CYNNAL | SUSTAIN
CYMRU | WALES

Cynnal Cymru Advice to Lightwood Regarding the Proposed Use of Land North of the M4, Thornhill, Cardiff

19 August 2021

Table of Contents

1. INTRODUCTION 3

THE WELL-BEING OF FUTURE GENERATIONS (WALES) ACT 2015 4
THE PLACEMAKING WALES CHARTER 4
GENERAL MANAGEMENT AND MAINTENANCE OF PLACE 4

2. LOW CARBON HOUSING & LIVING 5

2.1 CONTEXT 5
2.2 VISION 5
2.3 CHALLENGES AND OPPORTUNITIES 6
2.4 RESOURCES AND GOOD PRACTICE EXAMPLES 8

3. LANDSCAPE DESIGN & BIODIVERSITY NET GAIN 10

3.1 CONTEXT 10
3.2 VISION 10
3.3 CHALLENGES AND OPPORTUNITIES 12
3.4 GOOD PRACTICE EXAMPLES 13

4. OPPORTUNITIES FOR JOBS, SKILLS AND EDUCATION 14

4.1 CONTEXT 14
4.2 VISION 14
4.3 CHALLENGES & OPPORTUNITIES 15
4.4 GOOD PRACTICE EXAMPLES 16

5. CONCLUSION 17

1. Introduction

Cynnal Cymru is the leading organisation for sustainable development in Wales. We work across industries and sectors to promote an integrated and action-focused approach to sustainable development, including the goals in the Wellbeing of Future Generations (Wales) Act 2015.

We have been asked by Lightwood to recommend how the sustainability of potential proposals for a low carbon development at Thornhill, North Cardiff, could be maximised in line with vision and objectives for the replacement Local Development Plan and the priorities for sustainable development in Wales.

We recognise that development of green field sites is contentious and will always attract challenge. As an organisation working towards a thriving natural environment, we start from the premise that developments on green field sites are generally *unlikely* to improve the environment. Equally, the current need for current models and standards of housing is unlikely to be wholly met on brownfield sites alone. On the basis that development of this site seems highly likely to occur, we have agreed to provide a frank, robust and informed view on some of the opportunities for maximising the overall sustainability of this unique proposal, given the size, characteristics, and location of the land, including our suggested approach to achieving a net gain for nature.

In doing so, this report set out our vision for a development that is consistent with the principles of Sustainable Development as defined in the 1987 United Nations report, "Our Common Future"; namely, *development that meets the needs of the current generation without affecting the ability of future generations to meet their needs.* To achieve this, development must take place within the limits of the local and global ecological capacity to self-generate and sustain the full variety of life, including of course, human life.

Four core principles ensure that the best use of technology and social organisation delivers within these limits:

1. Zero carbon
2. Zero waste
3. Biodiversity gain
4. Social and economic well-being

At this stage, we have focused our advice in three areas:

I. Low carbon housing and living
II. Landscape design and biodiversity net gain
III. Opportunities for jobs, skills, and education both throughout the development process and on completion of the site.

The structure of each topic within the report is as follows:

1. Contextual overview identifying relevant local and national policy and other drivers for innovation and goal setting
2. Idealised vision
3. Examination of practical challenges, barriers, and opportunities for achieving the vision
4. Examples of good practice that set a relevant precedent

The Well-being of Future Generations (Wales) Act 2015

This legislation is unique to Wales and has caught the attention of policy makers around the world. The Act was given royal assent in the same year as the United Nations Sustainable Development Goals and is essentially a local expression of the same principles and values.

The Act places a duty on all public bodies in Wales (including Cardiff Council) to make decisions according to the *Sustainable Development Principle* and be accountable to the Future Generations Commissioner in being able to demonstrate that their decisions contribute locally to seven national Well-being Goals.

In practice, this means that a local authority like Cardiff Council, when planning for the future,should seek to create inclusive, diverse, healthy communities with excellent access to essential services in locations with low carbon credentials and those that do not threaten ecosystem resilience and can achieve biodiversity enhancements.

Carrying the principle over to the Local Development Plan, the Council shouldbe more likely to allocate land for projects that are zero carbon, achieve biodiversity net gain and deliver multiple co-benefits such as employment, skills and training, social housing, equal opportunities, and support for healthy lifestyles.

The recently approved application for the development of the new Velindre cancer centre on a greenfield site (in Cardiff) is an interesting example of the interpretation of the Act in the context of planning specific law and planning policy. The site was surveyed by ecologists, given approval by Natural Resources Wales and the design aims to use sensitive lighting and create/replace habitat. Local people however protested vigorously, citing the Act as an obligation *not* to build on a greenfield site. The application went to government review, and it was decided that on balance, the health benefits of the cancer centre, combined with the eco-sensitive design and habitat creation provided a net sustainability/well-being outcome in keeping
with the aspirations of the Act. The citizens' campaign to prevent the development however remains unconvinced that building on a greenfield site can in any way be an improvement on the biodiversity and amenity value that is already present.

The Placemaking Wales Charter

The Placemaking Wales Charter has been developed in collaboration with the Placemaking Wales Partnership, which is made up of stakeholders representing a wide range of interests. We note that Lightwood is signatory and suggest that all future parties involved in the design of the proposed development sign the Charter and use it as guidance for the master plannng of a neighbourhood . Further information on the Charter is available on the Design commission Wales website.

General Management and Maintenance of Place

Several developments across the UK and Europe that aspire to maintain the high standards of sustainability that defined their design and build, are associated with legal structures that ensure residents are responsible for upholding these standards. We think that it will be necessary to ensure that the Thornhill development is also protected by legal agreements and its ongoing management is the responsibility of the residents themselves.

A Community Interest Company (CIC) appears to be the most used governance structure. Maintaining a management overview that is steered in large part by residents but anchored in principles fixed by legal obligation, will ensure that the ethos that guided the design and construction is carried over for the well-being of future generations.

2. Low Carbon Housing & Living

2.1 Context

The built environment is responsible for approximately forty percent of the UK's total carbon emissions and is an area prioritised for decarbonisation by Welsh Government.

The UK Climate Change Committee has advised all UK governments to decarbonise the housing sector as an immediate priority and this is echoed by the Welsh Government's Decarbonisation of Homes Advisory Group.

"….new homes must be built to be low-carbon, energy and water efficient and climate resilient.
…. no new homes should be connected to the gas grid. They should instead be heated through low carbon sources, have ultra-high levels of energy efficiency alongside appropriate ventilation and, where possible, be timber-framed." UKCCC, 2019

Whilst we are aware of positive examples of low carbon newbuild developments in Wales, including Gwynfaen Farm in Swansea and Pobl's "Homes as Power Stations" in Neath, the Thornhill development could set a precedent in being the first volume development using a Net Zero (or even net carbon positive) Whole Life Carbon approach.

2.2 Vision

The Thornhill development is net carbon positive; the whole site produces more energy than the buildings within it use.

A life cycle carbon footprint is calculated for the whole development to give assurance that it is net carbon neutral at the build phase, during its use, and in the replacement and disposal of building fabric at the end of its operational life. The development will off-set emissions using on-site planting and land management; and on-site renewable capacity will exceed the operational energy demand.

Design of all buildings will take a fabric first approach, aiming to minimise the operational energy required. As the development is on a south facing slope, many of the buildings will be orientated to utilise passive solar gain. Glazing will be high performance permitting sufficient heat and light to enter the building in summer, while remaining air-tight and energy conserving in winter. Air tightness and high insulation will avoid thermal bridging and maintain an optimal temperature band throughout the year. Mechanical and electrical heat recovery will ensure the buildings are heated by non-fossil fuel energy sources. Electrical power will come from renewable sources. All public and private buildings will be constructed from mainly natural and recycled materials that are not associated with a high transport carbon footprint.

All buildings will be EPC rated A, Code for Sustainable Homes level 6; mainly modular off-site construction using timber frames and recycled materials or Welsh wool for insulation.

A 'Design and Provide' approach to transport planning will be taken to create the circumstances to effect behavioral change (modal shift). Streets and plots are car-free and the master plan incorporates design principles established by car-free developments such as Stellwerk 60 in Cologne, and in other European cities. Parking is accommodated in one or two locations only, and not on the doorstep. with each home allocated a dedicated parking space with its own electric charging point linked to the homeowner's account. The communal garage itself has integrated solar PV. Back at the homes, there is attractive bike-lock architecture for residents and visitors with charging facilities for e-bikes which Lightwood plans to provide to each household, alongside dedicated routes to Thornhill Station. Cardiff Bus Route 27 is extended into the site to provide a 'turn up and go' service (5 buses per hour).

Development parcels offered for self-build are done so on a strict legal agreement on construction materials, methods, power and heat supply, and EPC/SAP ratings. "Self-build" could mean innovative eco-designs and/or natural materials and organic building methods such as cob or straw bail. The self-build parcels could be allocated as a result of an open design competition or linked to a training/assistance programme for low waged families to build their own homes. There are communities in Wales such as Lammas which have, through co-operation with Welsh Ministers, incorporated into Welsh planning law, a set of principles for eco self-build.

Public and commercial buildings would also be constructed from timber or other natural materials (e.g., cob, rammed earth) to ensure low levels of embedded carbon and have green roofs and surrounding planting to help mediate summer temperatures.

Residents are trained in the optimal use of the low carbon technology installed in their homes and a community website will host "how to" instructions and "top tips" for maintaining energy efficient homes and living a low carbon lifestyle.

The whole ethos of the development and its public profile is focused on low carbon and environmentally conscious living. Residents of the Thornhill development will have to make a conscious decision to adopt a greener lifestyle as there will be obligations as well as benefits. Overall, the development will have a reputation as a diverse, affordable, and ecologically balanced community.

One of the salient features of the site is *"no red bricks, low carbon cement."* The buildings will look very different to the developments at Plasmawr and Cardiff Gate. Where timber is deemed unsuitable, buildings are faced with natural stone that echoes dry stone walling and farm buildings found in south Glamorgan. Any cement or cement products is innovative low carbon, produced local companies such a Cenin Renewables.

2.3 Challenges and Opportunities

Materials

Timber construction has a lower embodied carbon footprint than brick or block. The low carbon Passivhaus development being designed by Mikhail Riches in York will be net-zero carbon when in

use but will have considerable embodied carbon.

The review/amendment of part of a green wedge designation to enable Cardiff to meet its future housing needs will be controversial. Certainly, this will be exacerbated if new homes are not at least net zero carbon and if their architectural treatment is not suitable for the site. This development should aim to be innovative in all aspects of construction *and bespoke and high quality in terms of* design, fusing a fabric first approach with architectural detailing that draws on the local vernacular to create a total composition that sits politely in its surroundings.

It is not clear if imported or local timber provides the lowest carbon alternative for construction. The quality of Welsh timber is sufficient for frames but it's likely that load-bearing joists need to be imported timber.

The life-cycle embodied carbon calculation of each parcel of development should aim to identify the least environmentally harmful option – a calculation that will consider the location of growth, harvesting methods, processing and transportation of the timber/products used to construct. The Gwynfaen project is employing a life cycle assessment (LCA) practitioner to undertake an 'embodied carbon to practical completion' Carbon Assessment of the project using RICS professional standards and guidance.

Small scale developments (e.g., Ty Solar) have used very local timber but the economies of scale may dictate the use of an imported product. Using local Welsh timber should be the goal, if possible, to deliver economic co-benefits

We understand that the manufacturing expertise for natural or recycled insulation products, able to supply at sufficient scale, is not available in the UK. The price of Welsh wool, however, is at an all-time low and if the development was to use wool for insulation material it would be an advert for an under-valued and abundant product. Tai Tarian is piloting the use of several natural forms of insulation, including mycelium (mushrooms), Welsh sheep's wool (sourced from nearby Crynant Farm), and wood-fibre insulation (created in-house from waste timber).

The supply and therefore price of timber fluctuates. This will cause a challenge for any developer accurately predicting the unit cost. A decision to embrace timber construction must, therefore, in part be values-led rather than economic. Welsh Government is keen to develop a "home-grown homes" industry and so a design commitment to build using Welsh timber will be going with the grain (pun intended) as far as policy is concerned and therefore more likely to attract the approval of Ministers should planning permission be called in for government level scrutiny.

For this to be a zero-carbon development, the foundations, pathways and roads also need to be considered. There are lower carbon cement alternatives available locally and re-use and re-purposing of waste from industrial processes or demolition is also a source of aggregates. Surfaces should in any case be permeable to minimise surface water flooding and run-off from the site.

Criticism will focus on the "ripping up" of farmland or, as it may be perceived by the public, "natural green space" and the importation of materials extracted from other parts of the geosphere. Therefore, the more that the development can be justifiably called "organic" and local, using natural (permeable) materials that were recently part ofthe biosphere, the greater the scope for the mitigation and amelioration of the effects of development .

Off-site Construction

There are manufacturing plants in Wales able to supply off-site, modular timber units but they tend to be small and new into the market. One expert we spoke to stated that it was not possible, without a financial subsidy provided by the Welsh Government, to deliver social housing using innovative low carbon methods and an entirely Welsh supply chain for materials and labour. Recently established partnerships between social housing providers and Welsh manufacturing companies, however, may prove to be the foundations of a sector that would make modular timber homes a financially viable option for private sector developments in the near future. This is a sector undergoing rapid growth with the backing and enthusiasm of the current Welsh Government ministers.

The developer should work with actors within the Welsh wood economy to explore how this challenge can be overcome and seek to use procurement to enable investment in emerging technologies and processes.

Modular alternatives to timber are also available in Wales because of government-backed partnerships between universities, manufacturing, and social housing. Transpired solar collector (TSC) cladding is a home-grown steel product that would be appropriate for this south facing site. It has been used in the Pobl 'Homes as Power Stations' development in Neath.

Skills and Expertise

There is not a wide-spread availability of the skills and experience to construct ambitious, innovative, low carbon homes and buildings. Social housing providers have experienced problems in piloting new designs such as Passivhaus when working with established local building firms. Construction becomes slower as mistakes are made or the wrong materials are ordered and must be replaced. All of this adds to cost. The financial constraints emanating from this lack of skills has forced companies to scale back their ambitions for creating homes with the lowest possible embodied and performance carbon. However, as discussed in section 4, there is increasing funding and attention on ensuring the necessary skills for a low carbon future and the scale of the Thornhill development, would be well placed to support individuals and organisations developing such skills and knowledge.

Renewable Energy

We are not convinced that every home needs to have integrated solar PV. This is a common feature of low carbon developments. Consider, the maintenance and replacement of this technology when it is part of a private home, not to mention the embodied carbon of its manufacture. A solar PV roof can become a liability for a homeowner. We recommend further exploration as to whether a suitably sized solar array on-site can provide local power for all homes combined with bespoke green tariff in a Power Purchase Agreement.

Our enquiries indicate that some building professionals are not yet certain whether new homes should be all electric or anticipate the decarbonisation of the gas grid. This question may be partially answered by a LCA analysis that considers the embodied carbon of boiler manufacture and gas supply versus ground/air source heat pumps. The predicted rise in the unit price of electricity must also be factored in to arrive at a balanced sustainability/well-being outcome.

2.4 Resources and good practice examples

- Home Grown Homes Project, A study for improving the Timber Construction Supply Industry in Wales, *see page 14 for the life cycle carbon assessment*

- Ty Solar - TY Solar - Eco Homes Pembrokeshire - low carbon footprint
- Mikhail Riches unveils carbon-neutral Housing Delivery Programme in York (dezeen.com)
- Sustainability | Sevenoaks Modular Ltd (somodular.co.uk)
- MINERALS – Cenin

3. Landscape Design & Biodiversity Net Gain

3.1 Context

"Nature-rich housing developments, designed with environmental sensitivity and green infrastructure at their heart, can provide people with easy access to nature where they live and work and deliver multiple social, environmental and economic benefits."
The Wildlife Trust

Section 6 of the Environment (Wales) Act 2016 places a duty on public authorities to *'seek to maintain and enhance biodiversity*' so far as it is consistent with the proper exercise of those functions. In so doing, public authorities must also seek to '*promote the resilience of ecosystems'*.

Section 7 of the Environment (Wales) Act 2016
'The Welsh Ministers will publish, review and revise lists of living organisms and types of habitat in Wales, which they consider are of key significance to sustain and improve biodiversity in relation to Wales. The Welsh Ministers must also take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section, and encourage others to take such steps.'

Cardiff Green Infrastructure SPG Technical Guidance

As the land is currently designated as part of Green Wedge, the following advice/policy pertains to it, with the designation itself preventing large scale development during the current Plan period (to 2026). Should, through a process of Plan review, part of the Green Wedge be identified as being needed to meet future growth needs within South East Wales and Cardiff, the spatial extent to the designation would itself need to be reviewed. In such circumstances the Council would still likely want to see the overall concept respond to the matters below to mitigate and ameliorate the effects of development.

'In order to strategically manage the urban form of Cardiff and to protect the setting of the urban area, a Green Wedge is proposed on land North of the M4 as shown on the Proposals Map. Within this area development which prejudices the open nature of this land will not be permitted. Positive biodiversity, landscape, climate change mitigation and informal recreational management and enhancement measures will be encouraged in this area to further enhance the long-term role of the area as a key natural resource benefitting the city.'

3.2 Vision

An immersive experience in which the boundaries between human settlement and natural ecosystems are blurred.

Natural construction materials and the elevation of buildings ensure that the settlement folds into the landscape and does not stand on it. Sight lines from above and below, confirm the organic nature of the site design – there is nothing jarring or contrasting and residents of neighbouring areas and walkers along the ridge are re-assured that the landscape aesthetic has not been compromised or degraded.

There is an opportunity to open up a place-making vision for the site (and its practicable implementation in term of master planning and design) to contributions from the Design Commission for Wales and even the School of Geography & Planning at the University of Cardiff.

Before a formal plan for the development is created, the whole site is thoroughly surveyed by independent ecologists to provide a comprehensive baseline of the ecological assets currently in place. The subsequent masterplan for the site is consequentially informed by the survey evidence: existing assets are protected from development and suitable buffer zones are included. Habitat connectivity is maximised, creating linking corridors where none currently exist.

Sites suitable for habitat creation are identified during the master-planning phase and habitats are created during the build phase so that they are functional before residents take up occupancy.

Residential and public areas are lit in ways that minimise disruption to the normal behaviour of nocturnal animals and insects.

Buildings, where suitable, include habitat features for birds, bats and over-wintering insects including bug hotels, swift bricks, and owl nest boxes. Garden fencing and other boundaries will be permeable for small mammals: “hedgehog highways” will be a salient feature of the development.

Green infrastructure will include community food growing plots, an orchard, allotments, and outdoor forest school classrooms.

Existing water courses, ponds and wet areas will be retained and enhanced – ponds will be created and made suitable for amphibians and waterfowl. All roads and paved areas will be permeable or drain to soak-aways according to the principles of “sustainable urban drainage” (SUDs). Cardiff already has a successful, innovative SUDs scheme in Grangetown and new development should replicate this approach.

Sixty percent or more of the whole site will be green/blue infrastructure.

The guiding principle of the construction phase will be *Do No Harm*. Some destruction of habitat will of course be necessary during construction but there will be an environmental/biodiversity management masterplan for the construction phase including strict site management protocols. All construction personnel will receive training so that they can carry out their duties and responsibilities according to the protocols.

A comprehensive biodiversity management plan will be created for ongoing management post construction. This will include regular monitoring of species and timetables for habitat maintenance work. The biodiversity management plan will be protected by legal agreements that stipulate the responsibilities and spheres of control of various organisations within a partnership or trust convened to ensure the long-term ecological integrity of the whole site. This will include Cardiff Council, the local wildlife trust and the residents’ community interest company.

The overall design/approach for recreational access and leisure will not undermine the ecological integrity of the site: careful consideration must be given to the design of access points to ensure that four by four safaris,scrambler biking and fly-tipping cannot take place. A series of dedicated mountain biking trails are created and managed in a commercial agreement with a trails specialist

such as Bike Park Wales (free to use for residents) to ensure that rogue/unofficial DIY trails are not built in the woods. The management trust or CIC will have the right to determine access by any potential class of user, remove trails or constructions, and put up barriers as necessary to protect ecological integrity.

3.3 Challenges and Opportunities

Cardiff Council requires *"the impact of a development proposal upon nature conservation interests must be assessed prior to determination of an application."*
An Ecological Impact Assessment (EcIA) is the normal procedure by which impacts upon nature conservation interests on a site are assessed. An EcIA may relate to a number of habitats, species, ecological features or ecosystems present at a site. The presence of protected species should be determined before planning permission is granted.

For this development to set an example for a ''strategic ' site, a comprehensive baseline net gain survey should be undertaken in addition to the normal statutory surveys . The effect of development proposals, including mitigation such as habitat enhancement can then be measured to demonstrate an overall enhancement to the biodiversity of the site upon completion. For example, gross losses of areas of low value habitat for housing can, with appropriate advice and investment, be more than compensated for (a net gain) via the creation of an appropriate extent of new high value habitat elsewhere within the same site (e.g., woodland) bearing in mind however that once land is lost to housing then the potential to improve that land for biodiversity in the future is also lost. The timing of interventions should also be considered if habitat enhancements need time to mature before biodiversity gains can be realised.

A **Nature Tool for Urban and Rural Environments** has recently been released for general use. The **"Nature Tool"** is a product of collaborationbetween WSP, Ecosystems Knowledge Network and Northumbria University with funding from Innovate UK. The aim of the tool is to help determine if new development can/will deliver net biodiversity gains. In England the Environment Bill, once it receives royal assent will mandate the achievement of at least 10% biodiversity net gain, with compliance measured using Natural England's Biodiversity Metric (3.0). In Wales biodiversity net gain is not yet being put forward as a legal requirement. The Welsh Government aims to publish its biodiversity net gain strategy by 2023 as part of its Nature Recovery Action Plan. CIEEM's Biodiversity Net Gain Good Practice Principles for Development should also be followed.

Assuming that the design, planning, and construction of the site takes place with successful protection of existing species and green infrastructure, with the construction of new green assets, the challenge remains to continue, protect and enhance this work. Therefore, a management body needs to be established and given the legal status to make and implement decisions, and to work with the Council, Police and Natural Resources Wales to monitor and enforce any legal protections. We have suggested a CIC but a trust or some other structure would suffice.

Tadpole Garden Village is a large multi-phase development in Swindon. A community interest company has been established to manage all communal assets. All residents, retail unit occupiers and any other property-owning stakeholders become members of the CIC. The CIC employs a managing agent to oversee the day-to-day management of the communal infrastructure. On other similar developments, the management of specific green assets is placed in the hands of specialist trusts.

We have referred previously to the marketing of the development concept as a lifestyle choice for

ecologically minded families and individuals: at **Barratt's Kingsbrook development in Aylesbury**, the RSPB have been engaging new homeowners, providing information on how to maintain wildlife-friendly gardens andencouraging them to become active in local conservation work. Show home gardens are planted according to RSPB and Barratt guidelines to give potential residents ideas and a sense of what they would be buying into.

Being so close to urban settlement, and with Lightwood's concept of much of the site being a country park with high permeability from surrounding areas, including current GI assets, natural ecosystems will be subject to additional pressure and require robust, continuous monitoring and management. Similar arrangements are already in place for Wennalt Woods (Woodland Trust) to the west and these would be needed to ensure an overall ecologically sound approach for an extension to Cardiff. Ecological pressures could be further relieved through investment in raising levels of eco-literacy amongst residents and visitors (in line with the call in the Future Generations 2020 report "urgent need for a better knowledge of nature") and conceivably through creation of new areas of GI elsewhere in and around Cardiff, as well as through mitigation measures at the site itself.

Conceivably, a new area of GI could relieve ecological pressures elsewhere in and around Cardiff e.g. at Wenallt Woods.

3.4 Good Practice Examples

- Housing and wildlife - examples | The Wildlife Trusts
- RSPB at Kingsbrook | New Homes in Aylesbury | Kingsbrook (kingsbrook-aylesbury.co.uk)
- Tadpole Garden Village - Tadpole Garden Village

4. Opportunities for jobs, skills and education

4.1 Context

A recent report by the TUC, New Economics Foundation and the Future Generations Commissioner highlights the opportunities in Wales for the creation of jobs and skills in off-site housing manufacture and construction, as part of a green recovery and a just transition to a low carbon economy.

Research has shown there is currently a *'performance gap'* between design intention and actual achievement of low carbon buildings, in particular, because of the lack of adequate vocational training, shortage of cross-trade knowledge and skills and the lack of knowledge of a building as an integrated system.

Welsh Government has recently awarded £2m to six further education colleges to provide training for jobs in the green economy, including in environmentally friendly heating systems and e-bikes.

The funding is part of the Welsh Government's Personal Learning Accounts programme, which supports people in lower-income jobs to retrain and move into longer term, skilled jobs with higher earnings.

Actors within the private, public and third sectors have also collaborated on a vision for a National Nature Service for Wales that could support land-based career pathways that serve nature and ecosystem resilience. Further scoping of this service is currently being considered by Welsh Government.

4.2 Vision

Construction of the site will be aligned with a comprehensive training programme for modern methods of construction (modular off-site, Passivhaus etc.) mediated by local Further Education colleges but involving stakeholders from the industry. The site will therefore be nationally significant as a learning zone, developing skills in existing and new members of the workforce that can subsequently be used in retrofit and new-build sites around south Wales. One dwelling will remain half built as a "construction laboratory" that is maintained by an FE college partner to train both students and employees of local firms.

The ongoing management of the built and natural environment within the site will require trained site managers employed by the CIC. Management of the site's green and blue infrastructure will offer opportunities for traineeships and apprenticeships in various land-management disciplines. These will be developed and promoted through links with Wales's National Nature Service if and when it materialises, and with other relevant FE and skills bodies.

Income for site management will be derived from licences, letting agreements and a precept raised (with or similar to) the council tax.

The site plans include commercial units, communal buildings and green infrastructure. All of these can be leased for a variety of uses including education. An eco-lodge, for example, can be let for parties, family gatherings or ceremonies. Outdoor classrooms can be hired by local schools and

colleges and used to provide after-school sporting and recreational club activities that reduce the need to travel to the city centre.

Additional income streams can come from a mountain bike park, an eco-camping site, the construction lab (see above & below), access agreements for filming, donations and project funding.

The development includes a primary school but the site management staff will also include an education officer who co-ordinates visits by other schools and further/higher education field trips.

The management staff are variously qualified in skills that enable them to maintain the public buildings (and residential buildings on request) to the high environmental design standards, and also in horticultural and land management skills that enable them to maintain the wider site.

Connectivity for residents ensures that they can easily commute into Cardiff without using private cars: there is a twice hourly bus service, and walking and cycling access to Thornhill rail station. Caerphilly and the M4 can quickly be accessed via the mountain road and the Cardiff Gate junction respectively. House design and the provision of a community workspace however will ensure that residents have everything they need to work from home. This will be a major marketing feature of the development coherent with it being car-free.

4.3 Challenges & Opportunities

As mentioned above, the skill levels in the current and emerging workforce are not compatible with the goal of achieving zero carbon homes. For a development to be efficient and within the predicted budget, there needs to be clear communication and understanding along the supply chain. For example, the manufacturer of off-site modules, the architect, site manager and the labourers all need to understand the principles of the system and the practical requirements for successful completion: the existing labour force needs to be trained in the new methods of construction while a new generation of apprentices also acquires the necessary skills.

While the focus is on colleges and apprenticeships, the existing workforce needs CPD training. For them, highly focused, short courses would be suitable e.g. “how to fit and maintain an air source heat pump”. If the proposal included a commitment to provide nationally significant training for the existing workforce this would contribute to an overall sustainability outcome coherent with the Well-being of Future Generations (Wales) Act 2015.

There is therefore, an opportunity for Lightwood to make a virtue of this need and work with local Further Education colleges, specialist agencies and local firms to ensure the development provides experiential learning for the sector. We see the possibility for this development to deliver quality, low carbon homes, but also to be a teaching and learning resource for the Welsh building sector, delivering qualified individuals who can go on to construct similar buildings in other locations.

The site could host a “teaching lab” – a semi-constructed home typical of the dwellings on-site, where people would come to learn the skills and principles of modular timber build. We understand that Cardiff and Vale College will soon be opening a city centre practical learning site for low carbon housing skills. As mentioned above, a partnership with a suitable FE college could be the basis for a construction lab for practical / experiential learning.

Job opportunities for local people do not need to be highly skilled roles. Policy makers and politicians frequently call for apprenticeships in new projects as a community benefit. One should be aware however that many local firms already have apprentices and in practice, developers push the obligation for apprenticeship places down to the supply chain. The contractors then cite their existing apprentice(s) as evidence that the social obligation has been met when in reality, no new opportunities have been created. It would be better therefore to require the main construction partner to provide evidence of new employment rather than "apprentices". If the development included partnership with a social housing provider, the construction partner could employ suitable social housing tenants as security staff, gate keepers, labourers etc. These low-skill jobs would be an opportunity for school leavers and long-term unemployed people without creating apprentice places in firms which already have a sufficient quota of apprenticed tradespeople.

If the development is to be mixed use with some retail units, this would be an opportunity to attract specific types of business that are relevant to sustainable development. Preferential grants/rates could be offered to attract certain types of business. This approach is being used in White Hill & Bordon new town, Hampshire.

4.4 Good Practice Examples

- Joint venture model for innovative construction training delivery and services
- Attracting specific sectors and types of retail: http://whitehillbordon.com/
- Investment in Further Education for the new green economy: https://www.insidermedia.com/news/wales/new-college-courses-for-jobs-in-the-green-economy

5. Conclusion

This report explores how sustainability of a potential low carbon development at Thornhill, North Cardiff, could be maximised, should there be a change to the area's current Green Wedge designation. Whether or not it would be necessary or desirable to amend this designation is beyond the scope of this report and the authors make no recommendations or comment around this. However, should the designation change and all other legal requirements be met to allow the proposed development, we have provided an idealised vision of how such a development could become a strategic exemplar. It has not been possible to consider all aspects of sustainable development within this short report and so this vision has focused on three key areas, informed by the climate and nature emergencies and the urgent need for a green recovery.

The development would be the first volume development to use a whole-life approach to measuring and mitigating embodied and operational carbon, using natural, low impact materials and with the whole site producing more energy than the building within it use. Restrictions on, and alternatives to, car ownership would be provided to enable modal shift to more sustainable travel and residents would be trained and enabled to benefit from optimal use of low-carbon technology.

The design strategy would be landscape-led, seeking to blur the distinction between human settlement and natural features, using materials and aesthetics prevalent in the local geosphere, with a place-making vision co-produced by local design schools or other actors.

Comprehensive biodiversity surveying, monitoring, management and intervention, together with existing and newly created green infrastructure and habitat would aim to ensure that there is biodiversity net gain and that the ecological integrity of the site is preserved. The engagement of residents in eco-literacy and site ecological management would preserve this over the long-term.

The site would also serve as a nationally significant learning zone, providing training and education opportunities both in construction and retrofit through its 'construction laboratory' and in land management disciplines through its green and blue infrastructure. This would help equip the existing and emerging workforce in these future-proofed skills and enable the learning from the site to be shared and replicated further.

This report also acknowledges that there are challenges to achieving this vision, not least in terms of materials, skills shortages and a relative paucity of other relevant exemplars. However, we believe that a development that does successfully integrate all the elements outlined in our vision could contribute to Wales' Well-being Goals to an extent not previously seen in a volume housing development, whilst helping address those same challenges along the way.

We would like to thank Wood Knowledge Wales, Linc Cymru and Aled Guy for their views and experiences which have been used to inform this report.