DESIGNING RESILIENT COMMUNITIES – A WAIRARAPA CASE STUDY

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Abstract

In any model of a sustainable future, there is an ever-increasing duty of care on developers and designers to provide infrastructure that provides for the ongoing wellbeing of its occupants. Whilst this duty may not yet be perceived by developers or the broad mass of the public, it is nonetheless an important part of our future (PCE, 2002). Wellbeing can be diminished by any number of climatic, political, health, and economic factors.

The design of residential developments can have a significant influence on the ability of a community to meet these requirements under demanding external conditions. This paper describes a case study of Totarabank, a small residential subdivision in the Wairarapa, which incorporates a number of novel sustainability design criteria to increase the resilience of the community.

Keywords

Resilient; sustainable housing; communities

Introduction

Resilience is a term that's meaning depends on the context. In general terms, it is the ability to recover from a shock, suffering or disappointment.[i] A resilient community exhibits ecological and psychological qualities in addition to a 'systems' or operational context. Whilst psychological resilience relates to coping with trauma[ii], system resilience is the ability to provide and maintain an acceptable level of service in the face of faults and challenges to normal operation[iii]. A resilient community can therefore be thought of as one that has ability to provide and maintain the physical and emotional wellbeing of its occupants during, and following, periods of duress.

A community's resilience relates primarily to core requisites that sustain its inhabitants, namely the provision of;

- Shelter & warmth
- Water & food
- Refrigeration
- Light
- Safety
- Communication
- Community support

There are now a number of criteria that can disturb the equilibrium that we have come to expect from our surroundings. On a global scale, it is clear to see that physical and political issues are today affecting the quality of life of millions of people, with more to come as climate change effects increase. This could be through power cuts, water supply issues, wastewater disposal, food supply, storm/flood damage, or economic crisis situations.

The challenge facing land developers is this: to create an environment that provides a degree of resilience against factors that could jeopardise the needs of inhabitants, whilst meeting aesthetical, fiscal, legislative, and market requirements. At the same time, the development should aim to reduce its contribution to climate change. This is, in essence, the philosophy behind the Totarabank subdivision.

This paper describes the Totarabank development and investigates the methods used to try an increase the resilience of the resulting community. The

Background

Totarabank is an eight-lot residential subdivision on the outskirts of Masterton in the Wairarapa. Lot sizes range from 1200m² to 2000m², with each individual title owning a one-eighth undivided share of six hectares of common land.

The subdivision plan was developed in conjunction with a Masters thesis (of the author) that investigated solar access, optimum eave angles, and thermal energy self-sufficiency criteria for the site.

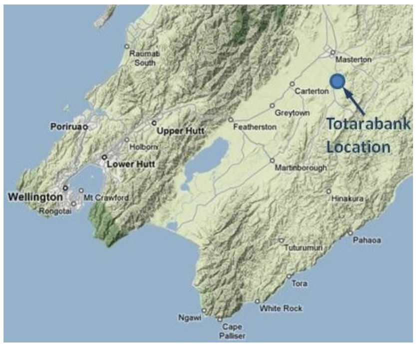

Figure 1 location plan

The proposal had several elements bordering on or outside of standard Council planning criteria (e.g. road widths and lot sizes). Whilst the subdivision eventually received approval, the path was not easy. Also, contrary to the wording of the District Plan, the local authority made no effect to support the sustainable initiative, choosing to obstruct where possible.

The development has evolved to some degree based on other concurrent research projects (see Mandy Armstrong paper at SB10).

The development currently has three dwellings constructed, one of which is the residence of the author/developer.

Enabling Resilience

1. **The concept and practice of enabling resilience.** An appropriate analogy of resilience is that of 'float' – a margin of safety above and beyond the expected operational parameters. Whether this be in provision of light, thermal energy, food, water, or in community support or flood prevention, this float provides the resilience. The practice of enabling resilience is about providing the physical and legal infrastructure to allow this to happen, and then to systematically work towards providing a float in each of the relevant criteria.
2. **Land tenure** was the first issue addressed at Totarabank. There are significant benefits in adapting the development so that the land is used for the purpose for which it is best suited. For example, there may be soil variations, variations in access to wind, water, or solar energy, or suitability for crop growing. By choosing an appropriate form of land tenure, the use of the land can be optimised. Tenure options considered for Totarabank were; freehold, tenancy in common, cross lease, and unit title.

   Totarabank uses freehold titles for the eight building lots (1200 to 2000m²), with a ninth lot (6Ha) being held in undivided shares between the eight (fig. 2). A resident's society is defined in the covenants, and this specifies the method of management of the common facilities, saving the need for the somewhat restrictive impositions of a body corporate. This choice enables mortgageable sections, the provision of common land, and a process by which communal decisions can be made.

Figure 2 Satellite photograph with subdivision components overlaid

3. ***Land use*** was the next consideration. The land tenure choice freed six of the seven hectares for non-building use. This area has been utilised based on the following criteria (fig. 2):

- Identification of soil conditions most suited to wastewater disposal. A common wastewater disposal area has been constructed (facilitating smaller building sections than would be possible if each required individual on-site wastewater disposal). The wastewater is utilised to irrigate a native bush block, which in turn provides buildings shelter from cold southerly winds, and habitat for birds.
- Land least suitable for building purposes has been planted in a coppicing firewood lot, to provide thermal energy for the development (fig. 3).
- Grazing land has been provided including cross grazing the firewood lot and apple orchard.
- Edible landscaping has been adopted throughout the common land, providing a non-invasive, permanent food supply. An olive grove, pine nut plantation, fruit trees, nut trees, wild berries and herbs make up part of the 'background' landscaping.

Figure 3 Coppicing firewood lot

4. ***Electrical Energy.*** The most sustainable electrical load, is an avoided one. Thus the covenants on Totarabank require houses with low thermal loads, and restricted peak electrical loads (by limiting the main circuit breaker capacity to 30Amps). By introducing minimum building thermal performance (BPI) criteria (the new building code Clause H1 requirements goes some way towards this, but not far enough by world standards), and providing thermal energy from the woodlot, the owners are guided towards lower electrical space heating loads. Similarly a covenant requiring a percentage of the water heating load to be from renewable resources guides owners towards consideration of solar and wetback options.

   There will however always be some non-displaceable electrical loads. In an attempt to increase resilience to energy issues, the electrical setup at Totarabank is as follows:

   - One national grid connection, with an internal electricity grid owned in common (embedded network) (fig. 4). This has significant advantages over traditional individual connections (fig. 5) in reduced line charges, backup possibilities, and ability to achieve benefits of scale by acting communally.
   - Facility for communally owned grid connected renewable generation. Specific sites have been set aside for wind and solar photovoltaic generation, and the electrical infrastructure incorporated as part of the subdivision main construction phase. Communal generation facilities are included in the section price (notionally a 6kW turbine, however may be photovoltaic or mixed generation), triggered by the fifth lot sale.
   - It was originally envisaged that smart meters would be installed to allow individual properties to export to the local grid and to allow management of the system. It is not however clear how or if this facility is best utilised. There is a fine balance between versatility and over-complexity. Certainly, the installation of smart meters would allow for greater electrical control and information provision, but the cost of implementation and data retrieval may not be justified until a firm communal goal has been identified. There is much to recommend research partnerships in this area, however suitable partnerships have been evasive so far. Smart meters provide the best outcome for demand side oriented loads, and would be ideal for assisting matching load to generation. However until renewable generation has been installed and all the lots are occupied, the worth of this step is debatable. Initially houses are being installed with simple digital meters and this will be revisited at a later date.
   - The site has the ability for backup generation for grid-down situations. The goal is that during times of failure of the national grid, energy generated anywhere on site could used within the embedded network with some battery storage. During these times a signal will be sent from the backup unit to each lot, tripping electrical relays so that only essential circuits remain open, ensuring a sustainable rate of energy use. This equipment has yet to be installed.

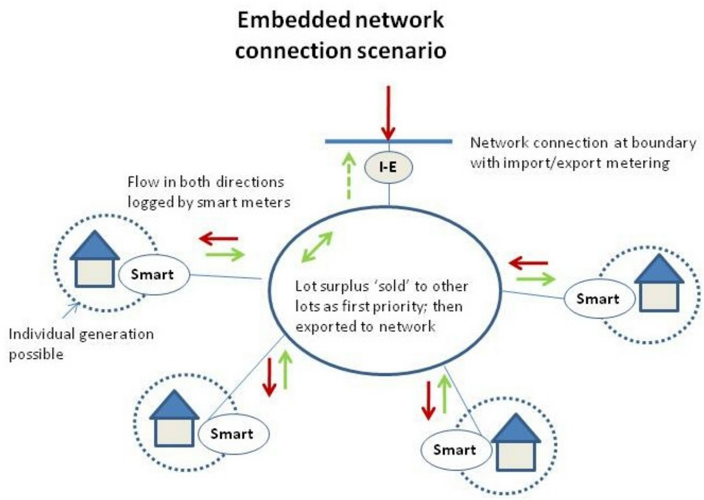

Figure 4 Embedded network connection

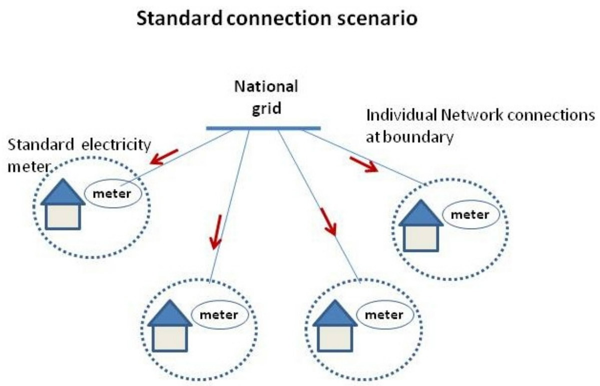

Figure 5 Traditional individual grid connection

5. Building design

In addition to building energy efficiency covenants, there is information available to residents regarding sustainable design and specific information relating to the site. Whilst building design at Totarabank is at the discretion of the owner (other than BPI), resource material is provided to allow owners to make informed decisions.

Of the buildings planned or underway on the site, two are timber framed and one concrete tilt slab. The first house built (Fig. 6) used the optimum eave angle data from the site specific information (Duncan, 2005). Detailed projections of the building performance were carried out (Lamige, 2008), indicating that the average winter temperature in the building without any heating would be higher than the New Zealand winter average house temperature *with* heating. Similarly, summer internal temperature predictions for the house are up to three degrees cooler than buildings with no eaves.

These predictions are being validated by the building performance to date. For example, the author has noted morning outside temperatures of -2° and corresponding indoor temperatures of +11° when the building had no curtains, and had at that time never had any heating whatsoever.

Figure 6 House on lot 2. Note eaves design and concentrating solar collector panels.

The house on lot 1 (Fig. 7) has a similarly low BPI (roughly two thirds of the building code requirement) plus a novel solar air collector for underfloor heating.

The site

A number of fringe design criteria were adopted early in the decision process to lower construction, and longer-term impacts:

- ***Easements.*** There are no easements on the subdivision as all infrastructure facilities are located on common land (land equally owned by individual lot owners), negating the need.
- ***Road width*** was reduced with the introduction of passing bays. This reduces construction energy, imported materials, heat generation, stormwater runoff, and diverts focus away from being road dominated. Footpaths are widely used around the property. The road is constructed on the south side of the property, providing a large kid-safe area to the north of the house sites, the natural focus for outdoor living.
- ***Swales*** and a stormwater retention pond have been used to lessen stormwater impacts.
- ***Use of on-site materials.*** No material has been exported from the site, with excavation material from the road and lake being used to form landscaping mounds screen adjacent buildings and providing privacy between lots. Materials used on site were, wherever possible, sourced locally.
- ***Solar energy***. The lots have been oriented for solar energy capture, and arranged towards the south of the development, leaving a large open area of common land to the north. This allows ongoing solar access and prevents shading from the adjacent property. The site plan has been overlaid with *solar access contours* (Duncan 2005) that define the maximum permissible height of obstacles (be that buildings or plants) before shading occurs on each and every house lot. These contours were then applied as land covenant giving legal status to the contour plan and ensuring ongoing solar access.

- ***Edible landscaping.*** In addition to native areas, the site has been planted with a number of food producing crops – Olives, pine nuts, apples, stone fruit, hazelnuts, herbs etc.
- ***Ecological corridor***. Using the main stormwater channel as a basis, native vegetation has been planted to provide an ecological corridor between the river reserve to the west and the hill country to the east. Plant species selected were guided by Regional council information on the species that would have typically populated this locality. The benefits of this is already apparent (five years since initial planting), and the development is already home to resident Tui, Pukeko, Morepork, as well as a healthy frog population.
- ***A common building*** is included (on the ninth, common lot) in the lot price. With the average house size increasing, and the average family size decreasing, one intended use is to be that of the 'spare room', such that each owner has less need to build for peak occupation as guests can be housed on site, but in the common building.
- ***Transport.*** Until fully populated shared transport facilities are unlikely to materialise, however an electric vehicle powered by generation on site has been mooted. In the short term, there is broadband connectivity, the site is located on a school bus route, and Masterton is within cycling distance. On-site walking tracks have been created for passive and active recreation.

Barriers & Solutions

The development has a number of facets that are out of the ordinary, and this potentially poses barriers for Councils, electricity suppliers, and prospective purchasers.

Whilst individual local authorities may welcome attempts to incorporate holistic aspects to land development, (Waitakere springs to mind), each Local Authority (LA) around the country will have different views, and opposition may be encountered (as was the case with Totarabank). However, since conception in 2004, it is noticeable that there have been significant changes in political stance and in revision to New Zealand standards, for example, Helen Clark's climate Change speech[iv], the new NZS4404, the Building Code revisions, and the new distributed generation standards. Each of these changes reduces the barriers to alternative land development, and paves the way for further advances in the way that we create new residential environments.

In terms of marketability, any major change from the ordinary can have the effect of either increasing or decreasing the target market. The desirability of land parcels is subjective and driven by perceptions. Similarly the perception of risk (be it drought, flooding, food supply or power cuts) is dependent on the experiences and vision of the observer (i.e. don't ask someone from Fiordland the value of water, ask someone from Australia).

This poses questions as to the appropriate course of action for those working in the land development industry: to what extent should we supply purely what the market perceives as desirable, as opposed to what our experience tells us best provides for the needs of the community and environment?

Status

The physical works is substantially complete on Totarabank, roading, telecom, wastewater disposal area, non-potable water supply, and electricity all in place. Three of the eight lots were pre-sold, and one other in stage 1 is sold and nearing completion. Two lots have practically completed buildings (Figs 6&7).

Figure 7 House on lot 1 under construction

After a consolidation period, stage 2 sales are about to commence – it will be interesting to see the market reception given the worldwide changing perception of values. It is somewhat difficult to comment on the reception that the project receives in the market due to the economic downturn. In general, it appears that such developments occupy a small market niche: mainstream buyers appear not particularly interested in unusual concepts.

The management of the common land currently operates partly by communal input and partly through contracted work with a per lot levee. The management and planning of communal works is just starting to develop as it becomes clearer where maintenance costs lie, and what level of service is desired.

Conclusion/Discussion

As climate change and political/financial uncertainty looms as factors that will increasingly dominate our lifestyles, could ‘resilience’ be a concept whose time has arrived?

Land development techniques and choices by necessity should be an ongoing evolution. The speed with which changes to the political or physical environment are adapted into the ethos of land development is a reflection of both the land development industry and market perceptions. There appears to be an educational gap between sustainability researchers/practitioners, and the general public. This perhaps stems from perceived needs in terms of our collective understanding of the impact of our actions on the environment (PCE, 2004). If so, it will take either a significant local effect (drought/flood etc) or persistent and penetrating changes to our community education to effect a change to our national level of understanding.

Totarabank is becoming established and although has not yet reached critical mass in terms of residents, with three out of eight lots with buildings underway, the ‘feel’ of the development is becoming clear. In terms of building sustainability, it appears that owner-driven perceptions are still dominant in dictating the end product. Whilst significant steps can be taken to guide the sustainability of developments by providing the infrastructure and information, there are many energy and sustainability pitfalls for the average homeowner that can deduct from the original objectives. There is a delicate balance to be found between guidance and regulation.

So far the practicalities of designing and building sustainable housing against a backdrop of industry scepticism or lack of knowledge, is that significant owner commitment and knowledge is required to crystallise general concepts into something more concrete. Large scale change in the short-term may need to rely more on regulation than on a collective understanding of the consequences of our choices.

The resilience features incorporated into the site are silently apparent. Energy efficient houses with high natural lighting are cheap and easy to operate: on-site food is a pleasant background and the coppicing firewood lot is a visual reminder of stored energy. Community interaction of the residents so far is high. On site electrical energy generation has not yet started, but understanding of energy choices increases with each research project carried out.

Further information is available on Totarabank is available on the website www.totarabank.com

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