building design, construction and demolition/re-use.

4.3 Sustainable Construction[4]

The creation and responsible management of a healthy built environment must be based on sustainable construction principles. Sustainable construction is generally used to describe the application of sustainability or sustainable development to the construction industry.

Sustainable construction may be defined as building practices that strive for integral quality, including economic, social and environmental performance and issues. It is the set of processes by which a profitable and competitive industry delivers built assets (buildings, structures, supporting infrastructure and their immediate surroundings) which:

- enhance the quality of life and offer customer satisfaction;
- offer flexibility and the potential to cater for user changes in the future;
- provide and support desirable natural and social environments; and
- maximise the efficient use of resources,

leading to a healthy built environment. Clients and end use occupiers also have key roles to play in delivering sustainable construction.

Sustainable Construction = Minimising the negative and maximising the positive to achieve a balanced triple bottom line in terms of environmental performance, economic performance, and social performance.

[4] Please note this Section borrowed from the following source: Sustainability Action Group of the UK Government Construction Clients' Panel, 2000 http://www.property.gov.uk/services/construction/gccp/100700.pdf

A sustainable approach towards the construction process requires continual improvement in how environmental, financial and social issues are dealt with. As previously discussed, sustainability is increasingly being recognised as embracing not just long-term environmental viability but also economic and social issues. Issues of sustainability will therefore increasingly be 'market-driven' and a concerted effort will be required to change the embedded culture of building industry thinking to one which embraces sustainable thinking as an integral part of how the construction process is procured, designed, supplied, and maintained. Inherent within this change will be the need for sustainability to be more clearly 'valued' and supported by the financial community, clients and the public alike.

5 Relationship With Other Themes

The issue of built environment sustainability, and the State Sustainability Strategy emerging from Peter Newman's Sustainability Policy Unit, can clearly be linked with other significant State Government themes. There are clear synergies with themes such as the State Strategic Plan and the developing Building WA Strategy, which are outlined briefly below.

5.1 State Strategic Plan

Four key principles are emerging as Government Priorities in the State Strategic Plan, currently being developed by Department of the Premier and Cabinet. These priorities are briefly outlined below; their inherent relationship to sustainability can be clearly inferred.

5.1.1 Sense of Place

Promoting a sense of place, centred on environmental and regional sensitivity.

5.1.2 Community Building

Community building in WA, concerned primarily with social justice and inclusiveness.

5.1.3 Resilience

Concerned with the resilience of the State of WA with a focus on sustainability and long term synergistic planning.

5.1.4 Wealth Creation

Creating wealth in the State of WA, concentrating on innovation and economic diversity.

5.2 Building WA Strategy

More specifically related to the built environment is the Building WA Strategy currently being developed by DHW Works. The strategy will establish a framework for the Government's works and construction policies and initiatives. The framework identifies four key objectives for the WA built environment, based around a number of themes.

5.2.1 Quality Built Environment

Provision of a quality built environment in WA, both aesthetically and functionally, while focusing on environmental, social and economic sustainability.

5.2.2 Vibrant Industry

Focus on developing and sustaining a vibrant and healthy building and construction industry.

5.2.3 Regulatory Protection and Enablement

Providing a regulatory environment consisting of both regulatory protection (for environment, industry, consumers) and enabling regulation.

5.2.4 Best Practice Works Procurement

Ensuring the delivery of Government works procurement in line with best practice through the provision of frameworks, standards, systems and guidelines.

6 Targeting Effort

6.1 Sectors / Components of the Built Environment

The WA built environment incorporates a number of individual sectors and components in which Industry and Government operate. For the purposes of this paper the following sectors have been identified:

9. Built Form – All Public and Private Assets: the holistic view of the built environment incorporates all public and private sector built assets. Within this complete built environment picture are the following sectors;
10. Built Form – All Public Assets: this segment of the built environment consists of all public sector built assets, incorporating Commonwealth and Local. Contained within this sector of the built environment is the following;
11. Built Form – State Government Public Assets: this segment incorporates all State Government built assets.

Cutting across these public and private sectors are a number of differing components that make up the built environment. For the purpose of this paper, the built environment is considered as comprising three separate components:

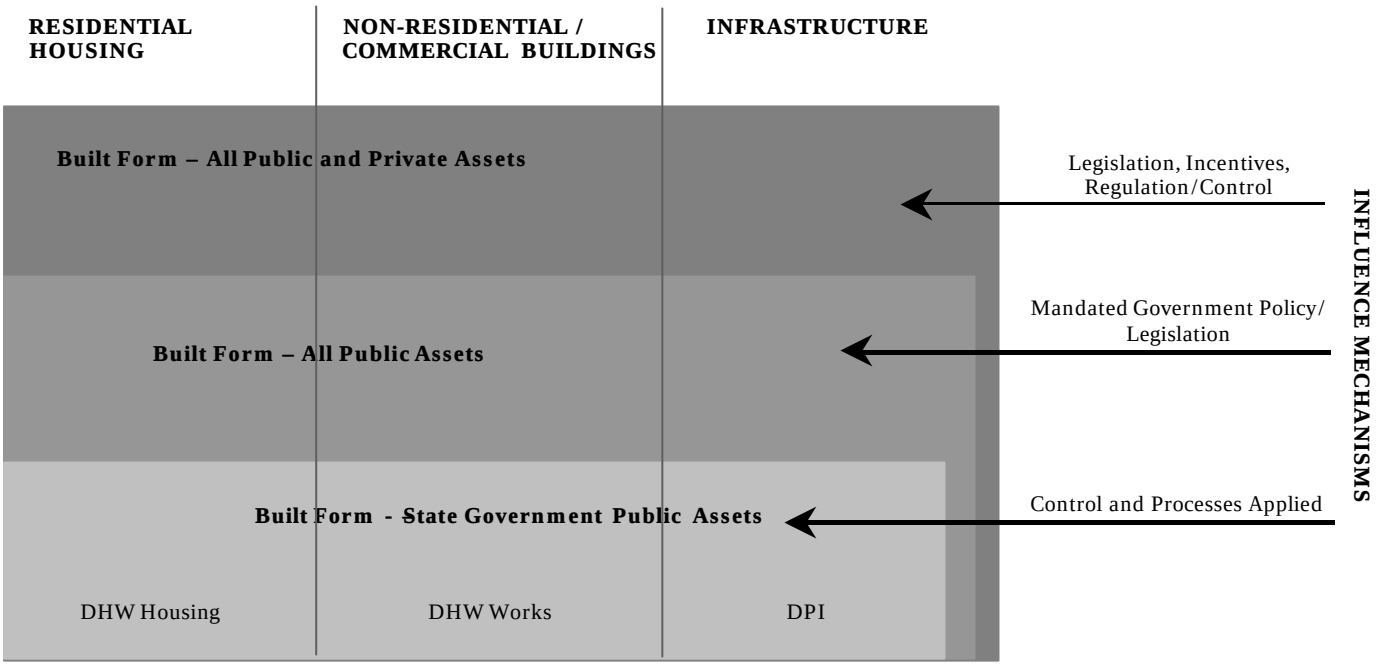
1. Residential Housing
2. Non-Residential/Commercial Buildings
3. Infrastructure

There are a number of mechanisms that may be utilised to influence and encourage sustainability within the various sectors of the built environment:

1. Built Form – All Public and Private Assets: Legislation, Incentives, Regulation
2. Built Form – All Public Assets: Mandated Government Policy/Legislation
3. Built Form – State Government Public Assets: Control and Processes applied through the relevant State Government Departments.

These sectors, components and influence mechanisms are illustrated in the diagram below. DHW Works fits within the State Government public assets sector, in the non-residential/commercial buildings component of the built environment, with DHW Housing residing in the residential housing component. Departments such as the Department of Planning and Infrastructure (DPI) reside within the infrastructure component of the State Government public assets sector of the built environment.

The WA Built Environment



Effective change in the built environment is best achieved by targeting the appropriate mechanisms at the particular sector where change is required. Any single change objective may require use of a number of the mechanisms to achieve across the board success.

6.2 Built Asset Life Cycle[5]

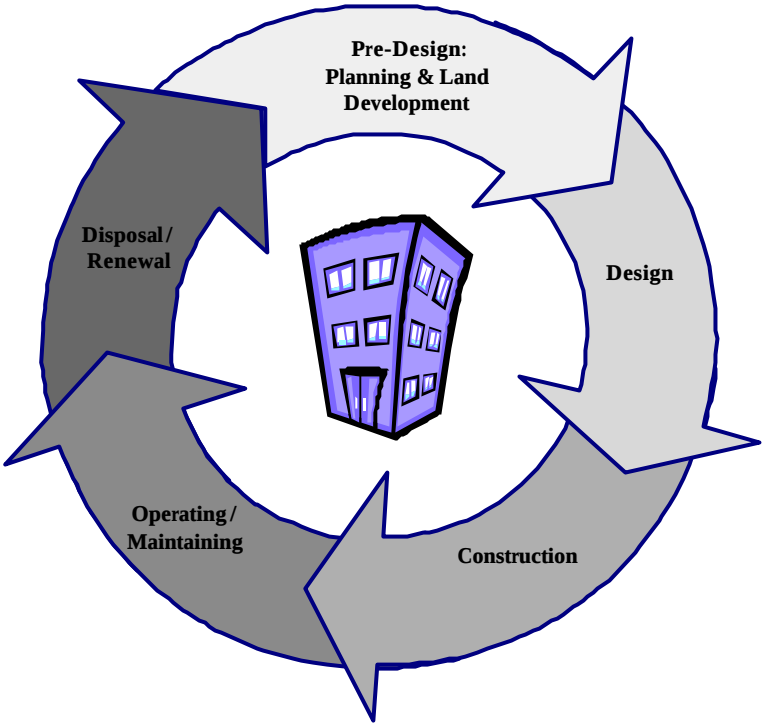
Sustainable building involves considering the entire life cycle of buildings, taking environmental quality, functional quality and future values into account. In the past, quality issues have hardly played a significant role. However, in strict quantity terms, the building and housing market is now saturated in most countries, and the demand for quality is growing in importance. Whole life thinking needs to prevail from design and throughout manufacture, to build, operation, maintenance and disposal of facilities.

Efforts to achieve sustainability should be focused on the various stages of the built asset life cylce. The environmental, social, and economic impact of an activity is fully realized when the life cycle is considered. Each part of the building process, or the built asset life cycle, has different impacts on the environment and therefore provides different opportunities to develop appropriate sustainability responses. Using a life cycle perspective, these impacts can be measured and used to design individual buildings.

The built asset life cycle is from "cradle to grave". Issues for the non-residential/commercial works industry fall under five different areas, which represent the life of a built asset. These include the pre-design aspects of planning and land development, design aspects such as raw material extraction and building product manufacturing, the actual construction of the building, operation and maintenance, and renewal or disposal at the end of the buildings life.

[5] Please note this Section has borrowed from the following source: Building Energy Efficiency Research (BEER), Sustainable Construction, 2002 http://www1.arch.hku.hk/research/BEER/sustain.htm#2.1

Built Asset Lifecycle



6.2.1 Pre-design / Planning / Land development

Issues:

- Appropriate uses of land,
- Alternative uses of land,
- Sharing of land,
- Reducing environmental impact – on surrounding areas, and in choice of location,
- Increase community involvement,
- Plan for social cohesion and equity,
- Cultural aspects – aboriginal heritage etc.

6.2.2 Design

Issues:

- Green design principles,
- Decrease energy consumption – passive solar designs etc.,
- Accessibility,
- Quality of life aspects,
- Decrease environmental impact of materials used.

6.2.3 Construction

Issues:

- Decrease environmental impact of construction materials and machinery used,
- Control of annoyance to surrounding community (noise, pollution etc),
- Site clean up,
- Waste management and control of site waste.

6.2.4 Operating / Maintaining

Issues:

- Improve renovation and repair methods and practices,
- Data concerning operation and maintenance costs, and better asset management, will play an important part in ensuring the sustainability of existing facilities,
- Invest more in repair, maintenance, renovation and refurbishment of existing facilities to extend the life of the built asset, and therefore produce notable overall savings by reducing the need for building new assets.

6.2.5 Disposal / Renewal (including cultural heritage value)

Issues:

- Consider all available options for disposal
- Recycle materials upon demolition of asset,
- Consider all deconstruction issues,
- Re-use of asset,
- Renewal of facilities,
- Consider any heritage and cultural issues and act accordingly

Future development undertaken in a sustainable manner represents new ways of thinking in planning, designing, building, operating, and maintaining the built environment. It should be noted that many of the issues that may arise later in the life cycle of a built asset are best-considered and catered for during the initial development and planning phases. These early phases offer the most effective opportunity to influence the overall sustainability of future built assets. Although some of our existing built assets may not have been designed with sustainability in mind, significant benefits can still be achieved by applying sustainable practices during each remaining phase of the assets life.

7 Specific Priorities

This paper has so far identified the dimensions and objectives of sustainability in general and the characteristics of a sustainable built environment, setting out the key sustainability issues and exploring the elements of an ideal sustainable building and the theory of sustainable construction. The sectors and components of the WA built environment have been recognised along with the appropriate mechanisms for influencing sustainability through the various sectors. The importance of considering the life cycle of a built asset has also been explored, with future development and sustainability progress seen as representing new ways of thinking throughout the stages of a built assets life.

It is recognised that the identification of specific key priorities is required to focus our efforts in the pursuit of a sustainable built environment. As DHW Works is only one player within the built environment, this paper does not attempt to set priorities for a sustainable built environment. It is necessary to obtain assimilation of thoughts, research efforts and knowledge from all stakeholders in the built environment to be able to set these specific priorities. At the State Government level, this would involve the integration of all State Government Departments operating within the built environment.

However, the Building WA Strategy discussed in Section 3 has identified four high level key objectives for the WA built environment, based on the emerging priorities of the State Strategic Plan. Whilst these are not all directly focussed on sustainability, elements of sustainability arise under each. These four priorities are:

1. Quality Built Environment
2. Vibrant Industry
3. Regulatory Protection and Enablement
4. Best Practice Works Procurement

These four broad objectives could be integrated with more specific sustainability priorities for the built environment. It must be stressed that DHW Works has not yet given exceptionally deep consideration to these issues and are only providing preliminary thoughts at this stage of the State Sustainability Strategy process.

Again, there is a need to develop these priorities in consultation with all involved in the WA built environment, but some suggestions of suitable priorities (in no particular order of importance) are provided below under each of the three sustainability objectives.

7.1 Environmental

7.1.1 Priority 1: Improved Energy Efficiency and Use of Renewable Energy Resources

- Orientation – properly sited buildings will benefit from solar heat, natural shading, and natural lighting and thus reduce energy requirements.
- Building Envelope – houses/buildings that are airtight and well-insulated consume less energy.
- Building Systems – select the most energy efficient equipment possible. The energy cost savings will more than outweigh the possible higher initial cost.

7.1.2 Priority 2: Reduced Overall Environmental Impact

- Preserving Integrity of Site – evaluate the site and determine how the building could best blend in with the natural environment.
- Landscaping – incorporate green landscaping for low water and maintenance requirements. Proper landscaping can also help reduce heating and air-conditioning energy consumption and water consumption.
- Materials Selection – consider each material with respect to its impact on the environment by selecting local materials and materials that have less impact on the environment.

7.1.3 Priority 3: Increased Resource Conservation

- Recycled Content Materials – selecting materials that have at least some recycled content
- Minimisation of Construction Waste – recycling construction related waste where possible. Waste can also be reduced by salvaging rather than landfilling.
- Use of Alternative Building Materials – utilising technologies that allow for more efficient use of resources.
- Materials Re-use – salvaging certain products when buildings are demolished or rehabilitated.
- Water Conservation – installing energy efficient appliances and fixtures and changing irrigation practices and behaviour can reduce water consumption.

7.1.4 Priority 4: Enhanced Indoor Air Quality

- Reduced Chemical Content of Products – reduce risk of indoor air pollution by buying natural products wherever possible, or those that are low in chemicals.
- Adequate Fresh Air Supply – mechanical ventilation systems for providing fresh air.

7.2 Economic

7.2.1 Priority 5: Increased Efficiency / Productivity of Construction Process

- Process and Team Integration – improving links between planning, design and construction to reduce waste and facilitating use of sustainable materials through a sharing of knowledge and skills.
- Product Development – new technologies etc.
- Improved Customer Focus
- Quality Management Systems
- Training – increase job knowledge and efficiency.

7.2.2 Priority 6: Better Working Conditions for Employees and Contractors

- On-site facilities,
- Health and Safety Measures,
- Use of Local Employment, and
- Training,

to ultimately retain workers through increased safety, job satisfaction and social interaction.

7.2.3 Priority 7: Improved Business Relations

- Long-term Partnerships
- Non-confrontational Contracting
- Codes of Conduct
- Quality Assurance / Environmental Standards

7.3 Social

7.3.1 Priority 8: Increased Consideration of Community Issues

- Siting Buildings – situating buildings, where possible, near public transportation and other amenities such as shopping centres, medical centres and recreational facilities.
- Pedestrian Friendly – sites that are pedestrian friendly encourage walking and cycling, reducing the need for automobiles.
- Historical and Cultural Preservation – preserve the historical and cultural aspects of the community with designs that blend in to the natural feeling and aesthetics of a community.

7.3.2 Priority 9: Contribution to Safe, Viable and Cohesive Communities

- Co-housing – encourage co-housing facilities as a resource efficient housing option with a strong sense of community offering social, economic and environmental benefits.
- Providing for community diversity through a mix of housing
- Accessibility – ensuring ease of access to public buildings i.e. disability access
- Measures to improve quality of built environment, both functionally (healthy and safe buildings) and aesthetically (public art and renewal programs).

7.3.3 Priority 10: Increased Responsiveness to Customers, End Users and Other Stakeholders

- Involvement of communities and end users in project planning design.
- Consultation with other stakeholders affected by development/construction
- Environmental reporting

8 Barriers

It is possible to identify several broad areas of the non-residential/commercial building sector that may present barriers to a more proactive approach to sustainability in the built environment:

8.1 Industry Culture

- **Historical divisions** between the trades involved in the construction process and the wide range of actors involved in the realisation of both development and public construction projects;
- **Historical characteristics** of the industry (e.g. conservatism), which mitigate innovation of sustainable practices.
- **Industry drivers** provide an effective barrier to more sustainable practices in the built environment. The building industry (both government and private) is driven by short-term economic goals, which prevents life cycle economic, social and environmental savings and benefits. Currently capital costs dominate building economic costing, but represent approximately two percent of the building costs over a 30 year time period. Operations and maintenance costs equal six percent and personnel costs equal 92 percent.
- **Financial pressures and professional attitudes** toward sustainable building are the root cause of barriers to life cycle initiatives and sustainable practices in the building industry. All sectors of the building industry are affected including development, design, building products, construction, use and maintenance, retrofitting and waste management in both the government and private sector.

8.2 Economic

- **Underdeveloped market** for sustainable products and initiatives prevents the wider use of these products in non-residential/commercial construction projects.
- **Perceived investment risks:** Sustainable buildings are often branded alongside 'Green' buildings by investors. The image is of natural materials, green roofs, radical passive design, and technological gizmos. They are seen as a potentially short-term fashion trend with a narrow market place appeal that runs counter to longer-term investment strategies. Such buildings clearly do not appeal to long-term investment planners.
- **Perceived capital costs:** It is a commonly held belief that more sustainable buildings cost significantly more in terms of their capital cost. This belief is not well founded and is based on experience with 'bolt-on' sustainable design solutions. It does also reflect a wariness of the unknown amongst building and construction professionals in general and Quantity Surveyors in particular.
- **Building cost decisions** are based on short-term capital expenditure rather than life cycle costs, which tends to give the impression that the inclusion of sustainable initiatives is more costly.
- The **tenant/owner financial relationship** inhibits the reduction of recurring costs: building capital is an investment by the owner but the burden of recurring expenses is shifted to the tenant. For existing buildings, the owner is unlikely to invest money for capital that gives returns to the tenant. Similarly, the tenant is unlikely to invest in reducing recurring expenses if the investment becomes part of the owner's capital.

8.3 Educational / Awareness

- A **general lack of awareness of all the issues** surrounding sustainability and a sustainable built environment: There exists a marked lack of understanding and awareness amongst industry, government and the general community in relation to sustainability – if all stakeholders had attained full awareness of the issues, there would be a much speedier transition to a more sustainable built environment with the uptake of new technologies and design processes.
- The **architect's attitude** and the **client's commitment** to sustainable design: the commitment of clients to sustainability depends upon the financial viability and occupant comfort of buildings. This relates to the level of awareness among clients and Architects/designers of the benefits of sustainable practices. Although the Australian public has a high level of environmental concern generally, it appears unlikely that these concerns will translate into sustainable buildings without market incentives and the promotion of sustainable practices through education and awareness campaigns.
- **Lack of information** resources and design assistance for environmental and economic life cycle information: There is a lack of environmental and economic life cycle design tools and information in Australia. It is critical that architects and designers can demonstrate to clients that sustainable design is cost effective.

8.4 Institutional / Process

- Relatively **short occupation periods** for which developers/contractors occupy a site, making management of local environmental impacts a lower priority;
- **Design teams are traditionally segmented** according to their skills: the design process rarely has an interdisciplinary team or thorough input from all the stakeholders. One or two architects make the key design decisions that form the framework for the work by other designers.
- **Separate capital and recurrent budgets**: Separate budgets for capital and recurrent costs are reflected in the design and construction process of government buildings. The **types of contracts** used illustrate the emphasis on reducing capital costs without regard for life costs.
- The **approach to asset management** restricts life cycle concepts: Total Asset Management (TAM) is supported by all levels of government in Australia and potentially restricts the full consideration of life cycle costs.
- **Procurement of materials** does not advocate environmental life cycle issues: the Australian government spends billions of dollars annually on the procurement of goods and services. However, the evaluation process for government tenders does not include a system for assessing life cycle economic, social or environmental issues.

9 Mainstreaming Sustainability: Facilitating Change

It is possible to identify a number of areas that represent the key to bringing about change and facilitating a more sustainable built environment. Issues of sustainability and whole life cycle principles will increasingly be 'market-driven'. A concerted effort will be required to change the embedded culture of all stakeholders involved in building and construction projects to one which embraces sustainability at every level. Sustainability must be more clearly 'valued' and supported by the industry, community, and clients alike.

9.1 Market Demand: Client / Investors / Community

Community, clients and investors – creating market demand for sustainable practices:

- Generate a change in client mindset – deeply ingrained attitudes and social conscience working against sustainable practices. Well-informed and clearly motivated clients are required, who place emphasis on community development and the expression of cultural identity.
- Generate a change in mindset of investors and industry players – deeply ingrained attitudes and lack of awareness of sustainable practices and initiatives is working against sustainability in the built environment. Investors and industry players who are fully informed and aware of the opportunities that exist, and the practicalities surrounding them, are a necessity.
- Generate general community desire to attain a sustainable built environment to generate demand for appropriate technologies etc, and further encourage Government (through political pressure) to take a leading role in these initiatives. An active community is required, with a concerned commitment to improving the quality of their built environment.

9.2 Affordability / Delivery: Industry

Industry (Building and Construction Industry) – achieving and delivering affordable sustainable practices:

- Advancing new sustainable technologies – the lack of advancement of new sustainable technologies is hindering the widespread implementation of sustainable initiatives. The advancement of sustainable technologies will in turn lead to the achievement of affordability. Professionals promoting and advancing sustainable technologies are a necessity within industry.
- Adopting new initiatives and technologies in sustainability – lack of demand has led to a lack of adoption of new initiatives and technologies. Generation of demand (the first key area of change) will encourage the widespread adoption of sustainability initiatives and technologies, which in turn will lead to more affordable sustainable practices. Industry players are required to adopt new initiatives and technologies.
- Adopting Best Practice procedures with a focus on the triple bottom line of sustainability – economic, social, environmental impacts. The development of new forms of design practice is required involving collaboration amongst design, arts, environmental, landscape, planning and other such professionals, and consultation with the community, for the advancement of the quality of the built environment while recognising the increasing importance of ecological sustainability.
- Adoption of more environmentally responsible construction processes– waste, clean up, pollution etc. During the construction process the adoption of more environmentally sound

practices are required to reduce the impact of construction on the surrounding natural environment, construction workers, and the inhabitants of the general community.

9.3 Regulation / Facilitation: Government

Government – providing a regulatory environment and acting as the driver and facilitator of sustainable practices:

- Promote general awareness of importance of sustainability – Government must take the lead in raising awareness of the general public and the community at large to generate demand, leading to affordable sustainable practices and widespread adoption.
- Offer incentives to business and community for adopting sustainable practices and technolgies – Government is in a position to offer incentives to business and the general community through programs and initiatives. This again will generate a higher level of demand, reducing costs and increasing delivery of sustainable practices.
- Legislation, regulation and policy implementation – Government is in the position to regulate industry and implement mandatory legislation and policy to encourage more sustainable practices in the built environment. Accordingly, policies that contribute to the sustainability of building practices should be implemented, with recognition of the importance of existing market conditions. Both the environmental initiatives of the construction sector and the demands of users are key factors in the market. Governments will be able to give a considerable impulse to sustainable buildings by encouraging these developments.
- Best Practice promotion – the promotion of best practice techniques in procurement of building services for a sustainable outcome is an important function of Government in working toward a sustainable built environment.
- Lead by example – Government is in prime position to lead by example in sustainability initiatives through pilot projects, showcase studies, further research and development, and adoption of sustainable principles and thinking throughout its planning and procurement of building services. Agencies need to adopt sustainability as part of their mindset when planning for new assets or disposal / renewal of assets.
- Education – education plays an integral part in facilitating change toward more sustainable building practices. Many areas of education already include sustainable ideals and it is important for these to continue so tomorrow's generation will hold sustainable principles in high priority.

10 Research and Development Requirements

Research and development efforts should centre on identifying ways of overcoming the recognised barriers to a sustainable built environment, through coordinated research and development programs. Research and development efforts should be coordinated and linked between all parties working within the built environment to ensure no double up of research efforts, whilst enabling the sharing of vital information and developments.

Currently a substantial amount of research is being undertaken all around the nation and globe relating to sustainability and the built environment, and more specifically, sustainable construction. For some examples of existing research efforts see Appendix 1.

These research efforts represent only a small portion of the research activities currently underway in Australia and overseas. A method of integrating these research efforts and widely disseminating results and findings, would ultimately be for the benefit of all. In order to overcome identified barriers and drive sustainability in the built environment a mixture of new research, and more effective dissemination of existing research, is required. Research efforts need to be interdisciplinary and collaborative with end users.

In addition to coordinating and integrating existing research efforts, Western Australia should be conducting its own research and development programs focused on sustainability in the built environment. Research and development requirements in WA should concentrate on:

- **Improvements in environmental quality:** there is a need to provide convincing evidence of the business benefits of environmental good practice and to disseminate this, and the tools to implement it, throughout the industry and the wider community. This could include such things as:
  - an explanation of 'What is' sustainable construction/built environment,
  - information on who is taking effective action,
  - information on all technologies and initiatives currently available for sustainable design, management, buildings and construction practices,
  - information to convince those who doubt the benefits (business or other) of sustainable buildings and construction,
  - effective communication of best practice and research outputs,
  - how to assist small to medium businesses in the move towards sustainable construction.
- **Sustainable building and construction industry:** there is a need to transform the market into one which is receptive to sustainable buildings, where sustainable materials are appropriately certified, and where the right price signals exist. This involves:
  - the provision of information and tools for the practical application of whole life cycle costing,
  - information on available technologies and initiatives for sustainable design and construction practices.
- **Delivering a sustainable built environment, contributing towards sustainable communities:** research is required to examine the interaction between the construction side of the industry and other industry players and stakeholders (e.g. those involved in planning, land development, transport, safety, health) and regulatory structures (e.g. planning and building control regulations, Government).

- To ultimately decide how the building and construction industry will change methods of external and internal communication to improve sustainable performance throughout the whole built environment.

In relation to **building performance and construction** in particular, research should be undertaken into the following:

- the environmental performance of buildings and other permanent structures;
- factors relevant to the health, safety and comfort of human occupants and users of buildings and other permanent structures;
- the efficiency of energy use of buildings and other permanent structures;
- the performance and durability of materials used in construction;
- the efficiency and methodology of the construction process;
- the application of information technology to aspects and techniques of building.

Again, it should be noted that these are preliminary thoughts only and DHW Works require more time and resources to provide a more thorough and well thought out list of R&D requirements for a sustainable built environment. Critically though, more sufficient attention must be paid to the communication of research or innovation findings. This is to allow construction practitioners to make pragmatic business decisions that reflect the current best practice understanding of how the industry can contribute to sustainable development.

11 Options for Action

In Australia the rate of adoption of environmental building design and other sustainability initiatives has been relatively slow. Government programs can reverse this trend by addressing the various barriers and acting accordingly.

DHW Works is the "best practice" centre of expertise for capital works procurement and issues surrounding the non-residential/commercial sector of the built environment, and are a facilitator between Government and the Building and Construction Industry. This places DHW in an ideal position to ultimately play a regulator or facilitator role for encouraging sustainability in the Western Australian non-residential/commercial sector of the built environment.

Options for Government to encourage and promote a more sustainable approach to the built environment should centre on overcoming the identified barriers through focussing on the key areas for facilitating change (Regulation/Facilitation – Government; Affordability/Delivery – industry; Market Demand – client/community/investors). This section identifies options for sustainability action that will help address identified barriers and facilitate the mainstreaming of sustainability initiatives in the built environment. Again it must be stressed that these initiatives and suggestions are only the preliminary thinking of DHW Works and require more contemplation and development.

These options for action could include:

1. **Regulation/Facilitation – Government**:

Mandatory minimum sustainability requirements for Government projects, including incentives for a higher sustainable performance.

2. **Affordability/Delivery – Industry**:

Fiscal incentive schemes for sustainable performance – e.g. tax deductions, government fees reductions, consumer rebates, tender price preferences, and funding incentives for Government Agencies.

3. **Market Demand – Client/Community/Investors**:

Educational and Awareness Programs.

4. **Other General Strategies**:

Programs to improve existing built facilities; forming alliances and partnerships; the development of a built environment research unit for further research and development.

11.1 Sustainable Asset Management Lifecycle Strategies

A more sustainable methodology for asset management involves taking an integrated approach to develop projects and policies that will facilitate beneficial social, economic and environmental outcomes in both the short and longer term. A framework for achieving sustainable outcomes in the asset management process should be developed by linking Strategic Asset Management (Treasury's SAM process currently in place in WA Government agencies) principles with sustainability principles.

Strategies for sustainable asset management can include:

- consult stakeholders effectively in the planning phase to consider sustainable approaches;
- provide equitable access across communities, cultures and regions;

- protect and enhance heritage features, as well as key flora and fauna habitats and movement corridors;
- integrate service delivery and infrastructure to increase reliance on public transport;
- plan, procure, and provide for sustainable materials and objectives throughout the life cycle of a built asset

Implementing Sustainable Asset Management could be undertaken along the same lines of Queensland Department of Public Works Ecologically Sustainable Asset Management (ESAM) framework. This framework should encourage asset planners and managers to adopt strategies at the most appropriate phase of the asset life cycle to ensure best return for effort.

Key goals to plan and aim for in each phase can be assessed and planned for objectively, transparently and systematically, using the approach shown in the tables at Appendix 2.

11.2 Capital Works Project Approval and Funding Process

To support the framework of ecologically sustainable asset management, the Queensland Department of Public Works' Building Division has also developed a decision-making and planning tool called the ESAM five-star rating system that measures whether organisations, building projects/facilities and suppliers plan and operate in an economically, socially and environmentally responsible way (Queensland Department of Public Works, http://www.publicworks.qld.gov.au/07_showcase/content_showcase_essam.htm). DHW suggests a similar approach for Western Australia based around a new capital works project approval and funding process, incorporating a works project sustainability rating system.

A rating system could be used to guide and encourage agencies toward achieving sustainability performance (incorporating sustainability principles) for their works projects. Funding and approval would be linked to obtaining a sustainability "tick" in the project approval process for meeting economic, social and environmental sustainability objectives. An agency would obtain a "star" for each sustainability initiative incorporated within the works project, and a certain number of stars would be required to obtain the sustainability "tick" for the particular project. Treasury could then extend incentives, such as further funding or some other financial incentive, for the project if an agency takes sustainability initiatives a step further (i.e. obtains **over** a certain number of sustainability "stars").

Funding incentives would certainly prove to have the most affect in relation to encouraging sustainability initiatives in works projects, as most agencies struggle to obtain the level of funding required for some capital works projects (considering a chunk of that funding must go toward DHW Works project management fees etc).

A diagrammatic example of the proposed star rating project and funding approval system can be seen at Appendix 3. Social, economic and environmental sustainability objectives would be listed, with agencies obtaining a star for each objective considered within their particular project.

This initiative is currently in conceptual stage and would require further research and development if it were to be adopted.

11.3 Fiscal Incentive Schemes

Fiscal incentive schemes are a major key to overcoming cost barriers and delivering affordable sustainability initiatives in the built environment. Incentives will always work best if they are of a financial nature – in business, whether public or private, financial concerns are paramount.

11.3.1 Incentive Schemes for Business / Private Sector

Price preferences could be offered to private sector practices that incorporate or consider sustainability. Price preferences along the same lines as Buy Local Policy preferences, could be incorporated in government tendering processes to encourage contractors / consultants to incorporate built environment sustainability principles in their tender submissions and subsequent design and construction work on behalf of Government.

Price preferences could be extended to those organisations that offer environmental, social, and economic sustainability principles in their tender for the particular project. This will ultimately encourage those wishing to win tenders for Government public works to think seriously about, and to start implementing, sustainability principles into their every day work practices.

11.3.2 Incentive Schemes for Government Agencies / Public Sector

Financial incentives could be offered to those agencies with major capital works programs (such as DHW Works major clients – Education, Health, and Justice). Treasury could offer higher funding incentives for those agencies who incorporate sustainability objectives in their capital works project planning, to further encourage the push toward a more sustainable built environment. This initiative is linked to the Capital Works Projects Approval and Funding Process option discussed previously.

11.4 Educational and Awareness Programs

Education and awareness programs are integral to educating the youth (as tomorrows decision makers), investors, and the general public on the importance of sustainability, to mainstream sustainable thinking into the community and create market demand. Education and awareness programs should include Architecture and Design principles that support sustainability to ensure tomorrows decision makers are fully aware of sustainability principles, and requirements in design, for built assets and infrastructure.

11.4.1 Education Centre for the Built Environment

An education centre for the built environment could be established to promote built environment initiatives and sustainability concerns.

In 1988 Europe introduced CUBE – Centre for the Urban Built Environment. CUBE is committed to the investigation, discussion and advancement of design quality within the built environment. The centre is aligned with Government and is cited as an integral player in the delivery of high quality urban design. CUBE is dedicated to broadcasting the ideas and issues that lie behind the buildings, spaces and environments that make up the built environment. The centre also provides education on the built environment, aiming to enrich the learning process of children as tomorrows decision makers for the built environment, and undertakes a program of challenging exhibitions, educational activities, publications and events. (http://www.cube.org.uk/)

11.4.2 Promote Sustainable Buildings and Infrastructure

If sustainability is to be integrated in every level of business and community within the built environment, Government must take the lead in promoting sustainable buildings and infrastructure to act as a leader / facilitator of sustainable initiatives. Promotion would involve Government taking the lead in non-residential building projects by undertaking showcase projects to promote sustainability initiatives in the built environment. This would ultimately accelerate the widespread introduction of new technologies, “intelligent” products, standardised pre-assembled components and advanced materials into every level

of the built environment. This in turn will create new business opportunities, improve living and working environments and enable information feedback to improve overall construction quality.

11.4.3 Promote the Business Benefits of Sustainable Construction

Environmental design provides economic returns that need to be widely conveyed to increase general awareness. The business benefits of sustainability must be highlighted and brought to the attention of the building and construction industry and the community at large. The economic returns of sustainable design and construction must be conveyed to provide greater likelihood of widespread adoption of such practices.

Many research papers have been prepared on the business benefits of sustainable construction, the conclusions of which need to be communicated to all players in the building and construction industry. Examples of such research papers are examined at Appendix 4.

Reports such as these should be widely distributed to ensure awareness of all benefits relating to the incorporation of sustainable initiatives in building projects. This will help increase demand for sustainable initiatives, drive costs down and lead to a far more sustainable built environment.

11.5 Rebuild Public Service Expertise

Traditionally the public sector was responsible for setting and maintaining standards for design quality, training and apprenticeships, guidance and long-term strategic directions for the building and construction industry. With the push toward outsourcing and contracting practices, the public service lost control of many of these once core functions. The current WA State Government has recognised that a major core function of Government in general is to provide where the market fails. Throughout this paper we have seen that currently the market is failing to provide for sustainability in the built environment – it does not currently provide for future generations and intergenerational equity.

If the WA State Government is serious in driving sustainability initiatives in the built environment, a rebuilding of public sector expertise could facilitate this process. Currently DHW operate with no professional design staff (Architects, Engineers etc) to ensure sustainability is of a high priority in public works design and construction. Therefore, working directly toward sustainability in the built environment is difficult without a policy or legislative directive aimed at the consultants and contractors we engage, or the Government agencies that make up our client base.

DHW Works recommends the rebuilding of expertise in the relevant public sector departments to oversee the works design and construction processes to ensure sustainability principles are adhered to and implemented in all public works projects. Employing State Architects, Designers, Engineers etc. to oversee and coordinate design would ensure alignment with sustainability principles – professionals such as these already exist in our organisation and could be further developed and educated to be utilised for such a role.

11.6 Built Environment Sustainability Research and Policy Unit

As part of rebuilding public service expertise, DHW Works recommends the development of a Built Environment Sustainability Research and Policy Unit, consisting of representatives from all State Government Departments operating within the built environment. These departments would include all those under the Minister for Works portfolio to enable the coordination and

integration of policy efforts in respect of the built environment and to ensure no double up of efforts in the area and a sharing of knowledge and sustainability initiatives.

Alternatively, individual research units could be established for each State Government department operating within the built environment. However with so much overlapping of issues between the different expert agencies and areas that comprise the built environment, some cohesion is required to formulate workable policy and initiatives embracing all areas.

Such a research and policy unit would undertake extensive research and scanning of the built environment to investigate initiatives that will facilitate the most improvements for economic, environmental and social/cultural sustainability in Western Australia. Extensive research is required to determine the type of initiatives required to achieve a higher level of sustainability through the built environment. Policy, legislation, government incentive schemes, or the most appropriate delivery strategies for increasing sustainability in the built environment could be researched and assessed, along with initiatives being utilised in other States and countries (including their results).

Research papers on available initiatives, new technologies, business benefits of sustainability, government offered incentives for sustainable practice, etc. could be published through this unit to enable widespread dissemination of sustainability information. This would help facilitate the mainstreaming of sustainability thinking into the wider community and every day business and working environments, ultimately increasing demand, driving costs down and developing a more sustainable built environment.

The unit could also be utilised to demonstrate new building technologies, products and practices through showcasing specific government sustainability building projects. Demonstration and evaluation of sustainable products in government building projects will eventually lead to greater adoption of these initiatives throughout the built environment.

A sustainability policy and research unit could certainly be utilised within DHW Works to "sell" or promote sustainability initiatives to the Government agencies that make up our client base. As a centre of excellence in capital works procurement DHW Works could implement a sustainability area whose function is to research and encourage the implementation of sustainability initiatives in capital works projects. This may involve canvassing our main clients (Justice, Education, Health) and providing advice on appropriate sustainability initiatives for their capital works projects.

Various similar research units developed in other states and nations support the establishment of such a built environment sustainability unit in Western Australia and are examined at Appendix 5.

11.7 Improve Existing Built Facilities

The improvement of existing built facilities will aid the progress toward a more sustainable built environment. Improvement of existing built facilities could be undertaken in two ways:

1. Renewal programs aimed at refurbishing and repairing existing facilities in the built environment; and
2. Improvement of renovation and repair methods and practices.

Programs aimed at renewing the existing built environment could be initiated to increase sustainability. Investing more in repair, maintenance and refurbishment extends the overall life of a built asset, substantially diminishing the requirement for building new assets. A large degree of the existing built environment was not designed to be inclusive, so there are somewhat limited

facilities for the elderly and disabled. This obsolescence in existing buildings and structures could be overcome by technical fixes or re-use. The majority of existing built assets were also not designed with sustainable principles in mind but, as we have seen from the built asset life cycle analysis, significant benefits can be achieved by applying sustainable practices during each remaining phase of the assets life.

DHW Housing has been actively involved in north of Perth urban renewal programs to increase the aesthetic aspects of residential property in certain northern suburbs to increase the ultimate value of those suburbs in general. Similar programs as this, aimed at the non-residential/commercial sector of built environment, could also be undertaken for improvements to hospitals, schools, and other public buildings and assets.

With a large amount of construction output consisting of repairs and maintenance to existing built facilities there is a need to find new ways to exploit its potential and value through lateral thinking about alternative uses and the application of innovative technology. The improvement of renovation and repair methods and practices, with better refurbishment 'processes' and improved standards for their supply, will enhance living conditions and add value and appeal to existing built facilities. Data concerning their operation and maintenance costs, and better asset management, will play an important part in ensuring the sustainability of existing facilities.

11.8 Forming Alliances and Partnerships

Developing and maintaining productive partnerships with businesses, government organisations/agencies, and non-government organisations is an integral key to successfully achieving sustainability objectives. DHW Works has identified massive quantities of completed and continuing research and information surrounding sustainability in the built environment, as indeed most agencies producing similar submissions to this would agree. Forming alliances and partnerships enables the sharing of this vital information, research, findings, and new technologies, with minimal double up of research and development efforts. To achieve a more sustainable built environment, unification is required of all bodies researching different aspects of the same issue.

Alliances and partnerships could be pursued in the following manner:

- Consultation and collaboration with key industry representative bodies such as the Master Builders Association, Property Council of Australia, Royal Australian Institute of Architects, Australian Building Energy Council etc.
- Co-operation and co-ordination of efforts with other WA Government agencies operating within the built environment;
- Co-ordination of research efforts with Universities;
- Implementation of programs and coordination of research efforts in collaboration with similar organisations/departments operating within the built environment in other jurisdictions or nations;
- Indirect partnerships with other stakeholders and consumers within the broader community.

11.9 Implementing Legislation

Legislation is a possible tool for improvement to achieve maximum sustainability benefits with a minimum of regulation. Legislation in areas such as management of asbestos, safe on-site practices, construction waste management, and other such detrimental environmental impacts is recommended.

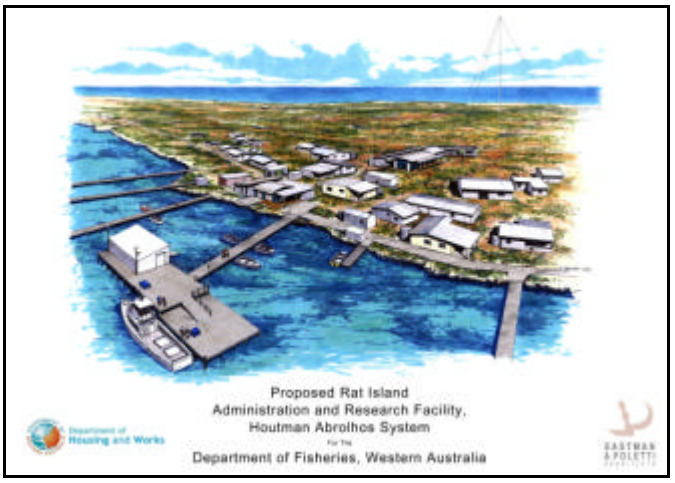
12 Case Studies – Sustainability in Action

The public works component of Department of Housing and Works (DHW Works) can demonstrate an existing commitment to sustainability through a number of past projects and existing initiatives. Each case study provides an overview of the project or initiative, followed by a number of points to demonstrate how the project works toward economic, environmental or social sustainability through the built environment.

Five case studies are included in this paper:

1. Rat Island Research Camp – Abrolhos Islands
2. Shenton College
3. Energy Efficient Design of Schools in WA
4. Fremantle Prison and Heritage Precinct
5. Percent for Art Scheme

CASE STUDY 1: RAT ISLAND RESEARCH CAMP – ABROLHOS ISLANDS



DHW Works in Geraldton, on behalf of Department of Fisheries, is currently documenting designs for a new Research facility on Rat Island, part of the Abrolhos Group, approximately 50km west of Geraldton. These islands are used as a live-in base for Western Rock Lobster fishermen between March and June of each year. There is no infrastructure on the islands and, due to their remoteness and difficulty in access - traditionally fishermen have used diesel-powered generators for all their power requirements.

This project at Rat Island comprises construction of a new jetty, dinghy landings and storage sheds, administration and research building, accommodation for 10-12 visitors (visiting researchers, fisheries inspectors etc, mess hall, kitchen and ablutions

Consultants have been engaged to research environmentally sustainable options for supplying power to these facilities. This includes both solar and wind powered generators feeding into battery bank for AC power supply for lighting, fridge/freezers, pumps and a range of other services. Power supply also needs to be maintained during off-season where camp usage is very ad hoc. Further research is proceeding

Sustainability Characteristics

This research has the potential to contribute to increased sustainability in the built environment through delivering the following benefits:

- Promotion of an ecologically viable alternative power supply
- Solar/wind orientation and design
- Incentive for other solar or wind powered features
- Decreased environmental impact
- Utilising the benefits of the natural environment

CASE STUDY 2: SHENTON COLLEGE

Shenton College[6]

A north facade of the upper school showing highlight windows with shades[6]

DHW Works arranged for the procurement and construction of Shenton College. Shenton College was designed to combine two former state schools in Perth's Western suburbs, an area that has become a desirable place to live over the last decade. A lengthy consultation process was undertaken with tenderers, students, parents, and local community to define the brief. This was the largest consultation process ever undertaken for a new school, involving more than 300 stakeholders over 16 weeks.

There were a number of key objectives of this project, of which one of the most significant was to design the school to minimise operating energy costs. Shenton was to achieve energy efficiency for heating, cooling, and ventilation. Surrounding bushland was also retained and landscaping for the school centred on complementing the existing bushland.

Environmental Consultants were engaged to identify passive design opportunities, including enhancement of natural ventilation, analysis and assessment of options for sun shading, building envelope, glazing, thermal insulation and daylighting.

The school contains the following energy efficient features:

- Buildings thermal mass is managed to regulate summer temperatures, facilitate night cooling, and in winter, retain internally generated heat. Buildings are oriented so that most windows are facing north, with dedicated shade structures on north facades to help keep interior temperatures down in summer.
- Natural ventilation and summer cooling optimise comfort conditions – strategies include openable windows at body height for air inlet, ceiling sweep fans and operable high level ventilation.
- Daylighting – glazing down to floor level opening out to courtyards. Highlight windows are used throughout the school for daylighting. The more common use of skylights was not adopted as they can be a source of radiant heat.
- Artificial lighting has been based on energy conservation principles. Classrooms contain ceiling suspended luminaries with high performance low brightness reflectors. Lights are on a timing cycle.

[6] Photo's reproduced from Australian Building Energy Council, Building Case Studies http://www.abec.com.au/

Sustainability Characteristics

Despite political and administrative changes, a culture of designing for positive environmental outcomes has survived and is beginning to prosper in WA. This project has directly contributed to increased sustainability through the built environment by delivering the following benefits:

- Decreased environmental impact on development
- An ecologically viable alternative for clients
- Lower operating costs
- Utilises the benefits of the natural environment
- Strong community consultation and involvement
- Provides incentive for others to work toward energy efficiency in buildings
- Government providing leadership and setting an example for energy efficiency awareness

CASE STUDY 3: ENERGY EFFICIENT DESIGN OF SCHOOLS IN WA

DHW Works have engaged an Architectural firm to conduct a research project into the energy efficiency of existing primary schools in Western Australia. The project's primary focus is the current "standard pattern primary school". It will review the current energy efficient guidelines for new primary schools, identify deficiencies in these guidelines and prepare potential new or amended guidelines for consideration.

The firm will conduct an environmental modelling analysis demonstrating potential energy efficiency improvements and prepare capital and recurrent cost estimates for implementing potential guidelines.

Sustainability Characteristics

This research has the potential to contribute to increased sustainability through the built environment by delivering the following benefits:

- Decreased environmental impact on development
- An ecologically viable alternative for clients
- Lower operating costs
- Utilises the benefits of the natural environment
- Provides incentive for others to work toward energy efficiency in buildings
- Government providing leadership and setting an example for energy efficiency awareness

CASE STUDY 4: FREMANTLE PRISON & HERITAGE PRECINCT

Main Cell Block from South West

Prison Gatehouse

The Fremantle Prison is one of Western Australia's premier heritage sites, centrally located in the heart of the port city of Fremantle. The site is listed on the Australian Heritage Commission's Register of the National Estate, on the Heritage Council of Western Australia's Register of Heritage Places and in the Fremantle West End conservation area. Many of the buildings in the precinct are also listed with the National Trust of Australia (WA).

DHW Works has been promoting the Prison Precincts exceptional cultural heritage values, which has ensured the site is not only WA's premier heritage site, but is now an overall complex for government, community and commercial use. DHW is continuing work to conserve, interpret and promote the history, culture and use of the Prison Precinct to standards that acknowledge the precinct's exceptional cultural heritage values. This is done through:

- Conservation of the Prison precinct
- Interpretation of the Prison precinct
- Attracting visitors to the Prison precinct
- Using the Prison precinct as an educational resource
- Attracting compatible uses
- Integrating the Prison precinct into Fremantle
- Best practice in heritage management and financial planning
- Working actively to achieve world heritage listing

As part of the management policies for the long-term sustainability of the site as a heritage place, new uses have been developed for a number of buildings within the precinct. Leases include tourism, education, and community ventures. The *conservation and future use* approach to the management of the precinct has ensured the history and significance of the place are maintained while providing for continuing use of the site.

Sustainability Characteristics

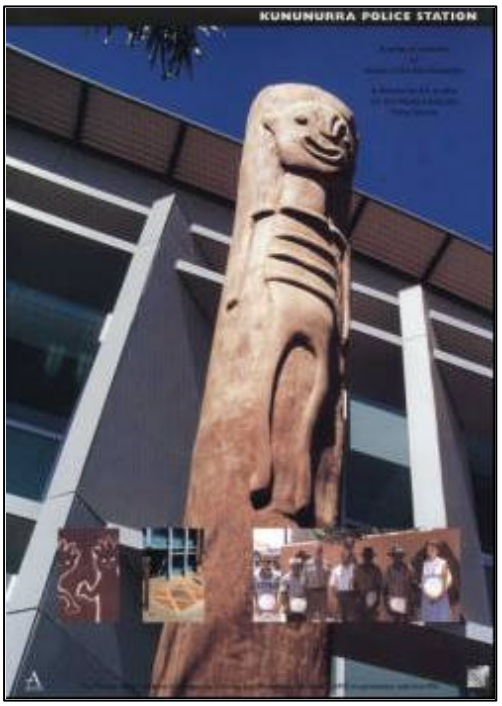
The City of Fremantle demonstrates that retaining built heritage and a walkable city centre, contributes significantly to sustainability. Fremantle's built environment provides a strong foundation on which to support diverse communities and business and to reduce the impact of its populations on the environment. The vibrancy and history of the community attracts tourists

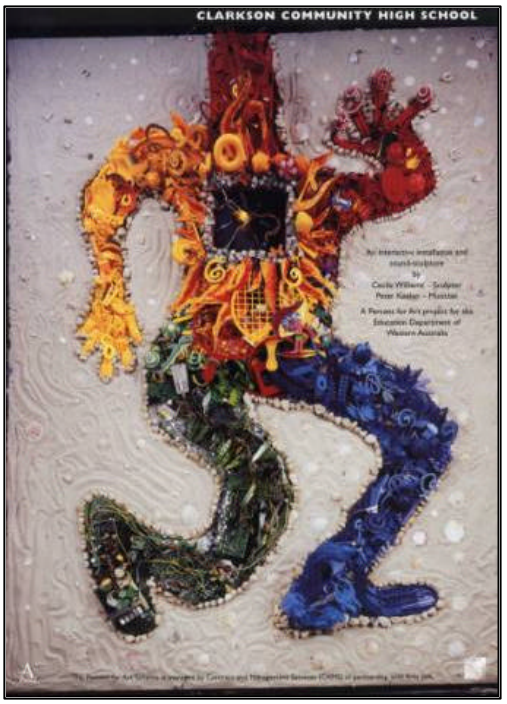
from interstate and overseas, providing a valuable economic resource for the state, and employment for local people in their local area, all of which are essential for social sustainability.

The Fremantle Prison Precinct is an integral historical part of the City as a premier heritage site and tourist attraction. By preserving and enhancing the prison, a remarkable part of Fremantle's history is passed on to future generations. DHW is helping create a culture of sustainability in which practices that preserve our cultural and heritage values, and enhance individuals' quality of life become part of every day living. The Prison Precinct contributes to increased sustainability in a number of ways:

- Rich in cultural history – facilitates cultural identity through our heritage
- A tourist attraction
- Enhances the local economy
- Contributes to the creation of a local identity
- Creates a sense of belonging and pride in the community
- Contributes to a stimulating, vibrant built environment

CASE STUDY 5: PERCENT FOR ART SCHEME





The Percent for Art Scheme is a Western Australian State Government program, forming part of the broader Minister for the Arts "Public Art Initiative", designed to foster the creation of art in public places. The objectives of the scheme are to improve the quality of the built environment and the value of public facilities, and to create opportunities for Western Australian artists. The Scheme seeks to achieve this through public art projects carried out as part of the Western Australian State Capital Works Program.

The Scheme applies to most new State Government buildings and major additions over $2 million, and is managed through a strategic alliance between DHW Works and ArtsWA. The Percent for Art Scheme is allocated a percentage of the construction cost of State capital works projects, usually one percent, to commission artists to work as part of the project team. The artist's role is to create works that are conceptually integrated with the building or its landscape.

DHW Works manages the implementation of the West Australian Government's Percent for Art Scheme, maintains a consultant panel for public art co-ordination, and provides advice on public art procurement.

The Percent for Art Scheme in WA is currently generating more public art activity than anywhere else in Australia with most state government building projects over 2 million dollars having art projects built into their budgets. Local government authorities such as Melville and Fremantle, and redevelopment authorities such as East Perth and Subiaco are also implementing public art projects.

Sustainability Characteristics

The Arts make a significant contribution to quality of life, regeneration, and bringing communities together, and should therefore be accessible to everyone. The Percent for Art initiative is helping work toward social and cultural sustainability by instigating a sense of

community and pride in Western Australia, while supporting local and indigenous Artists. Percent for Art has the prospect of reducing crime in society and graffiti in public places such as schools, hospitals, police stations and the like.

The benefits of incorporating public art within the built environment align with the fundamentals of social and cultural sustainability, and incude:

- Enhancing quality of life
- Improve the quality of our built environment
- Contribute to the creation of a local identity
- Enhance the local economy – provide employment for artists and local businesses
- Express aspects of local history or heritage
- Contribute to the safety of a place and reduce vandalism
- Develop community pride
- Create new landmarks
- Become a tourist attraction
- Contribute to the Reconciliation process with Aboriginal peoples
- Make the world a more interesting place
- Contribute to a stimulating, vibrant environment

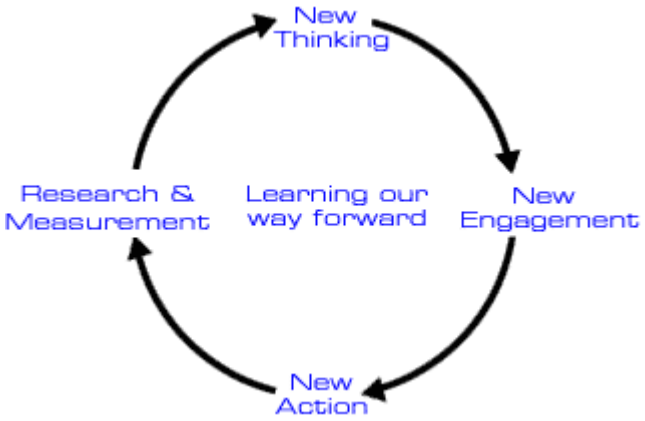
13 Conclusion

This paper identified the dimensions and objectives of sustainability and the characteristics of a sustainable built environment, setting out the key sustainability issues and exploring the elements of an ideal sustainable building and the theory of sustainable construction. The sectors and components of the WA built environment have been recognised along with the appropriate mechanisms for influencing sustainability through the various sectors. The importance of considering the life cycle of a built asset has also been explored, with future development and sustainability progress seen as representing new ways of thinking throughout the stages of a built assets life.

Suitable priorities for the built environment were established, whilst highlighting that these priorities need to be developed in consultation with all involved in the WA built environment. Barriers to a more proactive approach to sustainability were explored, along with identification of a number of areas that represent the key to bringing about change and facilitating a more sustainable future. Research and development requirements were observed, along with a group of case studies. A number of suggestions were also provided for action toward a sustainable built environment, from the viewpoint of DHW's non-residential/commercial component.

Progress toward sustainability can be perceived as a continuous loop of new ways of thinking, new engagement of technologies and initiatives, new actions in the way we do business and impact on the environment, and further research and measurement.

Sustainability progress loop



The scale of the building and construction industry, the sustainability impacts of its operations, and the influence of its products on the nation's quality of life make it a key player in delivering sustainability in the built environment. However, the full impacts on the built environment are not under the direct control of the industry, or DHW Works, as decision on patterns of development are shaped by the broader policy context of planning, housing, regional development and others. Integration of all these aspects will enable full appreciation and control of the effects of the built environment, to lead the way to a more sustainable future for Western Australia.

14 Appendices

14.1 Appendix 1: Existing Research Efforts

Currently a substantial amount of research is being undertaken all around the nation and globe relating to sustainability and the built environment, and more specifically, sustainable construction. Existing research efforts include:

- The Natural Step, a U.S based organisation, has been conducting research to strengthen the theory and practice of sustainability, drawing on the experiences of nine international offices. TNS conducts both applied and conceptual research related to sustainability issues and key barriers to sustainability. (http://www.naturalstep.org/about/about_tns-us_research.html)
- A U.K based organisation, CRISP (Construction Research and Innovation Strategy Panel) brings together Government, clients, industry and the research community to consider research priorities for sustainable construction. CRISP has a wide research remit encompassing all aspects of generating and refining the knowledge that industry and its clients need to improve the performance of U.K construction. (http://www.crisp-uk.org.uk)
- AnewNZ, a New Zealand based organisation, has been conducting ongoing sustainability research and awareness campaigns to ensure all New Zealanders hold a clear understanding of the issues and can effectively contribute toward a sustainable future. (http://www.anewnz.org.nz)
- Foundation for the Built Environment, a U.K based organisation, conducts extensive sustainability research programmes to achieve a higher quality built environment; built facilities that offer improved functionality and value for money; and a more efficient and sustainable construction sector, with a higher level of innovative practice. (http://www.fbe.co.uk/research/)
- BRE Centre for Sustainable Construction, another U.K based organisation, is currently conducting a two year intensive case study based research into the underlying benefits of more sustainable building design and management options. This research incorporates the new build, refurbishment and existing building sectors. (http://projects.bre.co.uk/suscon_casestudy/)
- CSIRO (Commonwealth Scientific and Industrial Research Organisation) Built Environment, and Australian based organisation, conducts continuing research into issues surrounding the built environment. Many of these research efforts are based on sustainability. (http://www.dbce.csiro.au/res-proj/)
- Western Australia's Murdoch University Institute for Sustainability and Technology Policy also conducts research into key sustainability issues for the built environment, such as sustainable cities and regions. (http://wwwistp.murdoch.edu.au/)

These research efforts represent only a small portion of the research activities currently underway in Australia and overseas. A method of integrating these research efforts and widely disseminating results and findings, would ultimately be for the benefit of all.

14.2 Appendix 2: Sustainable Asset Management Lifecycle Strategy Tables

Key goals to plan and aim for in each phase of an assets life can be assessed and planned for objectively, transparently and systematically, using the approach shown in the tables[7] below.

Table 1: Whole of Government Strategies for Sustainable Asset Management

Whole of Government Context	Economic, Social, Environmental Sustainability Principles
Community Expectations and Service Demand	Conserve resources and materials, water, fresh air, energy, soil, minerals and scarce resources.
	Enhance habitat elements of biodiversity, natural reserves and landscape.
	Reduce emissions to water, air and natural reserves.
	Protect values of heritage, security, recreation & equity.
	Enhance the quality of the built environment with aesthetically pleasing structures (including public art incorporation)
	Community participation in built environment projects
	Enhance environmental health by "green" buying, healthy building and ensuring work-place health.
Corporate Directions	Develop clear statements of vision, mission & purpose with respect to resource conservation.
	Develop, maintain & implement policy to enable resource conservation, social and economic objectives to be met.
	Invest in research on resource conservation.
	Develop clear statements of vision, mission & purpose with respect to maintenance of environmental qualities.
	Develop, maintain & implement policy to enable environmental health quality, social and economic objectives to be met.
	Invest in research on environment health protection.
	Consider an Environmental Management System (EMS)

[7] Tables have been borrowed from the following source: Queensland Department of Public Works, http://www.build.qld.gov.au/sam/sam_web/content/esd_cont.htm

Table 2: Built Asset Lifecycle Sustainability Strategies

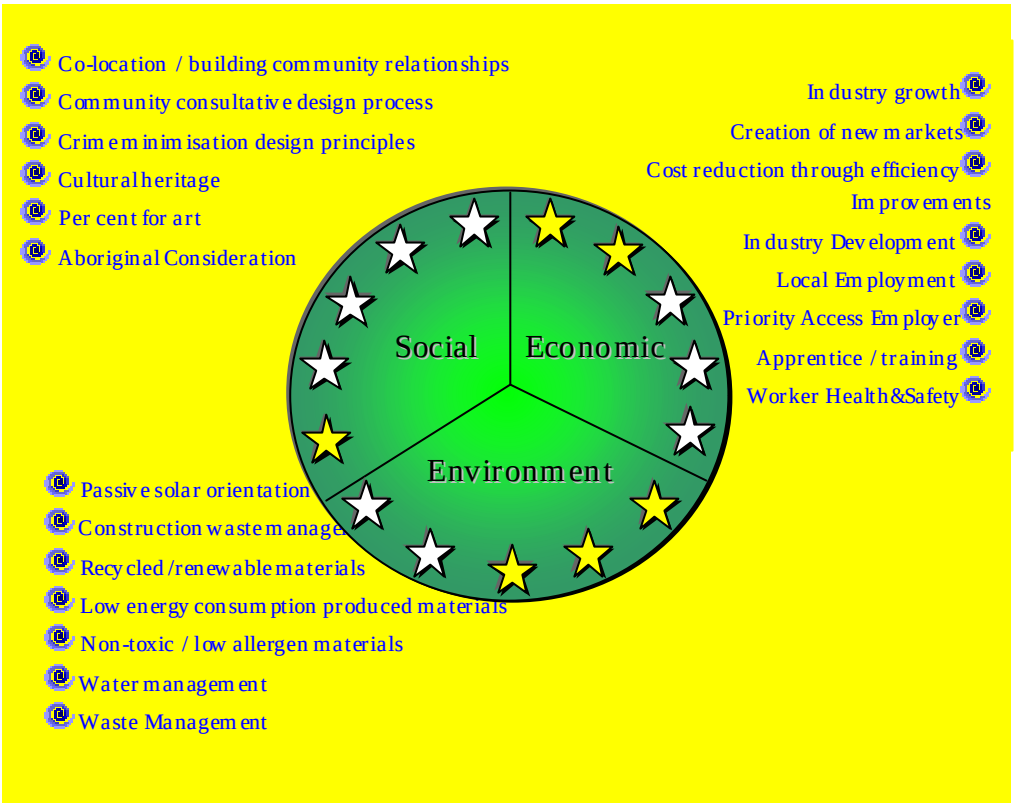
Asset Lifecycle Phase	Economic, Social, Environmental Sustainability Principles
Planning	Seek non-asset solutions/demand.
	Management solutions.
	Plan for capital investments to specifically adopt innovative, sustainable technology.
	Plan disposal to recover scarce resources.
	Ensure consistency with heritage and cultural values.
	Ensure equity of access, safety and security.
	Enhance environmental health, key heritage elements and adoption of low-pollution products or services.
	Consult stakeholders and community & integrate planning with local & State Government service delivery initiatives.
	Implement an Environmental Management Plan (EMP) as outlined in AS/NZ ISO 14000.
Design	Reflect cultural, heritage & social context.
	Enable present & future conservation of energy, water & materials.
	Maximise individual control of natural ventilation.
	Design for disassembly of components.
	Minimise harmful emissions via intakes from & to the external environment.
	Ensure equitable access for public transport & service delivery to disadvantaged groups and disabled persons.
	Incorporate natural landscapes & visual amenity.
Procurement	Evaluate tenders on:
	enhanced renewable energy usage
	increase recycled content & reduce waste
	avoidance of scarce resource usage
	use of local resources in labour and materials.
	Ensure new built assets reflect existing urban form & are integrated with public transport.
	Ensure habitat-sensitive development methods.
	Pre-qualify suppliers in terms of pollution abatement.
	Minimise hazardous, volatile and reactive compounds.
Construction	Ensure:
	reduced wastage, on site recycling
	conservation of scarce resources, water and soil
	protection of cultural & heritage features.
	Minimise noise and dust emissions.
	Implement pre-qualification of contractors & suppliers in terms of Occupational Health and Safety & EMP.

	Minimise disruption of natural and human habitat.
Refurbishment	Facilitate:
	increasingly efficient use of energy and materials
	reliance on renewable energy and resources.
	Conduct pre-& post occupancy air quality audits.
	Pre-qualify contractors and suppliers in Occupational Health and Safety & EMS.
	Facilitate improved pollution abatement.
Operating	Pursue practices that:
	maximise total system energy efficiency
	minimise finite energy/scarce resource usage
	avoid material waste & increase total resource efficiency
	facilitate purchase of increased renewable energy.
	Facilitate quality improvement via Occupational Health and Safety & EMS.
	Ensure Sustainability training & Human Resources key performance criteria.
	Ensure avoidance of hazardous materials & procedures.
	Reduce emissions to air, land and water.
	Enhance preservation of habitat/regional biota.
Maintenance	Pursue practices that:
	increase efficiency & renewable energy use
	ensure soil conservation; less materials wastage; healthy site biota; and avoid scarce resource use.
	Conduct pre/post-occupancy audits to ensure reduced emissions to air, land & water; and reliance on hazardous materials.
	Enhance biodiversity in natural and human habitat.
Disposal	Pursue practices that:
	minimise demolition waste
	facilitate re-use of materials
	ensure the safe recovery of hazardous materials such as contaminated air, soil and effluent.
	Ensure allocation is based on evaluation of all significant social, environmental and economic factors.
	Pre-quality contractors for Occupational Health and Safety & EMP in best site restorations; and minimize emissions to air, land & water.

14.3 Appendix 3: Capital Works Project Approval and Funding Process – Star Rating Diagram

A diagrammatic example of the proposed star rating project and funding approval system can be seen below. Social, economic and environmental sustainability objectives would be listed, with agencies obtaining a star for each objective considered within their particular project.

This initiative is currently in conceptual stage and would require further research and development if it were to be adopted.



14.4 Appendix 4: Research Papers – Business Benefits of Sustainable Construction

Many research papers have been prepared on the business benefits of sustainable construction, the conclusions of which need to be communicated to all players in the building and construction industry. Examples of such research papers are examined below:

- A report prepared by the NSW Department of Public Works and Services, "Economic and Environmental Lifecycle Costs of Buildings", found that over 35 Australian case studies demonstrated economic savings from environmental design. NSW SEDA has achieved an average internal rate of return of approximately 40% for energy retrofits of buildings. This relationship is supported by a multitude of international case studies. (DPWS, 1998 http://www.industry.gov.au/industry/building/LCReport.pdf).

- Alan Yates from the UK Centre for Sustainable Construction has also prepared a report on the business benefits of sustainable buildings in which he identifies a number of economic, environmental and social benefits to businesses (http://projects.bre.co.uk/suscon_casestudy/report1290301.pdf).

- Donald Reed from the World Resources Institute Sustainable Enterprise Program prepared a report in December 2001 titled "Stalking the Elusive Business Case for Corporate Sustainability". This paper explored the conventional mind-set that sustainability initiatives adversely affect corporate profits, while making note that many companies have found prudent environmental investments can lower costs or improve efficiency sufficiently to be a net economic gain. Using an analytical approach focusing on estimating the expected financial results of specific strategies, this paper examines the business case for corporate sustainability strategies and the attempts to quantify it financially. (http://www.getf.org/file/toolmanager/O16F24459.pdf)

- Also in existence are a various self-help tools such as NSW Environment Protection Authority's "Profits from Cleaner Production – A Self Help Tool for Small to Medium Sized Businesses" which aim to assist and alert businesses to the potential for reducing costs and boosting productivity by integrating environmentally sustainable practices and processes into the everyday running of their businesses. (http://www.getf.org/file/toolmanager/O16F24527.pdf)

14.5 Appendix 5: Built Environment Sustainability Research Units

Various similar research units developed in other states and nations support the establishment of such a built environment sustainability unit in Western Australia. Queensland have set up a number of different research units aimed at promoting sustainability in the built environment. These include:

- Cooperative Research Centre (CRC) for Construction Innovation: which is a consortium headed by the Queensland University of Technology with Department of Public Works as a venture partner to undertake extensive research in a number of areas, including sustainability. (http://www.publicworks.qld.gov.au/07_showcase/content_showcase_crc.htm);
- Built Environment Research Unit (BERU): a branch of the Department of Public Works aimed at supporting the research, development and demonstration of new sustainable building technologies, products and practices. (http://www.publicworks.qld.gov.au/07_showcase/content_showcase_research.htm)

Examples of similar research units around the globe include:

- Foundation for the Built Environment (FBE): a UK non-profit organisation developed to achieve a higher quality built environment, with a more efficient and sustainable construction sector, through a higher level of innovative practice. (http://www.fbe.co.uk/)
- Centre of Excellence for Sustainable Development: a unit of the US Department of Energy developed to provide information and services on how communities can adopt sustainability in the built environment as a strategy for long term well-being. The centre conducts research and development programs, promotes sustainable technologies, provides educational materials and produces articles and publications. (http://www.sustainable.doe.gov/index.shtml)
- Anew NZ: An independent non-partisan cross section of motivated and concerned New Zealanders contributing their collective talent, skills, experience and time to facilitate a process of national awakening and change. They aim to promote a vibrant and sustainable society with the highest quality of life through conducting research, surveys and awards. (http://www.anewnz.org.nz/index.html)
- The Natural Step: A United States based international organisation established to help organisations and communities understand and move toward sustainability. The organisation conducts research, holds events, develops programs, and showcases sustainability initiatives. (http://www.naturalstep.org/index.html)

15 Resource List

Primary Resources

Anew NZ
http://www.anewnz.org.nz/index.html

Bartuska, T & G Young, *The Built Environment, Creative Inquiry into Design and Planning,* CRISP Publications, 1994

Building Energy Efficiency Research (BEER), Sustainable Architecture, 2002
http://www1.arch.hku.hk/research/BEER/sustain.htm

Building Research Establishment (BRE) Centre for Sustainable Construction
http://www.bre.co.uk/sustainable/index.html

Built Environment Research Unit (BERU)
http://www.publicworks.qld.gov.au/07_showcase/content_showcase_research.htm

Centre of Excellence for Sustainable Development, U.S Department of Energy, *Green Buildings*
http://www.sustainable.doe.gov/buildings/gbintro.shtml

Construction Best Practice Program, Sustainable Construction, UK
http://www.cbpp.org.uk/cbpp/index.jsp

Cooperative Research Centre (CRC) for Construction Innovation
http://www.publicworks.qld.gov.au/07_showcase/content_showcase_crc.htm

CRISP Sustainable Construction Theme Group, *Integrating Sustainability and Rethinking Construction*, Environmental Resources Management, UK, May 1999 http://www.crisp-uk.org.uk/reports/isrt_fr.pdf

CRISP Sustainable Construction Theme Group, *Theme Group Report*, UK
http://www.crisp-uk.org.uk/REPORTS/sctg_r.pdf

CRISP *Construction for Sustainable Development - Research and Innovation Needs*, UK
http://www.crisp-uk.org.uk/REPORTS/9915_sum.htm

Environmental and Energy Services of the NSW Department of Public Works and Services (DPWS), *Economic and Environmental Life Cylce Costs of Buildings* Discussion Paper, 1998
http://www.industry.gov.au/industry/building/LCReport.pdf

Foresight, *Constructing the Future,* Department of Trade and Industry, UK, June 2001

Foundation for the Built Environment (FBE)
http://www.fbe.co.uk/

Queensland Department of Public Works (Building Division), *Ecologically Sustainable Office Fitout Guideline*, June 2000
http://www.build.qld.gov.au/aps/apsdocs/ESDMasterDocument.pdf

Queensland Department of Public Works, Ecologically Sustainable Asset Management (ESAM) (http://www.build.qld.gov.au/sam/sam_web/content/esd_cont.htm)

Queensland Department of Public Works, Ecologically Sustainable Strategic Asset Management (ESSAM)
http://www.publicworks.qld.gov.au/07_showcase/content_showcase_essam.htm

Reed, Donald J, *Stalking the Elusive Business Case for Corporate Sustainability*, World Resources Institute (WRI) Sustainable Enterprise Program, December 2001
http://www.getf.org/file/toolmanager/O16F24459.pdf

Royal Australian Institute of Architects (RAIA), *Environment Policy*
http://www.architecture.com.au/i-cms_file?page=/1/17/32/218/RAIA_Env_Policy_SDS_for_Arch.pdf

Sustainability Action Group of the UK Government Construction Clients' Panel, *Achieving Sustainability in Construction Procurement*, Office of Government Commerce, June 2000
http://www.property.gov.uk/services/construction/gccp/100700.pdf

The Natural Step
http://www.naturalstep.org/index.html

Yates, Alan (Centre for Sustainable Construction), *Quantifying the Business Benefits of Sustainable Buildings*, Building Research Establishment Ltd, February 2001
http://projects.bre.co.uk/suscon_casestudy/report1290301.pdf

Secondary Resources

Australian Building Energy Council, Building Case Studies
http://www.abec.com.au/

Centre for the Understanding of the Built Environment (CUBE)
http://www.cube.org.uk/

Centre of Excellence for Sustainable Development
http://www.sustainable.doe.gov/index.shtml

Community Environment Art and Design (CEAD), Murdoch University of Western Australia
http://wwwistp.murdoch.edu.au/su/site.html

EPA Cleaner Industries Unit, *Profits from Cleaner Production – A Self Help Tool for Small to Medium Sized Businesses*, NSW Department of State and Regional Development and NSW Environment Protection Authority, August 2000
http://www.getf.org/file/toolmanager/O16F24527.pdf

Sustainable Energy Development Authority (SEDA), *Corporate Plan 2000 – 2002*
http://www.seda.nsw.gov.au/pdf/plan.pdf