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The Development of the Index 21 Housing Layout Tool: The Assessment of Non-Monetary Environmental Benefits

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ABSTRACT

In recent years mass housing developments, built by speculative developers in Scotland, has broadly focused on economically led strategies, with housing built to high densities. Current methods of development have widely ignored environmental issues. In contrast, the wider issues of sustainability, and consequently housing developments, have become ever more complex. Yet local planning authorities are required to incorporate these issues into the planning process. This paper focuses on the development of a housing layout assessment tool, termed Index 21: Housing Layouts, which provides a practical method of assessing the environmental friendliness of housing layouts. This tool has been developed to provide a discursive forum between the designers of housing developments and planners to aid the planning process.

There is a lack of effective tools that would facilitate the effective choice of environmental friendly housing layouts. The index 21: Housing Layout tool is aimed for use during the planning stages to encourage the adoption of more sustainable housing layouts and also to encourage dialogue between designers of housing layouts and the planning authorities. Index 21: Housing Layouts is based on the assessment of five Indicators, namely Climate, Energy, Resources, Biodiversity and Social Sustainability. Using a case study at Rothesay, on the island of Bute, the tool has been tested on three design layouts for a housing association on a sensitive semi-urban site. The paper concludes with the description of the next phase of development for the tool as it stands and a similar tool that encompass the assessment of social and environmental issues of housing design, to encourage more sustainable methods of housing design.

Keywords: Housing Layout; Environmentally Friendliness; Sustainable Housing; Housing Assessment Tool

1. INTRODUCTION

The construction industry has a history of achieving short-term goals, without realising sustainable, long-term objectives for housing (NAO, 2001). The Urban Task Force was created partly to find 'radical solutions' to this problem (DETR, 1999), recommending changes predominantly to the planning stages for real, long term sustainable benefits. Environmental, ecological, or green design, as it has variously been called, is a means, if used appropriately, of helping to achieve more sustainable, long-term housing goals.

The early planning stage of a development is the ideal time to adopt passive solar principles, but there are some key obstacles described by Yannas (1994) namely; the lack of design information; credibility and applicability of environmental principles; marketability of environmentally friendly housing layouts; lack of incentive from the government to adopt these technologies; perceived increase in the costs when these technologies are adopted; and (aesthetic) design quality. In general the planning profession is not particularly well trained or suited to determine the benefits or otherwise of the physical performance of buildings. Planning professionals, however, potentially can make decisions that can radically affect housing designs and layouts. In addition, planning officials have to deal with a whole series of other environmental issues, of which the future physical, psychological and environmental performance of buildings may be low on the priority list. Housing developers therefore remain the driving force behind early planning decisions - decisions such as basic layout, quality, strategy, process, management and density. Their housing strategy is economically driven, once the minimum building regulations and any stipulations of local planning authorities are achieved (NAO, 2001). If sustainable practices are added at a later stage in the design process, this would lead, in most cases, to increases in capital costs in the short term and the reduction of the potential to save heating costs and emissions in the long term.

Across the construction industry in the UK suburban housing developers plan, design and build on very similar principles, arguably with limited innovation in housing (Blackler, 2002). This makes for the slow adoption of alternative housing designs and layouts, such as environmental design, amongst mainstream speculative developers where issues such as sustainability and green design can be marginalised (Blackler, 2002; Cullingworth and Nadin, 2002). These concerns, however, coupled with increased density for housing developments, are central to the objectives of the planning office and government (Cullingworth & Nadin, 2002; DETR, 1999).

For a housing developer, if a sustainable project was to be developed, there is a perception that there is an additional monetary risk, which is forwarded onto the homebuyer, making this type of project less marketable. In short, the principal housing form is for densely packed, detached homes built to minimum building regulation standard, which is the result of economic imperatives coupled to risk aversion. This short term focus, although relevant, fails to take account of the long term costs to the environment.

In addition, during the planning stage, environmental aspects of designs are often vague, leading to flaws in the decision making process if professionals are not

properly trained in environmental architecture or do not have access to this form of housing development appraisal. Bordass (2000) states that it is often difficult even for professionals well trained in environmental or 'green' design to differentiate between an environmentally friendly dwelling and one which merely claims to be. More information to aid decision making at this stage is required – both for short and long term decision making. An environmental site assessment tool, which appraises a site comparatively, based on simple building geometry and layout providing indicative costs, would be a useful tool to investigate the potential of a site at the initial stages.

Currently, the only time when a change can be made to the developer's planning strategy is at the planning consent stage. However the adoption of environmental designs at this stage in speculative developments is unlikely without further incentive. For an environmental design to be adopted, one incentive that a housing developer may find attractive would be a rapid planning consent. It is hoped that an easy to use, transparent tool such as the one developed in this research could speed up the planning consent for the housing developer, if passive solar or other 'green' design principles are adopted during the planning stage. This paper illustrates a tool developed to ascertain the, predominantly, socially and physical sustainable benefits of housing layouts in Scotland. Using a case study for a pilot test, coupled with other planning strategies, this paper also charts the application for development of a sensitive semi-urban site in Scotland.

2. RESEARCH METHODOLOGY

2.1. Background

Sustainability is a recognisably complex area for research, with many interlinked ideas and issues that often do not readily mix. There is a long established research team at the Robert Gordon University on the wide topic of sustainability in housing and housing layouts, established over ten years ago. The main ethos of the team is to make the issues of sustainability more readily understandable to the architect, developer and planner so that sustainable housing, in this case, can be designed, built and lived in.

In this specific case, the purpose of the research was to identify the key elements that will create an environmentally friendly housing layout. Initially through EU LIFE funding, and latterly through Aberdeenshire Council and ESF funding (so that the tool can be used educationally) the tool has been developed for use at the planning stage. Although it does have a scoring system, to rank a housing layout, the main idea is to provide an online discursive forum between designer and planner.

2.2. Development of the tool

Figure 1 shows the high level development of the index 21 tool. The indicators, and the values from which the indicators were derived, was researched by designated work packages (during the 'research' phase of figure 1). These work packages were both large and small, but were distinctively individual. Therefore, the work packages included work by PhD students, for example Smith, (2001), funded projects by the client completed by members of the research team and collective research by non-funded discursive forums made up from planners,

designers and developers in the North East of Scotland. Collectively, the work packages provided the raw data behind the tool and aided in the development of the questions and format of the online tool.

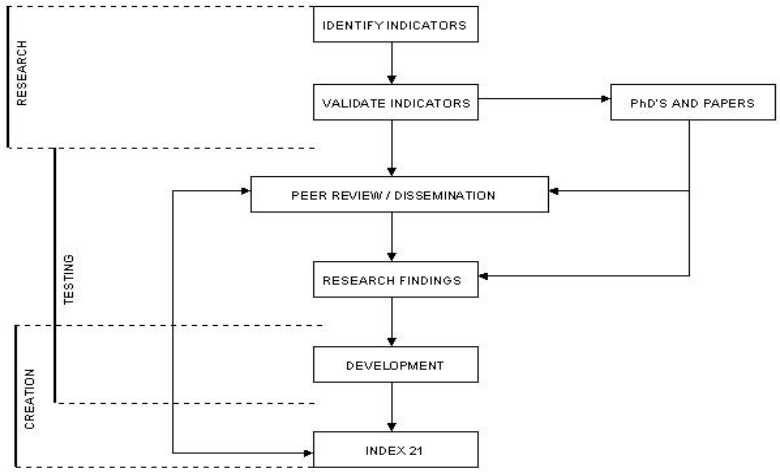

Figure 1: Methodology of Index 21 tool

The background research also helped to identify the five main indicators which affect environment friendliness around the North Sea coast – namely Climate, Energy, Resources, Social Sustainability and Biodiversity. Packages of further research were carried out in respect of each of the 5 indicators.

The climatic research produced a design framework which identifies effective layout topographies and actual elements in layouts which reduce the impact of, for example, wind-speed. Monitoring equipment was installed in a variety of building types on the demonstration site to monitor energy efficiency. Guidance tables were produced for the assessment of resource efficiency in commonly used construction materials and methods. Questionnaire surveys were carried out to identify the aspects of the design of living environments which are recognised and valued by residents. Biodiversity monitoring continued throughout the four year duration of the project to assess changes in the quantity of flora, fauna, birds and butterflies across the broader site area.

The data from the research was disseminated in discursive forums towards the end of the project (peer review in figure one). For wider dissemination a national conference was held to promote the tool and discussion on the way forward for the tool (dissemination in figure one).

When considered collectively, the findings generated through these pieces of research resulted in a template for assessing the environmental quality of housing layouts. This assessment system has been named *Index 21: Housing Layout* and has been developed as an on-line tool, accessible to registered users anywhere in the world. Potential users represent all sectors of the housing

market, including developers, designers, planners and house buyers. It is anticipated that *Index 21: Housing Layout* will be used as a tool to clearly define sustainable housing layouts within the housing industry.

2.3. The Way Forward

The tool has been, and will be, tested with a variety of housing developments around Scotland to investigate a range of criteria. An example of one such case study is provided in this paper. Investigation of the user interface with an online tool and whether the tool correctly identifies leading sustainable issues in housing layout are two such examples of future work. Each of these examples are still under investigation and testing. Currently the tool has attracted interest but does require significant future development to ensure successful implementation at the planning stage. To date, a small number of local firms and public bodies have expressed a willingness to participate but more national based bodies need to be approached to ascertain, for example, marketability to other areas in Scotland.

The system is currently being piloted within Aberdeenshire, with the aim of incorporating the framework into local policy over the coming years. It is hoped that the tool will take the lead in promoting the use of Sustainable housing layout nationally, as well as assisting with its introduction to other coastal areas of Europe over time.

3. THE INDEX 21 ASSESSMENT TOOL

As Index 21 has been developed principally to assist planners in recognising environment friendliness when they assess housing layouts, the factors involved relate only to matters under planning control - from the skin of houses outwards. The Index is also limited to factors involved in the laying out of a site, once it has been selected for development. Figure two illustrates the process.

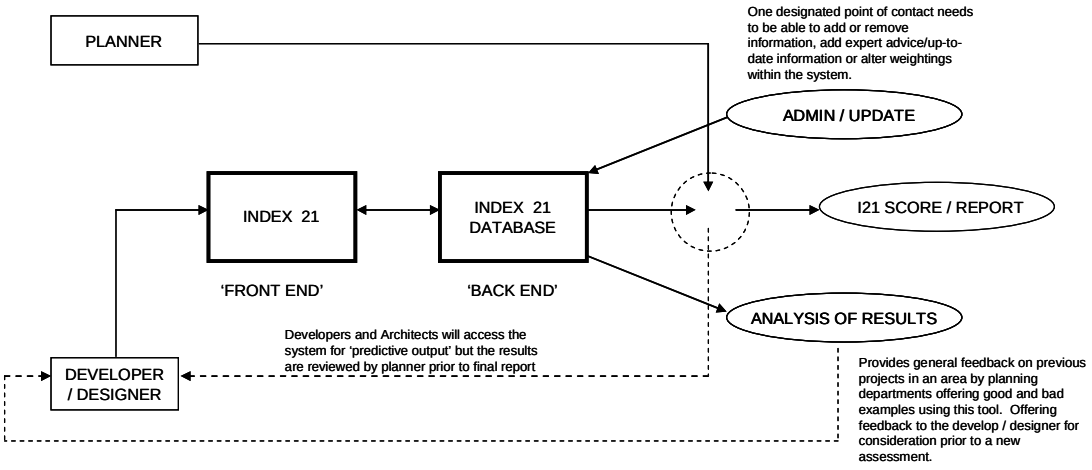

Figure 2: Structure of the Index 21 System

In order to compile the index, the research on each of the five indicators was distilled into a number of key issues. For each issue there are a number of questions to be addressed, each of which is accompanied by a list of things to consider, detailing the key factors to be considered when responding to the

question. Further to this is a list that describes what to look for in the layout when scoring the application. Each topic is supported by a number of illustrations of good and/or bad practice.

The background research, which has been carried out by Aberdeenshire Sustainability Research Trust (ASRT) during the four year project is also included, detailing the main academic and practical findings that underpin the index, including a glossary and a bibliography for further reference.

Index 21 is effectively a simple 'scoring sheet', which summarises how well a layout is likely to perform based on the assessment of issues of climate, energy, resources, biodiversity and social sustainability. The overall Index score is generated from the combined results of each of the five Indicators, yet no individual Indicator can be ignored. An applicant therefore requires a minimum score under each Indicator in order to achieve a pass.

The Index was initially conceived as a spreadsheet type system to be filled in by the assessor as he went through the process. However, the huge amount of information and the complexities of the calculations once weightings etc. are introduced encouraged the trust to commission an on-line, database driven system. This also offered many additional advantages such as controlling access and use, being able to track and analyse results, ability to share assessments and scores between team members, and the ability to simply update the system as required.

For many designers the exercise of going through the process will be almost as important as the final score. The system therefore requests a statement of self-assessment for the design layout, providing an opportunity for the applicant to set out how each topic has been addressed (or how it has been addressed in an alternative way, or perhaps why it has not been addressed at all). For the assessor this will provide a valuable aide to ensure key elements of the intended design are not overlooked. The Index is of course designed to accommodate new, innovative practice and give credit for features or strategies not currently included.

The system is currently being piloted with a number of selected users and initial feedback is part of ongoing research and re-development of the tool. Continuous performance monitoring, feedback, training days and seminars will assist in the further development and refining of the system. It is the intention that Aberdeenshire Council will integrate Index 21 into local policy over the next couple of years, with the longer term aim of adapting the system for use in coastal areas across Britain and Northern Europe.

4. THE FIVE INDICATORS

The project involved developing five different indicators of sustainability, which together form *Index 21*. These were devised from research in the area at the University and with collaboration with the strategic team on the project. A description of the research carried out in developing each of these indicators follows.

4.1. Climatic Indicator

In order to develop a design framework for wind modification in coastal residential areas, wind speed measurements were taken at coastal housing layouts along the North East coast (Smith, 2001). These measurements assisted in the identification of effective layout topographies and actual elements in layouts which reduce the impact of wind-speed, giving outdoor shelter to residents. The data collected by the internal weather stations records the effects that developments have on the microclimate of the area, with a control station gathering baseline data at a distance where it will remain unaffected by the development of the site.

Ideally, there are a minimum of three stations on a site. The control weather station supports instrumentation for the measurement of wind-speed, wind-direction, air temperature, sunshine hours and biometric pressure, powered by a solar cell. The two (or more) internal stations measure air temperature, wind speed, wind direction and humidity.

Baseline data was regularly downloaded from the weather stations in order to evaluate as accurately as possible the climatic conditions prior to construction, and the same parameters continued to be measured during and after planting and the construction of a development. This allows the changes the built form has on the climatic conditions to be assessed.

4.2. Energy Indicator

The collection of data to inform the energy indicator involved the installation of monitoring equipment in various houses. At the Robert Gordon University, the research department has extensive expertise in the physical monitoring of energy performance in a range of housing types. This involves life cycle analysis, performance analysis and occupancy evaluation. This asses the internal energy performance but has also included the assessment of the effect of woodland, shelter belt planting and other details of the site layout have on energy efficiency.

The sensors are monitoring temperature and humidity in the buildings as well as the temperature of hot water tanks and pipes. It is anticipated that, in time, the configuration of the houses on a site along with the development of adjacent landscaping should have a significant effect upon the performance of the housing.

The specification of street lighting has also been studied, from the point of view of both energy efficiency and the levels of light pollution which they omit. The street lighting can be specified on a dimmable system, to reduce energy waste and levels of light pollution during the night, for example.

Although not part of the demonstration development, the use of renewable power sources (such as hydropower, biomass, geothermal heat pump, wind power and solar thermal) has been researched for inclusion in *Index 21*.

4.3. Resources Indicator

The specification of resources in housing developments will impact on the environment in many ways. The resources indicator focused on three main areas: embodied energy, management of water and waste, compactness of built form.

Embodied energy refers to the total energy required to win raw materials, to process and manufacture them, transport them to their place of use and put them together. The research carried out focused on six main elements of construction, namely: engineering works, landscaping works, outer leaf wall cladding, roof cladding, windows/doors, and structure. Information was principally gathered from existing sources, as well as through interviews with manufacturers, suppliers and buyers of construction materials.

Water management covers both recycling of grey water and disposal of drainage. The research carried out included a study of existing policies on the inclusion of sustainable urban drainage systems (SUDS) in housing developments. Reports were commissioned on the potential for including a wetland drainage system and a detention pond for storm water run-off at a demonstrative site.

The research has shown that the most significant impact on resource use in housing layouts is the construction of the site itself - that is the length of road required to service the site and excessive re-contouring or infilling to remodel the site. Current policies do not encourage minimising the area of hard landscaping within a housing layout, and this has therefore been addressed through the Index 21 assessment.

4.4. Social Sustainability Indicator

The social sustainability indicator was developed through carrying out questionnaire surveys of residents at several housing developments within Aberdeenshire. The aim was to demonstrate what differences the movements, opportunities and activities of living in various locations and types of housing layouts have on the sustainability and healthiness of the residents 'lifestyle, and the effect on the overall sense of community as a result of the design of their living environment.

This part of the study aimed to assess the three factors that are necessary for a socially sustainable human settlement. That is the potential of a given area for building and maintaining social relationships, acquiring and using social knowledge of the environment and its resources and the ability to adapt to social change and reproduction.

The surveys therefore covered three main areas, which were:

- Cultural capital / Social integration: The extent to which residents are aware of the identities of their neighbours and the level and frequency of their interaction.
- Spatial / Cognitive integration: The ability of residents to identify and interpret their own system of important features and resources that may be present in their area.

- Flexible interpretation: To measure the layers of residents 'interpretation' produced by the physical, ideological and social inputs of a place, which can then support the multiple roles able to be adopted by inhabitants.

Analysis of the responses has enabled a design framework for the development of socially sustainable settlements to be compiled.

4.5. Biodiversity Indicator

Baseline studies on vegetation, bird and animal life were carried out at a demonstrative site in order that changes may be evaluated over the course of a specified period. Butterfly transects through and around the site was carried out regularly by an environmental consultant to the project. The transects were carried out in accordance with the nation-wide Butterfly Monitoring Scheme, organised by ITE, which takes place over a 26 week period from April to September each year. Butterflies are an excellent 'indicator species' giving a general picture of the condition of the natural environment. They have been used as one of the main indicators in assessing the increase or decrease in the biodiversity on and around the site.

Woodland is also an important indicator of the diversity on a site as, for example, very limited shelter on a site may mean that migrant species will tend to move through very quickly. Quality and diversity of planting will ensure that diverse life can be maintained on a site. The environmental consultant monitored the range of species in the area whilst carrying out his transects over the four years of the project, comparing results to the baseline data from 1997.

5. CASE STUDY IN ROTHESAY

In 2001 the client (Fyne Homes Ltd) approached G Deveci Architects and The Robert Gordon University regarding a sensitive site on the Island of Bute. Due to the environmental and social sensitivity of the site the client had found it difficult to reconcile the need for new housing and meeting sensitivity objectives. The site is set prominently with magnificent views of Rothesay bay, sea views to the North and the hills to the South with a very dense yet diverse range of woodland and shrubs over the majority of the site. The site also has a considerable slope from North to South with a stream running within but to one side of the site with only one access (for vehicles) to the site. There are a number of derelict buildings on the site (the previous use included a private home which was later turned into a hotel) which were destroyed by fire in 1994. There is also a Doocot on the site. Since this period the site has had considerable amenity appeal to the local community.

The site has an impressive avenue of mature trees. Most of them are subject to Tree Preservation Orders. The species include sycamore, ash and lime, although a wide variety of other species are present. The woodlands have not been managed over the last two decades and were neglected yet it was important that the majority of the existing trees and shrubs were not to be disturbed. The site can be divided into three distinct areas.

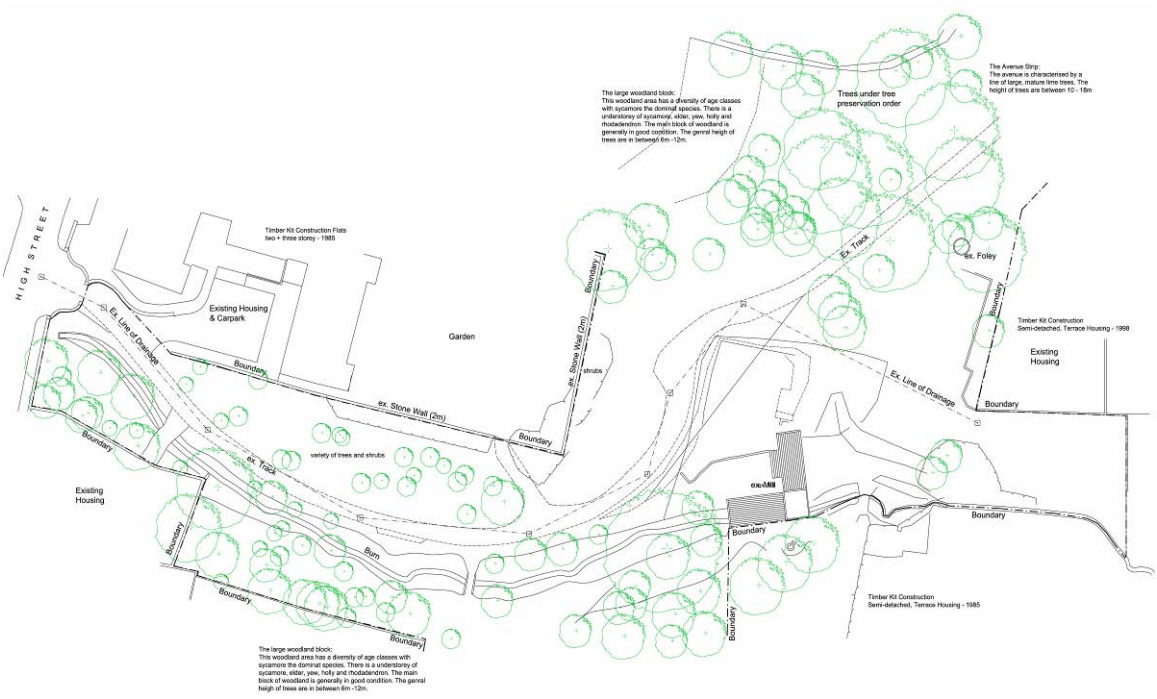

Figure 3: Site Plan

The streamside area (bottom). This long and thin strip has the widest range of species. It also has a significant under-storey of sycamore and holly regeneration and areas of rhododendron and other invasive exotic shrubs. There are some interesting features within this area, including a small stone bridge and a stone well. Many of the specimen trees are over-mature with visible signs of decay.

The avenue strip (from High Street on the left towards existing building along existing track to the top of the site). This is the thin strip between the Avenue and the recent Foley Park Housing development. The avenue is characterised by a line of large mature lime trees, which exhibit no visible signs of decay.

Woodland block (as in figure). This woodland area has a diversity of age classes with sycamore the dominant species. There is an under-storey of sycamore, elder, yew, holly and rhododendron. The main block of woodland is generally in good condition and is heavily used by the public. Along the boundary, there are individuals with large crowns very close to buildings.

The following lists the design options to ensure the sensitive nature of the site was complimented with the need for a housing development on this site. The project aimed to build a maximum of fourteen dwellings for rent in Rothesay, on land zoned for housing. It is intended to provide mix of two and three bedroom dwellings for the young couples, elderly, disabled and for general local needs.

Each of the design options were analysed using the Index 21 assessment tool. The tool lists how each option scored against each of the indicators mentioned in section four, the final scores for each indicator are given in the conclusions.

5.1 Option One

Figure 4: Option One site plan

The first design option shows 12 number detached and semi-detached 2 to 3 bedroom homes. The proposed houses will facilitate life-time homes concept, extendibility and flexibility, barrier free design principles as well as community and user participation in the actual process of design and planning.

Design philosophy

The sustainability and innovation aims will be met by considering:

- The well-insulated timber-frame construction (about 40% improvement on the Building Regulation requirements) reduces heats loss and helps minimise the heating requirements for the houses.
- The use of timber as the main construction material helps to minimise the embodied energy of the building as a whole.
- The use of engineered timber as part of the building structure and envelope minimises the use of non- renewable alternatives with high-embodied energy.
- The timber panel construction to form the walls and roof is based on the use of complete standard sized panels with no off cuts, maximising the efficient use of standard building components and reducing waste.
- Off-site production enables closer control of the construction process, thus reducing wastage and enabling the recycling of the waste produced.

The achieved cost efficiency in the construction of the dwelling shell will allow the following;

- Increased floor area for comfort of residents and flexibility of use. Incorporating attractive features and materials for consumers choice.

Index 21 Assessment of Design Option One

Although detached housing is prevalent in the area and, of course, throughout the country, this scheme of detached housing is orientated towards the South. In the Index 21 assessment it scores highly in this aspect.

The Index 21 tool was critical in a number of areas in this design option. The tool raised concerns, in particular, with the compactness and, consequentially, the amenity of the site. With the 14 units as required by the client expressed as detached housing, the tool queries whether the units could have greater density. This would allow for greater amenity for, for example, green-space or open-space (termed public space in the Index 21 tool). In addition, the detached housing detracts somewhat from the natural beauty of the site. The Index 21 tool also raised the lack of private space for each dwelling as an issue.

There was also the risk with this design option, the tool noted, for the bio-diversity of the site to decrease. Significant cutting and felling of trees, especially the younger trees, could result in a significant change to the environment and atmosphere of the site. Although in the community presentation this detached housing option was seen favourably by a good proportion of the community, it was not see by the tool to add socially or architecturally to the area. In addition, the design was not seen as sensitive to the needs of this site – it had a high impact.

5.2 Option Two

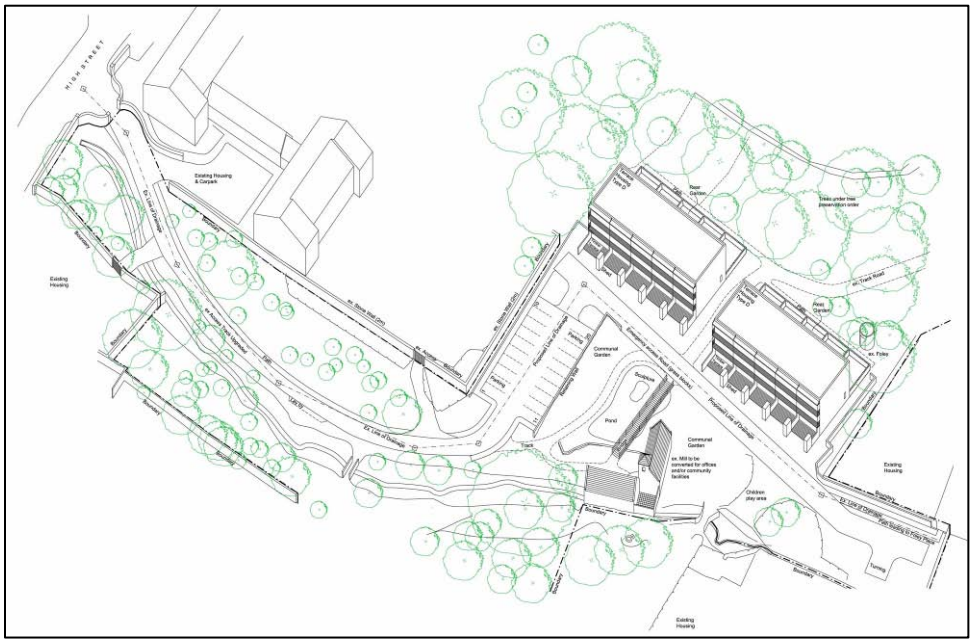

Figure 5: Option Two site plan

The second design option shows two terraced house blocks with 2 to 3 bedrooms. The proposed houses will also facilitate life-times home concept, extendibility, adaptability and flexibility, barrier free design principles as well as community and user participation in the actual process of design and planning.

Design philosophy

The design philosophy of the proposed houses was to abolish a rigid internal planning. By having fully flexible, adaptable and moveable partitioning the homes can offer maximum adaptability and the possibility of meeting the needs of a wider variety of user needs over the building's life cycle. Floor plans show the flexibility and adaptability of the designs. The sustainability and innovation aims will be met by considering:

- Providing open plan shell.
- One service core providing all necessary service connections, and natural ventilation solar chimney.
- All internal partitions are non-load-bearing allowing flexibility and adaptability to lifetime changes and specific requirements and preferences of the residents.
- 10% increase in space standards to create better living environment, compliance with new part M requirements and principles of lifetime homes.
- The basic concept these design rest on the possibility of cost savings might arise from the use of very simple geometric plan form to maximise space/envelope ratio.
- Further savings will also accrue from modularisation of the simple structure and the minimisation of hallway structure.
- The concept lends itself to the idea of using a central prefabricated bathroom and kitchen module to reduce cost & enhance construction.

Index 21 Assessment of Design Option Two

Design Option Two was designed with a more compact building form. Index 21 rates this aspect quite highly but notes that the building form is out of context to the neighbouring properties. Although their are flats of this size nearby, they are significantly different in shape and architecture to this design.

The reason put forward for this design is the need for a balance between impact and passive solar use of the site. The design is, therefore, more dense and orientated south. As a consequence, the two blocks of flats are on the highest and least overshadowed area of the site. Index 21 gives some credit for the adoption of these principles.

The tool, however, is also quite critical of a design which seems to ignore context and the environment on the site. In addition, for the two blocks to be located where they are on the site, significant parking and roadwork is required, which is detracting and the tool scored these aspects poorly.

In the past, this site has been used by the local community as a through access route. With the layout as it stands, the through access route is between the two blocks. The tool notes that this could be an issue for security and privacy for the residents and could seem uninviting for the wider community.

5.3 Option Three

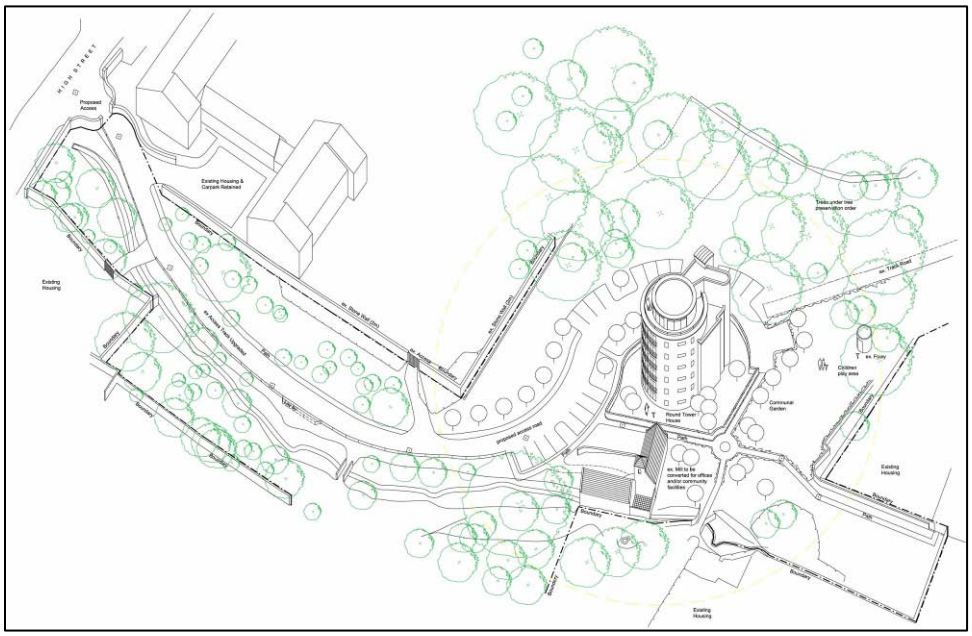

Figure 6: Option Three site plan

Design option three is based on a tower house concept accommodating 13 no two and three bedroom flats and 2 no semi-detached converted houses with magnificent views to the sea, Rothesay harbour and the surrounding hills. The low impact of the footprint area was the primary incentive for this design option and was the principle reason why it was chosen.

Design philosophy

The design philosophy of the proposed houses was to limit the impact on the site. By limiting the building to only a small portion of the site it restricts groundwork, limits the potential harm to the surrounding environment during the construction process and opens up the remaining areas of the site for social amenities. The building is also modern yet mirrors historical tower building in Bute and the wider Scottish architecture of tower design.

The sustainability and innovation aims will be met by considering:

- Increase density to ensuring construction is limited to a portion of the site
- One service core providing all necessary service connections.
- Solar access to main living spaces to reduce demand on dedicated heating systems.
- 10% increase in space standards coupled with open plan living to create better living environment, compliance with new part M requirements and principles of lifetime homes.
- The basic concept these design rest on the possibility of cost savings might arise from the use of very simple geometric plan form to maximise space/envelope ratio.
- The masonry walls were well insulated, over three times better than standard with energy efficient glazing.

- The concept lends itself to the historical context of Scottish tower houses.
- Improved social inclusion and quality of life.

Index 21 Assessment of Design Option Two

Design Option Three scored similarly in many respects to the previous design options. It benefits greatly by increased scoring from better access to passive solar, but this is counterbalanced by the increased risk of heat loss from cold winds.

This design option benefits from its compact building form and the benefits the project gives to the community. This design option has a significantly smaller impact, in terms of area, than any of the other of the designs put forward. For this reason the design scored highly on this site. In addition, and as a consequence of the compactness of the building form, the grounds of the site allowed for continued use by residents and the local community without issues of privacy or security. As part of the design much of the open (green) space can be re-planted back to an original environment. Overall the tool rated the atmosphere, social and architectural issues of this design quite highly.

The design was also quite readily accepted by the wider community, recognising the architectural merit as a landmark for Rothesay. Admittedly there were some reservations for those that were to live in these properties as to the practicalities and functionality of the building. A post occupancy evaluation will tell if this is the case.

6. RESULTS AND CONCLUSION

6.1. The Index 21 Assessment

The Index 21 assessment was conducted by an independent assessor. A standard housing development would be assumed to be awarded less than 50%, therefore on this basis each of the design alternatives performed significantly better than standard housing development. In a comparison between them, option three, which is the high rise option, gained a significantly higher percentage. Seventy five percent is deemed to be a high pass grade in this assessment. This has resulted from option three having a more compact form allowing greater access to passive solar and better usage of the surrounding landscape on what was a particular sensitive site, important for both the community and nature. Option three provided less impact on the site.

There were some budget constraints, and this is where the three options fail to get higher marks in indicators two and in particular indicator three, which was particularly concerned and water resource, drainage and embodied energy. These aspects of each of the designs were not fully developed at a strategic level.

Table 1: Summary of Index 21 Assessment

	Option One - detached	Option Two – terraced flats	Option Three – high rise flats
Indicator 1: Climate	B (82%)	B (81%)	B (89%)
Indicator 2: Energy	B (71%)	C (69%)	C (70%)
Indicator 3: Resources	C (55%)	C (62%)	C (66%)
Indicator 4: Social	B (75%)	B (74%)	B (76%)
Indicator 5: Biodiversity	C (64%)	C (64%)	B (71%)
Results	C (69%)	C (70%)	B (74%)

6.2 Community Involvement

Although the Index 21 tool identifies Design Option Three as the preferred, sustainable alternative there is a need to have dialogue with the community, especially on sensitive sites. This site had various meanings to a number of groups in the community, but this is balanced in the community by a recognised need for more housing especially social housing. A particular problem for the planning system is getting local interested parties involved in the planning process, however. Objections form evidence of the dislike and distrust of the unilateral decisions (or perceived decisions) of planning authorities to grant housing developments on land which locals feel 'are ours'. This is certainly the case in many sensitive areas of rural Scotland, and was the case in the case study provided in this paper. For this reason the community was brought into the design process.

The three designs were set up for critical appraisal by locals and potential owners of the buildings and they were asked, which option they would prefer. Designers should remember that any design not only impacts the users but those surrounding areas, which form the social cohesion of a community. Bad design could enhance a 'them against us' (Cullingworth and Nadin, 2002; Bordass 2000) attitude which is not conducive to social sustainability, an aspect of sustainable design often overlooked in housing. Community involvement, with the direct communication of ideas and concepts in a transparent forum, is one step in ensuring that a socially responsible design is chosen. In this social assessment phase, the community chose design three. Although many favoured the detached housing, particularly young adults and potential homeowners, the community at large felt that option three would give something back to the community and be a positive addition to Rothesay.

6.3 Summary

The Index 21 assessment intends to aid the planning process by assessing housing developments against sustainability indicators. The assessment of sustainability is a complex process for all involved in the design of housing developments, and the index 21 tool aims to act as guidelines for designers and planners alike, to provide a platform for ongoing discussion. It is not intended to dictate design.

On this practical case study, each option was rigorously assessed using the tool. Each design had environmental credentials to lesser or greater extent. The site itself was a particular sensitive site being on an island, in a small community and had been used recreationally by the very local community. The residents of the area did not want to see a standard housing development in their backyard. Each of the proposed designs had their individual merits but the compactness of form, the allowance of communal space and the visual impact of the design that option three provided ensured that option three was the preferred choice in both the Index 21 assessment and in the opinion of the community.

Once both assessments were completed and widely publicised, there was little obstacle or hesitation in allowing option three planning consent. On particularly close knit and sensitive sites in Scotland, this is a method for overcoming the inherent obstacles of building on beautiful and sensitive areas of Scotland.

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