PROVIDING INCENTIVES FOR LOW-IMPACT DEVELOPMENT TO BECOME MAINSTREAM

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ABSTRACT

This paper presents findings from a literature review on low impact urban design and development (LIUDD) and preliminary results from working with six key stakeholder groups: consumers, Maori, community, developers, regional and city councils. Conventional development practices lead to a range of adverse effects in urban areas and contribute to escalating infrastructure costs. LIUDD is defined here as a cost-effective design and development approach utilising natural systems and enhancing sustainable outcomes: economic, environmental, social and cultural. Some councils have recognised the opportunities for environmental protection and infrastructural cost-savings by producing a variety of low-impact strategies and guidelines. However, major constraints to their adoption remain: consumer and practitioner behaviour, deficient pricing of water resources, conflicts between stakeholders, and variable quality of planning instruments. Significant work is required to encourage broader uptake of LIUDD. The core environmental and other information necessary for LIUDD is well-known, but developers and regulators need a rational set of criteria and incentives to facilitate the transition to sustainability. Developing these will need more information on i) the performance of LIUDD at the development site and catchment scale, ii) the economics of conventional versus LIUDD, and iii) the potential for integration amongst different types of instruments (district plans and subdivision, engineering and building codes).

KEY WORDS

Stormwater, low impact urban design and development, sustainable, incentives.

1. INTRODUCTION

Rapid urban growth puts pressure on the capacities of natural resources and physical infrastructure (MfE, 2000). Both greenfields development and urban retrofitting lead to increasing demands on conventional infrastructure (e.g. energy, transport, reticulated pipe networks). The costs of maintaining existing and new systems using conventional design and engineering approaches are escalating. The Auckland region will be spending NZ$5,000 million over the next 10 years to replace aging pipes and meet the demands of new development for water, wastewater and stormwaterservices alone (Manukau City Council). This investment in infrastructure will not, by itself, reduce adverse environmental impacts in the receiving estuaries and rivers since current development practices and infrastructure lead to continued adverse effects from stormwater runoff in urban areas. Contaminants and sediment reduce water quality, damaging streams and estuaries. While extensive piped systems remove discharges from the site, urban stormwater discharges (flow peaks and contaminants) are unpleasant and are degrading coastal and inland waterways (Curry, 1981; Williamson, 1991; Wilcock, 1994; Snelder and Trueman, 1995). Current approaches in environmental research focus on the entry, distribution and “end of pipe” monitoring of biological effects (Eason and O’Halloran, 2002), but have failed to put sufficient emphasis on mitigation or removal of the cause of these adverse effects.

Conventional approaches to residential land development in New Zealand substantially contribute to the problems (De Kimpe and Morel, 2000; Basher, 2000). In particular: (i) New subdivisions alter the land surface, significantly increasing impervious surfaces and compacting hard ground to the extent that there is a near-total loss of permeability after development (Basher, 2000; ARC, 2000; Zanders et al., 2002); (ii) Topsoil is commonly compacted or destroyed, washed away in storms, discarded into landfills, or sold, which increases the need for irrigation of gardens and green spaces and the cost of planting and restoration strategies (Zanders et al, 2002); (iii) During infill housing, retrofitting and new development, impervious surfaces proliferate across whole districts, resulting in increased stormwater runoff and catchment-scale impacts (Schueler, 1994; Arnold and Gibbons, 1996; Schreier and Brown, 2002; McConchie, 1992).

New research findings into loss of habitat and biodiversity conclude “houses are becoming worse than people”. New Zealand, with Brazil, and China, is cited as a hot spot where the number of households is rising at nearly twice the rate of the population (Lui et al., 2003; Keilman, 2003). This situation, and the resulting urban sprawl, is acute in Auckland. The Auckland Regional Growth Strategy (ARGF, 1999) anticipates that 70% of all new growth over the next 50 years will take place within metropolitan Auckland, making LIUDD a critical component of achieving urban sustainability.

In recent years as LIUDD has been investigated in New Zealand, several issues have gained wider public recognition; worsening traffic congestion (especially in Auckland) and the difficulty of identifying more environmentally and economically affordable transport solutions, accumulation of contaminants in urban receiving waters, escalating costs of new and existing energy, water supply, wastewater and stormwater infrastructure and deteriorating quality of housing stock and public health.

Reviewing LIUDD – perhaps as part of the current building industry review – enables us to take the opportunity to ‘join the dots’ amongst New Zealand’s many sustainable development initiatives – energy efficiency, waste minimisation, climate change, regional economic development, water conservation and the like. The development sector offers an opportunity to integrate these and other related programmes, because of its (often wasteful) consumption of materials and its impacts on national and local infrastructure for energy, water, wastewater, stormwater, roading and other services.

Next, we comment briefly on the state of practice overseas and in New Zealand. Then, from our discussions with stakeholders and review of literature we identify key environmental, economic and social benefits of implementing LIUDD. Our discussion focuses on stormwater, although our current work recognises that truly sustainable urban development encompasses a wider range of environmental issues.

2. LITERATURE REVIEW ON LIUDD

2.1 METHODS

We reviewed the international and New Zealand LIUDD literature and practices, focusing on environmental, social and economic implications. We conducted a literature review of the costs and benefits of LIUDD approaches from a “triple bottom line” (economic, environmental and social) perspective. We examined the literature on comparative assessments of sediment, pollution and flow discharges from LIUDD versus conventional building sites, and LIUDD versus conventional urban catchments. We have included in the review publications on the cost–benefit of the pollution-control infrastructure associated with LIUDD and conventional developments where possible.

2.2 PRELIMINARY ASSESSMENT OF PRACTICE

LIUDD is based on both ecological (McHarg, 1969; Steiner, 2000; Arendt et al., 1994; Hough, 1995) and energy-efficient, compact approaches to urban design (Newman and Kenworthy, 1999). LIUDD comprises design and development practices that utilise natural systems and new low-impact technologies to avoid, minimise, and mitigate environmental damage. Key elements include working with nature to avoid or minimise impervious surfaces, utilising vegetation to assist in trapping pollutants and sediment, limiting earthworks, incorporating design features that reduce impacts, and enhancing biodiversity. In addition, LIUDD can also be cost-effective by reducing the need for construction and regular renewal of physical assets, such as piping (CCC, 1999; CCC, 2000). Internationally, LIUDD initiatives are still comparatively new, with demonstration developments and elements of LIUDD in many cities (van Roon and Knight, 2003a; van Roon and Knight, 2003b).

van Roon and Knight (2003a) report that:

‘In North America, where LIUDD is in its infancy, there are elements of LIUDD in brownfield sites in Portland-Oregon (Liptan and Murase, 2002), Seattle (City of Seattle, 2002) and Massachusetts (Goldsmith, 2002). In western USA and throughout Canada, many greenfield sites (e.g. Simon Fraser University, Vancouver

(CH2MHILL, 2002)) are at the design stage. Significant progress has been made by some councils in the writing of ordinances facilitating or requiring LIUDD (e.g. Cities of Olympia and Lacey, Washington) (Holz, 2002; City of Lacey, 2002; Hielema, 2002). The Bureau of Environmental Services has established a range of brownfield projects throughout Portland City, Oregon, demonstrating infiltration gardens in carparks, and the successful use of ecoroofs and rain gardens. These facilities are proving that a minimal discharge of stormwater from these sites is possible without infiltration to ground (Liptan and Murase, 2002).'

New York's water supply (Chichilnisky and Heal, 1998) is an example at the catchment scale of huge cost-savings achieved by working with natural systems once community support was elicited.

New Zealand has few examples of LIUDD. While soil information is recognized as an important component of urban planning (Basher, 2000), relative to permeability and erosion, the uptake of LIUDD is disappointing in view of the considerable technical knowledge and expertise in the design and application of LIUDD derived from overseas and New Zealand experience. Some Auckland councils, and other city councils in New Zealand, have recognized the opportunities for environmental protection and infrastructure cost-savings by producing a variety of comprehensive low-impact strategies and guidelines to encourage the use of swales, "rain-gardens", "roof-gardens", decreased imperviousness and other technology and strategies at the development site and catchment scale (ARC, 2003a; ACC, 2003; ARC, 2003b; NSCC, 2001; NSCC, 2002). Structure plans prepared by Auckland councils for greenfield sites show significant shifts toward LIUDD principles (e.g. for Long Bay, (NSCC, 2002)). However, developments are contingent on political willingness to implement relevant council plans and policies over a long time period. The *Christchurch City Waterways and Wetlands Natural Asset Management Strategy 1999* (CCC, 1999; CCC 2000) is an early example of an innovative approach yet is still not fully integrated with other council plans and strategies. Benefits from low-impact urban design and development are readily identified at a site level, although not all can be easily quantified.

2.3 ENVIRONMENTAL BENEFITS

Compared with conventional development, LIUDD practices reduce sediment and pollutant loads, reduce stormwater flows, and have less impervious surface area and more vegetated areas. In turn, these lead to off-site benefits in waterways (improved fish habitat), in estuaries (improved habitat derived from reduced contaminant and sediment accumulation), and for terrestrial local biodiversity (native vegetation corridors). Typically reported benefits of LIUDD practices are as follows:

- Schueler (1994) reports reductions of 83% for sediments and approximately 70% for pollutants using LIUDD in North America.
- Monitoring data reported in Schueler (1994) indicate that LIUDD stormwater practices (ponds, wetlands, filters or infiltration practices) can reduce phosphorus loads by as much as 40–60%.
- Vegetated swales, an element of LIUDD, have been shown in a study in Austin, Texas, to be effective sedimentation/filtration systems for reducing concentrations and loads of contaminants in runoff from roads (Barrett et al., 1998). The percent reduction in pollutant mass transported to receiving waters was above 85% for suspended solids; 69–93% for turbidity, zinc and iron; and 36–61% for organic carbon, nitrate, phosphorus and lead.
- In studies in Auckland and Hamilton, Pandey et al. (2003) have shown that stormwater treatment walls remove over 90% of heavy metals and polycyclic aromatic hydrocarbons (PAHs) from stormwater generated from roads.
- Models of the hydrological benefits of low-impact design predict decreased peak flows for a 2-year storm by 7–14% compared with standard subdivision practice, and total storm-runoff volume by 10–13% (ARC, 2000). Actual reductions should be greater. The model does not incorporate native vegetation in the low-impact design. Auckland Regional Council considers native vegetation as the only effective way to reduce total runoff to predevelopment levels (ARC, 1996).

2.4 ECONOMIC BENEFITS

LIUDD has the potential to benefit all stakeholder groups through lower costs, improved environmental assets, and potentially improved returns to developers.

- LIUDD has reduced energy requirement to less than 25% of conventional housing at a number of sites (BRESCO, 2000). "Bedzed" is a development of 100 dwellings in South London combining reduced energy requirements with reduced potable water demand (by 40%) through recycling of rain and wastewater (Shirley-Smith, 2002).

- LIUDD reduces infrastructure costs through the use of new design approaches and natural methods of stormwater avoidance and treatment. Auckland Regional Council (ARC, 2000) estimates LIUDD will deliver savings of approximately 10% of current stormwater infrastructure and maintenance costs—that is, a saving of $5 million per year by 2008—with increased savings in the longer term.
- LIUDD incorporates vegetated waterways rather than pipes. The *Christchurch Waterways and Wetlands Natural Asset Management Strategy* (CCC, 1999; CCC, 2000) identified that restoration with natural drainage systems costs between NZ$30–1000 per metre compared to pipe replacement at NZ$500–1300 per metre, with the latter requiring higher maintenance costs and replacement after 150 years as well.
- LIUDD is likely to reduce costs for developers. In recent modelling of the development of three sites (ARC, 2000), the financial performance of the low-impact design was variable, being better, the same and poorer than that for standard subdivision at the site.
- Coffman (2000) reports a 25% reduction in both site development and maintenance costs for the "Somerset" LIUDD subdivision in Maryland, USA. The developer saved $US4,500 per lot, or a total of $US900,000, by eliminating the need for kerbs, ponds and drainage structures.
- There is evidence that suggests that communities value the benefits accruing from LIUDD. In a community benefit survey (URS, 2001), Waitakere City residents indicated that they are willing to pay a combined total of $44.6 million/year in order to reduce the current levels of pollution in stormwater by 50% over the next 10 years.

2.5 SOCIAL BENEFITS

LIUDD has the capacity to improve amenity values on- and off-site. LIUDD practices provide small, but significant, benefits to homeowners and the local community that have the potential to synergise with wider transport and public health initiatives:

- Streams are retained in natural states. Walking for fitness and enjoyment is the single most popular recreational activity in the Auckland region. Many people like to take frequent walks in their local area, and there is increasing demand for scenic interest – and therefore natural habitat – to be retained in new subdivisions (ARC, 1996).
- Native vegetation is retained where possible. Residential streets may be narrowed and curved but street corridors can remain wide to accommodate 'rain gardens', large trees and swales. The existence of native vegetation on the properties is a frequent selling point.
- Ecological restoration in terms of urban form that is less colonial in style with restoration of native vegetation and traditional food sources will benefit Maori (indigenous people of New Zealand) and contribute to social and cultural restoration (Matunga, 2000).
- In comparison with conventional subdivision practices, subsoils are less compacted; and thus, less topsoil is removed or stockpiled in LIUDD. This means that soils are in much better condition, street trees establish and flourish, and lawns are lush and not flooded after rain because of poor drainage in the compacted subsoils.

3. POLICY BASED INCENTIVES

The benefits outlined in the above sections suggest that there may be incentives for the adoption of LIUDD practices, both in the form of lower development costs, improved environmental amenity and, where consumers are willing to pay more for this improvement, higher property values. There are also a variety of economic instruments that could be adopted to provide an incentive for LIUDD adoption:

- Reducing the relative costs of LIUDD *vis a vis* conventional development. This could be further improved either by providing a subsidy or credits for the use of LIUDD, or a imposing a charge on conventional methods to reflect external costs. For example, a number of US stormwater utilities provide credits (reduced rates) for property owners who undertake various LIUDD activities. Portland City charges property owners for stormwater management services but provides for discounts of up to 100% of the on-site fee for mitigation by impervious surface minimization and retention of large trees (Menzies, 2001). Imposing a charge to reflect the external costs of conventional development (for example, the damage done by runoff from impervious surfaces) could have a similar incentive effect, removing the implicit subsidy on conventional development. The passage of the Local Government (Rating) Act (2002) enables such a charge to be levied on impervious surface area through local rating systems.

- Financial and/or technical assistance may be made available to the adoption of LIUDD practices. This could be based on the certification of a project (given the existence of a suitable certification system). For example, developers in Seattle, USA, have the opportunity to apply to the LEED™ Incentive Program, which offers financial assistance to projects incorporating sustainable building goals and committed to gaining LEED™ certification (City of Seattle, 2000).
- Public education and promotion of LIUDD benefits may see an improved willingness-to-pay for properties incorporating water-friendly measures. To the extent that this was the case, an incentive would be provided through the market mechanism via improved prices/revenues. Public education can provide a powerful incentive for changing behaviour, whether it be through the provision of information about environmental damage, or information rationalising the use of other mechanisms such as fees or credits (Bow River Basin Council, 2002).
- Stormwater credit trading has been suggested as a useful mechanism to achieve the most cost-effective distribution of stormwater abatement within a watershed (Thurston et al., 2002; Thurston et al., 2003). Such schemes have significant information requirements, especially for nonpoint source schemes such as stormwater. The National Wildlife Federation points out that enforcement and monitoring are particularly problematic, and raise concerns about the equity issues and the development of "hot spots" (National Wildlife Federation, 1999). It is important to ensure the administration costs of such a scheme do not outweigh the efficiency gains.

4. PRELIMINARY INTERVIEWS

4.1 METHODS

We conducted preliminary interviews with six key stakeholder groups involved in urban development: consumers, community, developers, Maori, and regional and city councils to identify impediments to LIUDD and opportunities for change. We explored the reasons for the poor uptake of LIUDD practices by key stakeholder groups, including interviews with these groups (see Table 1).

4.2 RESULTS AND DISCUSSION

Interviews revealed that our six main stakeholder groups have specific needs (see Table 1) that influence positively or negatively their willingness and ability to exploit LIUDD. When viewed collectively these conflicting needs are often perceived as competing or insurmountable impediments to change. Currently, disagreement and litigation between some key stakeholder groups can be costly and impede change. Poor uptake of LIUDD results from many of the reasons summarized in Table 1.

Specific impediments can include price concerns, planning and institutional impediments. In New Zealand, there is a raft of council (local government) policies that influence environmental change. These plans are usually prepared under two key statutes; the Local Government Act 2002 and Resource Management Act 1991, although other Acts and regulations also influence building developments. The suite of council policies and plans, including district plans, structure plans and codes of practice, along with the conservative practices of professionals, are often seen as key impediments to change. In New Zealand this is further compounded by a lack of locally based technical, hydrological and economic data in a form that is able to influence these plans and codes. However we also see these mechanisms and stakeholders as key potential drivers for change towards sustainability.

To facilitate change by early adopters, innovative research and development is needed, complemented by new cost–benefit analyses of existing information, to modify and adapt LIUDD to local conditions. Environmental performance needs to be validated and development costs contained to bridge the current disjunction between performance and economic gain. For example, low cost housing may become slightly more expensive to build to sustainable standards, but this may be offset by lower infrastructure costs associated with LIUDD. Moreover, such housing may be more affordable for those on lower incomes to inhabit because of direct ongoing savings in energy and water use costs and indirect savings by avoiding or deferring public expenditure on a range of infrastructure services.

Table 1: Issues for major stakeholders (identified in a preliminary survey in by the University of Auckland and Landcare Research in Auckland and Christchurch, 2002–2003) relevant to low-impact urban design and development (LIUDD)

Community	Developers and professionals†	City council
• resistance to user pays and price increases • cross-subsidies • disassociation between user pays (water + waste) and local environmental quality • dissatisfied with urban pollution • higher quality of the environment • need for connectivity • traffic, safety & congestion • don't understand city or regional council LIUDD goals **Consumer** • house prices • running costs • unaware of choice • vegetation, nature viewed as problematical • those who want LIUDD can't access skilled developers • unaware that LIUDD will improve aesthetics & liveability	• lack of profit margins • council disincentives rather than incentives • LIUDD subsidizes city council infrastructure costs • rapid benefit/cost tools lacking • short payback requirement • time commitment to absorb LIUDD manuals • RMA does not provide incentive • need to maximize land cover to maximize profit • consumer demand lacking • lack of demonstration projects to emulate • risk to engineers who use non-conventional (piping) approaches **Maori**** • maintaining low-cost housing imperative whilst meeting Maori values • restoration and retro-fitting native vegetation • European identity predominates • knowledge on restoration patchy • waste of water and natural resources • desire for LIUDD but developers not familiar with those approaches	• lack of data to define financial contribution/ incentives in district plans • limited information to evaluate water cycle management options • threat to revenue base if water supply and waste water systems are reduced • maintenance cost • biophysical data on land resilience, planting and biodiversity for district plan • concern about disconnection between district plans that incorporate LIUDD & current engineering codes **Regional council** • concerns about variability in district plan LIUDD content • concern re misuse or misinterpretation of LIUDD • need robust information to use in new guidelines for developers and regional plans • lack of understanding by community of goals • LIUDD needs to be tailored to different conditions and different council's needs (greenfield versus intensification).

† professional = engineers, planners, architects
** Based on discussion with Ngarimu Blair, Ngati Whatua o Orakei (and from Matunga, 2000)

5. SUMMARY

LIUDD is a critical means for achieving more sustainable growth. Many parts of the country are growing rapidly, with the Auckland region now identified as a priority focus in the Government's *Sustainable Development for NZ Programme for Action in Auckland* (New Zealand Government, 2002). However, implementation not only in Auckland but more widely is dependent on the willingness of a range of stakeholder groups to embrace principles of LIUDD.

New housing development provides different opportunities and challenges for different stakeholders (Dixon et al., 2001; MfE, 2002; Standards New Zealand, 2001). For developers, profit margins are tight, often at 5% or less (Rhodes, 2003). Our survey identified house price and household running costs as key issues for buyers; thus, changes to development practices to reduce environmental impacts must be at least cost-neutral.

Councils want to reduce adverse environmental impacts but are constrained by the limited information available to underpin defensible rules to control development. City and district councils are concerned about rising infrastructure costs, which are exacerbated by design approaches that are costly to maintain. On one hand, urban communities expect traditional forms of infrastructure, such as kerbs, channels and extensive pavements, which reinforce current investment patterns by councils. On the other hand, these communities are demanding increasingly higher levels of environmental quality, such as clean streams and beaches (ACC, 2000), as well as increased numbers of native birds, and fish in streams (Heremaia, 2001).

The uptake of LIUDD may be influenced by a raft of instruments, including systems of charges and credits, public education, technical assistance and trading schemes, incorporated into statutory and non-statutory plans, strategies, and codes of practice administered by regional and city/district councils. Despite some very supportive codes (such as (ACC, 2003; ARC, 2003b; ARC 2000)) planning and regulatory processes are impeded by variable technical and economic information; poor integration across council policies, plans, and codes of practice (Beca Planning, 2001); as well as by lack of unity and buy-in from stakeholders.

There are also few incentives for change. Gathering the information needed to develop real incentives needs to be the focus for the future. Requirements include: i) data on the relative importance and performance of improved low-impact development approaches (such as hydrological performance) under New Zealand conditions in a form that is appropriate for economic interpretation , ii) to translate estimates of improved hydrological performance on development sites and reduced contaminant and stormwater loads from new development into economic values, iii) to address the widespread variability and poor integration amongst different types of instruments (district plans and codes of practice); iv) to incorporate wider dimensions of urban sustainability such as amenity, transport, energy and materials efficiency into development assessment criteria that make life easier for developers and regulators alike. This data will provide a platform for more rational development of incentives to facilitate the broad scale adoption of low-impact urban development practices.

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