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Final Report

Affordability and sustainability outcomes: a triple bottom line assessment of traditional development and master planned communities - Volume 1

authored by

John Blair, Deo Prasad, Bruce Judd, Robert Zehner, Veronica Soebarto and Richard Hyde

Australian Housing and Urban Research Institute

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
AMCORD	Australian Model Code for Residential Development
AURDR	Australian Urban and Redevelopment Review
BCA	Building Code of Australia
BDST	Building decision support tools
BREEM	Building research environmental evaluation model
CBA	Cost Benefit Analysis
CO_2	Carbon dioxide
CPTED	Crime prevention though environmental design (principles)
DCP	Development Control Plan
DOE2:	Department of Energy 2 (models)
DPGDHAJV	Delfin Property Group/Defence Housing Administration Joint Venture
EFA	Ecological Footprint Analysis
ESD	Ecologically sustainable development
GBTool	Green building tool
GHG	Green house gas (emissions)
HIA	Housing Industry Association
ISC	Impervious surface cover
ISO	International Standards Organisation
IUCN	International Union of Concerned Scientists
LCA	Life Cycle Analysis
LEED	Leadership in energy and environmental design
LGA	Local Government Area
MFA	Material Flux Analysis
MPC	Master planned community
NAEEP	National Appliance and Equipment Energy Efficiency Program
NatHERS	National Housing Energy Rating System
NGOs	Non government organisations
NSW	New South Wales
OECD	Organisation for Economic Cooperation and Development
PSD	Passive solar design
PSR	Pressure-State-Response (models)
QLD	Queensland
QOL	Quality of life
RQ	Research question
SA	South Australia
SDIs	Sustainable development indicators (UNCED)

SEPP	State Environmental Planning Policy (NSW)
SMH	Sydney Morning Herald
SOE	State of the environment (reports)
TAFE	Technical and Further Education
TBL	Triple Bottom Line
TRS	Traditional regulatory subdivision
UN	United Nations
UNCED	United Nations Conference for Environment and Development
WARR	Waste Avoidance and Resource Recovery Act (NSW)
WBAS	Whole Building Assessment Systems
WCED	World Commission on Environment and Development
WSUD	Water sensitive urban design
WWF	World Wildlife Foundation

TERMINOLOGY

400 metre threshold: The generally accepted distance that a person will walk from home in order to do convenience shopping and the like.

Abatement costs: The term generally refers to corporate capital expenditures connected with environmental protection and damage. It includes the direct costs of rectifying damage by pollution; the increase in operating costs by type of media that might be attributed to hazardous and other forms of waste from industrial processes; the level of disposal and recycling costs; and a miscellany of pollution prevention and remediation costs associated with site cleanup, habitat protection, environmental monitoring and testing, administrative environmental programs, application for permits and related fees and any penalties and fines connected with compliance issues.

Aquifer: The body of water that exists beneath ground surface and which is often drawn upon to supply water to towns and cities and for agriculture. Also known as a water table.

Biodiversity: The range and complexity of plant and animal life.

Building assessment tools: Tools which are used to evaluate the performance of buildings.

Building Decision Support Tools: Tools which are used to help guide investment decisions and the design of a building.

Carrying capacity: Carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations. The carrying capacity for any given area is not fixed. It can be altered by improved technology, but mostly it is changed for the worse by pressures which accompany a population increase. As the environment is degraded, carrying capacity actually shrinks, leaving the environment no longer able to support even the number of people who could formerly have lived in the area on a sustainable basis. No population can live beyond the environment's carrying capacity for very long.

Contingent valuation/willingness to pay: Contingent valuation is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non-use values and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods. The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services, either to give them up or to receive them. For example people may be asked for the amount of compensation they would be willing to accept if they were to live adjacent to a sewerage treatment plant. The compensation might be in the form of a discount on market price of a house in the vicinity. It is called “contingent” valuation, because people are asked to state their willingness to pay, *contingent* on a specific hypothetical scenario and description of the environmental service.

Cost-benefit analysis: CBA attempts to place dollar values on all economic, and some environmental and social impacts, usually expressed in terms of cost savings, abatement costs and contingent valuation (Dodd and Lesser, 1994).

Covenant: A legally binding provision which controls what can and cannot be done on a person’s property. A covenant is usually a detailed control extending beyond Council zoning and planning regulations.

Cradle-to-grave-impacts: LCA is probably the most developed and widely used material accounting technique. LCA is generally used at product or process level, accounting for all material, energy and related impacts, including ecological, human health, and resource depletion) due to material extraction, manufacture, transportation,

product use, disposal and/or reuse or recycling i.e. "from cradle to grave" (Moore and Brunner, 1996).

Crime Prevention Through Environmental Design: A set of environmental design principles (natural surveillance, territorial reinforcement, access control and target hardening) facilitating reduction in the fear and incidence of crime.

Debt servicing ratio: Average gross income required to service debt – based on average house prices, mortgage sizes and interest rates.

Development costs: The range of costs associated with the production of urban development, especially dwellings. Costs cover items like grading, installation of sewer and water lines, roads and gutters.

Development density: The number of dwellings per hectare, either as a net figure (net of other land uses like industry or parks) or as a gross figure (including all other land uses.

Ecological Footprint Analysis: EFA can be defined as the area of ecologically productive land and water systems required to provide all the energy and material resources used in maintaining a defined population and assimilating its wastes (Wackernagel and Rees 1996).

Ecologically sustainable development: Development which is ecologically sustainable uses natural processes and systems as the guiding principle for disposing of, for example, wastewater.

Environmental sustainability: Development which is sustainable from the viewpoint of the physical environment and not necessarily the social or economic spheres.

'Green' building: Building which is environmentally responsible in its energy and water consumption and the nature of the materials which are used in its construction.

'Green' mortgages: The costs of some green homes are slightly higher than conventional ones and mortgages are increased somewhat to account for this. Green mortgages are thus termed because they take into account the fact that the operating costs of green buildings can be much less than costs in a conventional home.

Greenhouse effect: Carbon dioxide emissions from burning fossil fuel in cars and factories have the effect of trapping the sun's heat. The earth is believed by most scientists to be warming up as a result of this.

Housing affordability: The degree to which people can afford to buy their own house given their income and other expenditure needs.

Impervious surface cover: The amount of hard surface covering an area such as the concrete and asphalt for roads, driveways and parking lots.

Indicators: Units of information describing the state of a system

Life Cycle Analysis: LCA is probably the most developed and widely used material accounting technique. LCA is generally used at product or process level, accounting for all material, energy and related impacts, including ecological, human health, and resource depletion) due to material extraction, manufacture, transportation, product use, disposal and/or reuse or recycling i.e. "from cradle to grave" (Moore and Brunner, 1996).

Low technology: In the energy conservation area an example would be passive solar design. In wastewater treatment an example would be disposing of sewage through constructed wetlands rather than a sewage treatment plant.

Master planned communities: MPCs differ from TRSs in that many additional elements are considered such as issues of solar access, overshadowing, privacy, community facilities, landscaping, pedestrian and vehicular traffic, and the nature and form of buildings. The planning and design of MPCs often considers such issues simultaneously in an integrated and significantly more comprehensive way.

Material and energy accounting: Material accounting techniques are defined as primarily seeking to quantify and represent flows of material and energy used in a production or development process as indicative of the level of environmental impact (Moore and Brunner, 1996).

Material Flow Analysis: The term material flow analysis is used to denote the method employed to record, describe and interpret metabolic processes. This method is a scientific procedure used to quantify the turnover of materials for a defined area over a specified period of time as the system boundaries. This method can be applied in the same way to energy turnover. The term "material flow (or flux) analysis" is found in international literature.

Neighbourhood satisfaction: Perceived satisfaction of individuals with various aspects of their local neighbourhood – both physical and social.

Ozone depleters: Gases related to the chlorofluorocarbons which are used in day to day activities by society and which have produced “holes” in the protective ozone layer. Some of these gases are being phased out under international protocols.

Passive solar design: A low technology application which uses the sun’s energy, ventilation and insulation to secure heating and cooling without resort to artificial devices like air-conditioning systems.

Post-occupancy evaluation: A systematic evaluation of performance undertaken after a designed facility or environment is occupied or in use for an appropriate time to establish its fitness for purpose.

Precautionary principle: The precautionary principle is about living with uncertainty and risk. It suggests that if we are unsure about future limits the prudent course is to temper our activities until proven that they do not pose a problem for current or future generations.

Pressure-State-Response model: An OECD indicator based model for understanding the dynamic relationships between the pressures of human activities, the state of environment and natural resources and the response of economic and environmental agents (OECD 1991).

Quality of Life: A comparative measure of the degree of well being of people in societies across a number of domains – political, economic, social, psychological and physical.

Sense of community: The extent to which individuals have a sense of similarity, interdependence and belonging to a local neighbourhood or community.

Shadow price(s): A method of valuing outcomes for cost benefit analysis that cannot be based on market price(s) but uses estimates based on other data or assumptions.

State of environment reports: A mandatory reporting system that focuses on the physical environment such as water and air quality, waste generation and biodiversity.

Stormwater management: Management of rainwater precipitation in such a way as to avoid flood damage but also maintain water quality in creeks and rivers.

Sustainable development: According to the World Commission on Environment and Development, it is “…development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (WCED 1987:43). There is still considerable disagreement over how sustainability might be obtained.

Community indicator programs: Suites of indicators compiled as a program for measuring the performance of neighbourhoods, cities and occasionally regions. They are very similar to TBL programs.

Traditional regulatory subdivision: It is typically characterised as meeting all relevant regulations like zoning ordinances and building codes, with lots sold individually and generally without additional controls on building design. The main development elements typically tackled include lot sizes and layout, open space, infrastructure provision including roads, stormwater, sewage, and utilities, and street lighting. There is little flexibility for developers or builders to apply innovative solutions to issues of affordability, aesthetics or environmental sensitivity.

Tri-domain model: An set of indicators representing the domains of society, economy and environment (equates with a Triple Bottom Line model)

Triple bottom line: Triple bottom line is a term that originated in the corporate sector in connection with socially responsible investing. The term is chiefly used by business firms. The concept of TBL is very closely related to sustainability since suites of indicators forming TBL performance measuring programs cover the social, economic and environmental domains.

Venn diagrams: Venn diagrams illustrate conceptually overlapping issues, in the case of sustainability, the three domains of human activity – the social, economic and environmental spheres.

Waste management: The management of waste to reflect its value as a resource through recycling and re-use rather than its allocation to a landfill as garbage.

Water quality management: Management of water so as to avoid pollution of the aquifer and creeks also maintain water quality in creeks and rivers.

Water sensitive urban design: An approach to urban design that advocates sustainable approaches to stormwater treatment to minimise run-off, allow for on-site detention and maintain quality of water discharged into stormwater systems.

Water supply management: The adoption of conservation strategies for managing water consumption – e.g. low flow fixtures, dual flush toilets and drip garden irrigation.

Zero lot lines: A development control strategy that permits the building of dwellings up to one or more boundary lines of a building allotment.

EXECUTIVE SUMMARY

Urban development, including housing, often brings significant environmental problems. An important aim of government is to provide housing which is affordable and which simultaneously reduces environment impacts. To this end, all levels of government in Australia are beginning to incorporate principles of environmental sustainability into urban development, especially new housing. However, there is little evidence to suggest how effective sustainability policy has been. This research has used a suite of triple bottom line (TBL) indicators covering the spectrum of sustainability to help determine this.

The primary aim of the research has been to assess the extent to which housing can be affordable whilst simultaneously being sustainable. Sustainability in this research project applies to all three human activity spheres. It applies in an economic or financial sense associated with housing costs; in a social way, for example, whether sense of community varies according to the nature and form of development. Thirdly, sustainability applies to the environmental arena, for example conserving water and energy, simultaneously bringing operating economies to housing and less pollution.

The research has two chief outcomes. First is a sustainability assessment method – the triple bottom line (TBL) model which is used to compare two key forms of residential development. They are the traditional regulatory subdivision (TRS) of suburban development and the master planned community (MPC). The second product is an evaluation of the economic, environmental and social characteristics of the MPC and TRS. Two case studies in the three capital cities in NSW, South Australia and Queensland were examined. The evaluation is a comparison of each case study pair, not an absolute assessment against established norms, though an occasional reference is made to an external benchmark where they exist.

Research Methods

A suite of TBL indicators was built from the sustainability literature as well as the specialized literature on indicators of sustainability. The suite was validated by the steering committee and finalized by the core team. A review of government sustainability policies in the three states was also carried out.

The two case studies selected in each state followed a number of common criteria and each case study pair included a MPC and a TRS. Data for each case study were collected from the Australian Bureau of Statistics, the local councils, private corporations, and through a questionnaire which was delivered to 600 households in each of the six communities. The results of the data collection and analysis process led to a number of conclusions and recommendations, the chief of which are presented below.

Key Findings

The Triple Bottom Line Indicators

1. The trial TBL suite of social, economic and environmental indicators has worked well for the comparative assessment of neighbourhoods. Its main flaw is that it is too large but it can be pared down without losing representativeness;
2. The TBL suite's greatest potential lies in monitoring the condition of Australia's cities and towns. Appropriate state agencies need to introduce requirements for regular TBL monitoring at local and state level, linked with state of the environment reporting.
3. The researchers recommend a pilot study of the TBL suite's application to monitoring a suitable metropolitan local government area (LGA), the nature of the indicators needed, and the data available.

4. A number of the indicators in the TBL suite need enhancement to raise their sophistication to a level more in tune with the holistic nature of sustainability. Upgrading should be done as part of producing the suite as a full model to be used as an on-line planning and design tool, accessible Australia-wide by multiple users, including developers.

Development Form

1. The results of the comparative assessment usually favour the MPC development form in NSW and to a degree in Queensland. In SA the results are equivocal. Regardless, successful design should not be dependent on one development form being pursued in preference to another. There is no inherent reason why multiple developers of traditional subdivisions could not be coordinated by a high calibre overall DCP as is the case with master planned community (MPC). It is an issue related to an LGA's planning and design functions.
2. The apparently superior planning and design outcomes of some elements of MPCs should be discussed by state and local government and if warranted, their principles applied to all new development.

Affordability and Sustainability

1. The two most effective measures that would greatly raise environmental sensitivity and affordability simultaneously are increasing development densities and starting a trend to smaller houses. Both measures generate spectacular synergies with issues like reducing greenhouse gas emissions, other forms of pollution and consuming fewer materials, especially energy and water. There are also major financial advantages in deferring or avoiding costly utility infrastructure expansion.
2. These synergies mean there is considerable potential for obtaining greater housing affordability at both construction and operating stages. Both higher density and smaller houses should become a policy priority of the planning agencies in the three metropolitan cities given land shortages and burgeoning population.
3. Applying physical and financial sustainability to housing, **assists** affordability rather than detracts from it. Low technology and passive solar design adds virtually nothing to construction costs and offers significant long term operational savings. Modifying zoning and building codes to incorporate such techniques is necessary at a national scale.
4. There are a number of other promising initiatives that can be pursued to improve affordability and sustainability simultaneously. They range from raising densities and reducing house size through to using unconventional materials and establishing cooperative systems for house construction.
5. Average house size is moving in the opposite direction to sustainability especially in Sydney. Higher densities and smaller houses are unpopular with residents and elected representatives but ought to be feasible in land-scarce metro Sydney. Development policy will still need to be strengthened through zoning and building codes to help gain affordability.
6. Voluntary water conservation has not been successful enough to meet Sydney Water's conservation targets. The NSW government is urged to contemplate a multi-pronged approach to the conservation/demand management of water such as integrating rainwater systems into existing as well as *new* dwellings; introducing full-cost pricing to reflect a scarce resource; and completing the package of low cost regulatory measures underway in Sydney Water.

7. The research project examined six existing neighbourhoods but did not consider the physical and economic measures that would be needed to make them sustainable. Research is needed into the economic feasibility of retrofitting existing housing with energy and water saving techniques with a view to improving the sustainability of a dominant part of the urban fabric.

In conclusion, the researchers feel that the TBL approach to the comparative performance assessment is effective but the tool's greatest contribution to good governance is in monitoring entire cities. While differences between the MPC and the TRS development forms are not large, the MPC often performs better and it is worth investigating how the numerous beneficial aspects of the MPC form can be applied to development in general. Finally, there are a number of gaps between policy intent and practise, especially in the environmental arena, but also in connection with housing affordability. There are sufficient initiatives available to close most, if not all shortfalls, given the political will to do so.

1 INTRODUCTION

Urban development, including housing, has significant environmental impacts such as resource consumption, over-extraction from aquifers, the pollution of water, the atmosphere and land, and the elimination of habitat and consequent demise of fauna. As a result, there is a growing desire to provide housing which offers a comfortable standard of living, reduces environmental impacts and which is simultaneously affordable. To this end, governments at federal, state and local levels in Australia are beginning to incorporate principles of environmental sustainability into urban development, especially new housing, and both policy and regulations are starting to reflect the need to become more environmentally sensitive.

The primary aim of this research is to assess the extent to which housing can be affordable whilst simultaneously being sustainable. Sustainability in this research project applies firstly, in an economic sense, for example to the financial costs associated with housing development. Secondly, sustainability applies in a social sense in that affordability of housing and a sense of community may vary according to the nature and form of the development. Thirdly, sustainability applies to the environmental arena, for example reducing impacts by incorporating features that will bring water and energy conservation – and greater operating affordability - or improved stormwater management and less pollution. Moreover, sense of community may be influenced by attention to environment, thus linking two of the three main spheres of human activity.

The research has two chief outcomes. First is a sustainability assessment method – the triple bottom line (TBL) model which is used to assess two key forms of residential development. They are the traditional regulatory subdivision (TRS) of suburban development and the master planned community (MPC). The suite of TBL indicators was built from the literature, validated by the steering committee and finalized by the core team. It is used to derive the second product - an evaluation of the economic, environmental and social characteristics of the two broad development types. Two case studies in each of NSW, South Australia and Queensland were examined within the context of several selection criteria (Prasad and Blair et al 2003). Five of the six case study sites were developed within the context of AMCORD criteria which encouraged the use of ecologically sustainable development (ESD) principles. The evaluation is predominantly a comparison of each case study pair. It is not an absolute assessment of the attributes of the developments. Nevertheless, occasional reference is made to an external benchmark such as expenditure on housing or rates of open space provision but there are very few established norms to allow such comparisons to be made.

In New South Wales the MPC selected is *Wattle Grove. Chipping Norton* is the TRS. Both are in the City of Liverpool, about 30 kms from the centre of Sydney. Wattle Grove was completed in the late 1990s. Chipping Norton represents the last of the traditional subdivisions in Liverpool. It was completed about 1990 before AMCORD guidelines became available. In South Australia, *Seaford Rise* (MPC) and *Woodcroft* (TRS) were selected as the case studies. Both are in the City of Onkaparinga, about 36 and 20 kms from the centre of Adelaide respectively. Both were developed from the early 1990s. Some parts of both communities are still being developed. In Queensland, *Forest Lake* was selected as the MPC and S*innamon Park* as the TRS. Both are in the City of Brisbane. The TRS is 17 kms from the city centre and Forest Lake 35 kms. Sinnamon Park dates from the early 1990s but is complete. Building started in Forest Lake in the early 1990's and is in the last of three stages of development.

The primary aim of the research, noted above, is elaborated into six research questions in Table 1. There were originally 5 questions but on reflection, part of Research Question 4 (What are the conflicts and synergies between economic, environmental and social priorities) is more appropriately discussed as a final question (RQ 6). Research Questions 1 and 2 were dealt with through the literature and policy reviews, summarized in Section 3 of this Final Report and discussed fully in the Positioning

Paper (Prasad and Blair et al 2003). Questions 3, 4, 5 and 6 are answered in Section 5 – Conclusions.

The Final Report is organized into two volumes. Volume 1 contains the summary research findings, conclusions and recommendations. Volume 2 contains the data and the sources and methods used in the research. Data gathering for such a large body of indicators has occasionally led to innovative and rarely employed approaches being taken and these are described, too. The accessibility and impervious surface studies are examples.

In Volume 1, Sections 1 and 2 briefly summarize the literature/policy review and research methods respectively. They give a context to the report. A degree of literature updating has been done for critical themes like energy and water and housing affordability which are introduced in the relevant parts of Section 4, Discussions. Sections 3 to 5 are presented in the same thematic sequence to encourage cross referencing. Section 3 presents the research results and Section 4 discusses the findings. Section 5 provides Conclusions. The three outstanding research questions – the TBL suite and its efficacy, the development form of the MPC and the TRS, and the policy implications of the results are directly addressed within each theme. Finally, the conclusions lead directly to a series of recommendations in Section 6.

Table 1: Research Questions and Methodology

Research Questions	Methodology
1. What are the current alternative methods for assessing the sustainability of differing land development types? How are they used and how effective are they?	Internationally based literature review focusing on sustainability measurement encompassing affordability
2. What government sustainability initiatives are there in Australia and what are the social, economic and environmental implications for affordability in housing?	National review of government sustainability policies
3. What social, economic, and environmental indicators are needed to yield a useful picture of the degree of sustainability achieved for differing development types, especially in relation to affordable housing? How are these parameters integrated?	The specialized literature on indicators of sustainability and expert opinion of the steering committee yields a suite of indicators (the TBL suite).
4. Do 'master planned' communities provide more sustainable outcomes than traditional regulatory subdivision?	Apply TBL indicators to a comparative assessment of MPCs and TRC in the three participating States
5. What are the best policies and land development practices for achieving sustainability goals in light of the proposed triple bottom line assessment model?	Analysis and conclusions of the policy and literature reviews and the case study assessment results
6. What are the conflicts and synergies between economic, environmental and social priorities?	Analysis and conclusions of the case study assessment results

2 WHAT THE LITERATURE TELLS US

2.1 The Nature of Sustainability

The term 'sustainability' is derived from the Latin *sustenere* meaning to maintain and its use in relation to the resources of the planet has a long pedigree dating from the late 18th Century. The contemporary term *sustainable development* was popularised in 1987 in the Bruntland Report which defined sustainable development as "…*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* (WCED 1987:43). Subsequent work on sustainability stems from action under the 1992 United Nations (UN) Conference on Environment and Development, specifically Agenda 21. More recent definitions and explanations of the concept now refer specifically to the finiteness of the world's resources and advance the notion of carrying capacity (for example Pronk and ul Haq 1992; IUCN 1991; and Hodge 1997). The term carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations (see glossary).

There are several conceptual levels in the definition of sustainability. One consists of philosophically encompassing statements such as that from the Bruntland Commission, above. A second level is articulated in conceptual models such as Venn diagrams (Hodge 1997) and Pressure-State-Response (PSR) models (OECD 1991). Such models tend to be ideological but encapsulate the notion of interrelatedness and balance between the social, economic and environmental domains. These models give no practical assistance on operationalising the concept so that interpretations of their meaning can be diametrically opposed depending on one's world view. However, a degree of consensus exists at a very practical level – reducing energy consumption, conserving water and minimizing environmental impacts from waste and pollution but in other tangible areas views are polarized. For example, changing the emphasis in transportation from private to public requires behavioural change and political fortitude, not technological innovation, *per se* (Scully 2000; Michalos 1997; Orr 1994).

The absence of consensus over the meaning and operationalisation of sustainability fifteen years after Brundland (1987) is due to the paradigm's breadth and generality. It is at once a strength and a weakness (Schiller 2001). As a strength, the entire spectrum of society can find some goals that speak to them. Therein lies the weakness, that is, the concept's function as a "man for all seasons"[1]. It is a hindrance to gaining a consensus on a discrete set of normative aims and applying the precautionary principle[2] (United Nations 1992).

The absence of a strong conceptual framework for sustainability points to the embryonic nature of assessment systems and especially the lack of holistic versions. Indicator suites that appear in state of the environment reports (SOEs) throughout the western world (for example North Sydney Council 2000; Willoughby City Council 2000) focus exclusively on the natural environment. Those that appear in TBL community indicator programs are usually cover all three sustainability domains but "Indicators used to report on a transition toward sustainability are likely to be biased, incorrect, inadequate, and indispensable. Getting the indicators right is likely to be impossible in the short term. But not trying to get the indicators right will surely compound the difficulty of enabling people to navigate through a transition to sustainability" (NRC

[1] Said of Sir Thomas More in *Vulgaria,* by Robert Whittington, 1520.

[2] The precautionary principle is about living with uncertainty and risk. It suggests that if we are unsure about future limits the prudent course is to temper our activities until proven that they do not pose a problem for current or future generations (Reid 1995).

1999: 265). The indicator suite compiled as part of this research project is a step in that direction.

As befits the term ESD, formal sustainability policy in Australia from federal to local government focuses almost exclusively on the environment. This may be a defensible emphasis since the environment provides society - and its economy - with critical ecosystem services like materials and sinks for waste disposal. The literature and policy reviews do not cover the vast amount of material covering community and economy and in any event the environment has inevitable and intimate connections with the two domains.

2.2 Methods of Measuring Sustainability

Four main ways of assessing sustainability in relation to land development were identified and fully discussed in the Positioning Paper (Prasad and Blair et al 2003). The first method covers *economic assessments.* The economic cost of housing is an important issue for a wide range of stakeholders including financiers, developers, governments and the public. Overall development costs, influenced by lot sizes, infrastructure run lengths and costs, development approval costs and building costs greatly impact affordability and saleability (Commonwealth of Australia – AMCORD - 1995)**.** Developers make it clear that financial concerns are paramount and are carefully considered in the design of housing (Mcnamara and Ilias, 2002) with single economic measures such as unit price and profit commonly used in assessment.

The other commonly used tool for economic assessment is cost-benefit analysis (CBA). CBA attempts to place dollar values on all economic, and some environmental and social impacts, usually expressed in terms of cost savings, abatement costs and contingent valuation (Dodd and Lesser, 1994). The term “abatement costs” generally refers to corporate expenditures connected with environmental protection and rectifying environmental damage. Contingent valuation or “willingness to pay” involves directly asking people how much they would be willing to pay for specific environmental services, either to give them up or to receive them. Both terms are explained in the glossary.

CBA was not chosen for the post-occupancy evaluation of two neighbourhoods. CBA is not a valid measure of sustainability at this point largely because of the number of assumptions needed to convert non-economic costs and benefits into monetary terms (Mazurek 1998). Barde and Pearce (1991) suggest that CBA is both time-consuming and expensive; that shadow price data are difficult to obtain and are unreliable at present; that some phenomena defy economic measurement so that according monetary values is questionable; and that while CBA appears to be objective it is often value-laden. The researchers accepted these grounds for avoiding a technique which is not yet capable of measuring sustainability.

The second method is *material and energy accounting* which includes such tools as Life Cycle Analysis (LCA), Material Flux Analysis (MFA) and Ecological Footprint analysis (EFA). LCA is probably the most developed and widely used material accounting technique. LCA is generally used at product or process level, accounting for all material, energy and related impacts, including ecological, human health, and resource depletion) due to material extraction, manufacture, transportation, product use, disposal and/or reuse or recycling i.e. "from cradle to grave” (Moore and Brunner, 1996). However, LCA is trenchantly criticised for relying on inadequate scientific knowledge and its huge data requirements (Guinee et al. 1993). Moreover, LCA does not comprehensively assess social and economic issues so the technique was rejected as a means of assessing land development models.

MFA is also a resource intensive assessment tool. Generally used in modelling for large-scale regional studies, MFA quantifies the flows of specified materials through a nominated region or industrial process and maps the principal material, energy, and waste systems, including key linkages, over a given period (Baccini & Brunner 1991).

While useful for evaluating and comparing single or simple materials, MFA is very resource intensive and a tool for application to the physical environment rather than the complexity of entire communities.

EFA can be defined as the area of ecologically productive land and water systems required to provide all the energy and material resources used in maintaining a defined population and assimilating its wastes (Wackernagel and Rees 1996). It is a tool still in search of a common methodology yet it has been adopted by organisations like the World Wildlife Foundation (WWF) and regional authorities in the United Kingdom for developing urban strategies.

The major strength of EF is that it takes into account principles of economics and the carrying capacity of our eco-system at the same time (Rees 2000). It is also an excellent communication tool, easily understood by the individual, professionals and politicians (Ecotec 2001 p 8; Prosus 2001; Deutsch et al 2000; Costanza 2000) and does not require extensive data since its calculations are based on a small group of indicators. It considers the export of pollution and import of ecosystem services in its calculation (UN, 1994). It may fulfill the role of a sustainable development indicator which not only reflects demand but also indicates the direction towards which we should be moving (Prosus 2001; Simmons and Lewis 2000).

There are many criticisms of the EF model. It is very specialized, covering only a few major resource categories and consumption activities. Spatial implications of waste discharges other than CO_2 are yet to be analysed (Rees 2000) and cradle-to-grave impacts are only measured in a highly-aggregated manner (Ayres, 2001; van den Bergh and Verbruggen, 1999). EF neglects the multifunctional nature of land and makes unconvincing comparisons of sustainability based on the use of global ecological productivity averages, the assumed static nature of resource productivity, and the incomplete array of ecological services covered (Daniels, and Moore, 2002). None of this lends credibility to the accuracy of the results, one of the major points of contention for the scientists working in this field, and it was deemed unwise to use EF in the case study assessment.

The third set of techniques use *Building Assessment Tools.* There is a large range of Building Decision Support Tools (BDST) offering predictive and measurement techniques for evaluating building performance, typically from an environmental and economic viewpoint (Athena 2000). Such tools lack comprehensiveness, focusing on specific aspects of performance either singly or in combination such as operational energy use, embodied energy, illuminance, daylighting. Examples are DOE2, NatHERS and ATHENA.

Whole Building Assessment Systems (WBAS) such as BREEM, GBTool, and LEED, provide a broader coverage than BDST of environmental, social and economic issues deemed to be relevant to sustainability. Using a mix of objective and subjective data and a process of weighting and aggregation, they distill information to provide useful indices of sustainability. Most whole building assessment tools claim to be life cycle assessment tools although they often do not meet the full ISO criteria (Athena 2000). WBAS have some potential for providing a broader based sustainability assessment but expert opinion suggests that their use would be prohibitively resource intensive. In a residential community each dwelling would need to be assessed separately and then aggregated for the neighbourhood. Neither BDST nor WBAS were thought to be sufficiently capable in their current form of assessing development at subdivision scale (Cooper 1999).

The fourth main measurement system uses *Indicators.* Indicators and their supporting data underpin all of the assessment tools described above. In this assessment they are used in a more formal sense as suites, for example to evaluate the performance of entire communities. Indicators are units of information describing the state of a system (Spreng & Wills 1996). Indicators have been used at national and international scale

for decades. Their use at urban scale to monitor communities and especially for assessing sustainability is more recent. It follows the 1992 United Nations Conference for Environment and Development that called on countries to develop Sustainable Development Indicators (SDIs).

Sustainability indicators build upon the early social, economic and environmental measures in that they aim to capture all three domains holistically. Attempts have been made to deal with the issue of holism by constructing sophisticated measures that attempt to identify patterns and measure linkages between phenomena (De Kruijf & Van Vuuren 1998; Hancock et al 2000; Nijkamp 1994). Some observers recognize that indicators may not be able to play such a role (for example (Hodge 1996; Cobb 2000a; Moxey et al. 1998) and that identifying relationships and causal connections can only be done through inferential modelling. Also relevant is the idea of indivisibility, expressed in the Santiago Declaration of the Montreal Process (in Lowe 1995, p. 347; Hodge 1998). It is that "no single criterion or indicator is alone an indicator of sustainability. Rather, individual criteria and indicators should be considered in the context of other criteria and indicators."

Traditional or "Quality of Life" (QOL) indicators do not seek holism. They are less about connections and more about single-dimensional counts or viewpoints. For example, knowing the number of litres of water consumed in a city does not reveal if the aquifer is being depleted or replenished (Klein 1997). Similarly, measuring median income is one-dimensional. It is a statement about economic, not social condition because it ignores the distribution of that income.

Elementary measures like these are useful but they ignore the complexity of many phenomena. A more searching indicator linking the social and economic legs of the triad would be the percent of the median income needed to pay for the basic needs of a person in the community. Such indicators integrate several data sets. They contribute more to sustainability but they are much more demanding of data.

In addition to the issue of causality, the open format of indicator suites has been criticised, especially how they are chosen, their accuracy, validity and whether they should be weighted for policy purposes. Despite these reservations, indicators are very useful for identifying, synthesizing, and communicating conditions and trends. They are well regarded for sustainability assessment and widely used (Meadows 1998). Successful indicators are (Innes and Booher 1999; Meadows 1998; Hart 1999; Adriaanse 1995; Redefining Progress 1995; and Sustainable Seattle 1995):

- Representative of important concerns;
- Relevant to policy issues and decision making at all levels of society and government;
- Clearly defined and reproducible, using accurate data, which is technically feasible to collect and developed using theoretically valid and transparent methods;
- Unambiguous, understandable and practical, and reflect the interests and views of different stakeholders;
- Constructed in a participatory process, especially if long term community monitoring is intended, to ensure that the set encompasses the visions and values of the community for which it is developed; and
- Presented as time-based graphs rather than as single numbers.

Triple Bottom Line Indicators

Triple bottom line (TBL) is a sub-set of the "*Indicator*" assessment method and was selected to carry out the appraisal of the two land development forms. TBL is a term that originated in the corporate sector in connection with socially responsible investing but it has been extended to measure performance in the community and environmental

domains as well as the economic/financial one (Deegan 1999). The twin concepts of TBL and sustainability are used interchangeably by many organizations (eg Manaaki Whenua Landcare Research 2002; Christchurch City Council 2002; Price, Waterhouse, Coopers 2002; Westpac 2003).

In conclusion, indicator suites possess many advantages. Their open framework brings an overall flexibility since specific indicators can be abandoned or introduced depending on circumstances like data reliability or data availability. They are useful in organizing data, their contribution to problem solving is valuable and they are applicable to virtually any spatial scale of enquiry. Indicator suites are pointed, that is they can be focussed readily on particular issues. Finally, they can be constructed in a single dimension or elaborated as multi-dimensional measures. These advantages are all highly supportive of the use of indicators as an assessment method and the TBL approach has bee adopted for the research.

2.3 Sustainability Policy

Most environmental policy has its gestation in the literature and in international treaties. It is then disseminated from Federal level to State and local government for implementation. Sustainability policy lacked specificity in relation to housing and urban development until the early-1990s. The main areas of policy development relevant to residential development are as follows:

1. **Sustainability and Urban Design:** A range of Commonwealth Government initiatives responding to international priorities such as Agenda 21 (UNCED 1993) have included the Better Cities Program (Commonwealth Department of Housing and Regional Development 1994), the Australian Urban and Regional Development Review (AURDR 1995) and the Australian Model Code on Residential Development (AMCORD). AMCORD code suggests ways of implementing sustainability in the areas of urban form, density, transport, site planning and solar access, building design, stormwater and integrated catchment management, for social and environmental benefit. Sustainability planning may involve the introduction of best management practices for stormwater management and water sensitive urban design (WSUD) for all forms of development, not merely housing. The former tends to emphasize disposal of water and water quality concerns, perhaps requiring on-site stormwater retention. WSUD is closely related to stormwater management and handling impervious surfaces (Booth and Reinelt 1994; Schueler 1994) but is rather more resource conscious in a water conservation sense. WSUD may advocate green fences and roofs to help absorb storm precipitation and water conservation may stress dual plumbing, low flow water fittings, and drip irrigation, all of which contributes to ESD principles. AMCORD was released in phases over the late 1980's to 1995. State Government has developed state-based legislation through PlanningNSW (SEPP 53 – Metropolitan Residential Development) and a development control plan (DCP) framework to encourage local councils in NSW to prepare consistent performance based codes based on AMCORD. In South Australia, PlanningSA has produced similar guidelines based on AMCORD (PlanningSA 2001).
2. **Flora, Fauna, Biodiversity:** In response to the International Convention on Biological Diversity (1992), the Commonwealth Environmental Protection and Biodiversity Conservation Act (1999) incorporating bilateral agreements with State and Territory governments and a variety of State Government statutes to protect wildlife and native vegetation of significance threatened by development. At least six NSW statutes are connected with urban bushland and biodiversity protection while in South Australia similar statutes protect significant urban trees and control the clearance of native vegetation in defined areas.

3. **Emissions – Ozone, Greenhouse Gas and Energy Use:** Australia has made an international commitment to control the consumption and production of ozone depleting substances. Responsibility for control is shared between the Commonwealth, State and Territory Governments. Such legislation primarily affects industry and controls the use of any of these substances in the manufacture of products including household appliances and products. To this extent, ozone depleters are modestly related to the type of residential development being appraised in this research. National greenhouse strategy initiatives related to housing (Commonwealth of Australia 1998) are mandated at Federal level and are driven by State legislation and enforced by LGAs. Initiatives incorporate energy conservation standards for new housing construction, water heating and heating appliances. Minimum energy performance requirements will also be adopted by all the states via the Building Code of Australia (BCA) during 2003/2004. For example, the BCA energy-efficiency provision 2003 was adopted in South Australia on January 1st, 2003. All new houses are now required to achieve high levels of energy performance equivalent to a four star energy efficiency rating. The state government also applies energy rating labels for domestic appliances and industrial and commercial equipment, which was developed by the National Appliance and Equipment Energy Efficiency Program (NAEEEP).

4. **Water Quality Management:** Commonwealth, State and Territory governments have adopted a National Water Quality Management Strategy. It aims for integrated groundwater management, embracing issues like groundwater quality, water supply, the possible impacts of groundwater extraction on soils, vegetation, surface water systems and dependent ecosystems and the impacts of land use activity on ecosystems. However, integrated water management principles were not in existence when the case studies were developed in NSW although in South Australia, The Water Resources Act (1997) provides a comprehensive framework for the planning, use and management of the State's water resources and the act directly concerns the Adelaide case studies.

5. **Storm Water Management:** In NSW the Environmental Protection Authority has a multi-phased Urban Stormwater Program which includes principles of Water Sensitive Urban Design (WSUD). State adoption of ESD principles is the context for LGAs in relation to WSUD initiatives. The authority for NSW urban stormwater management plans is Section 12 of the Protection of the Environment Administration Act 1991 with implementation mainly by LGAs. In new subdivision, lot design must be closely integrated with storm water management in mind, for example limiting or avoiding completely discharge off-site or off-subdivision. Formal WSUD provisions are too recent to have influenced the NSW case studies but AMCORD (1995) water management principles may have had some effect. Similarly, the Stormwater Infrastructure Planning package (PlanningSA 2002) in South Australia is too recent to have influenced the two Adelaide case studies directly though some elements of the policy have been carried through from earlier initiatives.

6. **Water Supply Management:** The NSW Water Management Act 2000 (NSW, 2000) provides for the sustainable management of the State's waters. The act was driven by the need to secure a sustainable basis for water management since the Sydney Region is now at the limits of its available water resources. State Government water conservation strategies are aimed at reducing water consumption in residential areas especially in metropolitan centres with fittings like low flow shower heads, dual flush toilets and outdoor drip irrigation. These measures have been in operation for at least a decade but have been strengthened through the Water Management Act, 2000.

7. **Waste Management:** NSW State Government policies have adopted the “waste hierarchy” which reflects resource management and ESD principles. To ensure that councils adopt efficient waste management practices, LGAs must comply with the Waste Avoidance and Resource Recovery Act 2001 (WARR), Local Government Acts 1993 and 1997 and the Protection of the Environment Operations Act 1991. While there are variations in the nature of waste management in the Sydney Region between LGAs, both case studies are in the same LGA so there is unlikely to be a marked difference in the response to waste and recycling issues. In South Australia waste management and resource recovery is an intergovernmental issue with waste management principles such as the “waste hierarchy” fully established. Given the recency of this policy material it is unlikely to influence the two Adelaide sites directly though some elements of the policy have been carried through from earlier initiatives.

3 PROJECT METHODS

Project methodology was presented in the Positioning Paper (Prasad and Blair et al 2003) but a summary is provided here for contextual purposes. Methods were developed to answer the research questions presented in the Introduction, above. The literature and policy reviews respond to Research Questions one and two and lead to the adoption of an assessment model which evaluates the two development forms. The specialized literature on indictors and operating programs helped construct an initial suite of indicators for the sustainability assessment (Research Question three). Research Question four concerns the affordability and sustainability characteristics of traditional regulatory subdivision (TRS) as opposed to master planned communities (MPC). It is answered by applying the suite of indicators acting as the assessment model. Research Question five – policy implications - is dealt with through the process of deriving conclusions and recommendations.

The TBL Indicators

The indicators use the tri-domain model, representing society, economy, and environment. The suite of indicators used in this sustainability appraisal is termed in this research as the triple bottom line (TBL) model. The suite is similar to the form of community indicator programs used to measure the condition of some cities in the United States and increasingly in other OECD countries, including Australia. Sub-categories within the model are thematic and the indicators have an emphasis on measuring outcomes as would be expected in a post-development evaluation.

There are 37 primary indicators representing the three domains of TBL analysis. If sub-measures are counted there are almost 100 indicators. They are distributed over the three domains of human activity and directly underpin the third and fourth research questions presented in Table 1. All indicators have exactly the same weight. The indicators are applied to two case studies in each of the three participating states. The suite of indicators is attached to the Positioning Paper.

Research Activities

A large scale data gathering exercise was undertaken to support the indicators with data. Two main lines of investigation were pursued: -

1. One line of enquiry uses a questionnaire, delivered to the selected case study sites. The questionnaire has a socio-economic emphasis but there are a number of environmental questions too.
2. The second line of research involved extensive discussions with the local government agency (LGA) in each of the three capital cities; discussions with the developers and builders of each community; conducting a number of separate investigations, partly on-site in the case study neighbourhoods, but also using data from organizations like the Australian Bureau of Statistics, water supply agencies and energy companies.

The data are summarized by indicator theme in Section 3 of the report, Findings.

Case Study Selection

Criteria were needed to ensure uniformity across the tri-state research project. The criteria ensured that both the case study MPC and the TRS had similar socio-economic characteristics; were representative of mainstream housing, that is, predominantly single-family dwellings in the mid to outer suburbs; and that they were located in the same LGA to control for differences in planning and zoning policies. Further, both neighbourhoods had to be reasonably mature, that is completed and occupied for a minimum of 3-5 years to allow at least the potential for sense of community and neighbourliness to develop; both communities had to be constructed in roughly the

same era; and finally, each community had to contain a minimum of 500 lots for survey techniques to be effective.

Finding a suitable traditional regulatory subdivision TRS was not difficult but locating a TRS and a suitable MPC in the same local government area which met all criteria was problematic in all three states. A specific problem in the Sydney component of the study was locating an MPC which had at least some environmental attributes and which was simultaneously old enough for sense of community to develop and be measurable. ESD principles have only been applied seriously in the last three years in the Sydney Region at LGA level (Flynn 2002), factors which hindered selection of an ideal MPC case study.

Developing The Questionnaire

The questionnaire was constructed using the TBL indicators as the basic guide for the instrument. Ten of the performance indicators are addressed directly through the survey instrument. The instrument has 31 primary questions, many with sub-questions and there are three parts to it. Part 1 asks eight questions connected with neighbourhood satisfaction. Part 2 asks nine questions designed to establish how strongly sense of community is felt by residents. Neighbourhood satisfaction and sense of community are two perception indicators that have to rely on resident input to gauge the success of the two development forms. Part 3 consists of 14 questions seeking environmental data on energy, water and other resource issues. The survey was delivered to 1220 homes in the NSW case studies, 1000 homes in Adelaide and 1200 in Brisbane. Responses are tabulated in the Work in Progress Paper (Blair and Prasad 2003.

Presenting the Findings

The following tables present the two main types of data noted above, the questionnaire-derived data and the information from all other resources such as developers, councils, energy companies and government agencies. Indicators using data derived from the questionnaire are highlighted with an asterisk (*****) in the tables. Where the data for each comparison are not statistically significant, the term “No significant difference” is used. Where the data are statistically significant the cell is shaded and a comparative rating is awarded (for example “higher density”; “lower density”). For a difference between communities to be statistically significant at the .05 level, the percentage difference would need to be as large as, or larger than, the percentage figures below: -

Sampling errors for Wattle Grove (N=142) vs. Chipping Norton (N=149):

- For percentages around 50%: 13.5%
- For percentages around 40/60%: 13.2%
- For percentages around 30/70%: 12.4%
- For percentages around 20/80%: 10.8%
- For percentages around 10/90%: 8.1%

Sampling errors for Forest Lake (N=105) vs. Cinnamon Park (N=101):

- For percentages around 50%: 16.0%
- For percentages around 40/60%: 15.7%
- For percentages around 30/70%: 14.7%
- For percentages around 20/80%: 12.8%
- For percentages around 10/90%: 9.6%

Sampling errors for Seaford Rise (N=98) vs. Woodcroft (N=83):

- For percentages around 50%: 17.2%
- For percentages around 40/60%: 16.8%

- For percentages around 30/70%: 15.7%
- For percentages around 20/80%: 13.7%
- For percentages around 10/90%: 10.3%

The significance figures are based on the following responses obtained from the distributed questionnaires (Table 2): -

Table 2: Questionnaire Responses in the Case Study Neighbourhoods

State	Local Government Area	Case Study Location	Number of Questionnaires Delivered	Number Returned	Response (%)
Sydney, NSW	Liverpool City Council	Wattle Grove	590	142	**23**
		Chipping Norton	630	149	
Adelaide, S. Australia	Onkaparinga Council	Seaford Rise	500	98	**18.5**
		Woodcroft	500	83	
Brisbane, QLD	Brisbane City Council	Forest Lake	600	105	**17.5**
		Sinnamon Park	600	101	

Second, non-questionnaire data is displayed in the tables slightly differently. Objective data for case study pairs that varies by more than 10 percent is rated, for example "More affordable; Less affordable". If the variation is under 10 percent the result is entered as "No difference".

Two terms are used in the following tables which also require explanation: -

1. If data are not available that is stated "Data not available" (and this category includes inadequate data obtained, for example for only one of the case study pairs).
2. If an element or technique has not been introduced into the development then the indicator is "Not applicable" (and there is no data).

4 FINDINGS

The findings present the salient elements of interest flowing from the research. The majority of comments are restricted to the comparisons of the case study pairs. Occasional comment is drawn in relation to the three states or an over-arching standard such as exists on housing affordability or local open space provision.

4.1 Housing Affordability (Indicators 1 – 12)

The first indicator theme summarized here is housing affordability (Table 3). It consists of 12 primary indicators but with sub-components there are a total of 16 measures in the theme. There are insufficient data to allow case study comparisons to be gained across several indicators and Indicator 9 is not applicable since “green” design was not implemented in any community. Ranking the performance of the case studies in NSW is of doubtful value in four cases - Indicators 2; 6a; 6b and 11 (median income, rent assistance and public housing) - even though there are data available. There are nine active measures in NSW; seven in SA and 11 in QLD. The results are highly equivocal in SA and QLD, favouring neither the MPC nor the TRS. Only in NSW are there appreciably more indicators favouring the MPC (in a ratio of 4:1).

Indicators 3 and 5 are the crucial measures in this thematic area since they combine income in relation to expenditure on housing. Renters and owners in both communities in NSW and QLD fall well below the recommended maximum level of 30 percent of total income being spent on housing (Indicator 3). Indicator 5 is a different expression of affordability and still generally places all communities below the threshold. There is no particular pattern of one development form performing better or worse compared with the other.

4.2 Sense of Community, Neighbourhood Safety and Satisfaction (Indicators 13-19 and 23)

Table 4 shows nine indicators for this theme including sub-measures. Data for two key measures (Indicators 16 and 17) are derived exclusively from the household questionnaire. Each embraces 12 and nine separate measures (or data sets) respectively. Indicators 16 and 17 are tantamount to an index of sense of community and satisfaction with neighbourhood respectively.

Of the nine indicators, one was abandoned in NSW (15b). A feature of the responses is the lack of difference across the case study pairs. All MPCs perform better than the TRSs but only in QLD does a marked number of indicators favour the MPC (2:0; 3:1; and 6:0 in NSW, SA and QLD respectively).

Regarding Indicator 15a, one of the few for which there is a standard, the official rate of provision of local active and passive open space is 2.8 hectares/1000 people. Both QLD and SA have much higher rates of provision than the standard. Only the MPC in NSW exceeds the standard.

The findings for Indicators 16 and 17 are extracted from the survey responses and capture the first two categories of the 5-point Likert scale for both indicators. The two categories are “Strongly agree” and “Agree” in the case of Indicator 16 and “Very satisfied” and “Satisfied” in the case of Indicator 17. Very few responses to any of these questions fell into the bottom end of the scale, that is, “Dissatisfied” or “Very Dissatisfied”.

Table 3: Housing Affordability (Indicators 1-12)

Indicator Number\Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	**TRS (Chipping Norton)**	**MPC (Seaford Rise)**	**TRS (Woodcroft)**	**MPC (Forest Lake)**	**TRS (Sinnamon Park)**
1. Median house prices	More affordable ($387,000)	Less affordable ($450,000)	No difference ($184,080)	No difference ($184,381)	More affordable ($177,000)	Less affordable ($273,500)
2. Median household income (per week)	Not meaningful to rank ($1350)	Not meaningful to rank ($1300)	Not meaningful to rank ($613)	Not meaningful to Rank ($642)	Not meaningful to rank ($912-$1118)	Not meaningful to rank ($1220-$1539)
3a. Housing costs as % of weekly median income – rent	More affordable (13%)	Less affordable (21%)	Data not available	Data not available	Less Affordable (18%)	More Affordable (15%)
3b. Housing costs as % of weekly median income –mortgage	No difference (22%)	No difference (23%)	No difference (30%)	No difference (30%)	Less Affordable (24%)	More Affordable (20%)
4a.Percent house prices below LGA median – rent	More affordable (72%)	Less affordable (48%)	More affordable (83%)+	Less affordable (72%)+	No difference (51%)	No difference (51%)
4b.Percent home prices below LGA median – mortgage	No difference (43%)	No difference (42%)			No difference (51%)	No difference (51%)

+ The data are for both rents and mortgages combined.

Table 3 (Cont): Housing Affordability

Indicator Number\ Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	TRS (Chipping Norton	MPC (Seaford Rise)	TRS (Woodcroft)	MPC (Forest Lake)	TRS (Sinnamon Park
5a. Prop. homes paying over 30% income on housing – rent	More affordable (13%)	Less affordable (29%)	No difference (28%)	No difference (28%)	No Difference (17%)	No Difference (15%)
5b. Prop. homes paying over 30% income on housing - mortgage	No difference (19%)	No difference (19%)	Less affordable (17%)	More affordable (14%)	More Affordable (24%)	Less Affordable (20%-21%)
6a. Rent assistance – private properties	Not meaningful to rank (See discussion) 118 props ($34) ($41)	208 props	Data not available	Data not available	Data not available	
6b. Rent assistance – publicly owned properties	Not meaningful to rank (See discussion) 3 properties	10 properties	Data not available	Data not available	Data not available	
7. Development costs – subdivision	Data not available See discussion		600m^2 lot - $15,000 450$m^2$ - $12,500 300$m^2$ - $10,000	Data not available	No difference	
8. Development costs – housing	No difference	No difference	$650 - $850/m2 ($104,000 - $136,000)	Data not available	More Affordable See Vol 2	Less Affordable See Vol 2
9. Development costs – green v conventional homes	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable (See Vol 2)	
10. Maintenance costs of public domain	Higher costs	Lower costs	No difference	No difference	Higher costs	Lower costs
11. Public subsidy	Not meaningful to rank (See discussion)		No difference	No difference	Not meaningful to rank (See Vol 2)	
12. Return on investment	Data not available		4 – 5%	Data not available	No difference	

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Note: Indicators 10 and 11 were ranked qualitatively by a local government official

In Indicator 16 – *Psychological sense of community* – responses to eight of the nine questions favour the TRS in both New South Wales and Queensland, sometimes strongly. The SA results favour the MPC against seven of the nine dimensions though the margin is usually small. These results are not statistically significant. The individual results for the nine questions on the survey instrument are shown in Vol 2. A feature of the table is the equivocal answers to intimate statements like “Fellowship runs deep” with a noticeable proportion of responses to all questions falling into the “neutral” category, that is, “Neither agree nor disagree”.

The MPCs in Indicator 17 - *Satisfaction with neighbourhood* – perform better than the TRSs in all three states against the detailed questions (Vol. 2) and produced results largely opposite to those for Indicator 16. Again, they are not statistically significant. A small number of responses are heavily skewed in favour of one or the other community.

Information for Indicator 19 – *Perceptions of safety in neighbourhood* – is derived from question 1 on the survey instrument. There was no statistically significant difference in perceptions of safety between the pairs of communities in NSW and QLD but a statistically significant difference in SA. Generally high rate of people felt “Very safe” or “Safe”, well over 75% on average.

Finally, Indicator 23 – *Accessibility to services* – contains nine specific dimensions consisting of typical community facilities summarized in Table 5. These are measured quantities using GIS software. The MPCs perform better than the TRSs in all three states but there are some polarized results especially concerning library and shopping facilities. The accessibility issue is considered further in Section 4, Discussions.

4.3 Transportation (Indicators 20 to 22)

There are three main indicators in this theme but with sub-measures there is a total of nine measures (see Table 6). In NSW the Wattle Grove MPC performs appreciably better than the TRS (6:0 with three yielding “No difference”. In the case of Indicator 22c (non-auto journey mode) the measure suggests there is at least double the propensity in the NSW MPC to walk or cycle (or skate board or scoot) to work compared with the TRS. This is a statistically significant finding. The Queensland MPC (Forest Lake) performs better than the TRS across five of the nine measures, there being no difference in 2 cases. In SA, there is no difference between the two communities against all nine measures.

Table 4: Neighbourhood Satisfaction and Sense of Community

Indicator Number\ Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	**TRS (Chipping Norton)**	**MPC (Seaford Rise)**	**TRS (Woodcroft)**	**MPC (Forest Lake)**	**TRS (Sinnamon Park)**
13. No. of newsletters, local meetings, projects, events	No difference	No difference	No difference	No difference	More numerous	Less numerous
14. Participation in community meetings, projects, events	No difference	No difference	More participation	Less participation	More active	Less active
15a. No. of parks, open spaces/ area of parks, open spaces	More parks/spaces (3.2 has/1000 people)	Less parks/spaces (0.8 has/1000 people)	More parks/spaces (22 has/1000 dwell.)	Less parks/spaces (15 has/1000 dwell.)	More parks/spaces (7.5 has/1000 people)	Less parks/spaces (6.3 has/1000 people)
15b. No. of people using public gathering spaces	Indicator not pursued (See discussion)		No difference	No difference	More use	Less use
* 16. Psychological sense of community	No significant difference (55%)	No significant difference (66%)	No significant difference (50%)	No significant difference (47%)	No significant difference (49%)	No significant difference (55%)
* 17. Satisfaction with neighbourhood	No significant difference (73%)	No significant difference (70%)	No significant difference (80%)	No significant difference (73%)	No significant difference (74%)	No significant difference (70%)
18. No. of pedestrians and cyclists	No difference	No difference	No difference	No difference	More numerous	Less numerous
* 19. Perceptions of safety in neighbourhood	No significant difference (77%)	No significant difference (72%)	Less safer (72%)	Safer (87%)	No significant difference (82%)	No significant difference (85%)
23. Percent homes within 400 metres walk of selected facilities	Better accessibility	Worse accessibility	Better accessibility	Worse accessibility	Better accessibility	Worse accessibility

Note: data cells that are shaded represent statistically significant differences between the two cases in each pair of case studies. Only survey responses are assessed for statistical significance.

Table 5: Neighbourhood Satisfaction and Sense of Community

Facilities/Services	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	TRS (Chipping Norton)	MPC (Seaford Rise)	TRS (Woodcroft)	MPC (Forest Lake)	TRS (Sinnamon Park
Community centre	23%	0%	6%	13%	24%	0%
Tennis courts	36%	0%	35%	0%	20%	0%
Swimming pool	2%	0%	0%	0%	10%	0%
Child care centre	23%	21%	0%*	0%*	24%	10%
Library	0%	0%	0%*	0%*	0%	10%
Primary school	59%	35%	35%	19%*	34%	0%
Local health services	28%	50%	0%*	20%	25%	10%
Public open space	100%	87%	100%	75%	90%	47%
Shopping facilities	28%	40%	29%	31%	25%	20%

Note: includes services/facilities located outside community but which have part of their 400-metre catchment within the case study pairs.

4.4 Environment – Biodiversity (Indicators 24 and 25)

None of the communities display any sensitivity towards protecting habitat or bio-diversity (Table 7). Very low levels of native bush remain throughout. Only in QLD is there a degree of difference between the case study pairs because a 12ha park has been rehabilitated entirely with native plants.

4.5 Environment – Energy (Indicators 26 to 31)

Of the 12 energy indicators presented in Table 8, including sub-measures, the techniques embraced by three of them (Indicators 29, 30 and 31) were not applied in a purposeful way to any of the case studies. Of the remaining nine indicators the NSW MPC performed somewhat better than the TRS on five counts and slightly worse on two counts. In QLD and counter to researcher's expectations, the TRS (Sinnamon Park) performed better than the MPC on four measures. The MPC did not perform better against any measure. In SA, none of the measures yielded any difference.

The critical indicator in the energy suite is total energy use, Indicator 26. These measures indicate that the NSW MPC consumes about 12 percent less energy overall than Chipping Norton, the TRS. Queensland's MPC consumes about 25 percent more than the TRS. Greenhouse gas emissions (Indicator 28) are a significant 24 percent lower in the MPC Wattle Grove, but approximately 28 percent higher in Queensland MPC Forest Lake. The NSW and QLD data are objective data from the energy companies.

Indicator 27 has been elaborated to accommodate additional information on renewable energy which is derived from the questionnaire responses, not from the energy companies. There is virtually no difference in take-up rates of alternative energy sources over the case studies and all are low with one exception (solar hot water in the NSW TRS).

Table 6: Transportation

Indicator Number\ Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	**TRS (Chipping Norton)**	**MPC (Seaford Rise)**	**TRS (Woodcroft)**	**MPC (Forest Lake)**	**TRS (Sinnamon Park)**
20a. Non-auto transport: bus route density	No difference (9.6km/1000)	No difference (9.7km/1000)	No difference	No difference	Lower density (5kms /1000 pop) (but see discussion)	Higher density (14.6kms / 1000 pop) (but see discussion)
20b. Non-auto transport: bus density	Greater density (7 buses/1000 people)	Less density (5 buses/1000 people)	No difference	No difference	Greater density (4 buses/1000 people)	Less density (2 buses/1000 people)
20c. Non-auto transport: bus frequency	Greater frequency (1 bus/37 mins weekday)	Less frequency (1 bus/64 mins weekday)	No difference	No difference	Greater frequency (1 bus/30 mins weekday)	Less frequency (1 bus/60 mins weekday)
21. Length of pedestrian and bike paths per dwelling (kms).	Greater provision (6.89 kms/1000)	Less provision (0.0 kms/1000)	No difference (13.77 kms/1000)	No difference (13.85 kms/750)	Greater provision (.94kms / 1000)	Less provision (.28kms / 1000)
22a. No. riding bikes and leaving the neighbourhood	No difference (but see discussion)	No difference (but see discussion)	No difference	No difference	Greater amount	Lesser amount
22b. No. walking and leaving the neighbourhood	No difference (but see discussion)	No difference (but see discussion)	No difference	No difference	Greater number	Lesser number
***** 22c. Person 1 journey mode: all non-car options	Greater non-car use (20%)	Less non-car use (3%)	No significant difference (15%)	No significant Difference (14%)	No significant difference (8%)	No significant difference (7%)
***** Person 2 journey mode: all non-car options	Greater non-car use (30%)	Less non-car use (13%)	No significant difference (14%)	No significant difference (13%)	No significant difference (18%)	No significant difference (20%)
***** Person 3 journey mode: all non-car options	Greater non-car use (44%)	Less non-car use (20%)	No significant difference (33%)	No significant difference (33%)	No significant difference (25%)	No significant difference (33%)

Note: data cells that are shaded represent statistically significant differences between the two cases in each pair of case studies. Only survey responses are assessed for statistical significance.

4.6 Environment – Other Aspects of Resource Consciousness (Indicators 32-33 and 36-37)

Most of the non-energy indicators in the environmental theme are connected with resource consciousness and they are gathered into a sub-theme in Table 8. The MPCs perform better than the TRS over all three states (6:0; 3:0 and 5:0 in NSW, SA and QLD respectively. In NSW and QLD, densities, average lot size and measures of house size all point quite strongly in the direction of the MPC using resources more frugally. While the researchers were unable to obtain comprehensive data on house size, other sources such as large scale aerial photography and responses to the questionnaire are highly suggestive of smaller houses in general in both the NSW and QLD MPCs.

Indicator 36 focuses on water consumption. Water consumption data was not available for SA. Both QLD and NSW MPCs use 15 and 14 percent less water per capita than the TRSs, reinforcing the impression of greater resource frugality. Application of conservation practices (Indicator 37, Table 11 are similar across the states, though SA has a remarkably high rate of installation of rainwater tanks.

Indicator 38 concerns waste management. There is no essential difference between the MPCs and TRSs which is unsurprising since each case study pair is located in the same LGA. The most noticeable feature of this indicator is the surprisingly high composting rate, consistent throughout the case studies.

4.7 Environment – Wastewater/Stormwater Control (Indicators 34 and 35)

Regarding Indicator 34 (Table 9) all communities in the three states are serviced by conventional sewage treatment infrastructure. There are very few fully ecological treatment systems in Australia regardless of age of development. Indicator 35 points to the NSW and QLD MPCs' greater environmental sensitivity on matters of water sensitive urban design (WSUD). The installation of stormwater quality improvement devices and sand filtration and bio retention pond technologies in Forest Lakes, and the extensive use of swales and natural drainage terminating in lakes in both MPCs, must help water quality management and flood control.

South Australia's City of Onkaparinga is renewing attempts to develop a more ecologically sensitive waste and storm water management system for all development including the two case studies.

A sub-component of Indicator 35 – impermeable surface cover, Indicator 35b – was introduced in the NSW study to add dimension to the water quality picture. It involved conducting an impervious surface cover (ISC) study. ISC is an example of an integrating indicator which serves as a proxy for several urbanization impacts (Prasad and Blair et al 2003). Table 9 indicates that Wattle Grove has essentially the same proportion of impervious cover by way of concrete, asphalt and roofing as Chipping Norton (respectively 39 percent and 42 percent). There appears to be no essential difference between the two NSW communities but the findings are important and they are discussed later.

Table 7: Environmental Theme – Biodiversity and Energy

Indicator Number\ Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	TRS (Chipping Norton	MPC (Seaford Rise)	TRS (Woodcroft)	MPC (Forest Lake)	TRS (Sinnamon Park
24. Area/proportion of site retained as native bushland	No difference		No difference		Lower Proportion (12ha or 1%)	Higher Proportion (12ha or 4%)
25. Management strategies/plans	No difference	No difference	Slightly more	Slightly less	No difference	No difference
26a. Energy use by fuel type (electricity): median per dwelling	More conservative (2347 kWh/year)	Less conservative (4048 kWh/year)	No signif. difference (4798 kWh/year)	No signif. difference (4279 kWh/year)	No difference (8,239 kWh/year)	No difference (8,933 kWh/year)
26b. Energy use by fuel type (gas): median per dwelling	Less conservative (25,332 Mj/year)	More conservative (18,835 Mj/year)	No signif. difference 23,461 MJ/year	No signif. difference 21,507 MJ/year	Data not available	
26c. Total energy use per capita	More conservative (3,127 kWh/year)	Less conservative (3,540 kWh/year)	No signif. difference 3,938 MJ/year	No signif. difference 3,752 MJ/year	Less conservative (Approx. 4,000kWh/yr)	More conservative (2,882 kWh/year)
26d. Total energy use per dwelling	More conservative (9,383 kWh/year)	Less conservative (10,620 kWh/year)	No signif. difference 11,315 MJ/year	No signif. difference 10,253 MJ/year	Less conservative (Approx.11,500 kWh/yr)	More conservative (8,933 kWh/year)
***** 27a. Proportion of renewable to non-renewable energy purchased	No significant difference (2%)	No significant difference (1%)	No significant difference	No significant difference	No significant difference (6%)	No significant difference (3%)
***** 27b. Prop. with solar hot water	Less conserving (1%)	More conserving (11%)	No significant difference	No significant difference	No significant difference (5%)	No significant difference (8%)
***** 27c. Prop. with solar electricity	No significant difference (0%)	No significant difference (1%)	No significant difference	No significant difference	No difference (0%)	No difference (0%)
28a. GHG emissions/capita	Fewer emissions	More emissions	No significant difference	No significant difference	More emissions (4,160kg /year)	Fewer emissions (2,997kg /year)
28b. GHG emissions per dwelling	Fewer emissions (3903kg/year)	More emissions (5117 kg/year)	No signif. difference 5720 kg/year	No signif. difference 5458 kg/year	More emissions (11,960 kg/year)	Fewer emissions (9290 kg/year)
29. Application of energy efficient design principles (site)	Not applicable (but see text)	Not applicable	Not applicable (but see text)		Not applicable	Not applicable
30. Energy efficient design (buildings)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
31. Lower embodied energy	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

Note: energy consumption data from the questionnaire was used only for S. Australia. Data for NSW and QLD are not subject to statistical significance tests.

Table 8: Other Aspects of Resource Use

Indicator Number\Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	**TRS (Chipping Norton**	**MPC (Seaford Rise)**	**TRS (Woodcroft)**	**MPC (Forest Lake)**	**TRS (Sinnamon Park**
32a. Gross residential density (dwellings/ha)	Higher density (10.72)	Lower density (7.8)	No difference (10.3)	No difference (9.7)	Higher density (21 pph)	Lower density (17 pph)
32b. Net residential density (dwellings/ha)	Higher density (12.7)	Lower density (8.5)	Higher density (15)	Lower density (12.3)	Data not available	Data not available
***** 33a. House size (sq m)	Smaller dwellings	Larger dwellings	No signif. difference	No signif. difference	Smaller dwellings	Larger dwellings
Prop. with 3 bedrooms	(68%)	(47%)	(63%)	(63%)	(68%)	(38%)
Prop. with 4 bedrooms plus	(25%)	(25%)	(25%)	(25%)	(26%)	(53%)
Community perceptions of house size (sq metres)						
• Up to 160 m^2	(45%)	(25%)	(56%)	(47%)	(26%)	(16%)
33b. Lot size – average (sq m)	Smaller lots (510 m^2)	Larger lots (681 m^2)	Smaller lots (470 m2)	Larger lots (650 m2)	Smaller lots (300 m^2)	Larger lots (550 m^2)
***** 33c. Perceptions of lot size						
• Small	(32%)	(4%)	(31%)	(18%)	(46%)	(8%)
• medium	(48%)	(77%	(62%)	(74%)	(38%)	(84%)
36. Water consumption/dwelling/year	Less consumption (287 kL)	More consumption (336 kL)	Data not available	Data not available	Less consumption (348kL)	More consumption (411kL)
***** 37. Use of best practice water conservation techniques	No significant difference (but see discussion)		No significant difference	No significant difference	No significant difference (but see discussion)	
***** 38. Solid waste: A - recycling	Data not available	Data not available	No signif. diff.(77%)	No signif. diff.(79%)	No signif. diff.(85%)	No signif. diff.(85%)
B - composting	No signif. difference (32%)	No signif. difference (42%)	No signif. difference (46%)	No signif. difference (38%)	No signif. difference (44%)	No signif. difference (42%)

Note: in Indicator 33a it is not possible to exclude the line item “Prop. With 4 bedrooms” from the shading of statistically significant difference.

Table 9: Environment - Water Quality Issues

Indicator Number\ Abbreviation	New South Wales		South Australia		Queensland	
	MPC (Wattle Grove)	**TRS (Chipping Norton)**	**MPC (Seaford Rise)**	**TRS (Woodcroft)**	**MPC (Forest Lake)**	**TRS (Sinnamon Park)**
34. Wastewater treatment (ecological v. conventional)	No difference (Wholly conventional)	No difference (Wholly conventional)	No difference (Wholly conventional)	No difference (Wholly conventional)	No difference (Wholly conventional)	No difference (Wholly conventional)
35a. WSUD for stormwater – number of best practices applied	Greater use	Lesser use	Greater use	Lesser use	Greater use	Lesser use
35b. Impermeable surface cover	No difference (but see discussion) (ISC -39%) (ISC - 42%)		Not applicable	Not applicable	Not applicable	

5 DISCUSSION

5.1 Affordability Indicators (Indicators 1 – 12)

House Prices and Affordability

In NSW, house prices in the MPC are about 14 percent lower than the TRS though the differential is less than might have been expected. The margin in favour of the QLD MPC is much greater. Somewhat different circumstances seem to apply in SA. House prices are identical in the two communities although there are more houses in the MPC with prices below the LGA median. Several innovative features were introduced into the QLD and NSW MPCs – zero lot lines, narrower roads, smaller lot sizes than normal and smaller homes in general. There is a variety of house and lot sizes in both MPCs, encouraging a diverse population of singles, families and the elderly. Wattle Grove in NSW was billed in the 1990s as the quintessential affordable community (Illias 2002). It is counter-intuitive that the MPC fails to offer noticeably greater affordability and a flow-on effect into Indicator 5b. A possible explanation is the detailed design covenant imposed by the Wattle Grove land developers (DPGDHAJV 1994) which has brought very high presentation qualities, of a calibre which may have placed pressure on prices. NSW's Wattle Grove seems to have been particularly affected.

The covenant lists 21 aesthetic elements including the textures and colours of the materials, landscaping and controls that were designed to ensure sunlight penetrated the courtyard of the villa homes for a minimum period during the day. The landscaping aspect of the covenant has brought lavish, generally native planting and considerable aesthetic benefits. Native vegetation tends to be drought resistant, too. However, the landscaping aspect of the covenant directly impinges negatively on Indicator 10 – maintenance costs of the public domain since costs are apparently well above average (Edwards 2003).

There are precedents for design raising real estate prices. One of the western world's first substantial subdivisions with ecological and new urbanist features was the affordable Village Homes development at Davis, California, completed in the early 1990s. Several years later it commanded sale prices that were about AUD$170 per square metre than comparable houses elsewhere in the Sacramento area (Corbett 2000). Affordability is being appreciably eroded here, a situation that can only be corrected by building more communities of the same calibre.

Recent Affordability Information

The data presented in Section 3 suggests affordability in reasonable. Some recent reports suggest that housing affordability on average is vastly better than it was in the late 1980s. In 1989, Sydney mortgage payments absorbed 83 percent of average male earnings. Now it is just under 50 percent (Porter 2003). Figures from the Australian federal treasury (Wade 2003) suggest that mortgage repayments as a proportion of gross income fell from 20 percent nationally to 16.7 percent between 1990 and 2000. Using 2002 figures, the Treasury also suggests that the debt servicing ratio has halved in Australia since the peak of 1990. The debt servicing ratio is based on average house prices, mortgage sizes and interest rates. However, other reports conflict with these affordability data. Figures released on May 8/2003 in the Housing Industry Association and the Commonwealth Bank March quarterly housing report indicated that on average, 38 percent of household income was diverted to maintain a Sydney mortgage. The national average is 23 percent (SMH 2003b).

The affordability averages for the two Sydney case studies conceal significant difficulties. The lowest income groups in both case studies were examined in the special tabulation obtained from ABS. It reveals that affordability for low income people is severely impaired by high real estate prices in the Sydney Region. Taking three low-income brackets spanning $200 - $499 per week, rent ranges up to 90 percent of

weekly income. It is far in excess of the guideline that no more than 25 percent of income be spent on housing for low-income groups (Commonwealth Department of Health et al 1993; NHS 1991). Mortgage repayments are in excess of 100 percent of weekly income, a staggering and at the same time, barely credible proportion.

It is politically and socially important to improve affordability. There are a number of current initiatives worth reinforcing and possible ideas to explore including:-

- The Housing Industry Association's suggestions (HIA 2002) of a radical review of planning and institutional controls. Macro-economic influences can still overcome purposeful affordability planning however, as intimated in the Wattle Grove case study.
- Establish BuildSmart centres or expand the functions of the existing Sydney Building Information Centre in NSW. BuildSmart is the Victorian Sustainable Building Education Centre promoting environmentally sustainable housing (Holmesglen TAFE 2003). It is a 'one stop shop' for information and education on environmentally sustainable design, construction and materials for both consumers and industry professionals.
- Promoting resource consciousness in the residential market along with smaller houses and lots will be a challenge in a period of burgeoning materialism (Gittins 2003). Builders also comment that "green" additions to new housing add appreciably to construction costs (HIA 2002). However, there is contrary evidence, for example a new Seattle (United States) 50-unit housing project will become the first low-income housing project in the US to win a green building LEED certificate (Kramer 2003). Affordability need not be compromised by sustainability in initial construction (Prasad 2001). A number of non-technical approaches in passive solar design (PSD) add virtually no cost through clever design. Other measures like added thermal insulation and solar hot water will bring extra construction costs but they are quickly amortized by lower heating and cooling costs and smaller water bills with short payback periods of under five years. The QLD research suggests that the differential for low technology "green" building solutions would cost only $22per m^2 (see Volume 2, p. 93). Another factor is that "green building" costs have come down dramatically in the last six years (Commonwealth of Australia 2001). Marketing green building's advantages positively as a "sexy product" (Toepfer 2003) could also help sustainable housing become mainstream.
- Government agencies could adopt a green building rating system. It has been taken up by a few LGAs in the United States (eg City of Scottsdale 2003) and Vermont (Wilson 2003). A group of Vermont builders are piloting a voluntary residential green building program. It is built around a combination of 54 mandatory measures and another 226 green features for which more than 430 points are available. To gain certification, a home must achieve all the required measures and earn at least 100 points. A unique feature of the program is the emphasis on house size. For smaller-than-average houses, points are awarded; for larger-than-average houses, points are subtracted (Wilson 2003).
- Innovative answers to the low income affordable housing problem are now occurring in several places in Adelaide, Brisbane and Blacktown, Sydney (Southgate 2003). Solutions are targeted at both rental and purchase components of the market and involve creative financing arrangements in a consortium of banks, realty investors and government agencies. It is not clear if environmental sustainability is simultaneously being addressed. If so it could lead to "green" mortgages which take operational savings into account in determining loans and repayment levels.
- Employing unconventional low cost materials like straw bales and house-building using a significant cooperative input by the prospective home owners, friends and local community.

5.2 Neighbourhood Satisfaction, Sense of Community and Safety (Indicators 13-19 and 23)

One reason for lower satisfaction levels in NSW's Wattle Grove regarding Question 7 ("Satisfaction with maintenance" - Table 4) may be connected with the lavish public landscaping provided by the developers. An unusually high proportion of people rated maintenance in the "Bad" or "Very bad" category (23 percent) and an unusually high proportion were unsure of their view, that is, "neither well nor badly maintained" (31 percent). Council took over the maintenance responsibility for landscaping and the high cost has apparently led to standards of care diminishing (Edwards 2003). Adding weight to this interpretation is the high satisfaction level reported in Wattle Grove (averaging close to 80 percent) with roads, bike paths and parks and open space which constitute most of the public domain.

Residents' reaction to standards of Council-operated maintenance of the public domain in the Forest Lake MPC in QLD is also relatively negative even though the developer, Delfin, still manages key visual elements of the MPC. In SA, providing an attractively landscaped and well-designed community was a major marketing tool in the MPC but standards of care have diminished since transfer of maintenance to the LGA. Nevertheless, satisfaction with neighbourhood maintenance in both the MPC and TRS is similar and quite high, contrasting with NSW and QLD where the TRS appears to be better maintained.

Open-ended comments in NSW on Question 7 raise an appreciable number of complaints about parks/open spaces being poorly maintained. Nevertheless quite high satisfaction levels are reported in both Wattle Grove and Chipping Norton to Question 8 "How attractive is your neighbourhood", 70% being satisfied or very satisfied .

There is little obvious explanation for the dissatisfaction claimed in Wattle Grove about access to library facilities (Table 4) and not the TRS. Neither community in NSW has a library and the nearest is about 1 kilometre from Chipping Norton and about 1.5 kilometres from Wattle Grove. Explanation for the divergent rating cannot be found in the open-ended comments. Equal percentages in Wattle Grove reported that the library was in a good location and also that it was too far away.

Both the QLD and NSW TRSs fared consistently better than the MPCs in Indicator 16 – Sense of Community - a result that was counter-intuitive to the researchers. The reason behind the NSW and QLD results is unclear but in both cases the TRS is embedded in an existing and mature community while the MPC is relatively isolated. Only one of the nine questions forming Indicator 16 favoured the MPCs. This is Question 17 on the instrument ("Living in this neighbourhood gives me a sense of community"). Question 17 acts as a summary of the preceding eight questions (see Table 5 above). The summary variable and the eight other "Sense of community" variables are highly related ($r = .80$), an indication that the composite variable is a useful way to summarise the sense of community concept. However, Question 17 was not used as the summary measure to compare the two communities in Table 3. First, the margin in favour of the NSW MPC is small and second, it has the effect of reversing the individual rating which seems rather drastic. In SA, the MPC performs better against Question 17, the summarizing measure.

Regarding Indicator 23 – Accessibility to services – it is possible to compare scientific measurements of access to facilities with perceptions of accessibility to them (Table 4). A higher proportion of people are closer to shops in the NSW traditional subdivision than the MPC using the 400 metre threshold. However, the satisfaction rate reported by residents in the household survey is the reverse though the margin is not statistically significant. There are two small shopping strips in Chipping Norton offering low-order facilities. There is only one neighbourhood centre in Wattle Grove. It is eccentrically located in the community though it is larger and offers higher order facilities. The shopping centre's design together with its non-retail facilities also give it vibrant civic

atmosphere. Scientific measurement using the 400 metre threshold, did not account for centre quality or size. Perception may be more useful than science sometimes.

Several contradictions exist in the accessibility results. First, in SA, both communities have library access facility but they are located more than 400 metres from housing. Ironically the survey shows that people in both communities profess a high level of satisfaction with library access, hinting again that the 400 metre guideline may be irrelevant. Second, measured accessibility for primary schools is noticeably better in Wattle Grove but against the satisfaction survey the reverse is the case. Third, the provision of open space (Indicator 15a) greatly favours Wattle Grove (Table 3) but the satisfaction results are very similar for both the NSW communities. Perhaps the existence of considerable tracts of regional open space on the edge of Chipping Norton explains these results. Only in the case of the community hall is the direction of the results the same, Wattle Grove being favoured by both the measurement and the perception analysis. There is a community hall in Chipping Norton but its catchment falls well outside the study area. However, given the comments in the transportation section about foot weariness, the 400 metre guideline may become largely irrelevant.

5.3 Transportation (Indicators 20 to 22 and Questionnaire)

There were virtually no differences between the two communities against the transportation indicators in SA. A possible reason in the QLD and NSW cases for the margin between Indicators 22a, 22b and 22c is that the MPCs' linear spine design brings bus routes closer to a much higher proportion of homes than the peripheral service of the two TRSs. The latter necessitate longer walks to bus stops. Designing for proximity to public transport need not be dictated by development form and may help generate patronage though there are other factors at play, too.

It should also be pointed out that bus passenger data were not sought and the existence of a network is no indication of intensity of use. Car ownership has increased in the Sydney metropolitan area over the last decade from 1.3 vehicles per household to 1.4, average household size has fallen and public transportation patronage has reportedly declined (Kerr 2002). There is not a complete correlation between car use and car ownership but in Greater Western Sydney (GWS) 50 percent of all households own two or more cars, compared with 37.2 percent in Sydney overall. Since public transport is not as good, GWS is more reliant on the private car. It is possible to speculate that a reasonable bus frequency in the MPC in New South Wales may constitute an over-provision at some point in the future.

Indicator 22a and 22b examined other forms of "journey to work" by bicycle and on foot. Sightings of pedestrians or cyclists were extremely limited in both communities although the findings for this indicator are based on field observations that are not comprehensive (see Volume 2). Regardless of the level of activity, there are difficulties in establishing data for this indicator. Only by interviewing people can one determine whether they are cycling or walking for recreational or journey to work purposes. Moreover, covering multiple exit and entrance points to each community would normally be possible only for a specialized transportation study. However, Kerr's (2002) analysis of current transportation trends, including reports that we are increasingly reluctant to use our feet, add some weight to the findings of Indicators 22a and 22b.

Indicator 22c offers a further perspective which underscores the results of the public transport appraisal. Residents of the MPC in NSW use non-auto modes for journey to work at about double the rate of the TRS. Explanations may be that bus frequencies in Wattle Grove are better; car ownership levels are slightly higher in the TRS; accessibility to services is somewhat superior in the holistically planned MPC; rail transport is a little closer to the MPC – 1.5 kilometres distant as opposed to 3 kilometres for the TRS; increased use of public transport is often associated with higher densities (Minnery 1992) and higher density development can also bring major resource savings, especially of energy; and finally, Wattle Grove is a porous neighbourhood. There are

many formal short cuts from culs de sac into adjacent road systems, allowing pedestrians to make direct rather than circuitous journeys on foot or by bicycle, the latter tending to promote auto travel.

5.4 Environment – (Native Bushland - Indicators 24 - 37)

The construction of both neighbourhoods precedes NSW regulation regarding protection of biodiversity and native vegetation. The vestigial remnants of bushland in both the TRS and MPC have aesthetic value and perhaps offer minor habitat/shelter opportunities. None are likely to have complex ecosystem functions. Indeed the remaining native bushland in Wattle Grove may be less important than the lavish landscaping provided by the land developers of the MPC (DPGDHAJV 1994). It probably acts as a useful habitat and food resource, helping indirectly to maintain biodiversity albeit in a minor way.

In more recent developments, Sydney faces the dilemma of accommodating a population growing at almost 1000 people per week while attempting to preserve ecologically valuable remnants of the formerly vast Cumberland Plain bush. It is one of the most threatened ecosystems in Australia. Some observers (for example Peatling 2003) are sceptical of scientists' ability to protect even 800 hectare flora and fauna reserves like that nominated for the Australian Defence Industry site in western Sydney. Others, (eg Fowkes 2003) suggests that patches as small as 10 hectares can be protected successfully with intensive management. However, maintaining full ecosystem health in metropolitan areas may be impractical even with a panoply of protection devices although aesthetic and water quality functions are likely to remain.

5.5 Environment – (Energy - Indicators 26 - 31)

While the Sydney TRS is marginally better in the alternative energy area, the smaller houses and higher densities of the Sydney MPC consume less energy overall and produce fewer greenhouse gas emissions. The reverse was the case in SA and QLD. Minnery (1992) found that higher densities can reduce interior heating and cooling costs by up to 26 percent, adding support to the empirical findings. Energy consumption is higher per capita in the Chipping Norton TRS partly because homes are larger. Responses to the household survey also show that Chipping Norton has higher rates of appliance and equipment ownership and lower efficiency ratings on four types of appliance. While the absence of passive solar design (PSD) is regrettable, the community could not be expected to be responsive to energy policy that was barely articulated at the time and certainly not regulated.

The consumption levels of the Sydney MPC are achieved with virtually no energy conserving features and are indicative of the potential that purposeful design for energy conservation could achieve. There are several measures in operation now in NSW which will improve conservation performance. Several were noted in the literature review. In addition, the NSW government is developing a voluntary residential energy audit policy to embrace building upgrades as well as behaviour change. The state government also anticipates adopting the Building Code of Australia in May 2004 with its new minimum energy rating requirements.

It is relatively straight-forward to gain energy savings and high positive investment returns of up to 20 percent in some areas like lighting (Cummins 2002) but demand management tactics through pricing are likely to be needed. The NSW energy companies are contemplating large price rises for households that use excessive amounts of power, such as those in large houses with swimming pools and air conditioning. Price signals would apply after a certain kWh use threshold had been passed (5 mWh per year) and also in summer. Peak time meters would also be installed for big residential users and small business (Davies 2003).

Initiatives like these should lead to lower per capita energy consumption and fewer GHGs but some trends are working in the opposite direction. Use of energy consuming

equipment is expanding and there is still a tendency for larger and larger houses to be built. For example, air conditioning is growing in popularity with more than 50 percent of western Sydney's residential customers of Integral Energy possessing air conditioning compared with 25 percent 10 years ago (Davies 2003). There are advanced air conditioning systems that can run 30 percent more cheaply overall and use a fraction of the energy (Cummins 2002). They are not yet being used in Australia but if society is serious about energy reduction, detailed attention on individual aspects of energy demand is needed.

5.6 Other Forms of Resource Consciousness (Indicators 32-33 and 36-37)

Where dwelling size is concerned, the smaller the dwelling, the greater the affordability in general and the better the response to natural resource issues and environmental impacts. The NSW case studies show that the MPC's higher densities and smaller dwellings probably contributed a great deal to the claim in the early 1990s that Wattle Grove was highly affordable, a cornerstone of social sustainability. Lots in general in metro-Sydney are smaller as a result of planning controls but new houses have increased dramatically in size. In a 10-year period, 1990 to 2000 average lot size has shrunk 700 m^2 to 540 m^2 but average home size in Sydney Region has grown from 169 m^2 to 267 m^2 – the size of a small fibro house from the 1950s (Verity 2003). New HIA homes in Sydney now average 283 m^2 compared with 211 m^2 in Adelaide and 254 m^2 in Brisbane (Lacy 2003). It is in breathtaking contrast to the frugality encouraged by government in the 1950s that saw legislation limit house size to 92 m^2 between 1938 and 1952. It might act as a reminder to government accommodation-planning efforts, especially in the Sydney Region, even though there will be strong cultural opposition to reducing house size.

While water consumption data are unavailable for SA, they are likely to have been influenced by its semi-arid climate as suggested by a noticeably higher rate of rainwater tanks and dual flush toilet installed compared with NSW or QLD. Water consumption is lower in the NSW MPC (Boerima 2003) but the difference is not related to the application of water conservation techniques. Only one conservation feature – dual flush toilets – was installed during building and that was done by one of the major builders in both Wattle Grove and Chipping Norton (Barnaby 2003). Moreover, the take up rate of Sydney Water's conservation retrofit program is similar in both communities, about 18 percent in Wattle Grove and 17 percent in Chipping Norton (Boerema 2003). Data from the household survey do little to provide an explanation for there is little to choose between the two neighbourhoods across six water conservation dimensions (Table 11, Volume 2).

Paradoxically, it is the energy data from Question 27 of the survey that suggest why water use is greater in the NSW and QLD TRSs. Ownership of dishwashers is much higher in Chipping Norton (72 percent) and Sinnamon Park (71 percent) than Wattle Grove (48.6 percent) and Forest Lake (42 percent) but the main explanation for differing per capita water consumption probably lies in lot size. First, ownership of swimming pools is much higher in both TRSs. Ownership is based on possession of a pool heater or filter and the data come from Question 28 on the survey, related to energy consumption. Pool ownership is 12 percent in Wattle Grove against 50 percent in Chipping Norton and 15 percent in Forest Lake against 34 percent in Sinnamon Park. Second, the greater the lot size, the greater the amount of garden watering that is likely to occur – and the proportion of drought resistant vegetation is lower in both TRSs, too.

The water consumption indicator in NSW (Sydney) is one of the few with targets. The targets apply to all uses in the supply area so the SFD consumption figures for the case studies are not directly comparable with the overall targets. A specific target for SFDs is not available at present. Consumption in the Wattle Grove MPC (287 kilolitres per

dwelling) is slightly below the Metro Sydney average for SFDs of 293 kL/d/year. The TRS is 15 percent higher than the average.

Good progress was made in the early 1990s to reduce consumption in NSW (Sydney) but improvement has stalled (SMH 2003a; Sydney Water 2002). Perhaps water restrictions in the Sydney Region have not been severe enough to push people towards conservation and perhaps water is too cheap for people to accept the inconvenience of conservation. Or perhaps the convenient solution for most people is to urge the government to build another dam, blissfully unaware of the collective cost to the treasury, the taxpayers and the environment. Regardless, low take up rates of conservation equipment suggest that the scheme needs reviewing. Indeed, Sydney Water is now actively working on a series of regulatory measures that are expected to be highly effective in reducing demand at a low cost to the community (Sydney Water 2002).

5.7 Wastewater/Stormwater Control (Indicators 34 and 35)

The impervious surface cover (ISC) study was carried out in NSW in an effort to strengthen indicator representation in the area of surface water quality. The findings imply that surface water quality is likely to be marginally better in the MPC but that has not been instrument-tested. Inherent measurement difficulties suggest that there is no real difference between the two communities. However, given the higher density of Wattle Grove in accommodating a greater quotient of urban development on the same area of land, it could be seen as a reasonable achievement for the environment in recording a similar impervious surface figure to the TRS.

Regarding efforts to minimize the impacts of extensive impermeable surfaces, the findings note some laudable attempts at ecological processing especially in QLD where a WSUD feature was recently incorporated in one of the final development phases of the Sinnamon Park TRS. The feature is an urban wetland and park which provides a unique recreational and visual amenity as well as a conservation corridor. It protects habitat for native species and helps protect local waterways by intercepting and filtering pollution, nutrients, and sediments from residential stormwater. It is an excellent example of progress in ecologically friendly urban development and could act as a model for that purpose.

6 CONCLUSIONS

Many of the indicators in the affordability and community themes of the TBL suite focus on the basic built form and layout of the communities. On the other hand, most of the environmental indicators in the suite are operational measures that track on-going management of a community. Fortuitously, design and operation are inter-connected, a relationship that underpins the research project. Hence the operational characteristics of individual houses as well as the community in general can be enhanced by careful planning. Conversely, some shortcomings in the original design can be corrected by post-construction adjustment to improve aspects of water conservation or energy consumption. However, getting the design right at the start is important because attempting to overcome careless initial design through retrofits is not as effective from a sustainability point of view and is usually more expensive, too.

The conclusions focus on providing answers to the research questions presented in Table 1. Research questions 1 and 2 were dealt with through the literature and policy reviews, discussed fully in the Positioning Paper (Prasad and Blair et al 2003) and are summarized in Section 1 of this report. Overall conclusions for Research Questions 3, 4, 5 and 6 are presented here. Research Question 4 formerly had two components. On reflection the issue of synergies and conflicts between the environmental, economic and social domains is best considered separately. It has been done as a new Research Question (RQ 6) in Table 14. A summary of specific data-oriented issues raised by the analysis as well as suggestions for future research follows the tables. Detailed thematic conclusions are discussed fully in Appendix A.

6.1 Triple Bottom Line Indicators

Overall Conclusions

The following conclusions are based on more than the questionnaire and other hard data sources. The Positioning Paper notes that the literature and policy reviews were to be used as a basis for conclusions as well as data collected through the research process. In the case of the TBL indicators, there is considerable reliance on the academic and the practice literature.

The over-riding conclusion in response to Research Question 3 is that the TBL approach to performance assessment is valuable and that it can be a highly effective device for improving governance (eg Atkinson 1996; Hart 1999 and 2000; Klein 1997). There are 11 overall conclusions, summarized in Table 10. The conclusion at Item 3 in Table 10 refers to a primary and supplementary suite of indicators, An explanation of the evidence for and source of each conclusion is presented in the second column of the table.

Table 11 presents the primary indicators and Table 12 the supplementary measures. The latter consists of indicators removed from the primary suite because of redundancy, data difficulties and the highly specialized nature of some measures. Table 11 also deals with the second part of RQ 3 – parameter integration.

Indicator Integration

Contemplating the set of TBL indicators against the three domains of human activity – social, economic and environmental – suggests they are inextricably linked. These links are sometimes weak, sometimes strong. Most indicators, including the TBL suite, emphasize one domain but are simultaneously connected, less directly, to at least one of the remaining two domains. Most of the environmental indicators have indirect influences in either the social or economic domains and in some cases, both. In other cases an indicator might have relatively equal influence in all three domains. Indicator 26c in Table 10 illustrates the point, energy use affecting the environment, the economy and society (through various emissions, financial costs and people's health) equally strongly. It is acknowledged that some of the selections in Table 11 are arguable. What

is incontrovertible is that the vast majority of indicators cross domains and issues. The phenomenon encourages indicators to be used more than once in a community indicator program (CIP), a significant advantage very rarely used in indicator programs. The inter-connections also allow synergies and conflicts to develop, an issue which is explored further in the next section of the report.

Summary of Specific Indicator Issues

Enhancing the Indicators

Very few of the measures in the TBL suite are multi-dimensional, the housing affordability and impermeability indicators being rare exceptions. As noted in the literature review (Prasad and Blair 2003) elementary measures like median income are useful but ignore complexity and the existence of relationships in a system. Similarly, expressing "numbers" (eg of stormwater best practices) is helpful to a degree but not penetrating. Knowing the number of kilolitres of water consumed does not reveal if the aquifer is being depleted or replenished. Indicator 2 (median household income) is not a valuable measure because it is a statement about economic, not social condition and it ignores income distribution. It also tells us very little in the absence of meaningful benchmarks related to income levels. A more searching indicator linking the social and economic spheres of human activity would be the percent of the median income needed to pay for the basic needs of a person in the community. It is generally accepted that the more sophisticated or analytic the individual indicators are, the more they are likely to contribute to sustainability (eg Hart 1999; Redefining Progress; Friend 1996).

Relevance of the Indicators

Some of the housing affordability measures are not suitable for a CIP or TBL program whether at neighbourhood or city scale. Such measures will be vital as internal indicators for monitoring state housing agency matters, however. It is difficult to say, for example, whether more or less development subsidy (Indicator 11) or greater or lesser rent assistance (Indicator 6) contributes positively or negatively to sustainability. Better might be an indicator that enquired about the basic clothing and food needs and whether they were being satisfied in lower income groups. Similarly, performance ranking the number or proportion of public housing units (Indicator 6b) is not meaningful because it is unclear whether there are targets in use at local scale and if so, what their rationale might be. Consequently, the presence or absence of public housing units in a particular suburb will not necessarily reflect need or social sustainability.

Several of the community indicators (13, 14, 15a and 15b and 18) are simple input measures and lack meaning in the absence of norms. It may be useful to retain the dimension they measure in part so Indicators 14 and 15a are kept in the primary suite and the balance moved to the supplementary suite. Indicator 15b (Number of people using public spaces) is too specialized for a general TBL suite. Its value does not reflect the resources needed to operationalise it. The same principle applies to Indicator 18 too. Tracking change over time in a permanent monitoring program would add weight to all these indicators, however.

Indicators 29 and 30 are concerned with the passive solar design (PSD) of site and building respectively. The latter has been merged into Indicator 29 since the concept of passive solar design (PSD) does not lend itself to a site and building split.

Lastly, a revised solid waste indicator (Indicator 38) is recommended, one that measures recycling participation and the composition of the waste stream through an audit. Simply recording whether or not there is recycling is unhelpful when the performance evaluation is conducted in the same LGA. In theory a more sustainable development would record better recycling participation rates than a conventional subdivision but this proposition ought to have been tested using an enhanced indicator.

Table 10: Summary of TBL Conclusions

What social, economic, and environmental indicators are needed to yield a useful picture of the degree of sustainability achieved for differing development types, especially in relation to affordable housing? How are these parameters integrated? (Research Question 3)	Evidence for and Source of Conclusion
1. The constructed TBL suite of social, economic and environmental indicators for the comparative assessment of neighbourhoods has worked quite well. The characteristics of those primary indicators, their inter-relationships and their integration are shown overleaf in Table 11.	The TBL suite represents the three domains of sustainability and current regional issues and problems and data has been obtainable for most of the indicators. Using TBL performance indicators is new to Australia. Evidence from the USA (eg Hart 1999; Redefining Progress 1998; City of Santa Monica 2003) suggests that they are the best available tool for this form of performance evaluation and is superior to techniques like CBA, MFA and LCA (see Section 1.2 of this report) mainly because of its open framework and flexibility (Prasad and Blair 2003).
2. The TBL suite is too large for most monitoring purposes. A leaner suite can come from removing redundant and mediocre indicators; those which present data collection difficulties; and those which are inherently valid but cause interpretation difficulties in the absence of norms (Item11).	The larger the number of indicators the greater the cost and difficulty of acquiring data and maintaining a monitoring program. Difficulties with some of the indicators justifies removing some of them, especially if the TBL suite is too large anyway. Average program size has been established at 45 indicators in a typology of CIPs examined by Blair (2002) though the range is large.
3. Partially redundant, simple and specialized indicators should not be discarded but placed in a supplementary suite where they could be used to derive nuances where resources or other circumstances justify their use. This allows the original suite to be divided into a primary and a supplementary set as presented in Tables 10 and 11.	
4. A smaller TBL suite can be given useful additional dimension by using the same indicators more than once in different themes. It optimises use of data and helps define synergies between phenomena.	Researcher's observation that connections between domains and issues promotes multiple use of the same indicator, permitting a leaner suite to be compiled.
5. The TBL suite has been used for a comparative assessment but it has great potential for monitoring the health of entire cities or even regions, much like state of the environment reporting. Adjustments to the mix of indicators might be needed eg economic measures for city-scale or regional monitoring in addition to the economic/social housing affordability indicators.	Conclusion derived from the international literature (eg Hart 1999; Redefining Progress et al 1997) and from Australian State of the Environment monitoring done at LGA scale.
6. Indicator suites are flexible and multi-functional but the primary suite should contain core indicators which will permit monitoring and comparability across different jurisdictions and scales like LGAs, regions and states in Australia.	TBL reporting in Australia is minimal. There is no body of data to construct core indicators. The gap is a significant drawback for performance monitoring. The conclusion is also derived from the international literature (eg Hart 1999; Redefining Progress et al 1997; Hancock et al 2000)

What social, economic, and environmental indicators are needed to yield a useful picture of the degree of sustainability achieved for differing development types, especially in relation to affordable housing? How are these parameters integrated? (Research Question 3)	Evidence for and Source of Conclusion
7. Most of the indicators in the TBL suite are simple quality of life (QOL) measures. Few are outcome indicators and few are multi-dimensional. Simple indicators ignore complexity and the existence of relationships in a system. Enhancement is needed if the holistic nature of sustainability is to be measured.	The literature distinguishes between simple, uni-dimensional indicators and multi-dimensional ones (eg Friend 1996; Meadows 1998). The former are generally termed QOL measures. The latter are analytic and are aimed at measuring sustainability but are difficult to construct and require much more data than simple input indicators.
8. Indicators that cannot be compared against norms or standards should be used with caution since it is difficult to know what is "enough". However, most indicators are non-normative at this stage. They would be of greater value if used longitudinally, in a permanent monitoring program. Federal and state research work to identify norms would be highly beneficial in providing standards and targets for such indicators.	Researcher's observation that some indicators in the environmental arena are matched with norms or standards (eg water or air quality standards) but that most measures in the social and economic spheres lack standards.
9. Obtaining quality data is a challenge but there are tangible side-benefits to operating indicator programs. They require extensive inter and intra-agency cooperation, a process which is valuable for communication, awareness-raising and coordinating policy between different levels of government and with NGOs.	Researcher's observation from the research operation requiring liaison and networking with several government and semi-government agencies, both local and state as well as the private sector. Contention supported by comments from the literature (eg Redefining Progress et al 1999; Hart 1999; Colorado Trust, 1999; Cobb 2000).
10. Community participation in TBL suite compilation and even the measurement process is vital if progress is to be made towards sustainability. Resident input into TBL suites and operational assistance will generate stakeholder interest even with city-scale programs. At neighbourhood level it should be a pre-requisite.	Comments received from residents during questionnaire drop and fieldwork. Heavily supported by the international literature (eg Redefining Progress et al 1999; Hodge 1998 and Hodge 1996)
11. There is overlap and some redundancy in the TBL suite, especially between affordability Indicators 1 and 4a/4b; Indicator 2 and composite measures 3a and 3b and the all-embracing Indicator 5; and between Indicators 4a/b and 5a/5b. There is also redundancy In the energy part of the TBL suite.	Researcher's observations following detailed application of the indicators during the data gathering and analysis stages of the project. For example, Indicator 5 is a multi-dimensional outcome indicator and is particularly powerful in the hierarchy since it "captures" many of the indicators in the affordability suite. Redundancy in the energy indicators occurs in presenting both per capita and per dwelling indicators since one is a derivative of the other

Table 11: TBL Primary Indicators: Relationships Across the Three Sustainability

Theme and Abbreviated Indicators	Direct Relationship			Indirect Relationshi		
	Social	Economic	Environment	Social	Economic	Environment
Housing Affordability Theme						
1. Median house prices	**X**	**X**				
3a. Housing costs (%weekly median income – rent)	**X**	**X**				
3b. Housing costs (%weekly median income-mortgage)	**X**	**X**				
4a. Percent home prices below LGA median – rent	**X**	**X**				
4b. Percent home prices below LGA median-mortgage	**X**	**X**				
5a. Prop. homes paying over 30% income on housing – rent	**X**	**X**				
5b. Prop. homes paying over 30% income on housing – mortgage	**X**	**X**				
Neighbourhood, Community Theme						
14. Participation in meetings, projects, events	**X**					
15a. No. and area of parks, public open spaces	**X**		**X**			
16. Psychological sense of community	**X**					
17. Satisfaction with neighbourhood	**X**				X	X
19. Perceptions of safety in neighbourhood	**X**					X
Transportation						
20a. Non-auto transport: bus route density			**X**	**X**	**X**	
20b. Non-auto transport: bus density			**X**	**X**	**X**	
20c. Non-auto transport: bus frequency			**X**	**X**	**X**	
21. Length of pedestrian and bike paths per dwelling (kms)			**X**	X		
23. Percent homes within 400 metres walk of selected facilities	**X**		**X**	X		
Environment - Biodiversity						
24. Area/proportion of site retained as native bushland			**X**	X		
25. Management strategies and habitat plans			**X**	X		
Energy						
26c. Total energy use per dwelling	**X**	**X**	**X**			
27a. Proportion of renewable to non-renewable energy purchased			**X**	X	X	
28b. GHG emissions per dwelling			**X**	X	X	
29. Application of passive solar design – energy efficiency principles (PSD)			**X**	X	X	
31. Materials of lower embodied energy			**X**	X	X	

Environment – Other Resources 32b. Net residential density (dwellings/ha)	**X**	**X**	X			
33a. House size (sq m)			**X**	X	X	
33b. Lot size – average (sq m)		**X**	**X**	X		
36. Water consumption/dwelling/year			**X**	X	X	
37. Use of best practice water conservation techniques			**X**		X	
38. Solid waste - recycling - composting			**X** **X**		X	
Environment – Wastewater/Stormwater 34. Wastewater treatment (ecological v. conventional			**X**	X	X	
35a. WSUD for stormwater – number of best practices applied			**X**	X	X	
35b. Impermeable surface cover			**X**		X	

Table 12: The Supplementary Suite - Redundant and Specialized Indicators

Indicator Theme, Number and Indicator Statement
Housing Affordability Theme
2. Median household income
6a. Rent assistance – private properties
6b. Rent assistance – publicly owned properties
7. Development costs – subdivision
8. Development costs – housing
9. Development costs – green v conventional homes
10. Maintenance costs of public domain
11. Public subsidy
12. Return on investment
Neighbourhood, Community Theme
13. No. of newsletters, local meetings, projects, events
15b. No. of people using public gathering spaces
18. No. of pedestrians and cyclists
Transportation
22a. No. riding bikes and leaving the neighbourhood
22b. No. walking and leaving the neighbourhood
22c. Persons journey mode: all non-car options
Environment – Energy
26a. Energy use by fuel type (electricity): median per dwelling
26b. Energy use by fuel type (gas): median per dwelling
26d. Total energy use per dwelling
28b. GHG emissions per dwelling
29. Application of energy efficient design principles (site)
Environment – Other Resources
32a. Gross residential density (dwellings/ha)

Additional Indicators

Although a number of redundant and other indicators have been transferred into the supplementary suite in Table 12, to be drawn on if necessary, two additional indicators are appropriate for the primary suite:-

1. One focuses on housing affordability at lower income levels, for example affordability among people earning 75 percent or less of the median local wage. The researchers suggest that the data obtained through census and private sources is relatively coarse and that more specialized tabulations are needed to illuminate circumstances prevailing at lower income levels.
2. The other is an impermeability indicator to help monitor WSUD initiatives. The literature suggests that this measure integrates several dimensions of the urban system for example water quality, urban heat island effects and indirectly air quality. The indicator ought to have been in the TBL suite from the outset.

6.2 Development Form, MPC/TRS and Sustainability

The over-riding conclusion in response to RQ 4 is that the MPC performs a little better than the TRS in NSW and QLD but in SA there is virtually no difference between the two development forms. Against many measures in NSW and QLD, MPCs perform no better than the TRS and in one case in QLD performance is slightly worse. Table 13 summarizes the results of the comparative sustainability assessment. The rating is allocated according to the methods explained in Section 2.

Table 13: MPC Performance in Relation to the TRS

Do 'master planned' communities provide more sustainable outcomes than traditional regulatory subdivision? (RQ4)			
Indicator Theme	**NSW**	**South Australia**	**Queensland**
Affordability	Slightly better	No difference	Slightly better
Neighbourhood cohesion Neighbourhood satisfaction	No difference No difference	No difference No difference	No difference Better
Transportation	Better	No difference	Slightly better
Environment • Biodiversity • Energy • Other Resources • Waste/Stormwater	 No difference Better Better No difference	 No difference No difference No difference No difference	 No difference Slightly worse Sightly better No difference

The findings from all three states suggest there is a gap between sustainability theory developed up to the mid - 1990s, the rhetoric of its transfer by state and local government into policy and regulation from the early to mid-1990s and its active implementation through the development process. The gap may be partly the result of inertia and the difficulty of adopting new approaches and systems. Certainly the gap in NSW is only partly explained by the lapse of time between completion of the Sydney MPC (about 1997/98) and more recent strengthening of the commitment to sustainability. In the QLD MPC only recent development phases from about 2000 have devoted specific attention to sustainability and that has been done by an industry leader on a voluntarily basis for marketing advantage. Circumstances in SA are similar although new DCPs covering the case studies have broader sustainability provisions and implementation procedures seem a little more rigorous. With few exceptions, however, there is little perceptible difference between the case study pairs in each state. Indeed, there is none in South Australia. In Queensland, the MPC performs slightly better or better on four measures (affordability, neighbourhood satisfaction, transportation and on "other resources"), slightly worse on one measure (energy consumption) with three

recording no difference. In NSW the MPC performs slightly better or better on four measures (affordability, transportation, energy and “other resources” with the balance showing no difference.

6.3 Land Development Policy and Practice, Synergies and Conflicts

Potential land development policies and practices are summarized in Table 14 and the main research conclusions regarding synergies and conflicts follow in Table 15. There is considerable overlap between the two tables however because synergies (and conflicts) are inevitable given the linkages between issues and domains, (direct and otherwise) so the list is not exhaustive.

An important reason for the better affordability and the resource frugality of the NSW and QLD MPCs is the conjunction of higher density and smaller houses. The planning and development literature and some of the study findings point to the potential for spectacular synergies to be gained from reduced GHG emissions and other impacts on the environment; materials conservation including lower energy and water consumption; reducing habitat clearance and the stress on biodiversity; and the potential for improving public transport use. Synergies exist at both construction and operating stages. The combination of higher densities and smaller housing could justifiably become a feature of policy planning in the three metropolitan cities given land shortages and burgeoning population. Both measures could be implemented using financial incentives and/or educational initiatives. However, obtaining rapid improvement in density and smaller homes probably requires mandating the changes if environmental sensitivity and affordability is to be gained. While mandates are often politically difficult to introduce, there are major financial advantages in deferring or avoiding costly infrastructure investments for water supply, for example, or energy generation.

There are always mutually opposing goals in society so conflicts are present as often as synergies. Potential conflicts between environmental goals and financial circumstances might not be realized because payback periods for energy saving technologies is shortening, for example. Nevertheless, conflict may persist because up-front capital investment requires a long-term view to be taken on an issue. It is a view which is often supplanted by shorter-term financial considerations.

Table 14: Development and Sustainability- Land Development Policies and Practices

What are the best land development policies and practices for achieving sustainability goals in light of the proposed triple bottom line assessment model? (RQ 5)	Evidence for and Source of Conclusion
1. An issue impeding progress with sustainability is the length of time taken to transfer information derived from monitoring energy or water use, for example, into new legislation and standards. Requiring LGAs to adopt relevant third-party environmental standards from other jurisdictions would help until new regulations are built into LGA policy. An alternative would be for state governments to mandate standards or targets through the state or regional planning process.	The research results indicate there is very modest evidence of sustainability in MPCs compared with TRSs. The researchers observations of residential development in the last 2 years suggest that only lip-service is being paid to the policy and statutes that are in place.
2. Applying physical elements of sustainability to housing **aids** affordability rather than detracts from it. Passive solar design (PSD) techniques add virtually nothing to construction costs and offer significant long-term operational savings. PSD is greatly undervalued as an inexpensive way of radically improving the energy and comfort characteristics of dwellings and its operating affordability and should be mandated for all new housing and some aspects of extensive renovation work.	The research results indicate there is no application of PSD in the case studies. The vast "green building" literature has advocated PSD for at least 15 years (e.g. CEC 1991; AA 1994; Commonwealth of Australia 1996; Cousins and McGregor 1998; Schiller 2002).
3. Few sustainability-oriented policies are being applied successfully at this stage. An exception is energy rating for new housing. Many are weakly applied, eg WSUD. Inadequate application means continuous performance monitoring is needed if policy intentions are serious and reinforcement or change is to be justified.	Research results, especially from indicators 16 and 17; 24; 26, 28b; 34; 35a and 37.
4. New home construction represents a very small proportion of the total residential sector. It adds only 2% to the existing building stock annually. In 10 years, 85% of the housing stock will be that existing today. Virtually none was built with sustainability principles in mind so retrofitting programs will be essential if we are to make progress towards sustainability. The data is derived from AGO (2002).	Lack of physical retrofit to the existing housing stock in the case studies is the main reason why it is difficult to see improvements in e.g. water or energy consumption.
5. There are several techniques with potential to make further energy efficiency gains in addition to mandating PSD. They include making voluntary residential energy audits mandatory; ensuring adoption of the NSW energy component of the revised Building Code of Australia; strongly supporting energy management tactics by utility companies using price controls; supporting environmentally sound initiatives taken by the Brisbane and Sydney GreenSmart developments; and encouraging research by federal/state agencies to produce an energy consumption target and preferably a long-term standard (See Appendix A).	The source of the suggestions is primarily recent media statements, especially the national press and authors like Cummins (2002) and Davies (2003).
6. WSUD needs to be applied equally to all new development but may require guidelines and state directives to be implemented. Regional agencies in western Sydney applying WSUD principles should monitor new development quantitatively by using the proposed impermeability indicator as well as retrofitting improvements to the existing urban fabric.	The research results indicate there are very modest attempts to apply WSUD in the MPCs and none in the TRSs.

Table 13 (Cont): Development and Sustainability – Land Development Policies and Practices

7. The MPCs in QLD and NSW have lower per capita rates of water use but voluntary water conservation in Sydney has not met Sydney Water's consumption targets. A multi-pronged approach to demand management may be needed eg integrating rainwater systems into existing as well as *new* dwellings; introducing full-cost pricing to reflect a scarce resource; and completing the package of low cost regulatory measures underway in Sydney Water. Water conservation promotion by an impartial NSW state agency might also be preferable to relying on the supply authority.	The research results give consumption levels in QLD and NSW (there is no data for SA) and recent reports refer to unmet targets by Sydney Water (SMH 2003a; Sydney Water 2002).
8. There is no inherent reason why multiple developers of traditional subdivisions could not be coordinated by a high calibre overall DCP. Advice and guidance in this area from state agencies may be needed to enhance LGA's coordination, planning and urban design functions.	The research results indicate there is little appreciable overall difference between the two development forms. Strengthening conventional land development practices would bring urban design and land use elements into an integrated whole, yielding a better product than is provided by the traditional land use and zoning approach.
9. Most of the results of the assessment need not be dependent on one development form (MPC and TRS) being pursued in preference to another. However, successful higher density development may need more creative approach to planning and design.	The research results indicate there is little appreciable difference between the two development forms on a large range of measures. The researchers conclude that most aspects of development are not form-dependent but simply require a greater or lesser application of design skill.
10. Unexpectedly high house prices in the New South Wales MPC may be a result of a premium on good quality urban design. Ensuring that LGAs subject all development to the same calibre of design should remove the premium and help affordability.	A Steering Committee observation following analysis of the results. House prices are an amalgam of many factors but from safety and locational viewpoints there is no real difference between the MPC and the TRS. Higher densities generally suppress prices. It is thus possible that high quality urban design has tended to raise prices.
11. MPCs are not perceptibly safer than TRSs which is surprising given the ready opportunities for holistic design. The advent of CPTED principles (crime prevention through environmental design) to Australia is recent but could be applied to all new development including redevelopment.	Derived from the research results. Guidelines covering this subject have been issued in NSW for major residential development. (NSW Government 2003).
12. Non-auto travel can be encouraged through the design process by emphasizing pedestrian permeability in new development; continuing to use the 400 metre walking design standard; introducing cost-effective transportation measures like car-pooling, multi-hire cabs, car sharing (hail-a-ride and dial-a-ride) and neighbourhood car leasing arrangements; and prohibiting new development that is unsupported by public transport.	Derived from the research results and recent literature, chiefly the major national newspapers (eg Kerr 2002; Australian Department of Transport and Regional Services 2003). See Appendix A).

Table 15: Development and Sustainability – Synergies and Conflicts

What are the conflicts and synergies between economic, environmental and social priorities? (RQ 6)	Evidence for and Source of Conclusion
1. Several resource consumption trends are moving in the opposite direction to sustainability in Sydney with more air conditioning, swimming pools and average house size rising strongly. Higher densities and smaller houses are unpopular with residents and elected representatives but may be feasible in land-scarce metro Sydney. Development policy will need to be strengthened to raise density and encourage smaller houses. This will help improve affordability as well as minimize resource use and environmental impacts.	Recent literature in NSW repeatedly refers to the trend to "Macmansions" including editorial reports in the major newspapers (Gittins 2003; Lacy 2003; HIA 2002). The research findings do not support this for two of the three case studies have higher density and smaller houses in the NSW and QLD MPCs.
2. The two most effective measures that would greatly raise environmental sensitivity and affordability simultaneously are increasing development densities and starting a permanent trend to smaller houses. Both measures could potentially generate spectacular synergies with issues like reducing greenhouse gas emissions, other forms of pollution and consuming fewer materials, especially energy and water. There are also major financial advantages in deferring or avoiding costly utility infrastructure expansion.	The research findings for the QLD and NSW MPCs suggest the synergies between house and lot size and matters like energy consumption, water use and GHG emissions.
3. These synergies mean there is considerable potential for obtaining greater housing affordability at both construction and operating stages. Both higher density and smaller houses should become a policy priority of the planning agencies in the three metropolitan cities given land shortages and burgeoning population. A possible conflict between social and environmental goals is in the public housing area where the slightly higher up-front capital costs for sustainable building are borne by the state agencies but the operating savings accrue to the occupant of the housing. This might also be viewed as a beneficial synergy by some observers.	The research findings suggest a link between lower construction costs for smaller houses and lower operating costs for water and energy use and overall maintenance and repair. Smaller lots also allow the land component of total price to be trimmed. The literature supports this finding (eg Lacy 2003; HIA 2002).
4. There are other promising initiatives that can be pursued to improve affordability and sustainability simultaneously. Some are land-based - promoting resource consciousness especially denser development and smaller homes in the development industry and the consumer market; neutralizing the myth that PSD adds to housing costs; and using unconventional building materials like straw bales. Some are administrative and organizational - establishing housing cooperatives and self-help systems for house construction; considering Housing Industry Association suggestions; establishing BuildSmart centres; introducing a green building rating system for capital cities; green financing; and building on the innovative answers to the low income affordable housing problem as are occurring in Adelaide, Brisbane and Sydney	This statement is derived mainly from recent NSW literature including environmental reporting in national newspapers. Payback periods for "green" additions for energy and water conservation are shortening (Barram 2004). There is mounting evidence that property value increases accrue after sustainability additions are taken into account and that payback is instantaneous (Prasad 2004). See also Appendix A.

Table 14 (Cont): Development and Sustainability – Synergies and Conflicts

5. There are synergies between medium and high-density development, public transport use and for example, propensity to walk and bicycle, energy consumption, reduced GHG emissions and reduced local hydrocarbon pollution.	The research findings are neutral on this point but the planning and development literature widely supports the connection between density and use of alternative transportation (eg Minnery 1992; Newman and Kenworthy 1999; Kerr 2002)
6. Some of the planning and design outcomes of MPCs are superior. Large scale land holdings tend to promote integrated design and planning which in turn produces a fuller range of facilities and services that are better located and of higher calibre than in conventional subdivisions (Indicator 23). Successful principles like these need to be extracted and applied to all new development.	Steering Committee discussion of research results suggested that the somewhat intangible advantages of MPCs might be a result of having large scale land holdings and enough flexibility to promote integrated design and planning solutions

6.4 Data, Questionnaire and Rating Issues

Data collection for the TBL suite was a major undertaking and a number of issues have emerged for consideration. In addition, questionnaire design is briefly discussed and performance rating.

- Certain types of data could not be obtained despite strenuous efforts to do so. The main examples are energy (gas and electricity) data in SA; water consumption data in SA; gas data in QLD and development cost data in NSW. It would be of immense value to research projects if state government agencies were able to encourage utility companies to provide data for genuine research purposes.
- Efforts to obtain energy consumption data from energy companies were made because responses to the household survey to (energy) Questions 29 and 30 were largely unusable. In NSW there was about a threefold discrepancy between the household survey power consumption results and the energy company's information. The assumption was made that the energy companies had more reliable data. The data from the household survey were not used in the NSW cases. In Brisbane only gas data from the household survey were used while in South Australia all the energy data was derived from the questionnaire.
- It is clear from the three-state study that the greater the effort devoted to design and layout of the survey instrument including the envelope and delivering the self-administered questionnaire at least twice to the same houses, the greater the response rate.
- Obtaining high response rates is important for meaningful analyses. Though more expensive, it is worth considering using household interviews instead of self-administered questionnaires.
- While interviews would bring higher response rates, there are questions that still might not be answered. Examples are inquiries which rely on householders knowledge and whereabouts of power or water bills within the home.
- Several innovative mini-studies were conducted as part of the research for example on accessibility and impermeable surfaces. They are reported on under the method and source comments for each indicator by state in Volume 2 as are several data issues which surfaced during the research.

Rating the Performance Results

It was originally intended to use a 5-point Likert rating system to evaluate the performance of two main development forms, the MPC and TRS but the researchers found it impractical. First, there were three different raters involved (in Adelaide, Brisbane and Sydney) so that a common base could not be established. Second, some of the performance results are quantitative and importing numbers into the Likert rating system is not possible because the upper and lower bounds of the data are unknown. The researchers rated the performance of each case study pair as "more affordable" and "less affordable" or "more efficient" and "less efficient" in each state. The rating is more transparent and does permit comparisons between states since numeric data is usually used as the basis for the rating.

7 FURTHER RESEARCH

Several areas of additional research are suggested by the research findings as well as the literature:-

3. The TBL suite has been successfully applied to residential areas but the suite has great potential for monitoring at different scales, for example that of entire cities (see Table 10, Conclusion 5 and the literature). Monitoring at this scale should be a routine activity by government agencies, perhaps in conjunction with NGOs. Research would be needed to pilot a TBL suite to a suitable metropolitan local government area (LGA), investigate the nature of the indicators needed and the data available. The pilot study would be linked to the regular tracking operation of State of the Environment reports also done at LGA level.

4. A number of the indicators in the TBL suite need enhancement to raise their sophistication to a level more in tune with the holistic nature of sustainability. Upgrading should be done as part of producing the suite as a full model to be used as an on-line tool. The model would be accessible Australia-wide and internationally by multiple users, including developers, as an aid in decision making (see Table 10, Conclusion 7 and the literature).

5. The research findings suggested there was limited application of sustainability principles even in the MPC. The project did not consider the physical and economic measures that would be needed to make either development form sustainable. Research on the economic feasibility of retrofitting the existing housing stock with energy and water saving materials and appliances is highly pertinent in view of its potential to improve the sustainability of a dominant part of the urban fabric (see Table 14, Conclusion 4).

6. The virtual non-application of sustainability principles suggests that a publication would be valuable that targets the housing affordability and sustainability issue directly and promotes the level of take-up by the building and development industry. It would draw together a series of case studies from around Australia including some of those noted in this research project. It should describe the costs of building and materials used in both new and renovated housing. It would ask what constraints were keeping eco-efficient developments out of the mainstream housing markets; and it would ask what would be involved in gaining support for widespread adoption of sustainable building practices and techniques like passive solar design, or the application of embodied energy principles. The publication should be circulated to the HIA and MBA for onward distribution to developers and builders, all state housing agencies, and private NGOs connected with housing. A series of industry workshops would also be held for training purposes to help disseminate the results of the research.

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APPENDIX A: THEMATIC CONCLUSIONS

Housing Affordability (Indicators 1-12 and Table 2)

The Triple Bottom Line Indicators

- On its own, Indicator 5 covers the critical needs of the affordability suite. Data are available for this and other higher order indicators.
- Although Indicator 5 is overarching, there is value in retaining some lower order measures in the supplementary suite. Every indicator adds something to the overall picture but retention has to be balanced against the cost and possible difficulty of obtaining the data. Indicators 7 to 10 are examples, being partly encapsulated by Indicator 1.
- Measures like Indicator 6 (rent subsidy) and 11 (development subsidy) are valid but they are placed in the supplementary suite because it is not possible to know what constitutes "enough". It is also unclear whether greater subsidy means a less or more sustainable position. Such indicators need enhancing, perhaps by exploring basic needs in relation to income.

Development Form and Sustainability Policy

- Unexpectedly high house prices in the New South Wales MPC may be a result of a premium on good quality urban design. Ensuring that LGAs subject all development to the same calibre of design should remove the premium and help affordability.
- In SA., the MPC's greater density may be a factor in affordability but a more potent one may be the serious attempt by the State Government to provide well designed affordable housing through a four-way joint venture.
- Section 4 – Discussions – outlined the apparently tolerable affordability position in Sydney but noted that the averages for the two case studies concealed very high rent and mortgage outlays by lower income people as a proportion of total income. There are several initiatives for improving housing affordability in the lower income brackets, including the Housing Industry Association's suggestions; establishing BuildSmart centres; promoting resource consciousness along with smaller houses and lots to the residential industry and the consumer market; neutralizing the myth that PSD adds to housing costs; introducing a green building rating system in Australia's capital cities; green financing building on the innovative answers to the low income affordable housing problem as are now occurring in Adelaide, Brisbane and Blacktown, Sydney (Southgate 2003); and employing unusual materials like straw bales and approaches to construction like cooperative building.

Neighbourhood, Community and Safety (13-19 and 23 and Table 3 plus details in Tables 4 and 5)

The Triple Bottom Line Indicators

- The accessibility measure (Indicator 23) could be equally useful in the transportation or even the energy themes.
- Indicators like 13 and 14 that cannot be compared against norms are weak from a policy perspective unless they can be used longitudinally.
- Data collection for Indicator 15b is particularly onerous unless needed by an LGA for a specialized purpose.

Development Form and Sustainability Policy

- In NSW, SA and QLD the MPC generally performs better than the TRS. **check**
- On an important measure in QLD and NSW (Indictor 16 - sense of community) the TRS is favoured though the signal is not strong. Sense of community was more pronounced in the SA MPC and the NSW and QLD findings were counter-intuitive. A possible explanation is that the TRSs are more strongly embedded in their locale. In NSW the MPC is relatively isolated, being surrounded on at least two sides by extensive tracts of Cumberland Plain forest. However, isolation could have had the opposite effect.
- The NSW MPC is perceived as being a little safer than the TRS but the reverse is true in QLD and SA. Applying CPTED principles (crime prevention through environmental design) could improve safety and be a useful marketing point for new development.
- There are federal government and state policies in effect to secure community well-being (for example NSW Government 2003). Building strong communities is a crucial goal but the results of the neighbourhood satisfaction and sense of community surveys in all three states are not sufficiently differentiated to enable the researchers draw policy guidance from them. SA points out that community identity may be partly determined by how actively the LGA promotes it. The City of Onkaparinga makes considerable effort to promote a sense of community, as shown in their Web site, newsletters and number of activities organised.

Transportation (Indicators 20-22 and Table 7)

The Triple Bottom Line Indicators

- Comprehensive data are difficult to collect for Indicators 22a and 22b (people walking and cycling to work) and they may be better in the supplementary set of indicators unless needed for a specialized evaluation.
- The accessibility measure (Indicator 23) could be used in this theme and perhaps allied with Indicator 21 (pedestrian and bike paths). Other links could be explored like Indicator 22 and Indicator 18 (safety) in the neighbourhood theme.

Development Form and Sustainability Policy

- It is unlikely that use of public transport is directly related to development type despite the higher use of non-auto modes for journey to work in the Sydney MPC. Undoubtedly, higher densities help but they do not flow from a particular development form either.
- Gaining air quality improvements in the Sydney airshed by expecting a major proportion of the community to walk up to 400 metres to services and facilities is wishful thinking. The present auto age is an important factor but safety, especially where children are concerned, may be another reason. Some form of stick as well as a carrot is needed to bring behaviour change and it may come in the form of rising fossil fuel prices responding to imposts like carbon taxes and the diminishing reserves of oil. Hence there may be long term value in planning for more walking.
- Use of public transport is often related to development density, creating another development synergy with potential resource savings.
- The calibre of MPC design suggests that public transport access can be purposefully facilitated but a panoply of other actions will be needed to reverse the drift from public transport use.

- Innovative solutions might include multiple hire taxis operating as minibuses, using non-fixed as well as fixed routes as in several south east Asian cities; dial-a-ride systems; and shared vehicle leasing schemes, originally adopted in Europe and now extended to the north west United States and Newtown, Sydney.

Environment – Biodiversity (Indicators 24 and 25 and Table 8)

The Triple Bottom Line Indicators

- The two indicators are satisfactory but a sophisticated approach to monitoring would require annual or biennial data from the specialist organizations responsible for implementing management plans.

Development Form and Sustainability Policy

- The QLD and NSW MPCs have lavish (often native) landscaping but it is not a function of development type and it is unlikely to replace biodiversity loss.
- Integrated design and planning of an MPC may favour biodiversity protection but development form is not a pre-condition for conservation. Buffering all new reserves with uses more compatible with retaining biodiversity like low density residential development, simultaneously ensuring the use of covenants to prevent the spread of exotic garden plants and ownership of predatorial pets would help. In addition the development process should avoid clear felling of vegetation and benching as part of the normal site works process so as to protect the ground plane and maintain the gene pool during construction.
- Functions of an aesthetic, water quality, or soil stabilization nature in conservation areas will always remain but permanent protection of flora and fauna ecosystems in an intense urban environment is extremely challenging. It will require a multiplicity of controls to neutralize passive invasion of exotic plants, human access and the destructive influences of feral animals and predatorial pets.
- In QLD an opportunity to rehabilitate native bushland was seized as part of retrofitting water sensitive urban design (WSUD) initiatives into new phases of subdivision in the QLD Sinnamon Park TRS. The approach could be a model for future retrofits but post-construction audits would be useful to monitor the rehabilitation process.
- In SA in recent developments biodiversity has been taken into account but the outcomes have not yet been available for assessment.

Environment – Energy (Indicators 26 to 31 and Table 8)

The Triple Bottom Line Indicators

- Several superfluous indicators have been removed from the primary suite, especially redundancy between per capita and per dwelling indicators and Indicators 29 and 30 are merged given the nature of the PSD concept.
- Measures like Indicators 27 and 29-31 are not applicable to either NSW case study, an important finding in itself. They should be retained in the supplementary suite until strong policy pronouncements are made regarding PSD and the like and then transferred into the primary set.

Development Form and Sustainability Policy

- The MPC in NSW performed better (12% less energy; 24% fewer GHGs), mainly a result of higher densities and smaller houses, not development form. Higher rates of appliance and equipment ownership in the TRS and lower energy ratings also contributes to the differential.

- In QLD, the TRS performed significantly better than the MPC (25% less energy and 28% fewer GHG emissions).
- In SA there was no statistically significant difference between the TRS and MPC.
- Reducing energy use is a policy priority in NSW and the consumption levels of the Sydney MPC are indicative of what can be achieved if housing is designed to conserve energy. There are several measures in operation now in NSW to close remaining policy gaps, as well as a number of proposed initiatives:
    - The NSW government's voluntary residential energy audit policy and the proposed Building Code of Australia adoption in 2004;
    - Demand management tactics by the energy companies in NSW using price controls for large household users and business. Per capita power reduction may be cancelled by expanding use of energy-using equipment like air conditioning systems unless highly efficient systems are promoted.
- An issue is that there are no norms for power use which are tied to larger sustainability principles. The general aim of reducing power use is laudable since any reduction secures less local pollution, resource consumption, fewer GHGs and smaller power bills. Without a long term standard or even a target motivation may weaken, however, and some initiatives die.
- The findings on Indicators 29 and 30 reveal there is no mandate on builders and designers to use PSD techniques to provide simple and cheap energy efficiency. Brisbane City Council is working on a sustainable building code that will award merit points to builders for integrating PSD design principles into new homes. The same principle should apply to NSW and SA. Similarly, Brisbane's GreenSmart packages, an initiative with the HIA, include items like extra insulation, water tanks and solar hot water heaters can cost as little as $7000 installed and is an initiative that could equally apply to NSW and SA.
- Integrate green infrastructure development costs within the land value costs, and provide cash back to builders to implement the green smart packages and hold training sessions.
- Promoting 'green' buildings is one way to achieve sustainable outcomes and the inclusion of the energy-efficiency provision in the Building Code of Australia (applied in SA from January 1, 2003) may be an important strategy. Its effectiveness in producing desired outcomes is yet to be discovered and will need monitoring for several years. Many energy studies have shown that incorporating energy-efficiency principles in the design of a house do not guarantee less use of energy. Energy consumption is also determined by occupant behaviour. Allowing people to readily monitor energy use by placing meters in a prominent place inside the house, offering positive incentives (or using price signals) and a government commitment to semi-continuous eduction may be needed to drastically reduce consumption. Promoting extensive installation of solar hot water tanks and in the future, photo-voltaic power through rebate systems, may be a more affordable option than applying other techniques which may be neutralized by behaviour and which do not guarantee long term energy savings.

Environment – Other Aspects of Resource Consciousness (Indicators 32, 33, 36, 37 and Tables 9 and 11)

The Triple Bottom Line Indicators

- Calculating both gross and net density may be superfluous. There is a strong connection with public open space provision (a separate indicator) so placing the gross density measure in the supplementary suite would be appropriate.

- The solid waste indicator is of negligible value as it stands since communities in the same LGA are likely to have the same service. A recycling participation measure or a waste stream audit indicator would be more inquisitive.
- Indicators portraying "numbers" (eg water conservation best practices) are too simple. An effectiveness measure is needed, perhaps in tandem with the "number".

Development Form and Sustainability Policy

- The NSW and QLD MPCs are much more frugal in their use of a range of resources – house size, materials, lot size (25 percent less in NSW, 27 percent less in QLD); land (density almost 50 percent higher in NSW and about 19 percent higher in QLD); and water consumption (14 percent lower in NSW, 15 percent in QLD) but in the last case neither community meets Sydney Water's or Brisbane targets.
- There is a gap between general policy and practice regarding desirable densities and house size with lots shrinking but houses increasing dramatically in floor area. The frugality encouraged by government in the 1950s that limited house size to 92 m^2 will be impossible to re-enact but the principle might act as a guide to government accommodation planning in the long term, especially in the Sydney Region.
- Occupancy rates have also fallen, implying excessive use of finite resources. Large houses can be strata subdivided to yield more than one dwelling unit but sustainability planning suggests that building larger and larger houses is unwise use of resources and possibly poor investment decision-making. Specifying maximum house sizes while being mindful of demographic characteristics could help solve the problem.
- A feature of sustainability relevant to single family dwellings is growing food in back yards. Low densities and quite large average lot size in the Sydney Region undoubtedly offer the potential for cultivation if circumstances dictate.
- Regarding water supply, voluntary water conservation has not been successful and if Sydney is to reduce its profligate use, cope with the growth in demand and minimize infrastructure outlays, the NSW government will need a multi-pronged approach to the entire conservation/demand management issue from several perspectives simultaneously, such as integrating rainwater systems into existing as well as *new* dwellings; introducing full-cost pricing to reflect a scarce resource; and completing the package of low cost regulatory measures underway in Sydney Water; and pressing for smaller houses and gardens.
- It is recommended that an impartial NSW state agency be nominated to promote water conservation rather than relying on the supply authority.
- Similarly, introducing the water saving initiatives of the Brisbane eco-home (Healthy Home Project Partners 2003) would reduce water consumption by 25 percent and allow the costly Hinze Dam expansion to be deferred from 2008 to 2025. Forging this kind of link between using existing and proven technology and pursuing sustainability has not been implemented on the ground in either the MPC or the TRS development forms.
- Integrating rainwater systems into existing as well as *new* dwellings is one example. Market pricing to reflect a scarce resource is another and Sydney Water's work on regulations is a third. However, it is a classic conflict of interest to expect Sydney Water, a state agency that earns revenue from sale of water, to promote conservation for which it is paid nothing.

- It is possible that South Australia could provide a model for a strategic approach to water conservation. Reduction of water use in houses is mandated, with penalties for excessive or unnecessary use water, and there are generous rebates for the installation of equipment like rainwater tanks.

Environment – Wastewater/Stormwater Control (Indicators 34 and 35 and Table 11)

The Triple Bottom Line Indicators

- The indicators are satisfactory but Indicator 35b (impermeable surface) could be formally added to the suite.
- The WSUD indicator (35a) portraying "numbers" (eg of best practices) is too simple. An effectiveness measure be more revealing of actual conditions.

Development Form and Sustainability Policy

- Despite much higher density, the MPC in NSW performs well against the impermeable surface measure (Indicator 35b). The designers of the MPC made no special effort to reduce impermeable surface but it is possible that the integrated design and planning of MPCs would encourage more innovation than in TRSs. Again, it is not dependent on development form.
- The authority for urban stormwater management plans is Section 12 of the Protection of the Environment Administration Act 1991. Implementation responsibility rests with LGAs and it is State adoption of ESD principles that is the context for WSUD initiatives. WSUD principles were in place at least for the Wattle Grove development but very little attention was paid to the policy (Flynn 2003). The only "best practice" introduced was the use of swales in a community-long spine, functioning also as open space. This represents a policy gap though there are some recent signs that response is more active at least at an administrative level in western Sydney and the Hunter Region (for example Upper Parramatta Catchment Trust 2003; Hunter Region Organisation of Councils 2002).
- Serious planning for WSUD will recognize the value of the multi-dimensional Indicator 35a and monitor practice from a quantitative viewpoint.
- Implementation of WSUD is feasible at design level but retrofit solutions are as critical a need in moving towards sustainability. The example of the recently added WSUD feature in the Sinnamon Park TRS (QLD) in one of its final phases of residential development is a tangible step in the direction of sustainability and a model to aim for.

Methodological and Data Issues

The Triple Bottom Line Indicators

Enhancing the Indicators

Very few of the measures in the TBL suite are sophisticated, the housing affordability and impermeability indicators being rare exceptions. Elementary measures like air and water quality and median income are useful but ignore complexity and the existence of relationships in a system. Knowing the number of kilolitres of water consumed does not reveal if the aquifer is being depleted or replenished. Indicator 2 serves little purpose, for example (median household income) partly because it is one-dimensional. It is a statement about economic, not social condition because it ignores income distribution. It also tells us very little in the absence of a goal or target related to income levels. In this comparative performance assessment it is partly redundant and its information is absorbed by other indicators like the composite measures 3a and 3b and the all-embracing Indicator 5.

There are ways of enhancing simple input indicators like this. For example a more searching indicator linking the social and economic legs of the triad would be the percent of the median income needed to pay for the basic needs of a person in the community. The more sophisticated or analytic the individual indicators are, the more they are likely to contribute to sustainability.

Indicator Redundancy

Affordability

While every indicator adds a nuance to a suite, there are some which serve little purpose, offering an opportunity to trim an over-large TBL suite. There is overlap, for example, between Indicators 1 and 4a/4b, between Indicator 2 (median household income) and composite measures 3a and 3b and the all-embracing Indicator 5 and between Indicators 4a/b and 5a/5b. Overlap in this theme is a consequence of "tiering" so Indicator 1 (median house price) "captures" measures like Indicators 7 and 8 and perhaps 11 and 12 as well. House price certainly reflects more phenomena than is embraced by these four indicators but Indicator 1 could act as a surrogate for the development and building side of the affordability equation. Indicator 5 is a sophisticated outcome indicator and is particularly powerful in the hierarchy since it captures many of the indicators in the affordability suite.

There has been difficulty in NSW and SA in gaining reliable data for some of the indicators noted above. For example, some of the measures that contribute to summary Indicator 1 – median house price – rely on commercial data where confidentiality has inhibited builders and developers from releasing information. If indicators 7, 8 and perhaps 10 make a major contribution to outcome Indicator 1 (median house price) and if data for Indicator 1 are readily obtainable from realtors that monitor the housing market, then making considerable effort to track down data for Indicators 7 and 8 is questionable. This also suggests that the affordability portion of the TBL suite could become much leaner.

Energy

The key indicators in this suite are concerned with total energy consumption (per dwelling and per capita) and greenhouse gas emissions because of society's growing preoccupation with global warming. Beyond this there is some redundancy in the energy suite. For example in a published monitoring report it is unnecessary to present both per capita and per dwelling indicators since one is a derivative of the other. In addition, Indicators 29 and 30 should be merged since the concept of passive solar design (PSD) does not lend itself to a site and building split.

Appropriateness of the Indicators

Some of the housing affordability measures may not be relevant in a public TBL program. Whether more or less development subsidy (Indicator 11) or greater or lesser rent assistance (Indicator 6) represents a movement to or away from a state of sustainability is problematic. Greater rent assistance might mean declining wealth or a more generous social welfare system so interpreting the indicator will raise a host of conflicting ideologies. Better might be an indicator that enquired about needs.

Similarly, performance ranking the number of public housing units owned by the NSW Department of Housing in the two NSW case studies (Indicator 6b) is not meaningful. DOH does not apply targets of provision at the local scale so the presence or absence of public housing units in a particular suburb is not necessarily a reflection of need or a function of sustainability. Using such an indicator in a TBL program at regional or metropolitan scale might be more defensible.

Community and Neighbourhood Indicators

Several of the community indicators in this theme (13, 14, 15 and 18) offer information which supplements the data from the questionnaire rather than acting as lead

measures. Indicators 13 and 14 are examples. They contribute qualitatively to the TBL suite in a comparative study but there is no way of knowing how much community activity is enough. Where performance assessment is applied to only one community, whether a neighbourhood or an entire city, the indicators are rather meaningless in the absence of norms. Tracking change over time in a permanent monitoring program might add weight to those indicators.

In NSW, Indicator 15b (Number of people using public spaces) was abandoned on the basis that it was too specialized for a general TBL suite. Priming the indicator with data would be important for specialized work by Council on parks and open space but in an over-arching TBL suite it is unclear what value the indicator has and work focussed on other priorities.

Energy

Indicator 31 concerns embodied energy, a concept which had no currency in most of the case studies and which architects and designers were only conceptually aware of in the period of in the early 1990s.

Indicators 29 and 30 are concerned with the PSD of site and building respectively. PSD is a technique aimed at maximizing use of natural daylight, conserving energy, and maintaining comfortable indoor temperatures without artificial heating or cooling. The latter two items are the largest single item of domestic energy consumption, up to 35% of the total (Szokolay 2002). Neither community in NSW or QLD applied PSD to either site or building but its value in an era that is increasingly preoccupied with energy consumption suggests that the indicators should remain within the suite.

Transportation

Availability of alternative transport is a pointer towards sustainability, both from a pollution and a resource consumption viewpoint. Indicator 20 is a useful measure of the extent of provision of public transport but the difference between the sub-measures is striking and suggests that caution needs to be exercised in adopting particular indicators.

Other Methodological and Data Issues

- Certain types of data have not been obtained despite strenuous efforts to do so. The main examples are energy (gas and electricity) data in SA; water consumption data in SA; gas data in QLD and development cost data in NSW.
- Efforts to obtain energy consumption data from energy companies was made because responses to the household survey to questions 29 and 30 were largely unusable. In NSW there was about a threefold discrepancy between the household survey power consumption results and the energy company's information. The assumption was made that the energy companies had more reliable data. The data from the household survey were not used in the NSW cases. In Brisbane only gas data from the household survey were used while in South Australia all the energy data was derived from the questionnaire.
- It is clear from the three-state study that the greater the effort devoted to design and layout of the survey instrument including the envelope and delivering the self-administered questionnaire at least twice to the same houses, the greater the response rate.
- Obtaining high response rates is important for meaningful analyses. Though more expensive, it is worth considering using household interviews instead of self-administered questionnaires.

- While interviews would probably bring higher response rates, there are question types that still might not be answered at all. Examples are inquiries which rely on householders knowledge of and whereabouts of power or water bills within the home.
- Several innovative mini-studies were conducted as part of the research for example on accessibility and impermeable surfaces. They are reported on under the method and source comments for each indicator by state in Volume 2 as are several data issues which surfaced during the research.
- It was originally intended to use a 5-point Likert rating system to evaluate the performance of two main development forms, the MPC and TRS but the researchers found it impractical. First, there were three different raters involved (in Adelaide, Brisbane and Sydney) so that a common base could not be established. Second, some of the performance results are quantitative and importing numbers into the Likert rating system is not possible because the upper and lower bounds of the data are unknown. A simpler and more transparent method was to rate performance of each case study pair as “more affordable” and “less affordable” or “more efficient” and “less efficient” in each state.

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Level 1 114 Flinders Street, Melbourne Victoria 3000
Phone +61 3 9660 2300 Fax +61 3 9663 5488
Email information@ahuri.edu.au Web www.ahuri.edu.au