University of Exeter Science Park

Masterplan Report

July 2008

CONTENT

[Figure 1] Aerial photo of the site

University of Exeter Science Park

Masterplan Report

[Figure 2] Site location in Exeter context

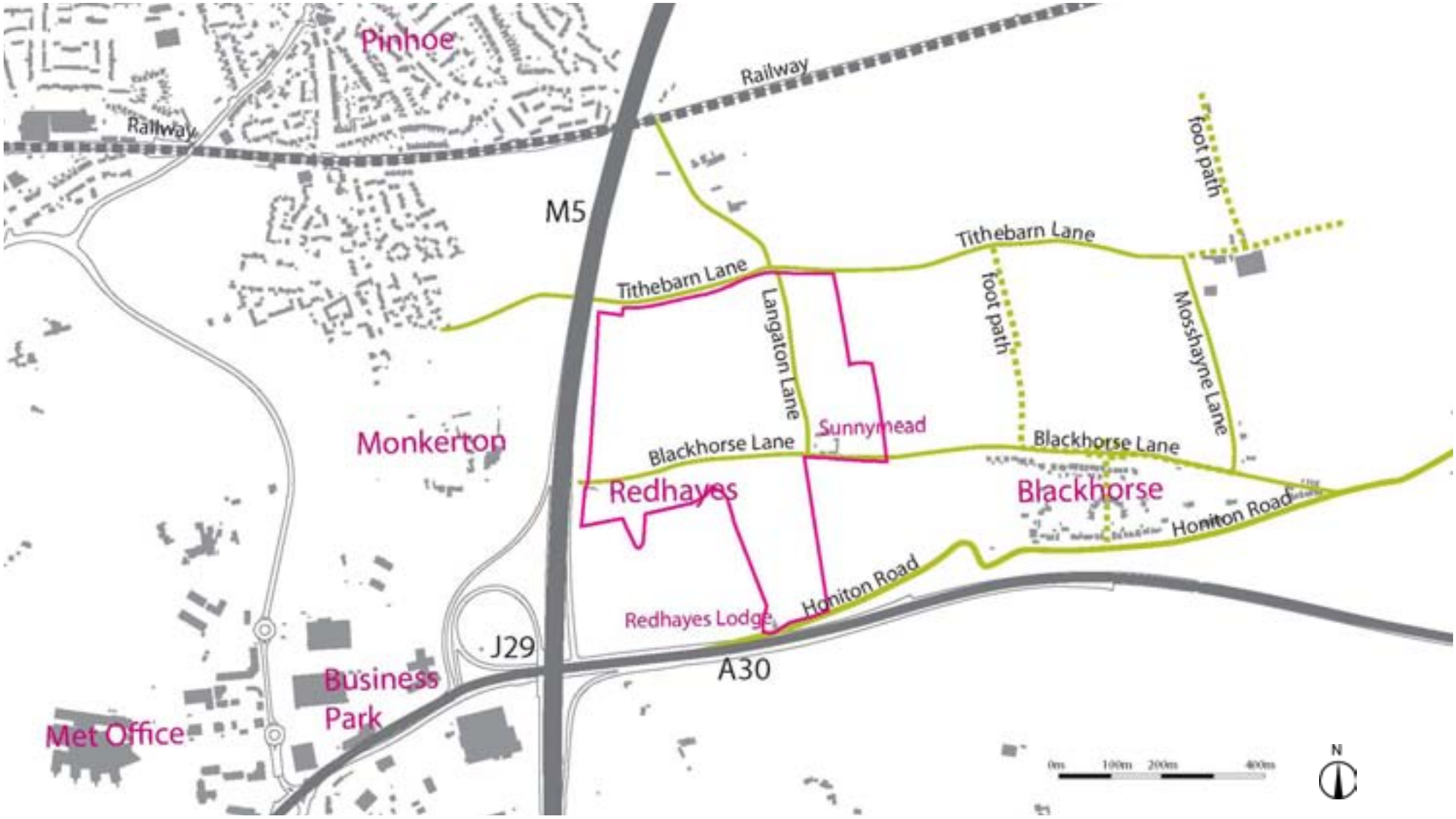
CHAPTER 1 INTRODUCTION

This document represents a broad consensus on the best way to design and implement a science park on the eastern side of Exeter. It reflects the aspirations of the various project partners and their desire to create a unique environment for innovation and investment that will strengthen the regional economy and the role Exeter plays in it. The site chosen for this exemplar development is comprised of 25 hectares of rolling agricultural land occupying a commanding position over the East Devon landscape at Redhayes, close to junction 29 of the M5.

Any special place is usually much more than the sum of its parts. Streets, spaces, buildings and landscape interact and create something richer than the simple elements they are made of. Exeter and surrounding settlements are growing and the UESP will add to the area's mix and diversity. How can a development offer be created that contributes to the whole rather than detract from it? How can the UESP enrich the City and region as a great place to live with an unparalleled natural and cultural environment? How can its development strengthen its single greatest selling point – the identity of the region within which it sits?

The UESP masterplan, prepared by LDA Design on behalf of the Exeter and East Devon New Growth Point Steering Board, seeks to answer these questions. It shows how the site offers a special opportunity to create a well connected and iconic development for the region; an environment that is highly valued for innovation, investment and for simply looking great.

Much has already been written about the UESP site and the nature of its surrounds. Most significantly, the UESP Supplementary Planning Document (SPD), adopted by East Devon District Council in May 2008, provides a full summary of the key issues to be considered in developing the site. This document does not repeat previous analysis. Instead it seeks to draw together the salient points of that analysis into a coherent story to provide a strong vision and physical framework for development. As development proposals for the site become more defined some of the recommendations within the document will need to evolve. However, the fundamental concept and physical framework should remain as a guide to development.



[Figure 3] Site plan with key streets, lanes and features annotated

CHAPTER 2 WHAT IS A SCIENCE PARK ANYWAY?

"When implemented the UESP will be the region's leading business support and technology transfer initiative. It will encourage and support the start-up and incubation of innovation led, high growth, and knowledge based businesses, will provide an environment where larger and international businesses can develop specific and close interactions with a particular centre of knowledge for their mutual benefit and will have formal and operational links with centres of knowledge creation such as Exeter University."

[definition based on UK Science Park Association definition of a ciene park]

Figure 4

[Figure 4] Picture of Cambridge Science Park

Figure 5

Figure 6

Figure 7

The term ‘science park’ has often been a tag attached to a particular commercial development rather than a type of place with a distinct community and environment. Such developments are rarely ‘parks’ and sometimes don’t even have much science going on in them! Nonetheless the ‘science park’ is a powerful concept. It conveys, even if it doesn’t always deliver, the idea of a place in which learning, innovation and the exchange of ideas operates commercially in a great environment.

The key to the creation of a high quality and lasting science park is sustainability. Many existing sceinece park models are inherently unsustainable – they address the economics of the development ‘offer’ but fail to deliver wider social and environmental benefits at the same time. A sustainable science park needs to be more than just the commercial proposition; a range of ‘science-based’ uses in unconnected buildings linked to nearby centres of knowledge. It should be a community of knowledge creation itself - a place in which ideas are exchanged and developed with mutually supportive uses. It should make prudent use of resources in its operation and make a positive contribution to the environment. A science park should be recognizable and distinguishable from other development offers. The activities going on in it will help to achieve this. So will the way its environment expresses the opportunities for innovation and knowledge exchange it offers.

A science park then is a ‘place’ in which a particular community works and builds its identity. It is commercially viable in the way that any successful place has to be, but it has a strong social and economic dimension as well. The development of the UESP is an opportunity that should be, in many respects, seen as a challenge similar to that faced by the founders of Exeter University. Looking at the site on the northern edge of Exeter at that time they too must have asked how they could create a development that would express its identity and create an environment that would stand the test of time. The founders of the UESP have a similar challenge to answer a similar question.

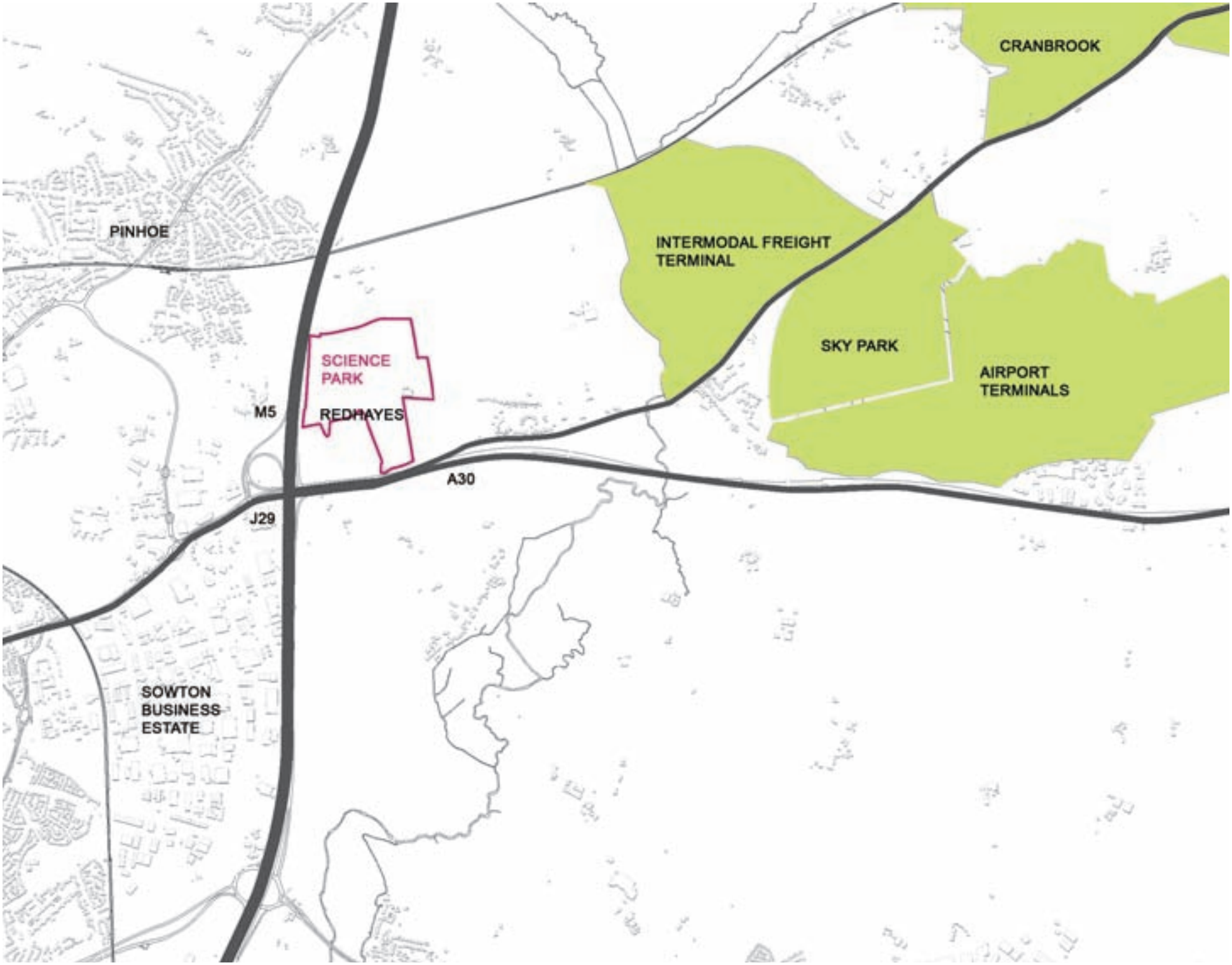
[Figure 5] Picture of Oxford Scienece Park
[Figure 6] Picture of Cambridge Science Park
[Figure 7] Picture of Oxford Science Park

CHAPTER 3 THE CONTEXT FOR DEVELOPMENT

Exeter and its surrounding area is becoming tremendously successful and, as a result, both are growing substantially. The area is strategically placed in the region, with good connections to all other major centres, to Cornwall and to London, including an international airport. It shares an economic sub-region with Plymouth and Torbay and has enjoyed three times the national average of levels of economic growth in the last five years (6% a year). Some key contextual issues are described below.

The current population of the City is around 120,000 and, together with East Devon, it serves a population of almost 250,000. Exeter is a designated as a 'Strategically Significant Town or City' in the Regional Spatial Strategy. However it is constrained by topographic and administrative boundaries, has a limited supply of development land and increasingly suffers from congestion. At the same time Exeter and East Devon is designated as one of the areas to accommodate the regions expanding population, which also underpins economic growth. Exeter City Council, East Devon District Council and Devon County Council have worked together with the regional agencies, including the South West Regional Development Agency (SWRDA), to develop a practical strategy to respond to growth. Key initiatives include expansion of Exeter Airport with additional employment land; the development of Skypark and the UESP; an intermodal rail freight interchange; motorway junction improvements to expand capacity and make full use of the M5/A30 routes; housing growth in the corridor to the East of Exeter, including areas within the city boundary and East Devon; a new Community at Cranbrook East Devon together with associated community and transport infrastructure, including high quality public transport links between homes and employment sites, city centre, intercity rail stations, and the airport. Many of these planned developments are shown of Figure 8.

The creation of strategic safeguarded sites for further investment in science and technologically based industries within this context is a requirement for the Local Development Documents for Exeter and East Devon. The aspiration is to achieve forms of economic growth that will be complementary to the area's high environmental quality. Policy support for the UESP development is set out in documents as diverse as the South West Regional Spatial Strategy; The Regional Economic Strategy; Devon Structure Plan; the UESP SPD.
The policy context described and the pattern of growth proposed for Exeter and East Devon stresses the fact that the UESP is a considered initiative that is part of a number of wider plans that see the status and influence of the City and surrounding areas expanding over the coming decades. Exeter is becoming an urban city within an almost unparalleled rural setting. Development of the UESP is one of the initiatives associated with the City's 'coming of age'. As part of this evolution the development needs to continue the standards set by the recent Met Office and Princesshay developments. Another exemplar development will serve to cement the City's emerging perception as a centre for innovation, quality and sustainability. The UESP therefore needs to be seen as more than 'just' a commercial science based development proposition; it also needs to be conceived of as an important new part of the urban fabric of the region working with other proposed developments to make the area a better place to live, work and invest.



[Figure 8] Exeter growth plan showing proposed developments

CHAPTER 4 THE CONSTITUENT PARTS OF THE UESP

The masterplan for the UESP development does not start with a blank sheet of paper. Many attributes of it are defined by associated projects, the physical characteristics of the site and the expectations and requirements of the science-based market sector. This section spells out some of these 'constituent' parts of the development.

4.1 Property

A report entitled Exeter Science Park Project Appraisal (January 2008) was completed by Cooper Simms on behalf of SWERDA. The report shows that ICT (Information Communication Technology), Environmental technologies, and Creative industries have been the main sources of growth in the Exeter area. Even without the effect of large businesses such as the Met Office, the underlying growth rate in the sector equates to 2.9% per annum. The UESP needs to provide opportunities to invest in the type of buildings and property the sector requires. An analysis of the market shows that it is not dominated by a small number of large users in big buildings like some high profile business parks. It is far more likely that the development will be occupied by a significant number of small-medium sized businesses with relatively modest space requirements in buildings, or groups of buildings offering support services. As an illustration of this, The UESP Business Plan, prepared by Pythia recommends a Phase 1 offering a range of unit sizes including: 4 units of 500 sq ft; four units at 1000 sq ft; three units at 2500 sq ft; 3 units at 4000 sq ft and 1 unit at 5000 sq ft. Pythia highlight the fact that similar UESP developments have tended to attract a majority, around 70%, of their tenants from within 30 miles. Whilst it will be an intention to attract users into the region from elsewhere, this local demand will inevitably be a strong driver of the development. Of 77 companies in the area surveyed to inform the Business Plan for the UESP 43% occupied less than 1000 sq ft, 37% occupied between 1000-5000 sq ft and only 9% occupied over 5000 sq ft. The UESP marketing must not only relate to the 70% of potential tenants from a 30 mile radius, but also seek to attract larger prospective tenants, most of whom are more likely to come from further away.

The UESP masterplan needs to provide a development proposition that can accommodate this range of units whilst at the same time allowing for appropriate major inward investment. The provision of this space in a desirable setting is an essential component of the UESP.

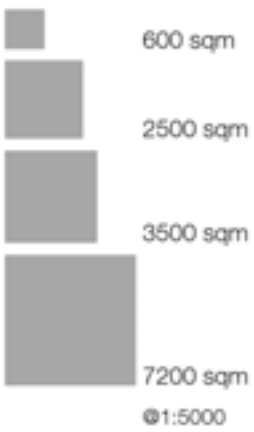
The study of precedent science parks included later in this document shows a range of building sizes between 600 sq m to a general range of buildings offering 2,300 – 3,500 sq m and some larger building of 7,200 sq m plus. What this demonstrates above all, is that the UESP masterplan will need to allow for a range of unit and building sizes. It must still provide an overarching and unifying framework for development. This requirement will influence the creation of a model that can adapt and evolve to accommodate a range of unit sizes. Other uses will be incorporated in the development of this model. The point has already been made that the UESP needs to be more than a single use development. It needs to be a community within which other uses are integrated. This means that the plan needs to be designed to incorporate a range of ancillary uses such as hotel, retail provision, a gym, crèche etc. Phase 1 of the development is likely to be mixed comprising a hotel; conferencing facilities; the initial phase of UESP space; and, an office HQ.

4.2 Amount

To determine a starting point for the masterplanning process some initial assumptions have been made about the total quantum of development that it might accommodate when fully developed. These assumptions have helped to define the brief for the project. These have been used to test densities on each part of the site as shown by the diagrams on the following pages. Although these are little more than 'test' densities used to understand the implications of overall quantum, parking standards, building height and infrastructure provision, they do underpin assumptions made by various parties on the potential return on investment. Figures dramatically different to these will mean that value assumptions may not be achieved.

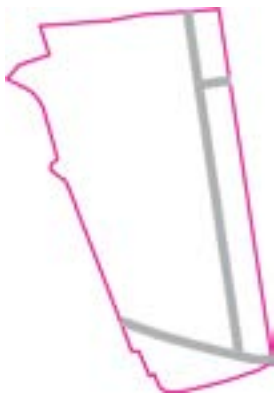
The diagrams show different phases of development and quanta assumed by SWRDA and the potential developer for Phase 1. Total gross quantum identified is 18,800m^2 (following discussion with the potential developer) for Phase 1 and 51467m^2 for Phase 2. This gives a total development quantum for the site of 70,267 m^2. On these figures the density of each area would be 5096m^2 of development / hectare for Phase 1 and 2563 m / hectare in Phase 2. I.e. Phase 2 is assumed to be half as dense as Phase 1. The diagrams also show the implications of different parking standards. Using a typical out of town employment site parking standard (assuming predominantly surface provision) a large proportion of the UESP would be dominated by car parking. This would make it difficult to provide significant areas of landscape. However adopting standards similar to those achieved by the Met Office development, combined with a higher density, significant parts of the site start to become freed up to provide the setting for the buildings. It should be noted that these figures are higher than those quoted in the UESP SPD to allow for potential business expansion.

This starting point shows that figures underpinning commercial assumptions suggest a reasonably dense and 'urban' environment for Phase 1, whilst Phase 2 will have the scope to have a higher percentage of landscape. The diagrams do however highlight the need for building heights to be generally over 2 storey and the provision of minimum parking standards (i.e. not more than 1 space for every 2 employees) to produce a strong landscape structure.



[Figure 9] Diagrammatic representation of building size range

4.21 Phase 1



approx. 44,600 sqm
18,800 sqm development

building in 2 stories
footprint 9,400 sqm

building in 3 stories
footprint 6,267 sqm

car park 1/30sqm
627 spaces (B1=387, Hotel 240)
1 space @ 27 sqm = 17,000 sqm

car park 1/50sqm
376 spaces (B1=136, Hotel 240)
1 space @ 27 sqm = 10,150 sqm

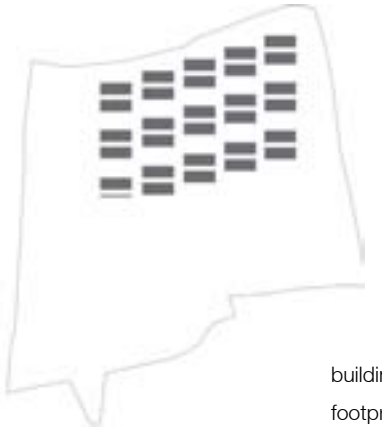
0.5 space/ employee
405 car park spaces
1 space @ 27 sqm =
10,935 sqm

[Figure 10] Phase 1 location plan
[Figure 11-16] Quantum diagrams of Phase 1 showing footprint and parking requirements.

4.22 Phase 2a

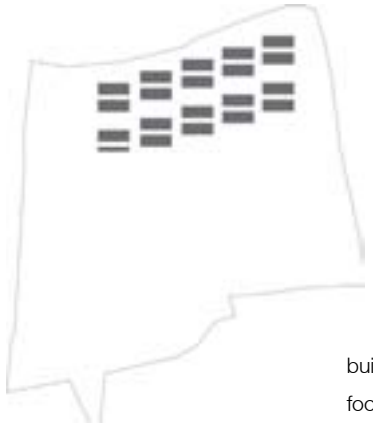
approx. 157,600 sqm

35,000 sqm development



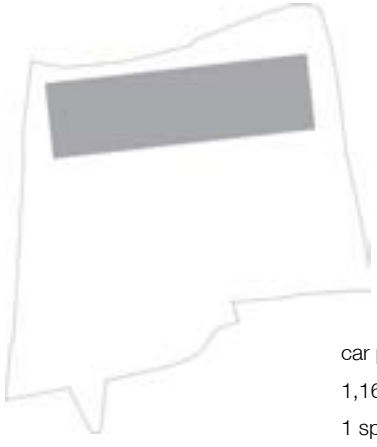
building in 2 stories

footprint 17,500 sqm



building in 3 stories

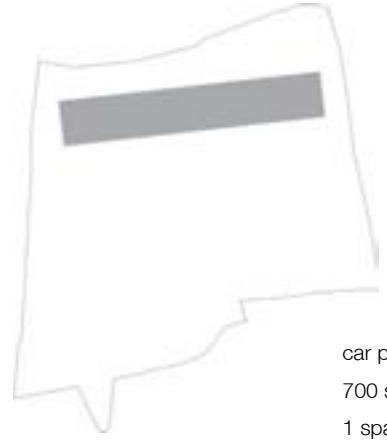
footprint 11,667 sqm



car park 1/30sqm

1,167 spaces

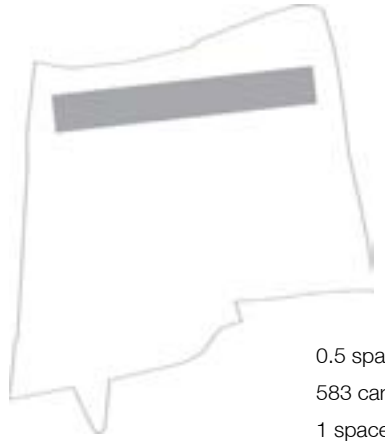
1 space @ 27 sqm =31,500 sqm



car park 1/50sqm

700 spaces

1 space @ 27 sqm = 18,900 sqm



0.5 space/ employee

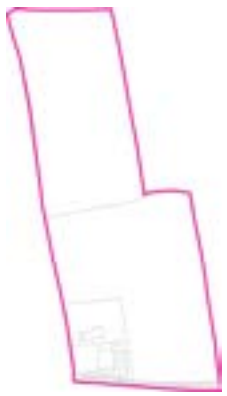
583 car park spaces

1 space @ 27 sqm =

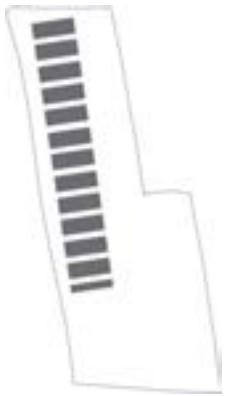
15,741 sqm

[Figure 17] Phase 2a location plan
[Figure 18-23] Quantum diagrams of Phase 2a showing footprint and parking requirements.

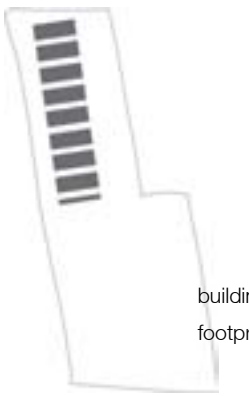
4.23 Phase 2b



approx. 43,200 sqm
15,000 sqm development



building in 2 stories
footprint 7,500 sqm



building in 3 stories
footprint 5,000 sqm

car park 1/30sqm
500 spaces
1 space @ 27 sqm =13,500 sqm

car park 1/50sqm
300 spaces
1 space @ 27 sqm = 8,100 sqm

0.5 space/ employee
240 car park spaces
1 space @ 27 sqm =
6,480 sqm

[Figure 24] Phase 2b location plan
[Figure 25-30] Quantum diagrams of Phase 2b showing footprint and parking requirements.

4.24 Maximum and Minimums

Maximum

Minimums

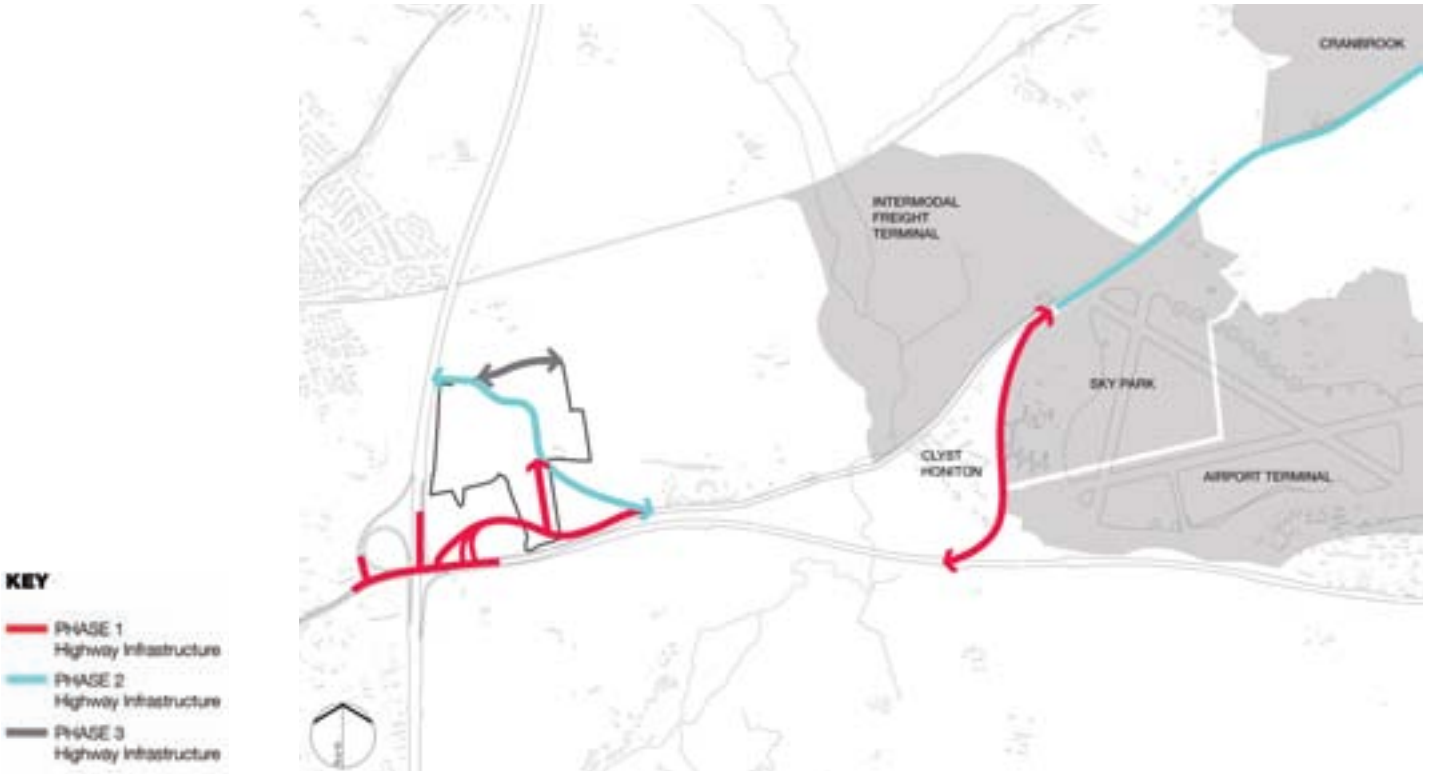
[Figure 31-33] Quantum diagrams showing potential maximum development footprint (2-Story buildings and 1 parking space per 30 sqm)
[Figure 34-36] Quantum diagrams showing potential minimum development footprint (3-Story buildings and 1 parking space for every 2 employees)

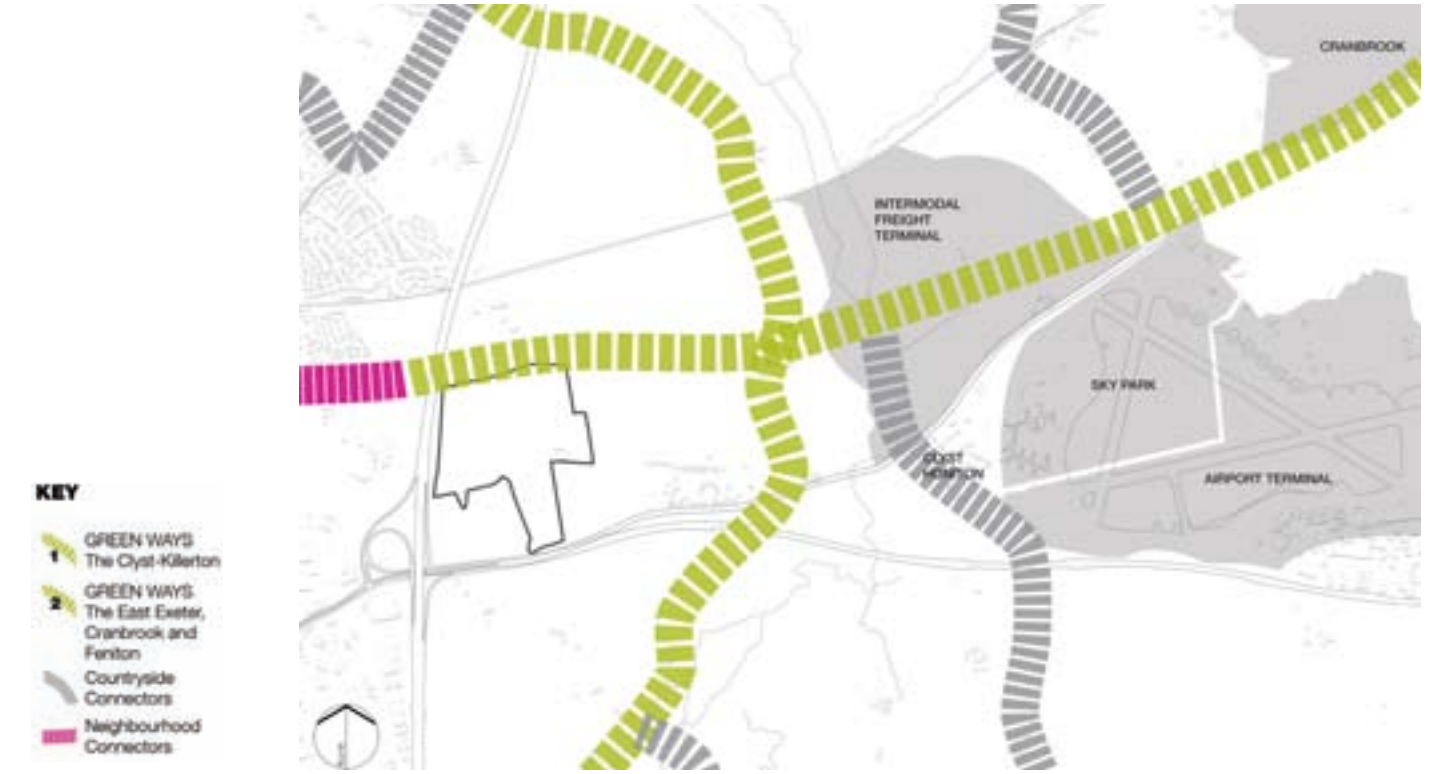
4.3 Infrastructure

The UESP needs to provide more than simply accommodating the development 'offer'. Whilst it has to be capable of being 'read' as a campus, within its bounds it also has to accommodate some major infrastructure. The site is fundamental to the improvement of Junction 29 of the M5 and the release of development land within the Exeter and East Devon New Growth Point. The remnant parkland at the south westerly part of the site will accommodate a major new part of the junction providing for all turning movements between the M5 and the A30. In addition the development of the site needs to accommodate a north-west to south-east vehicular route to a standard capable of accommodating all likely public transport options and other vehicular movements. This needs to be designed to tie in with, and complement the emerging transportation strategy for the East of Exeter. Figure 37 shows the current working alignment for this infrastructure. This is designed to minimise land-take and maintain the physical integrity of the site.

In addition to traditional 'hard' infrastructure the site has the potential to contribute to the provision of Green Infrastructure for the Growth Point as well. The emerging Green Infrastructure (GI) Strategy for the Exeter Fringes highlights the site as a location where key GI linkages might be achieved providing green, sustainable accessibility between the City, its landscape context and surrounding settlements.

[Figure 37] Plan of Junction 29 DCC preferred scheme



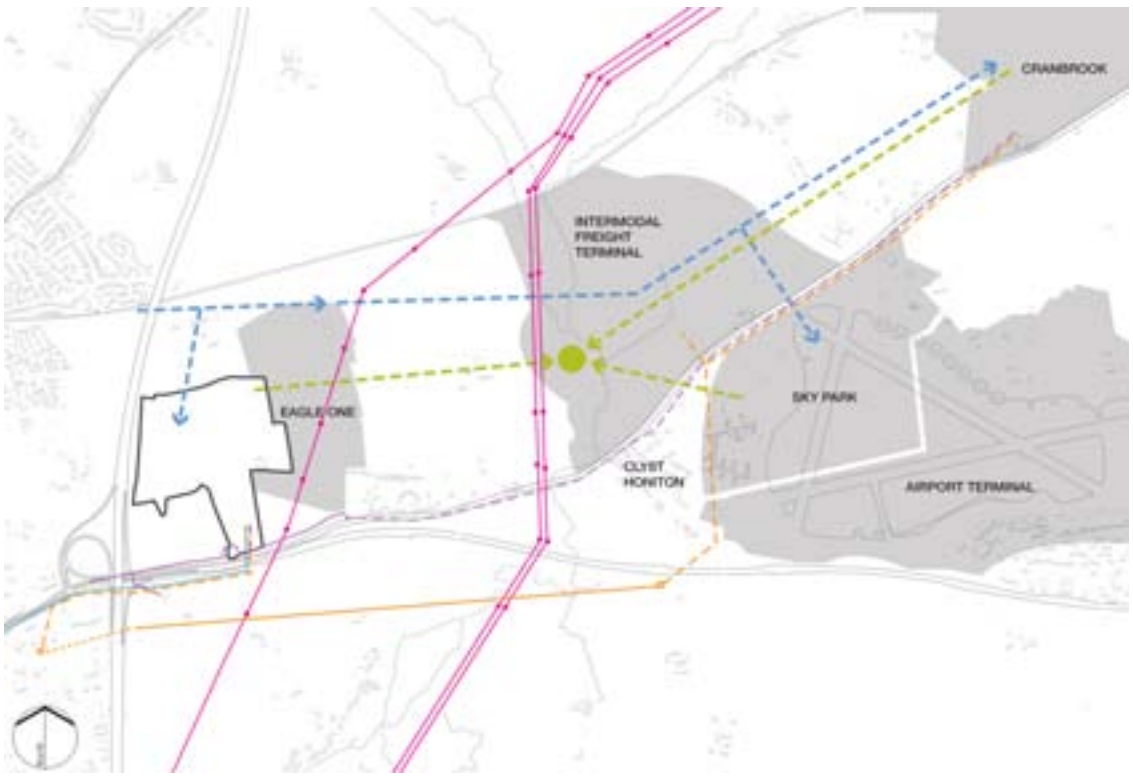


[Figure 38] Strategic transportation plan
[Figure 39] Green routes plan

4.4 Energy and services

The site can be connected in to the essential services provided to meet the needs of the growth point as shown by the diagram. Detailed infrastructure needs will be identified as the masterplan is developed and these will ultimately be integrated with the site development framework which will include the key junctions, streets, roads, spaces and parking areas.

One of the aspirations of the project partners is to achieve an exemplar sustainable development at the Redhayes site. This means extremely good public transport accessibility, a complementary mix of uses and sustainable design. It also means appropriate design of the energy infrastructure and the provision of a masterplan that complements this. This site has a number of opportunities for the incorporation of innovative approaches to the conservation and on-site supply production of energy. These opportunities have been considered by Fulcrum: There are a range of possible solutions. Such options include the provision of heat by a biomass / biodiesel boiler, solar thermal and ground source thermal. The provision of electricity is more problematic given that the most viable technology, wind power, is likely to be precluded on any significant scale due to the proximity of the airport. Photovoltaics (PV) provide an option but current economics are marginal. Combined heat and power options include biomass/biodiesel CHP and Gas CHP.



[Figure 40] Infrastructure plan of energy and service

4.5 Landscape

Another key component of the development that is fundamental to its success are those elements that are not used for built development. These are existing landscape features and the space between them. These elements structure the site and have been identified by the SPD retention and enhancement.

These features include the main tree groups, particularly those on the Redhayes site, individual trees scattered across the site and the key lanes and hedges.

[Figure 41] Key structural landscape elements plan

CHAPTER 5 THE SITE AND ITS SURROUNDS

The SPD brings together the key analyses related to the site. This section doesn't replicate these but rehearses the key issues in such a way that the implications for the masterplanning process, i.e. the challenge of fitting the 'constituent parts' of the masterplan onto the site, are clearly articulated. The masterplan is a coming together of the brief set by these requirements with the actual physical and cultural characteristics of the site. This section touches on the relevance of historic and current patterns of growth around Exeter and how the UESP furthers these. It goes on to address the aesthetic and physical characteristics of the site and how these might affect the physical form promoted by the plan.

[Figure 42] The growth of Exeter

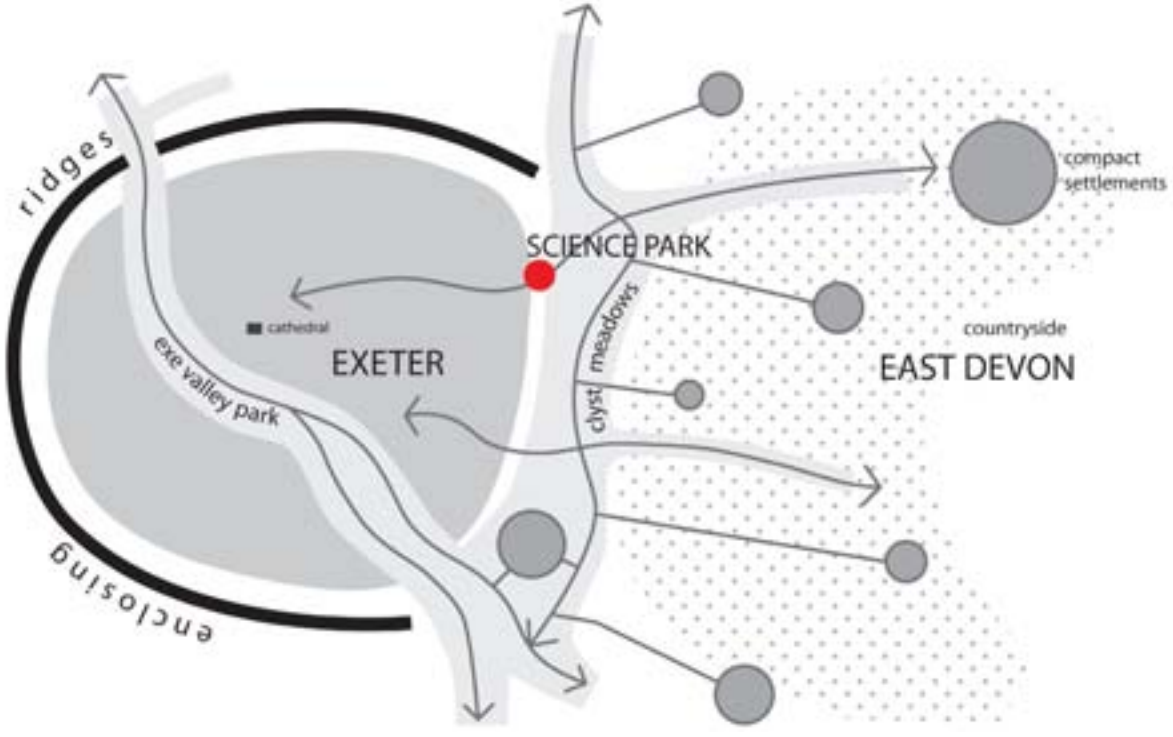
5.1 Growth Pattern

The UESP represents a new phase in the development of Exeter and the surrounding area. It will be seen, by many people, as the first development to 'leap' the M5 which has long been seen as the key eastern constraint to the City's development. Although it will be seen in the context of other new development, such as Skypark and the freight terminal, its containment by the floodplain of the Clyst valley to the east and its commanding topographic location gives the site a particular prominence and importance. It was not for arbitrary reasons that the builders of Redhayes Country House chose this site to develop. It is prominent and focal to the landscape. The proposed UESP is an appropriate high quality use for the site but it needs to be developed with confidence and vision because it will help to set the standard for what else will be built to the east of the M5.

The diagrams on opposite show the incremental growth of Exeter within it's green bowl and illustrate the strategic importance of the UESP site.

The Green Infrastructure study for the Exeter fringes provides an analysis of the landscape setting of the City and its proposed growth and puts forward a Spatial Vision for the city. This draws out the roles and importance of the 'bowl' to the north, west and south of the city. It identifies the 'Clyst Meadows' as providing the 'new' eastern edge of the City and shows a number of well defined settlements within East Devon with strong sustainable transportation linkages. This can be simply illustrated, as shown by the diagram.

Within this simple structure the UESP occupies a key location overlooking the Clyst Meadows with, potentially, a Green Infrastructure linkage passing through the site. What does this mean for physical form? It suggests firstly that there should be a strong relationship between the placement of buildings, topography and views. Redhayes Country House didn't ignore its context and neither should the UESP. The dominant position on the M5 and the opportunity to provide views to the context should drive the orientation and form of development. In many respects the UESP needs to interact with the Redhayes ridge to create a composition that can be appreciated from the M5 and the surrounding landscape and not read as an arbitrary extension of Exeter.



This is a conceptual diagram only and does not represent any future development proposals.

[Figure 43] Spatial vision of Exeter plan

5.2 Landscape Character

An understanding of, and response to, landscape character is one of the strongest tenets of the UK approach to planning and design. It is an approach that is enshrined in planning policy and guidance from bodies such as the Commission for Architecture and the Built Environment (CABE) and English Heritage (EH). Even if an area is to be substantially remodelled there will be attributes that will inspire or guide the nature of that change.

The Redhayes site sits within a large character area, as identified by Natural England in the Character Map of England, known as the Devon Redlands. Features that give this character area its distinctive quality are seen as being under threat, particularly around the urban edge of Exeter and other settlements.These features include the lanes, hedges and standalone trees. In 'The Devon Landscape' published by Devon County Council in 2002, the site is shown to be at the transition point between the 'Exeter and Estuary Fringe' and the 'Mid Devon Farmlands'. The 'East Devon AONB, Blackdown Hills AONB and East Devon District Council Landscape Management Guidance, November 2007' describes the site as failing within the 'lower rolling farmed and settled slopes'. Some of the characteristics that describe this area are evident on the UESP Site. These are summarised as follows:

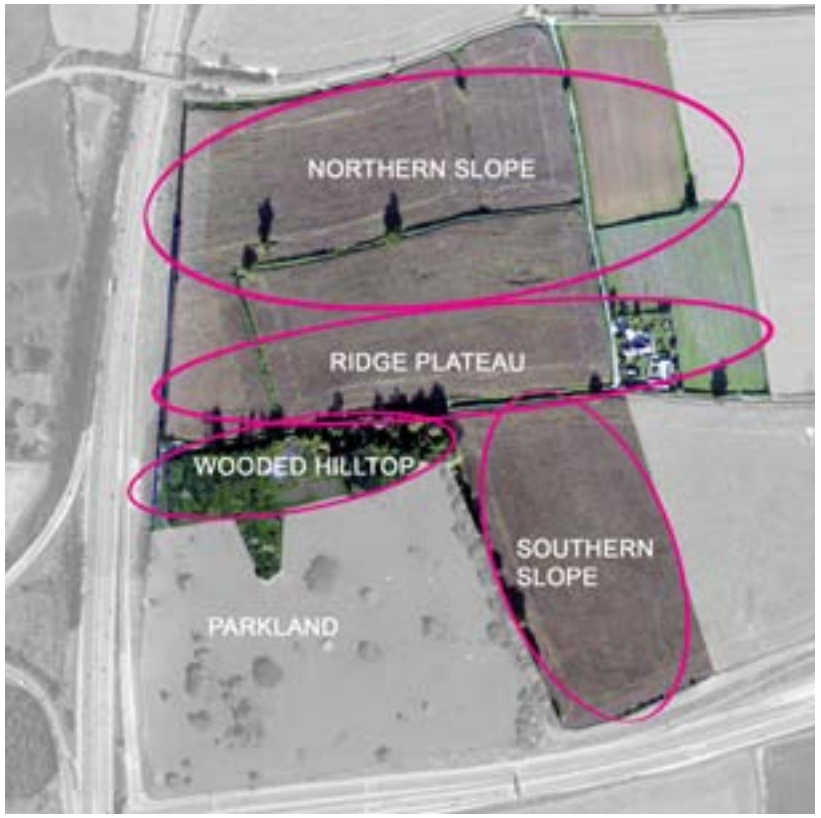
- Gently rolling landform, sloping up from valley floor;
- Variable size fields with wide, low boundaries and irregular pattern;
- Pastoral land use, often with wooded appearance;
- Winding, often sunken lanes;
- Tranquil and intimate

However, the location of the site on the edge of a major transport corridor and the city of Exeter does influence its specific character as a landscape. This 'split personality' highlights one of the key challenges of responding to the site positively; is it rural or urban? Is it possible to be a transitional development type, one that bridges city and countryside? Is it possible to respond to the landscape and be urban at the same time? Later in this document it will be shown that this dual personality can indeed be achieved through appropriate design and landscape management.

At the more local level, the site itself has areas of distinctive character. These are broadly identified in the SPD, although further subdivisions can be made on the basis of topography and aspect. The diagrams on this page show these subdivisions.

- the southern slopes are defined by the evenly sloping agricultural land and unbroken, southern panoramic views encompassing the Clyst and Exe Valleys. The presence of the A30 and Exeter Business park gives the area an urban quality that is less evident elsewhere on the site;
- the northern slopes have sweeping, undulating topography accentuated by hedges and tree lines and winding rural lanes evocative of the heritage of the site. Beautiful panoramic views stretch across the arable patchwork towards Killerton, Broadclyst and Ashclyst Forest. Despite the presence of the M5 the area feels predominantly rural.
- the wooded hilltop at Redhayes is prominent within the wider context. It offers a feeling of intimacy when one is looking out from within the stands of attractive trees. Thes spaces withn the trees and the open portions of the ridge give commanding long distance views out over the surrounding hinterland. The area retains relics of formal, classical landscape character especially with its sweeping parkland frontage.
- the ridge straddles both the northern and southern slopes, and stretches across to the wooded hilltop. This open exposed area with views to the north is a natural vantage point and from surrounding vantage points is 'read' as a continuation of Gipsy Hill (Pinhoe).
- to the south west of the site, although outside of the study area, lies remnant parkland formerly part of Redhayes with strongly undulating topography and stand-alone parkland trees.

These variations in character provide clues as to how the site should be developed. Each part of it has different conditions, in terms of vegetation, slope and aspect. A homogenizing design for the whole site would take away its distinctiveness and diversity and obscure one of the site's special selling points – its unique character and location. An even distribution of buildings across the site, for example, would leave little untouched landscape and relegate it to left over space between buildings. Given that 'competitor' science parks are by comparison fairly bland places that could be anywhere, responsiveness to local context could be a powerful means to differentiate the development offer. Achieving this in practice would need careful consideration. A science park is after all a recent innovation and there is no logical reason why it should reflect what has gone before. The key to a successful response to character therefore will involve retaining what is currently of value on the site; responding to the conditions to be found in each character area, i.e. the slope, aspect, views and topography; identifying and relating development to key views to influence the form and massing of buildings; looking to the site and context for clues as to the appropriate colour, tone and mix of materials in building and landscape design; and thinking imaginatively about what a science park is and how the activities that take place in it can be expressed.



[Figure 44-47] Images of elements of site landscape character
[Figure 48] Strategic landscape character diagram
[Figure 49] Site character

5.3 Views

If the different character zones suggest the need to create variation in character across the site, then the different views to, and within, the site can be used to influence the location, scale and form of buildings. The diagram shows some of the key views to the site from the surroundings and these are illustrated by the photographs. The photos speak for themselves in many respects. The site is a prominent local landmark and the distinctive grouping of trees on the ridge (i.e. view 4) is visible from vantage points throughout the eastern fringes of Exeter. In fact the site is just one of a number of the hills of Exeter that give the City one of its most distinctive qualities. The fact that the vegetation of many of the hilltops contains exotic species and evergreens just adds to the mystique of these features. The slopes of the site are exposed from many directions, particularly the north and south. The challenge of grouping buildings on the northern slopes is possibly one of the single most important aspects of the site to get right. For many the UESP will be the defining image of Exeter just as 'Green Park' establishes an image for Reading to users of the M4. The density of development required to make the scheme viable means that these steep northern slopes, exposed to the M5, will need to accommodate a substantial number of buildings. However the density is not sufficient to create a strong urban form that structures the entire landscape. If buildings are evenly distributed how will they be combined to create a definitive

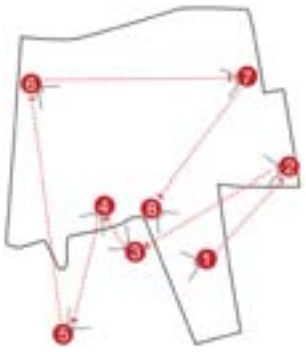
View 1

View 2

View 3

View 4

• Views within the site



[Figure 50] Location plan of views within the site
[Figure 51] View 1: Southern slope treed edge
[Figure 52] View 2: Sunnymead housing
[Figure 53] View 3: Redhayes remnant
[Figure 54] View 4: Treed ridge

View 5

View 6

View 7

View 8

[Figure 55] View 5: Parkland view
[Figure 56] View 6: Northern slope existing hedge line
[Figure 57] View 7: Northen slope, view looking towards west
[Figure 58] View 8: Southern slope, view looking towards south

and memorable image? How can they be grouped in such a way that they create a composition simple and attractive enough to strengthen the area's identity? The masterplan needs to show how this latter question can be answered.

One of the other lessons from assessing the site from its surrounds is to aid an understanding of the implications of getting the design wrong. Sowton Industrial Estate and Exeter Business Park show how not to create an attractive roofscape. From distant viewpoints the extensive expanses of pale roof materials glimmer like oasis' standing out harshly from the surrounding urban and rural areas. The design of the roofscape of the UESP will need to be carefully considered.

Views within the site show the diversity of landscape experience the site offers. Most important are those visual connections with key defining features such as the wooded ridge. However of more importance are the views from the site to the surrounds. The site has great views, and those to the north and east are unparalleled with landmarks such as Killerton Gardens, Ashclyst Forest and the Blackdown Hills being highly visible on clear days. In the future new development will intrude into these views , but the background will always be predominantly rural – a strong USP for the development.

View 9

View 10

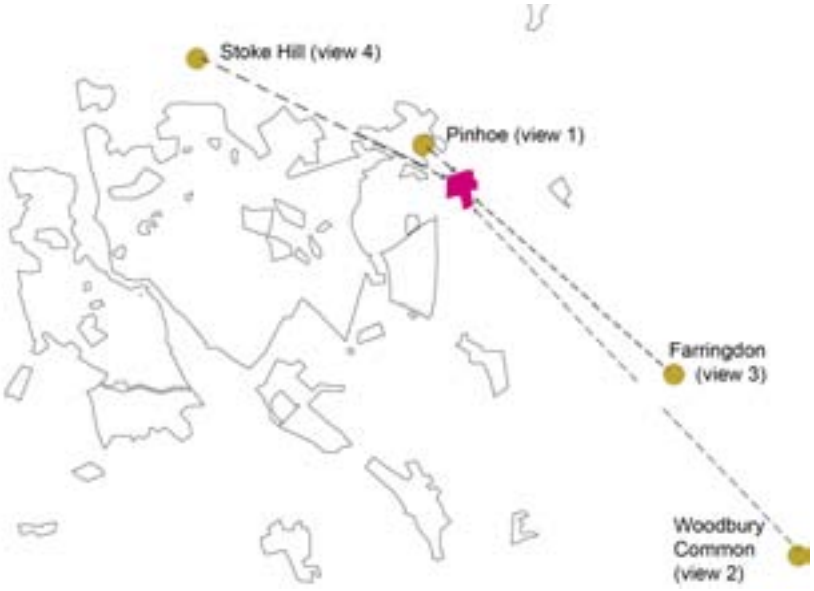
View 11

View 12

• Views to the surrounds

[Figure 59] Location plan of views from the site to the surrounds
[Figure 60] View 9: View of Pinhoe residential area
[Figure 61] View 10: View towards northwest
[Figure 62] View 11: View towards east
[Figure 63] View 12: View towards southeast

• Views from the surrounds



View 13

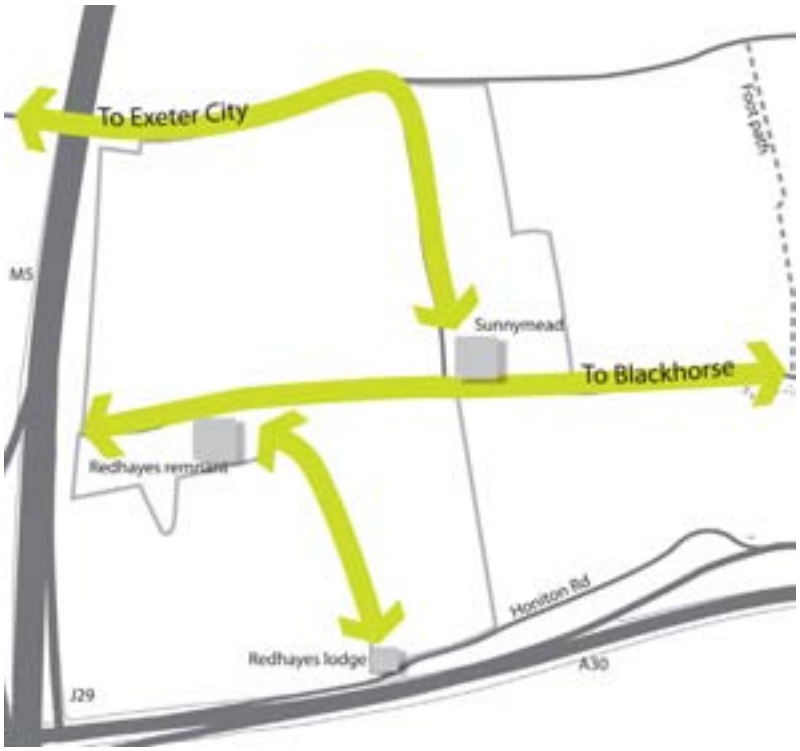
View 14

View 15

View 16

[Figure 64] Viewplan from the surrounds to the site
[Figure 65] View 13: view from Pinhoe
[Figure 66] View 14: view from Woodbury Common
[Figure 67] View 15: view from Farringdon
[Figure 68] View 16: view from Stoke Hill

5.4 Accessibility



One of the great virtues of the site is that in has the potential to be reasonably well connected to its context. The strategic transportation work being taken forward by Devon County Council ensures this. In the future the site will be connected through Monkerton and Pinhoe to the City Centre. Similarly it will be possible to easily move between the site to the new and existing settlements to the east. More immediately however there is significant potential for linkage to Monkerton, Gipsy Hill and Pinhoe to the West of the M5, Blackhorse and Clyst Honiton to the east. These linkages can be achieved by the variety of lanes and footpaths that run through the site. To the south linkage onto the A30 to Junction 29 is achievable, but less attractive.

The potential accessibility linkages can be used to shape the form of the development. Confluences of routes and consideration of walk distances can begin to shape where the centre and focus of intensity of the site might be.

5.5 Other Technical Site Assessments

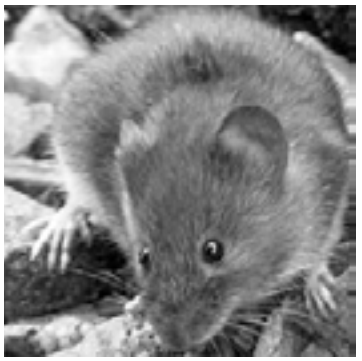
The site has been subject to a number of other technical assessments. These indicate, at this stage, that there are no major constraints to development but an ongoing sensitive approach to site development is required.

Archaeologically the site certainly has areas of interest. 10 archaeological sites are identified within the site area requiring a sensitive and responsive approach to design and development. Key findings included evidence of former field boundaries, six Bronze Age ring ditches, which may be associated with other as yet undiscovered features; other ditches and historic road surfaces; and historic farming enclosures. The SPD does not envisage archaeological issues influencing development form. However, it would be a shame if some of the historic structures were not maintained as layer in the

[Figure 69] Site existing accessibility diagram
[Figure 70] Archaeology diagram







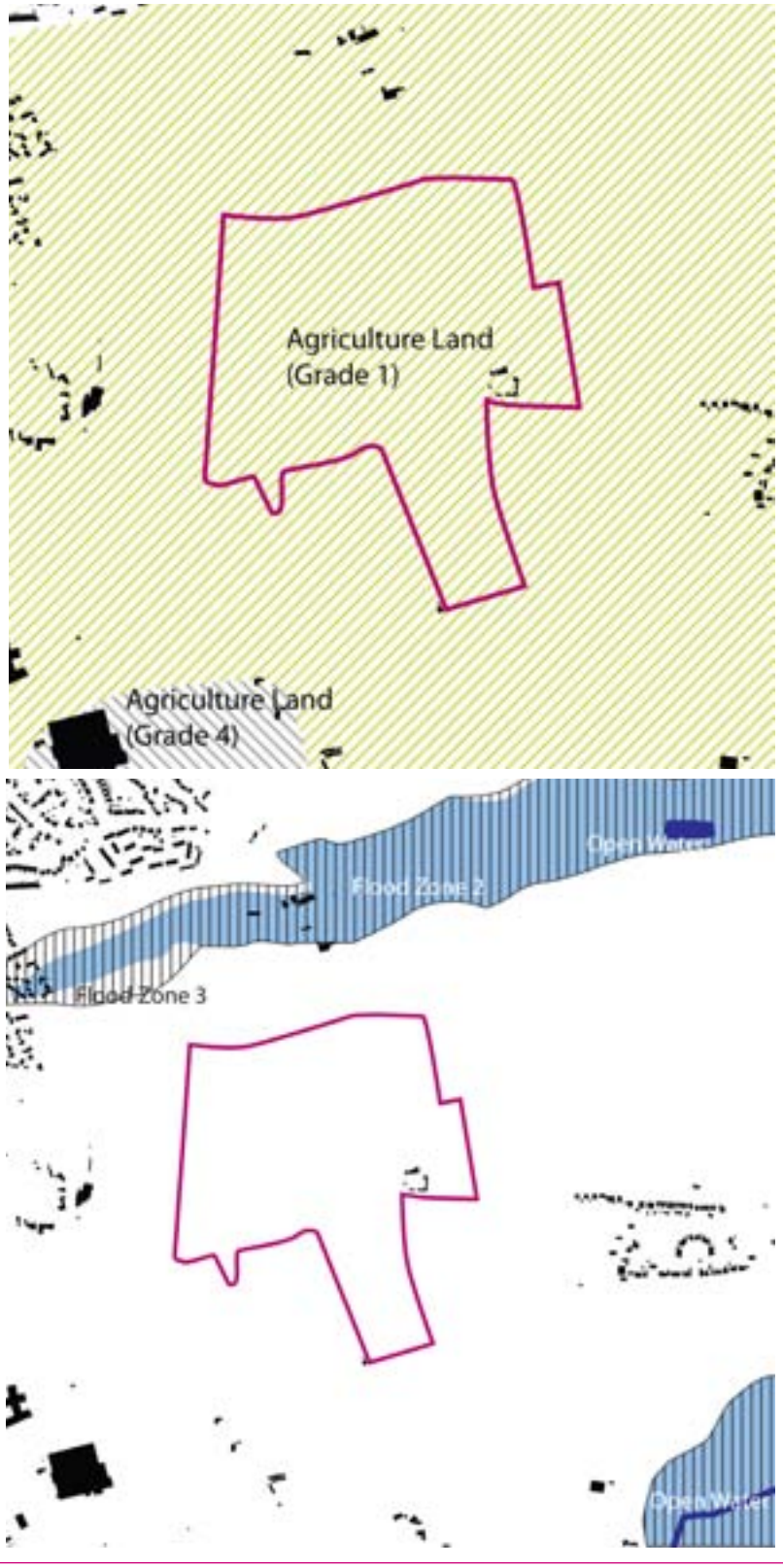
landscape. For example Blackhorse Lane across the top of the ridge is an ancient route towards Exeter and could enrich the personality of the development if retained.

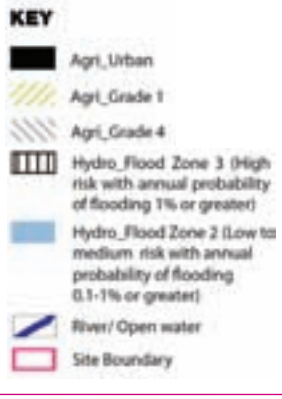
There are no designated wildlife sites at Redhayes and ecological study has not identified any major constraints to development. The site does have ecological value however, with a number of established habitats, bat roosts and use by badgers. The development of the masterplan can enhance biodiversity on the site from that provided by intensive farming. Tree cover and be improved and habitat types enhanced as a core part of the design concept.

[Figure 71-75] Images of fauna evident on the site
[Figure 76] Ecology diagram

The SPD and the emerging Green Infrastructure Strategy provide a range of other data related to the study area. Whilst describing the context, these data sets do not identify factors that particularly need to be taken into account in developing the masterplan. For completeness the key data sets are mapped on the diagrams. Perhaps the one of the most important issues is the productive capacity of the land. The GI strategy identifies the area being comprised of Grade 1 Agricultural Land, hence its predominantly arable use. This innate fertility may have implications for the landscape design and the type and quantity of plants that can be grown successfully. Equally it suggests that a 'natural' landscape style, for example allowing the development of wildflower mixes etc, may need careful consideration because these approaches normally only work effectively on low fertility soils. It may mean that special care should be taken to protect and reuse the topsoil from the site.

The Clyst valley, to the north and east of the site, is prone to flooding and includes flood Zones 2 and 3. These zones do not directly impinge on the site. However the nearby presence of flood prone areas emphasises the fact that stormwater run-off rates from the site are likely to need to match 'greenfield' standards.

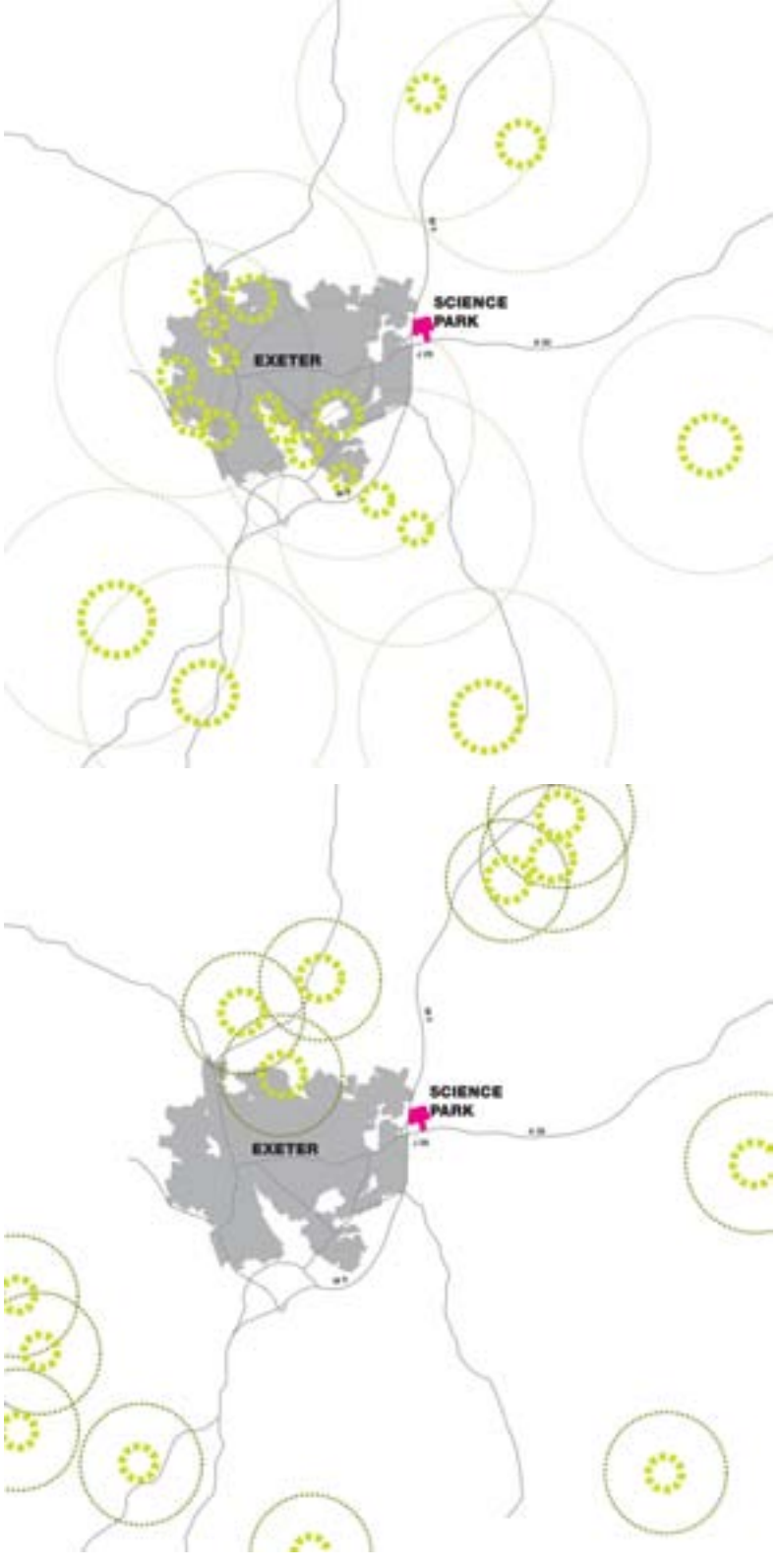




[Figure 77] Agricultural land status diagram
[Figure 78] Flood zones diagram

5.6 Community

It has already been stressed that the UESP needs to become, and be seen as, a community in its own right. However, it will also to be seen as a part of the community within which is located. Business Parks and science parks have not, in the past, tended to offer much to the communities adjacent to, or surrounding them. The UESP is much better placed to offer something tangible to the existing and proposed communities of East Devon and Exeter than many comparable developments. It is fortunate in that it can be connected to adjacent areas at a number of points allowing genuine integration. It can also help to meet the informal open space needs of the area. The diagrams show deficiencies in different types of open space provision around the edges of Exeter. The UESP site is ideally located to meet some of these deficiencies. In addition, its development may be able to help to deliver some of the aspirations of the wider GI Strategy for the area which highlights the needs for improved sustainable pedestrian and cyclist linkages from Exeter to the landscapes and settlements to the east.



KEY

Metropolitan Park
(Open Space between
60 ha - 400 ha)
District Park
(Open Space between
20 ha - 60 ha)

Metropolitan Park
(3.2km Buffer of Open Space
of between 60 ha - 400 ha)
District Park
(1.2km Buffer of Open Space
of between 20 ha - 60 ha)

[Figure 79] Metropolitan Park and buffer area
[Figure 80] District Park and and buffer area

CHAPTER 6 LESSONS FROM ELSEWHERE

Science parks are not a new innovation and other examples might give a clue as to what might be successful for Exeter and East Devon. A number of other developments have been studied to refine the brief and provide a more complete understanding of the competition within the market place. The diagrams on the following pages illustrate the physical form of these developments and itemise the property offer they provide.

6.1 Lessons learnt

There are a number of conclusions to be drawn from the consideration of other science parks:

1.The analysis gives a good indication of the type and range of unit sizes favoured by science-based businesses within the UK. The UESP needs to be able to accommodate the full range of these unit sizes in a variety of configurations.

2.The majority of the development models are fairly simple commercial propositions – a building and associated car park on an individual and defined plot. The ease of marketing and managing these development propositions is clear. However, the commercially driven approach has, in some instances produced a development form that is indistinguishable from the 'business park' model. This may make it difficult to differentiate the Science park offer from other development offers.

3.It may be for this reason that in some of the example schemes some of the uses are only loosely connected to science and technology. The lack of a clear and differentiated development offer may well have made it harder to adhere to the original founding Science park concept.

[Figure 81] Aerial photo of Oxford Science Park
[Figure 82] Aerial photo of Southampton Science Park

01. Sharp Laboratories of Europe (2955.5 sqm)
02. Magdalen Centre North (1600 sqm)
03. Magdalen Centre South (3084.5 sqm)
04. Edmund Cartwright House (617.5 sqm)
05. Medawar Centre I and II (1646 sqm)
06. Northbrook House (1630 sqm)
07. Florey House (1275 sqm)
08. John Eccles House (1123 sqm)
09. Hinshelwood Building (700 sqm)
10. Sherard Building (1225 sqm)
11. Danby Building (2345 sqm)
12. Fletcher House
13. Winchester House (2484 sqm)
14. Sadler Building (1740 sqm)
15. Minerva House (1181.5 sqm)
16. Nursery (460 sqm)
17. Ozone Leisure Complex (14478 sqm)
18. Kassam Stadium
19. Holiday Inn Express

1. 2 Venture Road (total 2155 sqm)
   Built to satisfy the demand for smaller companies with units
   from 18.58 sqm (200 sqft)

2. Kenneth Dibben House (total 1668 sqm)
   Building with units
   from 50 sqm to 464.5 sqm
   (540 sqft to 5,000 sqft)

3. Enterprise Road (total 7246 sqm)
   The two building in the foreground are both 836 sqm (9,000 sqft).
   The four others are the same size at 1393.5 sqm (15,000 sqft).

4. Benham Campus
   9 acres of land adjacent to the park, with detailed planning permission for 9476 sqm (102,000 sqft) of buildings.

[Figure 83] Figureground plan of Oxford Science Park
[Figure 84] Figureground plan of Southamptom Science Park

4.The physical development model of many of science parks is inefficient in terms of land use. In some cases, each building and car park has associated with it small areas of landscape in small strips between buildings, car parks and roads. A large part of many of the science parks consists of these areas and as a result the overall impression is of a site evenly distributed with buildings and parking. If all building and parking were to be grouped into a one or more focussed locations there would be much more landscape that could be used as open space or setting.

5. In each example there is little to suggest any sense of community. One has to suspect the people that work at these sites drive into the car park, walk to their building and rarely meet anyone else within the development. For a technology and ideas exchange initiative this would appear to be a significant omission in the model. Academics and researchers drawn from campus style university contexts may not be attracted to this development model.

6. Often there appears to be little about the physical form of each of the developments to suggest that it is associated with technology and innovation.

7. Many of the science park examples appear to be poorly connected and integrated into their surrounding areas and communities. They appear to be effectively 'mono use' and dependent on access by private car. As a result the majority are probably very quiet places after normal work hours. It is hard to see them evolving to become valued parts of the urban fabric in the way that, for example, Exeter University has.

The UESP can do better than its competitors – and its prominent location means that it has to. Key areas for improvement on the 'exemplar models' include making the most efficient use of the site to maximise landscape and creating a configuration of buildings that helps to build a sense a community and the possibility of interaction between people. However, it will be equally important to provide a property offer that is simple to implement, manage and market.

[Figure 85] Aerial photo of Tamar Science Park
[Figure 86] Aerial photo of Cambridge Science Park

Phase 1:
Room sizes ranging from 26.49 sqm (285.14sqft) to 125.25 sqm (1348.23sqft)

Phase 2:
Room sizes ranging from 14.41 sqm (155.16sqft) to 260.89 sqm (2808.25sqft)

Phase 3:
Room sizes ranging from 273.97 sqm (2949sqft) to 625.98 sqm (6738sqft)

Total Site Area = 61.5 Hectares
Total floorspace accommodating research and development companies is 145,540sq.m.
The smallest space provided is 93sq.m up to the largest units of 4,645sq.m

[Figure 87] Figureground plan of Tamar Science Park
[Figure 88] Figureground plan of Cambridge Science Park

CHAPTER 7 RESPONDING TO THE SITE AND CONTEXT

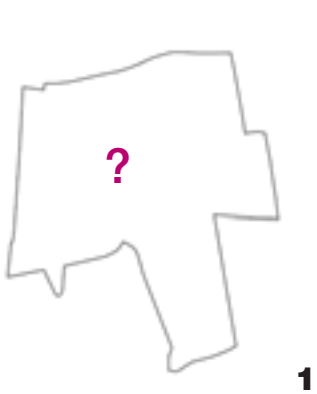
In the previous sections key factors shaping the brief and influencing the design for the UESP were outlined. These can be brought together into an organising concept for the site and specific proposals for the development if the various areas of it.

7.1 The organising concept

The organising concept is defined by a number of fairly pragmatic and objective responses to the site. These are shown by the diagrams which represent a step by step build up of the basic development model.

Diagram 2 shows the topography. This is the fundamental building block of the site. It defines slope and aspects and lifts the site above the M5 and the less elevated landscape to the north and east. The topography makes the site a distinctive and well defined part of the east devon landscape and creates its focal position. Diagram 3 overlays onto the topography the essential landscape structure as defined by the SPD for the site. Variations in topography and vegetation create the character areas shown by Diagram 4. Diagram 5 overlays on to the site two walk-distance radii delineating the widely used 400m walk zone. It shows how a walk-zone centred in the entrance to the site (the area defined as the initial centre for development in the SPD) covers only 50% of the site. However a walk-zone centred close to Sunnymead encompasses the whole site within the 400m radius. Diagram 6 shows the key linkages and connections that move through the site. The dashed line delineates the proposed public transport route. The confluence of key connections and the walk-zone analysis starts to define where the eventual centre of the development should be, Diagram 7. The location identified also has the benefit of being central to the any future eastwards development. Diagram 8 identifies the gateways to the site and Diagram 9 highlights the need for the creation of a strong edge to the UESP on the south east of the site. Diagram 10 identifies the ridge as a potential green link along the spine of the site, in line with the recommendations of the GI Strategy. Diagram 11 brings the various principles together to suggest the essential structure to the site and also shows the areas within that structure where development can be focussed. Five key areas are highlighted, Phase 1 (the southern slope) close to the A30, the 'centre' around Sunnymead, Redhayes, an area at the western end of the ridge and an area to the north of the public transport spine.

This organising concept underpins the development of the masterplan. The following section considers the various development options appropriate for each of the character areas within this overall organising framework.



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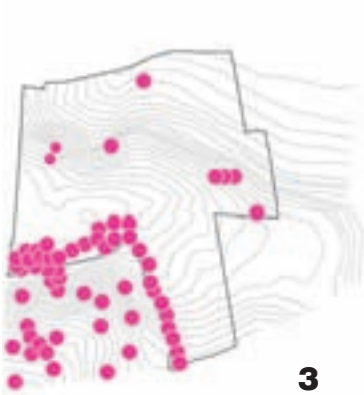
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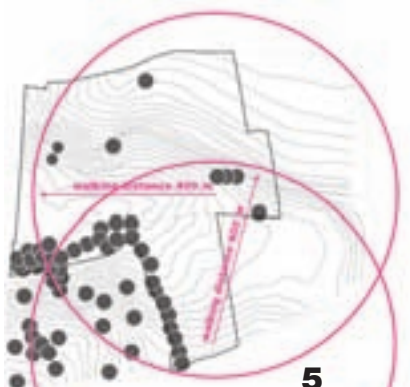
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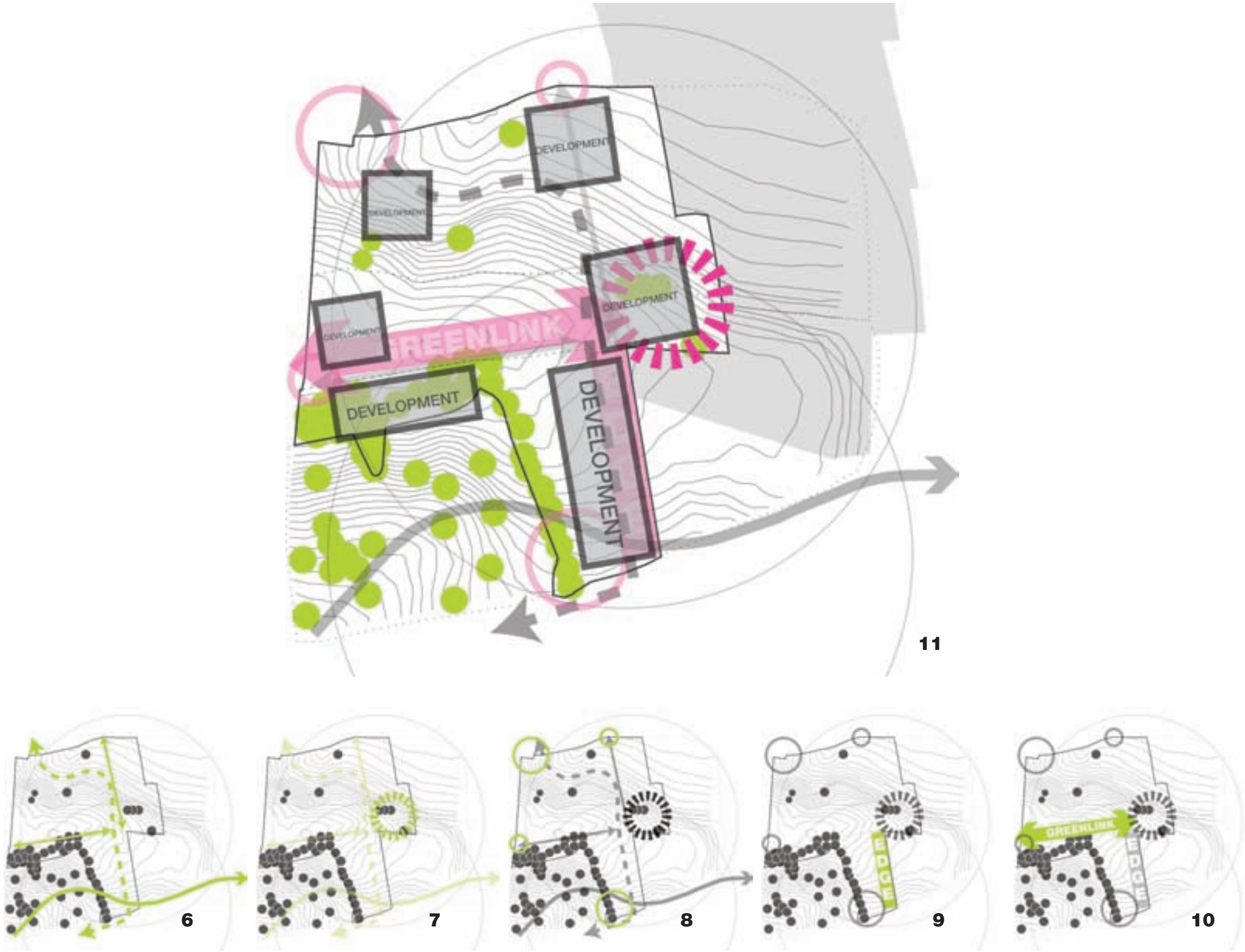


[Figure 89-99] Organising concept diagrams 1-11

CHAPTER 8 DEVELOPING THE MASTERPLAN

The organising concept provides a structure within which the key character areas sit. It has been suggested previously that the development form on each of these should respond to the site conditions found within each area to ensure a development that is responsive to site and context. This section assesses appropriate design responses for each area. The character of each area is briefly described; the development aspiration is identified together with the development quantum. The key challenges of developing the character area are identified and an appropriate masterplanning response is identified.

8.1 The Parkland

sweeping parkland
approx 9.0 ha

DEVELOPMENT ASPIRATION

The area needs to accommodate J29 Improvements. These amount to: approximately 580 linear metres of carriageway amounting to a total area of 15,250m^2, excluding cutting and associated footpaths.

SITE OPPORTUNITIES AND CHALLENGES

Role in development: The area provides a strong landscape setting to J29 and functions as a gateway between Exeter and East Devon. When the UESP is developed it will form its setting as experienced from the M5 and A30. It could provide an opportunity for a landmark development;
Topography: The area has sweeping and steeply rising topography which presents challenges to the sensitive design of the road infrastructure;
Views: There is visual exposure from the A30 and southerly views across the M5 and the eastern edge of Exeter, plus longer distance views towards Heavitree and Sowton;
Site features: mature specimen trees to be retained and managed.

MASTERPLANNING RESPONSE

- To accommodate junction improvements and link road whilst maintaining the parkland character and preserving a potential future development site.
- The key to achieving this successfully is through the miminisation of cut and fill and sensitive grading of banks and batters back into the landscape.
- The placement and quantity of signage and lighting will require careful consideration as will the design of road side barriers and fencing;
- The Parkland provides an opportunity to provide a land mark development overlooking the junction and the eastern side of Exeter.

LANDSCAPE STRATEGY

- Mature specimen trees to be preserved and collection added to if appropriate;
- Minimised cut and fill and gradation of road into landscape;
- Continue grazing the pasture to maintain the parkland feel.

[Figure 100] Photo of parkland

8.2 Redhayes

prominent wooded hilltop
approx 2.0 ha

DEVELOPMENT ASPIRATION

Assuming the area is developed to densities aimed for across the rest of Phase 2 the plot ratio would be 0.22 which would amount to a total development quantum of 4400m2. The SPD for the site suggests that the building footprint for a landmark development on this site should be no more than 1500m2 and a maximum of 3 storeys. This would give a development quantum of 4500m2 which is in line with the plot ratio. It may not necessarily be the best solution to achieve all of this development quantum in a single large building.

SITE OPPORTUNITIES AND CHALLENGES

Role in development: The area has a commanding ridge position with good views from the edges and shelter amongst the trees. The SPD places a limitation on the scale of development in this area
Topography: the area has even, relatively flat topography, gradually sloping towards the 'centre'
Views: distinctive tree line is visually exposed from south-bound lane of M5, requiring a sensitive design response. Significant southern and northern views from the edges of woodland
Site features: dense woodland (with group TPO) including dominating mature pines and undergrowth, with remnants of formal landscaping

MASTERPLANNING RESPONSE

- Development within the area needs to work with, and around, the existing trees.
- Sensitively placed smaller buildings may work better than one large building. These could be integrated within the tree groups and create a smaller scale environment for start up and creative businesses.
- The intimate treed environment should be capitalised on as a place to enjoy outdoor space.
- The established 'natural' palette of materials and colours could be reflected in the architecture.
- Opportunity for landmark building overlooking the south facing parkland slopes as a signifier for the UESP.

LANDSCAPE STRATEGY

- Maintaining the distinctive tree-lined ridge and the existing intimate woodland character
- Creation of small spaces between buildings to encourage informal socialising

[Figure 101] Existing vegetation tiers
[Figure 102] Small buildings with trees and landmark building

The Ridge

prominent open strip
approx 4.5 ha

DEVELOPMENT ASPIRATION

Plot ratio 0.22 applying to Phase 2 gives an overall development quantum of around 10,000 m2. It may be possible to concentrate this development elsewhere within Phase 2. The SPD refers to the ridge being kept free of development, though it is not clear whether this applies only to the Redhayes site. The commanding position of the ridge in relation to the M5 means that it would be a preferred location for a landmark building or cluster of buildings.

SITE OPPORTUNITIES AND CHALLENGES

Role in development: the linear and relatively flat nature of the ridge lends itself to acting as a means of linkage between the eastern and western parts of the site.
Topography: plateau topography gradually sloping towards the 'centre' does not provide any major constraint to development.
Views: Extensive panoramic views to the north, which also means that it is visually exposed from the south with characteristic back drop of mixed evergreen and deciduous trees. Travelling south along the M5 the site is often seen in silhouette and consequently building form and mass is important.
Site features: contains strong east west linkage to south, formed by Blackhorse Lane. The sunken feature is a strong part of the existing site character

MASTERPLANNING RESPONSE

- Intensive development of the ridgeline would conflict with the aspirations of the SPD and obscure views to the wooded backdrop. In addition parking would be pushed onto the steep surrounding wooded slopes. Nonetheless the area is a key focal location overlooking the M5 and can accommodate some development.
- To retain the ridge as an open space spine to the UESP, development should be clustered at the western edge overlooking the M5.

LANDSCAPE STRATEGY

Retention of open swathe of landscape to protect views of the tree-line from the M5 and south thus conserving the clear hilltop reflecting the vernacular landscape character

[Figure 103] Prominent tree line,view from north (leftt top)
[Figure 104] Exclusive ridgeline development (right top)
[Figure 105] Prominent tree line,view from north (right bottom)

The Southern Slopes [Phase 1]

south facing sloping ground
approx 4.5 ha

DEVELOPMENT ASPIRATION

The development plot ratio for this area of the site is 0.38 and reflects the desire to create a higher density development on Phase 1, which is located in this area. Phase 1 includes the provision of a hotel, the initial UESP building and a company HQ building. Phase 1 needs to be of a high quality and set the quality standard for subsequent phases of development. The SPD establishes this as the initial centre of the UESP development, although previous masterplan analysis located this deeper into the site.

SITE OPPORTUNITIES AND CHALLENGES

Role in development: accommodation of higher building densities and car parking associated with Phase 1. It is a key gateway site and strong signifier for the development when seen from the A30. It has to accommodate the key public transport and vehicular route through the development.
Topography: Uncomplicated, evenly sloping topography but some cut and fill will be required to achieve the high development quantum.
Views: Extensive southerly views and visual exposure from the A30, but considerably buffered by lime tree avenue from views to and from Exeter Business Park.
Site features: enclosing parkland boundary tree line, which should be retained, hedgerows and rural lanes

MASTERPLANNING RESPONSE

- The area requires an 'urban' design response to achieve the required development density and parking standards. It needs a strong presence when seen from the A30 and act as a gateway to the development.
- The public transport and vehicular spine needs to be integrated as an integral part of the development, and therefore the area will contain a significant 'street'.
- The activity of the street means the area may prove to be a good place to locate some ancillary uses such as a small amount of retail development.
- The eastern edge has no definition. In the future this area may be developed. A strong edge to the UESP needs to be created in this area.
- The slope means that the development is likely to need to be terraced up the hillside, maximising views and passive solar gain

LANDSCAPE STRATEGY

- Retention of strong tree edge to the west.
- Use of landscaping to divide and organise space and car parking.
- Opportunity to utilise the southern aspect in terms of solar gain and creating pleasant outdoor environments.
- Utilise the natural drainage slope to the south.

[Figure 106-107] Strong boundary edge allows organised development behind

The Northern Slopes

undulating slopes
approx 12.5 ha

DEVELOPMENT ASPIRATION

This area will accommodate development at a general plot ratio of 0.22. The area is extremely exposed visually to the north and the composition of buildings placed on it needs to create a defining image of the UESP.

SITE OPPORTUNITIES AND CHALLENGES

Role in development: This is the largest part of the site with stunning, far reaching panoramic, but northerly views
Topography: The complex undulating topography is problematic for accommodating buildings with large floor plates
Views: Very visually exposed from northern approach to Exeter on the M5 with high landscape sensitivity
Site features: The site contains low hedgerows cutting through the cultivated landscape which highlight opportunities for working gracefully with the landform to emphasise subtle undulations

MASTERPLANNING RESPONSE

Site requires a measured design response to create a composition of buildings that project a positive image when viewed from the M5. A number of different development scenarios have been tested (refer to figure 108-110):

- Development flowing along the contours maximises the northerly panoramic views and would involve minimal groundwork, but would be highly visible from the north and buildings would be isolated from one another. It would be difficult to provide communal parking. From the M5 it will be difficult to identify individual buildings. The built form would create few opportunities for social interaction.
- Development against the grain of the contours could involve large cut and fill exercises and buildings would be isolated from one another, though interesting spaces would be created between buildings. From the M5 the development would create a wall of buildings. The built form would create few opportunities for social interaction.
- Clusters of buildings allow for the creation of a composition of blocks of buildings with flowing landscape between them. Concentrating development enables efficient use of space and makes it easy to serve development with communal parking areas. The grouping of the buildings enables social interaction and potentially the exchange of ideas. The groups of buildings do not dominate the slopes and allow the landscape to flow into the development.
- The assessment of different possible development scenarios has led to the identification of the 'clusters' model as the most appropriate form of development to guide the development of the site.

LANDSCAPE STRATEGY

- Create a simple, easily maintained landscape to give coherence and order to the slopes.
- Encourage casual amenity use of the landscape
- Utilise the slope and natural run-off hollow to the north for sustainable drainage.

[Figure 108] Developing with the contours
[Figure 109] Developing against the contours
[Figure 110] Cluster development

Summary

The consideration of the approach to each character area starts to identify how each part of the development should be approached within the framework set by the overarching organising concept. Many parts of the site effectively 'design themselves'. For example there is little option within the southern slopes to accommodate anything other than a fairly dense urban scheme if the development aspirations for Phase 1 are to be met. On the Redhayes site the strong framework set by the trees dictates the scale of buildings and where they can go. There are opportunities within this area to provide either a range of smaller buildings or a single large building. The ridge line and the northern slopes together have the greatest flexibility with regard to layout. The key driver of the design of this area is the visibility of the site from the M5 and its general topographic prominence. There is a challenge in locating buildings to create an attractive composition in such a way that the underlying landscape is not dominated. The best way of achieving this would appear to be by clustering buildings within defined groups allowing for the landscape to flow between them.

The development of the 'organising concept' and the development of masterplan options for each of the character areas suggests an overarching vision for the site, which can be translated into an illustrative masterplan. The following section establishes a focussed vision of what the site could be and sets out a masterplan that is illustrative of how it might be developed.

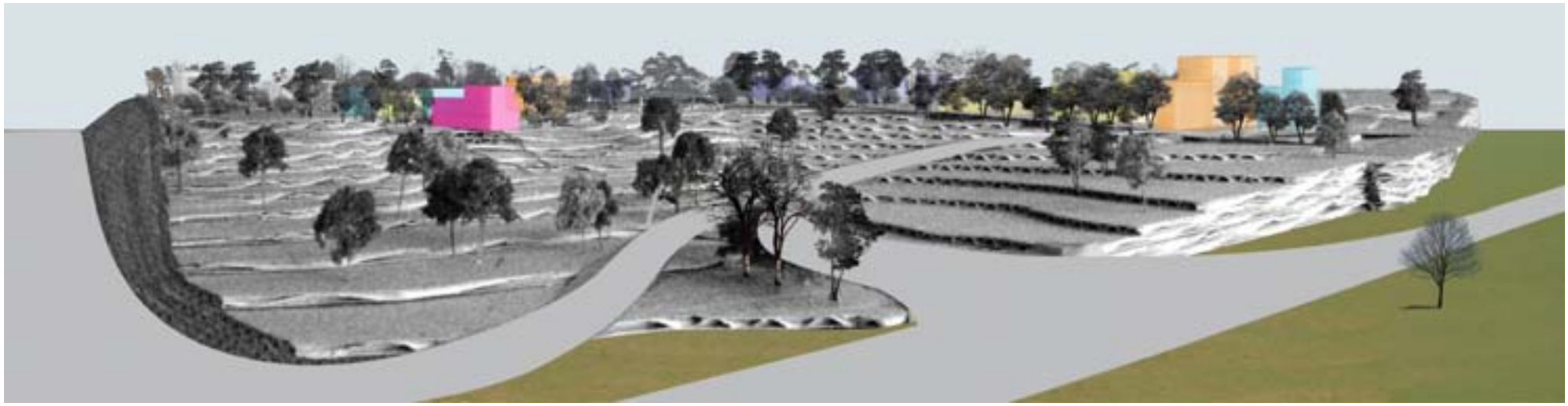
CHAPTER 9 VISION AND ILLUSTRATIVE MASTERPLAN

9.1 Vision

The vision for the UESP needs to achieve social, economic and environmental objectives. The following encapsulates many of the characteristics it needs to embrace:

The UESP is a low density zero-carbon urban area arranged in a beautiful composition of buildings and landscape on a hill on the edge of Exeter. It is home to one of the most creative and innovative scientific communities and acts as the commercial face of the region's centres for research and innovation.

[Figure 111] Vision image showing massing of clusters



[Figure 112] Vision image showing potential for as a landmark development over-looking J29

9.2 Illustrative Masterplan

The illustrative masterplan brings together the organising concept and the considerations of how each character area should be developed. It shows a fully implemented development with a centre around Sunnymead and with building clusters strongly linked to these.

1. Science Park Centre
2. Phase 1 mixed use neighbourhood
3. Redhayes Ridge
4. Tithebarn Lane cluster
5. Langaton Lane cluster
6. Ridge cluster
7. Parkland
8. Communal Parking
9. Landmark Building
10. Public Space
11. Potential pedestrian/cycle link over M5

[Figure 113] 3D drawing of masterplan

[Figure 114] The illustrative masterplan


Cafe Cafe Cafe

[Figure 115] Vision image of Redhayes cafe/recreational area

[Figure 116] Vision image showing clusters of buildings on northern slopes

[Figure 117-118] Character image Phase 1 and Northern Slopes Car Park

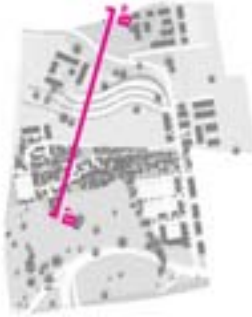
Scale
Assumed building heights demonstrated by the illustrative masterplan are shown on the diagram below. In some areas these exceed the levels suggested by the SPD where it is felt a stronger visual impact is required.

9.3 Sections

The illustrative masterplan has been shaped to respond to the topography of the site. The following sections through the site show the relationship of building mass and height in relation to topography and tree groups. A key issue they highlight is the importance of the ridge top tree planting in visually separating out Phase 1 and subsequent phases to create the campus style clusters of buildings.

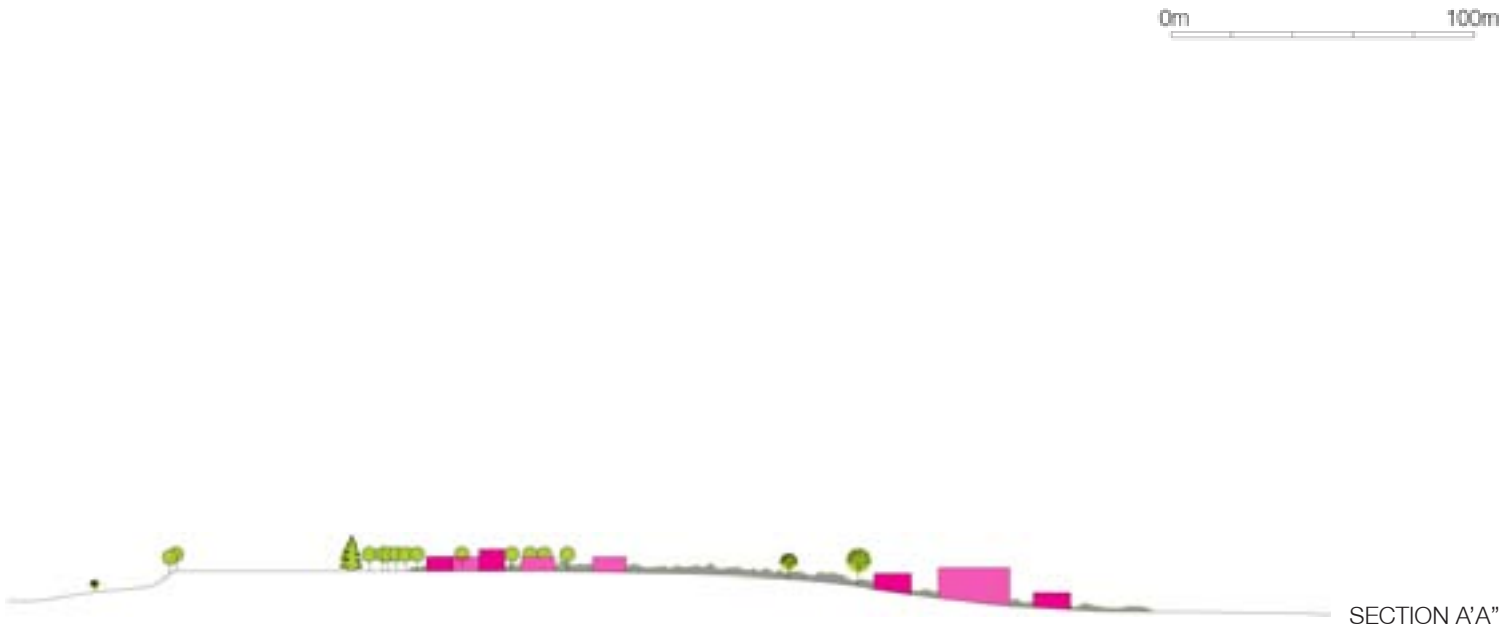
SECTION A'A"

SECTION B'B"



SECTION C'C"

[Figure 119] Indicative Building Scales
[Figure 120] Location of Section Lines



[Figure 121] Sections

SECTION D’D”

SECTION E’E”

SECTION F’F”

SECTION G’G”

SECTION D’D”

SECTION E’E”

SECTION F’F”

SECTION G’G”

CHAPTER 10 THE FRAMEWORK

The framework describes the main building blocks of the scheme. It sets out those elements that are fundamental to the delivery of the vision. The means by which development is delivered within the constraints set by the framework is almost entirely flexible. It allows for a range of architectural styles, building types and configurations.

10.1 Character Areas

The framework is based on the creation of four character areas across the site that reflect the existing slopes, aspect, views and development aspirations. The masterplan and detailed development proposals should be designed to deliver the vision for each of these character areas:

The Southern Slopes

This area should comprise the Phase 1 of the development. It should be an essentially urban development with a strong central street accommodating major vehicular and public transport linkages. Parking should be located to make efficient use of the site within an area that does not intrude on the street scene. The central street to the area will be animated by the uses that front onto it and will contain a range of ancillay uses such as hotel, shops and restaurants. The area should be animated by people arriving and leaving the site by public transport. The design of the area should ensure its prominence on the A30 and act as an important signifier and gateway to the site.

[Figure 122] Character Areas
[Figure 123] Possible character of ‘solar terrace’ on southern slopes

Redhayes Ridge

The Redhayes Ridge character area represents an expansion of the existing woodland block on the hill top. The additional woodland will serves to prevent the visual coalescence of buildings in Phase 1 and subsequent phases and allows for the creation of an attractive composition of buildings on the northern slopes of the site. The woodland provides an intimate setting to development, in particular providing for smaller scale business and incubation space. The woodland on Redhayes provides one of the most sheltered and intimate environments of the site and is likely to attract residents of the Park and local people as an open space and recreational resource. There will therefore be opportunities for small scale spaces, which could be enlivened with small scale food and drink outlets that cater for both occupiers and visitors to the park.

[Figure 124] Intimate courtyard within woodland
[Figure 125] Open space along ridgeline

The Parkland

The area has to accommodate the proposed Junction 29 improvements. The design intent is to maintain the parkland character through ongoing landscape management and sensitive highways design. Although the scale of the highways improvements are inescapable, nonetheless they should be seen as sitting within a parkland context rather that dominating the landscape. In practice this means implementing a parkland planting strategy for the area and ensuring the areas of cut and fill are integrated into the landscape.

The Parkland will be, to many people using the M5 and the A30, the front door of the development. To signify this there is potential for it to accommodate a landmark building overlooking the junction. A tall slim building that contrasts with the wooded backdrop might achieve this aim most successfully.

[Figure 126] Parkland

The Northern Slopes

The development on the northern slopes will be highly visible from the M5 and the north and will send a powerful message about Exeter and its region to people passing the city. Development should be sited to create a powerful and attractive composition when viewed from the main viewpoints. This means creating a number of clusters of buildings within a simple landscape setting. The clusters should be arranged so that from the various viewing angles they create a foreground, middle ground and background. The aim is that it is the clusters rather than the individual buildings themselves that sends the positive message about Exeter, East Devon and the rest of the region.

Each cluster of buildings should be designed with a mixture of both public and private space. It is envisaged that within each there would be common space in which people can meet and interact. Each cluster should be linked and have a direct connection to the centre of the development in a location around Sunnymead. Within each cluster there will be a variety of building sizes and types. Some clusters may be comprised of only 1-2 large buildings or even a single large user. Others may be comprised of an intricate mix of smaller buildings and accommodation with a diverse tenant range.

[Figure 127] Courtyard charcater on northern slopes with water feature
[Figure 128] Character image of ‘green’ internal courtyard

10.2 Movement

The movement framework reflects the outcome of a number of discussions between the masterplanning team and Devon County Council. It sets out an integrated movement strategy for the site comprising:

- Junction 29 improvements and the new link road alongside the A30. This has been designed to minimise land take within the parkland and Phase 1. It includes a signalised intersection to allow access into the UESP;
- A main public transport and vehicular route through the site. This connects the north west corner of the site with the south eastern corner and has been designed to enable future movement between areas to the east of Exeter and Monkerton/Pinhoe. The design of the route will be integrated with the design of the UESP so that it 'reads' as an element of the campus rather than a public highway dissecting the site;
- Connections to potential Phase 3 land to the east of the site and an allowance for a future diagonal route from the proposed UESP centre to Blackhorse;
- Pedestrian and cycle connections. This includes making good use of the laneways that currently run through the site to provide sheltered linkages between the outlying clusters and the UESP centre. It also includes new linkages including a possible covered pedestrian route along the contour from the north westerly building cluster to the UESP Centre.
- Parking. The key principle guiding the parking strategy is to provide a communal parking facility for each of the clusters. The quantity of parking has been calculated to be approximately the same as that provided for the Met Office. It is likely that early phases of parking provision will be provided at a higher standard (i.e. more spaces per sq.m of development) than subsequent phases when public transport provision is in place.

[Figure 129] Indicative vehicular movement framework
[Figure 130] Indicative pedestrian and cycle movement framework

10.3 Landscape

The landscape framework divides the site into a number of distinct zones of common design and management. These create a unified approach to all areas of the site and link key buildings and spaces. Landscape Areas are as follows:

Redhayes Treed Landscape: This is area comprised of mixed deciduous and coniferous woodland. The zone seeks to create a distinctive ridge top wooded landscape that echoes the exotic plantings associated with Redhayes Country House and nearby gardens such as Killerton. It performs a highly important function in providing visual separation between Phase 1 and the development area to the north. This prevents visual coalescence of buildings and enables the creation of a picturesque composition of building clusters on the northern slopes that will become a key part of the developments identity. The woodland should be developed early in the UESP's development as part of the landscape framework. The ground cover to the woodland zone will be kept to a limited palette of predominantly indigenous ground cover species.

Ridge Top Open Space: This area seeks to achieve a bio-diverse grassland. It will be created through sowing with appropriate wildflower species and maintained with a simple biannual mowing regime to encourage the development of species diversity. Key public areas will however be maintained to amenity standards (mown lawn) to enable public and UESP resident use.

Flowing Sculptural Landscape: The zone is the landscape related to the flowing north facing slopes. The area accommodates building clusters and car parking. The landscape unifies these elements and is sculpted to hide the parking from views from the M5.

Southern Side Urban Landscape: the denser Phase 1 development will have a high quality urban landscape comprised of high quality hard landscape using, where appropriate, durable natural materials. Formal tree planting will consist of a small number of deciduous species. There will be limited opportunities for shrub planting.

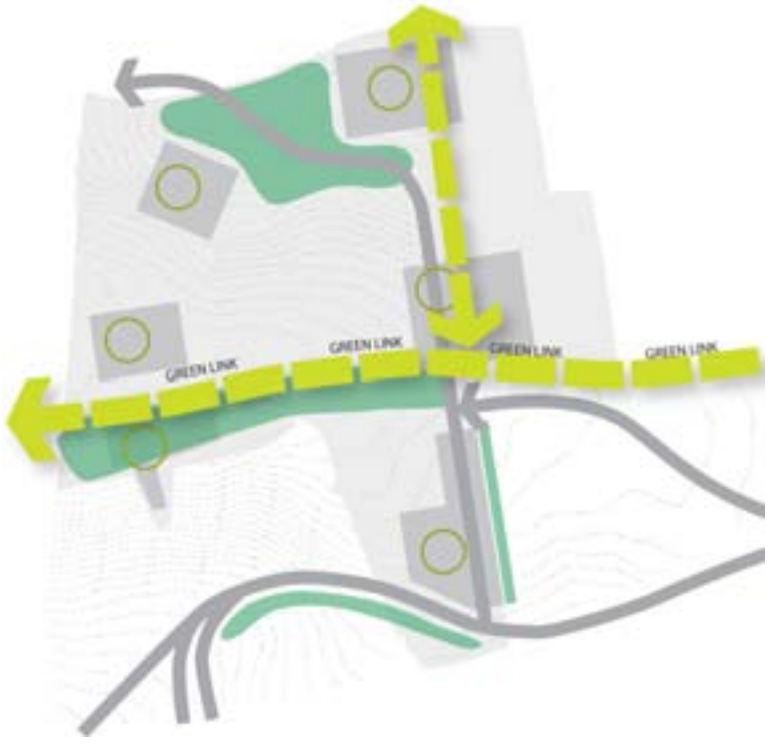
Riparian Landscape: the wet grassland occupies a natural topographic hollow in the northern part of the site. This area will be designed to catch and contain storm water run-off from the site and will be managed to develop in species diverse wet grassland. The aim will be to create a natural wetland character to contrast with the formality of the building clusters.

Public Space: The spaces framework identifies where the key publicly accessible hard and soft spaces should be located and identifies the linkages between. The framework is based on a simple principle of ensuring that each building cluster is served by a publically accessible space, in which people can meet and interact. Each cluster will be linked by a direct and high quality pedestrian route, which ensures that it is easy to move between groups of buildings. Each cluster is directly linked to the UESP centre by a sheltered pedestrian route.

The character of each space will vary depending on the detailed design of each building cluster. Some may consist of hard urban courtyards. Other spaces may be intimate green courts and yet other may contain water.

[Figure 131] Landscape framework plan

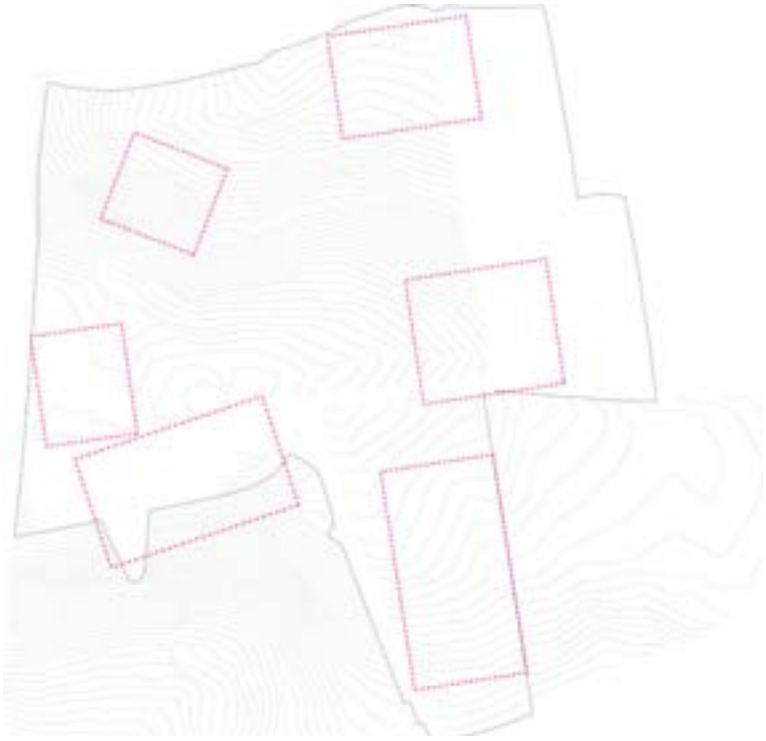
Key elements of the landscape framework can be identified as contributing to site ‘green infrastructure’ and biodiversity. These elements are shown by the diagram.



[Figure 132] Key linkages and spaces
[Figure 133] Green linkages and biodiversity integration

10.4 Built form

The framework identifies where the key building clusters should be located. These locations have been carefully chosen to respond to variations in topography and key view lines and are important to the composition created. Within the areas delineated for the clusters there is a huge amount of flexibility. For example it may be possible for one cluster to be a single large building whilst another might be comprised of a larger number of smaller and interlinked units. The key requirement of development within each of the cluster locations is that built form proposals meet the provisions of the design codes set out in the following section. These will determine scale, height, orientation, public open space.



[Figure 134] Indicative locations of building clusters

10.5 Energy

There is an aspiration for the Exeter UESP to provide low and zero carbon heat, cooling and electricity to achieve a high level of carbon reduction. The Masterplan's approach to the energy strategy identifies that this is likely to be achieved through the careful consideration of the energy requirements of the Park, the design of buildings that are energy efficient and intuitive to control, and the provision of zero carbon heat, cooling and electricity via shared infrastructure and the considered need to balance loads, and novel zero-carbon on-site energy generation technologies. The Park's combination of office, lab, and hotel provides an ideal situation to share and balance these services.

The Element Energy Study 'Energy Strategy for East of Exeter New Growth Point' discusses several options for energy provision, including renewables (i.e. PV, solar, biomass, wind ground source heat pumps, and CHP), and the positive use and economic benefits of a site energy system.

The provision of energy to the building clusters and site infrastructure (i.e. lighting and landscape features) is likely to be provided via a utilities service loop network. A loop system would enable flexibility and provide a robust design to link each cluster. A central energy centre, which connects to the utilities service loop network, can ensure the provision of this low and zero carbon energy is done in the most efficient manner. Buildings could be grouped depending on their energy use to optimise load balancing locally within the clusters, reducing communal pipework requirements. Local energy centres within the clusters linked to a communal system would provide a resilient design throughout phasing. This approach to the energy system can accommodate the utilities connections entering onto the site where a main hub can then connect to the clusters.

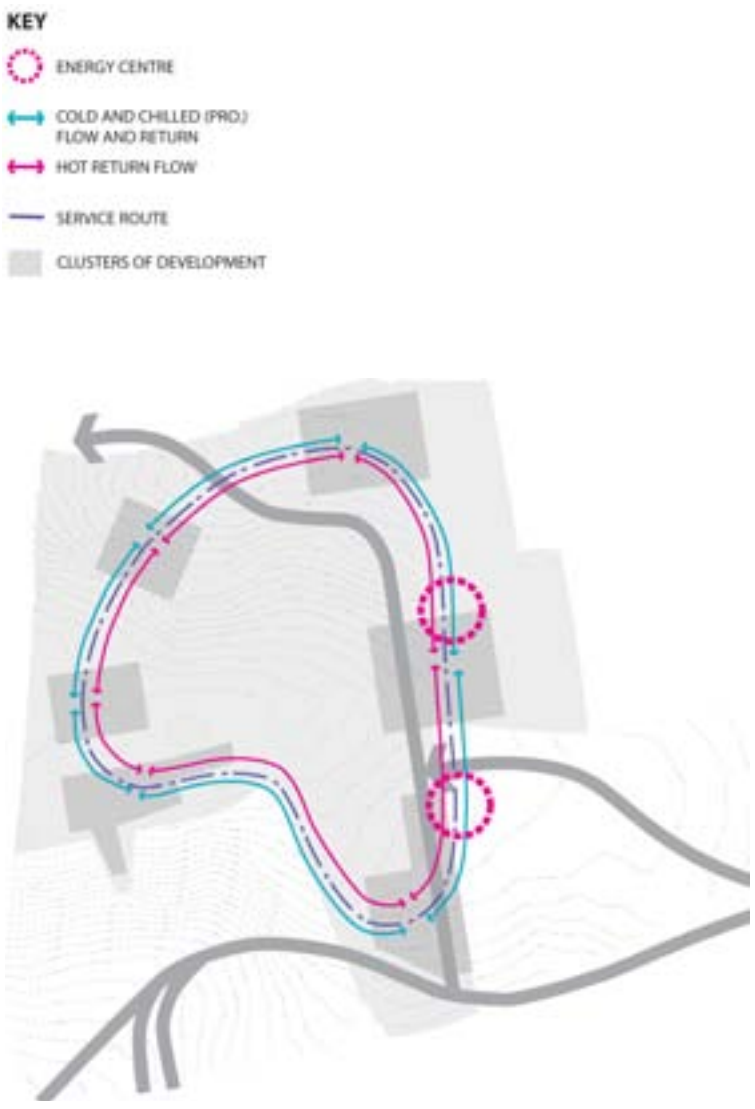
The advantage to this layout is the ability to accommodate both servicing, as there will be energy provision from both directions, and phasing. The phasing of the clusters with the infrastructure installation is relatively simple, where the initial investment can be extended and adapted across the site to meet the changing needs of the UESP and the available technologies and techniques. The buildings and their loads (i.e. heat, electricity, and water) can be more easily shared and grouped.

At the building scale utilisation of efficient building facades, solar shading and thermal mass is likely to be complemented with low-energy service systems such as; displacement ventilation, thermo-deck, thermal wheels, adiabatic cooling, chilled beams, and building integrated renewable technologies (i.e. PVs and GSHPs).

Those technologies that complement a site energy centre are CHP plant (biomass or gas lead), linked PV arrays, wind turbines, and ground coupled thermal storage systems. A CHP plant, using biomass can achieve high carbon savings, but is mainly a heat lead application and becomes feasible over 500kWe. Ground coupled thermal storage systems, such as; aquifer and borehole thermal energy storage (ATES/BTES) or inter-seasonal ground thermal storage systems, can provide an excellent source of very low carbon heating and cooling. Water is circulated through the buildings, absorbing and storing the heat during summer months and coolth during the winter months. This stored energy is then utilised during the following season enabling annual balancing of loads and significantly reducing primary energy requirements.

These systems tend to be of high commercial viability when considered on a larger site wide scale. The need to provide low-carbon cooling is of prime importance to the Park; further investigation into these techniques is imperative to achieve low carbon use.

The size of the development provides the opportunities to apply an Energy Services Companies (ESCOs) utility procurement arrangement to future proof the maintenance and low carbon management of the energy service installation. ESCOs are companies that, rather than just supplying electricity and/or gas to their customers, provide an energy services package which includes the supply of energy, maintenance, a guaranteed availability of services, and the implementation of energy efficiency measures whilst potentially offering a capital investment to the development. This can be either a privately operated company or a joint partnership between the University of Exeter Science Park Board and an energy supplier.



[Figure 135] Energy Infrastructure

10.6 Water

The EA has outlined that the southwest of England is in a moderate level of water stress, with Exeter subject to a serious level of water stress. Therefore, the ability to reduce water consumption and increase the ability to alternative sustainable water sources (i.e. borehole and rainwater) is of great importance to the design of the development.
At a building level, the use of low flow fittings and water appliances is important to achieving water reduction. The building clusters can be situated such that high water use buildings are located close to those with a low water use, enabling the better balancing and design of rainwater and possibly grey water collection facilities to be maximised.
Autonomous water collection and reuse is the most feasible solution. This can enable much larger total storage volumes of water. The ability to design water retention features for the individual clusters allows for the provision of water for irrigation or WC's to complement the phasing of the development. In addition, as the features are built out, it is possible for them to 'feed' one another, ensuring the balancing of available water. The clusters can utilise the topographical features present on site to provide local level surface water flood retention areas to serve them. This complements the EA's intent to reduce pressure on existing water infrastructure. (Hidden Infrastructure, 2007).

A hydrology and borehole report has been commissioned with the British Geological Society, which provides information on the aquifers near the site. This report provides gives initial indications on the possible use of Aquifer Thermal Energy Storage, a unique system that is being pioneered in the UK.

A note on the conclusions of the BGS study and the studies themselves along with a 1st principles calculation regarding feasibility, is in appendix 3 this document.

The ATES specialist advise is that given the potential aquifer availability and the required heating and cooling load, there is a good possibility of using the ATES system.

Phase 1, at 18,800m2, would likely need 3 boreholes, which could provide all the necessary cooling. Phase 2, at 50,000m2, would required approximately another 7 boreholes. The boreholes tend to be spaced 50m apart and given the size of the development there is likely sufficient space to accommodate the system.

This system is an excellent method of delivering very low carbon cooling potential and could help the UESP meet their aspirations of a zero carbon development and should be further investigated.

[Figure 136] Sustainable water strategy

CHAPTER 11 DESIGN CODES

The delivery of a complex scheme such as the Science Park requires a consistent approach to design and development control over an extended period. However the masterplan also needs to be capable of adapting to changes in social, economic and environmental conditions so cannot be too rigid.

The most effective way to deliver and manage change on a large site over an extended period is by ensuring development is guided by a flexible development framework as described in Chapter 10. Within this framework many different development scenarios are possible. However in addition to this framework there is also a need for more focussed design 'rules', or design codes, to describe how built form and spaces should be created in relation to the main elements of the framework. It is therefore proposed that a set of design codes are prepared to support the outline planning application for the Science Park and provide a basis for future design and development control decisions.

CABE (2005) sets out the following working definition of the design code:

A design code is a set of specific rules or requirements to guide the physical development of a site or place. The aim of design coding is to provide clarity as to what constitutes acceptable design quality and thereby a level of certainty for developers and the local community alike that can help to accelerate the delivery of good quality new development. The design code builds on the aspirations of the masterplan/ development framework and provides a vision, a rationale and a set of requirements (the codes themselves) as to how to achieve the aspirations. These can extend from urban design principles aimed at delivering better quality places and include requirements for streets, blocks, massing and so on, or may be focused more on architectural or building performance, for example aiming to increase energy efficiency.

The level of detail defined and required by a code will vary depending upon the circumstances of development. In order to provide certainty of outcome, it should carry some weight in terms of its role in the planning process or through developer agreements. Future improvements will always be beneficial and therefore aspects of the code might be subject to review over time.

The ultimate aim of design coding is to speed up the determination of planning applications and delivery on the ground and achieve higher standards of design.

This chapter sets out a recommended approach to design coding for the UESP project and describes the main aspects of the development for which codes should be prepared. Appendix 2 identifies and describes the key issues that should be coded for each part of the development. It should be noted that Appendix 2 does not comprise the actual design codes. These will be developed as the outline planning application is prepared with input from a number of stakeholders and the developer of Phase 1. However, it is expected that the final set of design codes will cover the issues identified.

11.1 The approach to design coding

Design codes do not replace the need for the development to be properly designed and undergo the appropriate scrutiny of the planning and building control process. Codes are not a 'design' and the need for a skilled and experienced architect remains. A design code will not make a bad architect into a good architect but provide clarity as to what constitutes acceptable design in order meet broader project aims. The developer will still need to ensure the design meets aesthetic and commercial requirements. Development control planners will still need to ensure that any proposals submitted under the egis of a design code meet the normal standards expected of all development.

Sustainable development principles should not generally be identified by the design code. These are integral to the framework for the site and are not an 'add-on'. The framework provides the context within which a sustainable place can be created. More technical aspects of sustainable development are addressed by other standards the development will need to meet such as the Building Regulations and the Code for Sustainable Homes and the forthcoming equivalent code for commercial buildings. However, where necessary the design code could supplement these standards with additional standards that are considered necessary to deliver the sustainable design dimensions of the vision for the site

The design codes for the UESP should therefore avoid replicating the design, development and building control processes all schemes have to go through as a matter of course. They should complement the framework for the site which sets out the intended physical structure of the development and how it links to its surroundings. The design codes should avoid issues of architectural style on the basis that this will be addressed by detailed design and planning processes. The codes should however set standards as to how architecture should 'perform' in the context of the wider vision. These 'standards' might relate to the general quality of design and the activity and diversity of frontage, rather than style. They should also inform how the spatial requirements of the proposed uses (scale, form and mass) should be accommodated on the site. However these standards do not impinge on the scope of the architect to respond creatively to the site. Indeed this creativity is actively encouraged.

11.2 The Content of the Design Codes

The fundamental aspects of the development that need to be secured in order to deliver the vision for this site are:

- the relationship of buildings to the streets and spaces, i.e. whether they are placed to the back of kerb, are set back from the road etc;
- the performance of visually or physically accessible streets and spaces, in particular how they integrate design, pedestrian, cyclist and vehicular functions;
- the scale, form and mass of building blocks / plots relative to the intended use;
- the activity and diversity of the 'edges' of each of the blocks.

The codes for the Science Park development should therefore comprise:

- General principles: these are the generally accepted principles of good design that apply to all aspects of the site as set out in best practice documents;
- Street codes: these set out a clear performance specification and specific standards for each street in the movement hierarchy set by the framework;
- Block codes: these set a performance specification for the scale, form and mass of each of the blocks within the development;
- Edge codes: these set a performance specification for the level of animation and diversity required of key frontages. This animation and diversity can be achieved through the mix of uses and the way entrances interact with the public realm;

Appendix 2 sets out how these requirements can be set out for each of the constituent parts of the Science Park masterplan.

CHAPTER 12 DELIVERY

Much of the groundwork to deliver the project has been achieved. Site purchase and ownership by Devon County Council was confirmed at the end of April 2008. Initial infrastructure design has commenced with the identification of a preferred highways design for Junction 29 and the link to Blackhorse. Over the coming months the basic components of the development framework will be fixed and taken through an environmental impact assessment (EIA) process to prepare for an Outline Planning Application. During this process there will be consultations with the community, stakeholders and statutory consultees. The development framework and masterplan will be refined to respond to both the EIA and consultation processes. At the same time the detailed design of key pieces of infrastructure and Phase 1 of the development will progress. Soon after, or at the same time as, the outline planning application is made detailed planning applications to implement the first elements of the scheme may be taken forward.

To ensure effective implementation of the vision for the site the framework will have to be prepared to provide rigorous, consistent and flexible guidance that will stand the test of time. All strands of the delivery process will need to be tailored to ensure effective implementation. This section describes these two aspects of delivery.

12.1 Framework

An outline planning application for the site will be prepared to gain consent for the proposed mix, scale and quantum of uses achievable within the development framework. The illustrative masterplan will represent one possible outcome of the application of the framewV

To ensure the masterplan is deliverable, the framework will need to be tested and refined as the EIA and infrastructure design proceeds. The aim should be to submit an OPA in which the main pieces of infrastructure, the bones of the development, are fully understood in design and cost terms.

In the process leading up to the submission of the OPA the framework set out in this document will therefore need to be developed. This will include:

- Refining the highways design of the main elements of the scheme;
- Integration of highways design with the key urban design principles, for example with regard to street cross section, parking, tree planting etc;
- Developing an outline design of the infrastructure so that this can be integrated with highways and urban/landscape design considerations;
- Refining the landscape framework to spell out key species and management regimes to ensure a consistent approach to landscape design as the project is implemented.

Before the OPA is submitted the cost implications of the framework should be assessed against the potential values achievable from development. Refinements will be made to ensure the deliverability and viability of the fundamental components of the scheme.

12.2 The Delivery Processes

Once relevant outline and detailed planning consents are achieved, delivery will involve a number of interlinked processes that will need to be focused on the implementation of the vision.

Establishment of the Delivery Vehicle

The principle of forming the UESP Company has been put forward by Pythia. The UESP Company will be the delivery vehicle responsible for taking forward the masterplan and delivering the UESP. Early establishment of the UESP Company will help to confirm the credibility of the project. This masterplan document provides an important promotional tool for the Company to focus on and promote in preparation for forthcoming outline and detailed planning consents.

One of the key roles of the company will be to establish and maintain momentum and focus on the vision for the UESP. One of the dangers of this type of development project is that progress can initially seem slow and as a result uses not strictly in accordance with the vision are admitted. The UESP Company will need to act as the project champion over a long period and ensure that aims of the project are not compromised for short term commercial gains.

Marketing and Branding

Branding is the key to the scheme's success. The creation of a brand for the overall scheme and sub brands for individual clusters will serve to raise awareness of the scheme and give confidence to developers, investors and occupiers in the delivery of the overall masterplan. This document provides a strong basis for the development of the brand and marketing image.

The creation of the brand should be informed by the vision statement set out in this document. Its ongoing development should involve key stakeholders to further crystallise support locally and regionally. Once established the brand will act as a conduit for interested parties on the national and international stage. The brand should be promoted by a range of material including:

- Brochure (outlining lifestyle attributes of the completed scheme, economic context)
- Website
- Stationary
- A film or animation of the site

The initial step, once the UESP brand has been established, would be to launch it in the local, national and international media. The brand must inspire confidence in developers, investors and occupiers that all aspects of the masterplan will be delivered. It will optimise values in the medium to long term.

The objective of a comprehensive marketing and PR campaign would be to bring the scheme to the

attention of developers; investors; occupiers; agents and media.

Planning and Development Control

An agreed framework will provide the 'bones' of the development; the physical structure within which change will occur. The framework will identify fairly tightly defined areas within which buildings can be located. For each of these areas there will be a set of design codes that will guide the form and architectural design of development. However there will be a significant degree of flexibility on building form, architectural style and size. Each cluster of buildings will be able to accommodate a large range of buildings types and scale.

The cluster approach makes delivery of the project via an ongoing process of development control as simple as it can be. Development control planners will be able to focus on a small number of key criteria to assess the acceptability of proposals. However to ensure that development control decisions fully support the implementation of the plan it will be essential for DC planners to be fully briefed in all aspects of the vision, framework and design codes to ensure consistent interpretation over the implementation period.

Implementation Phasing

The phasing of the development will be key to successful implementation. Because of the likely incremental nature of build-out there will be a fine balance between the cash flow and the provision of infrastructure. Land-take will need to be carefully managed to maintain an economic use for undeveloped land and avoid placing the burden of landscape management for the whole site onto the UESP Company at too early a stage. Phasing will, to an extent, be opportunistic. Initial plans may change if a major science-based inwards investor is identified for example. It is important that phasing proceeds so that more than one 'development proposition' can be taken forward at a time; the development needs to offer a variety of opportunities at any one time. An initial view of phasing is described below.

Infrastructure Phase

The masterplan has been prepared so that access to the site can be achieved without the need for major highways infrastructure. However it seems increasingly likely that the highways infrastructure (J29) will proceed at the same time as, or before Phase 1 is implemented. A key decision to be made at this time relates to the provision of the Tithebarn Lane to Blackhorse public transport link, which also provides the backbone to the scheme. It is not essential for this route to be built in its entirety in the initial infrastructure phase. However there may be capital cost economies to be achieved if this was provided at the same time as the J29 improvements. The benefit of doing this is that it provides a strong message to the market about the UESP Company's commitment to deliver the whole scheme. However it will result in additional expenditure which may impact on cash flow. It would also make management of the remaining agricultural land complex and have traffic management implications.

Landscape

It may be beneficial to implement key elements of the landscape framework as soon as possible. The landscape framework will provide the context for development and is particularly important on the ridge where it provides a back drop to development and ensures visual separation between clusters. The implementation of some aspects of the landscape framework provides an opportunity, at fairly limited cost, to provide an early win that can be seen as contributing to the Green Infrastructure of Exeter and East Devon whilst at the same time providing a longer term structure for development.

Phase 1

Phase 1 has been previously described and consists of the southern slopes of the development. Detailed design considerations for Phase 1 are due to commence. A key requirement for Phase 1 is that it sets the standard for subsequent phases and is prominent from the A30 as a gateway to the site. Phase 1 would be accessed either from the existing access to the south of the site or via the fully implemented highways improvements.

Phase 2

The entire Redhayes areas and northern slopes are currently described as Phase 2. In reality this extensive area is likely to be implemented in a series of stages. A proposed sequence is as follows:

A: Redhayes and western ridge: This is a logical area to follow on from Phase 1. It has a number of benefits. The area is currently under no beneficial use and is not managed economically or in landscape terms. It makes sense to develop this area in preference to more prominent areas to the north that can continue in beneficial agricultural use. The area also offers a range of diverse and potentially high valuable sites. These include an opportunity for a landmark development overlooking the parkland and Junction 29 and the cluster of buildings overlooking the M5. These two sites could accommodate reasonably large and high profile Science Based uses. However in the absence of demand for these, smaller sites within the Redhayes area can be achieved within a high quality, and highly marketable, woodland setting. The area has a strong brand identity that can draw on its history as a country house. This area can also be developed in an incremental way in a series of small steps and the landscape structure will mean that the amenity of the various users will be able to be protected as construction proceeds. Its development as an early Phase 2 stage would also allow the lanes through the site to remain in operation for as long as desirable.

B: Northern Slopes and UESP Centre: The development of any, or all of, the clusters will suit later implementation once demand has been established. Development demand for each cluster should reach a certain critical mass before being released. This may mean providing for one larger development or waiting until demand has been established for a number of smaller users. UESP Centre is unlikely to be viable until the public transport route is full established. This site would lend its self to implementation by a high quality mixed use commercial developer as a single development proposition.

The approach to the provision of building clusters provides an opportunity to separately define a brand and identity for each phase of the development within the overall UESP context. If the development offer for each cluster is sufficiently well differentiated it may be possible for their implementation to proceed concurrently.

12.3 Summary

The masterplan provides a coherent basis for developing the site in an incremental way. It is possible to phase development to optimise cash flow, but equally there may be some benefits in a substantial upfront investment in infrastructure.

APPENDIX 1 REVISED ILLUSTRATIVE MASTERPLAN

The illustrative masterplan shown on the opposite page represents the first satges of design development with further commerial viability testing work. This is a process that will continue through the susequent stages of the design development process, but the fundamental objectives and development principles set out in this report will guide this work.

The main amendments shown on the plan opposite are:

The reposition and alignment of the highway route connecting the new J29 link road and the Phase 2 DCC strategic route running across the site to the north of phase 1. This amendment resolves potential highways issues at both ends of 'the street'.

The critical mass of initial devlopment are located closer to the initial site frontage, with a more visually prominat position from the A30 and M5.

KEY

1. Science Park Centre
2. Phase 1 mixed use neighbourhood
3. Redhayes Ridge
4. Tithebarn Lane cluster
5. Langaton Lane cluster
6. Ridge cluster
7. Parkland
8. Communal Parking
9. Landmark Building
10. Public Space
11. Potential pedestrian/cycle link over M5

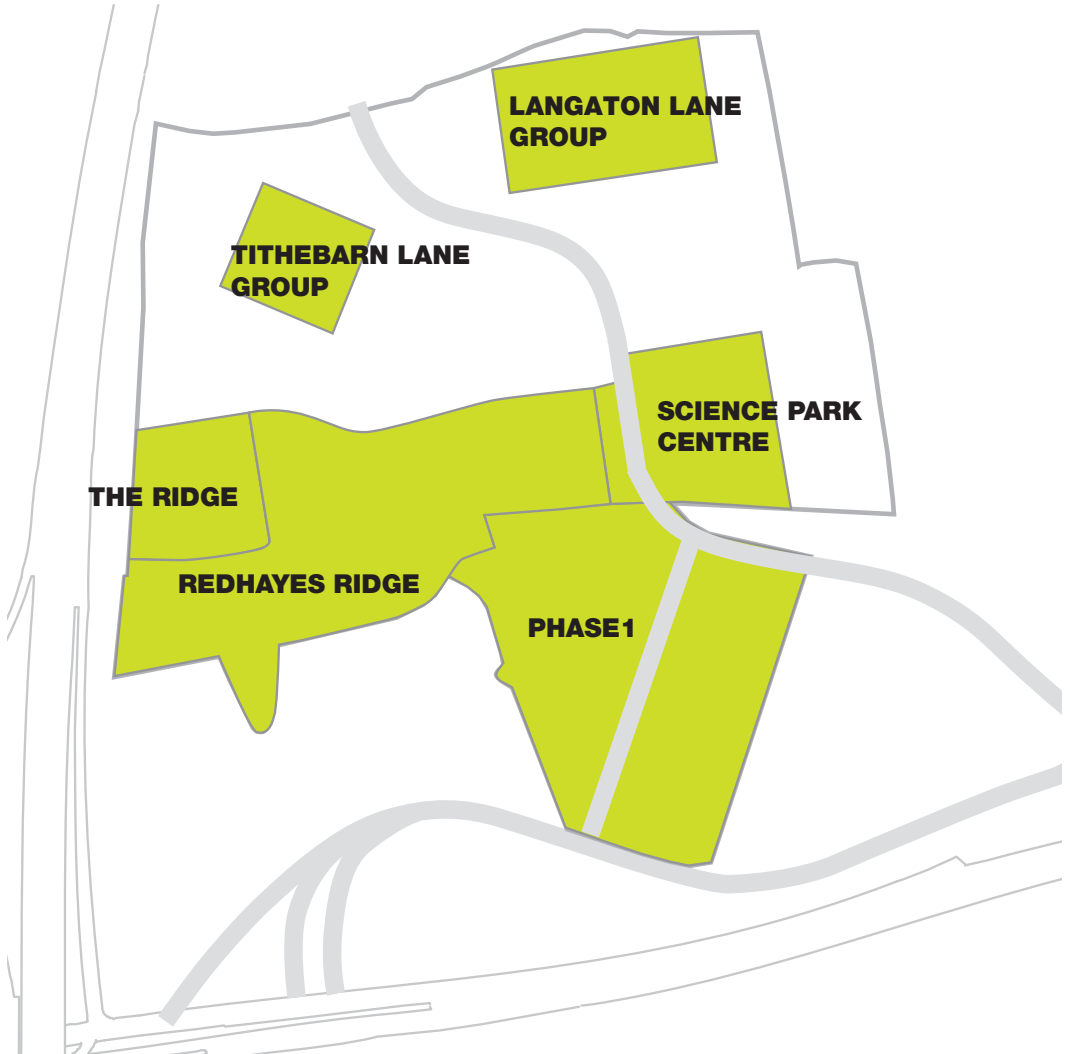
[Figure 137] The revised illustrative masterplan

APPENDIX 2 DESIGN CODE

This appendix provides a model for the development of design codes in support of the outline planning application for the Science Park. It spells out the key parts of the proposed development for which codes will be required to meet the recommendations of Chapter 11.

For Phase 1 a skeleton code has been completed as an example of the structure that the codes for other parts of the site should follow. For all other parts of the proposed development a coding diagram has been developed to give an indication of the streets, blocks, edges and spaces for which codes will be expected. The principles that the code for each of these areas will be expected to address are set out in a number of bullet points.

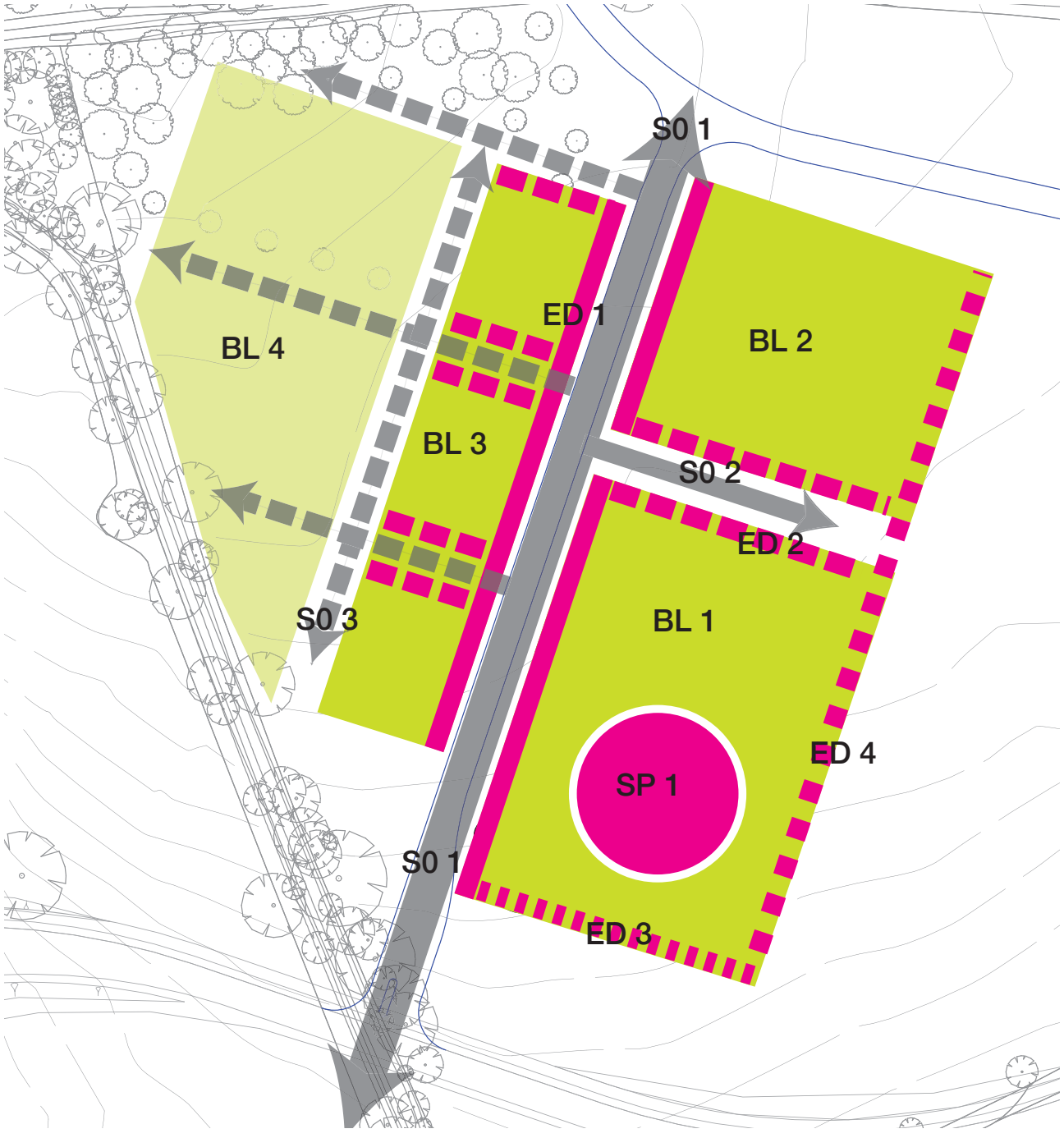
The final design codes will be developed through consultation with stakeholders, local communities and potential developers. They will be rigorously tested in both design and commercial terms. However, the fundamental principles set out in this appendix are likely to remain valid.



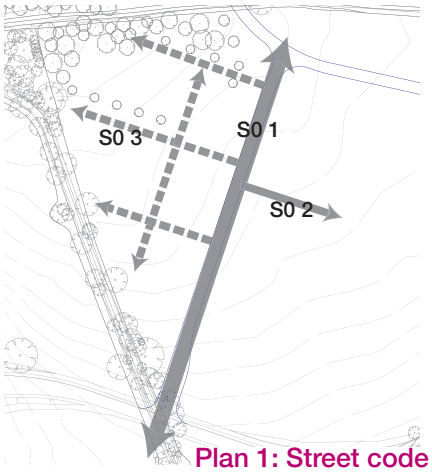
[Figure 138] (Left) Location plan of the cluster developments
[Figure 139] (Right) Site wide design code plan

PHASE 1: EXAMPLE MODEL CODE

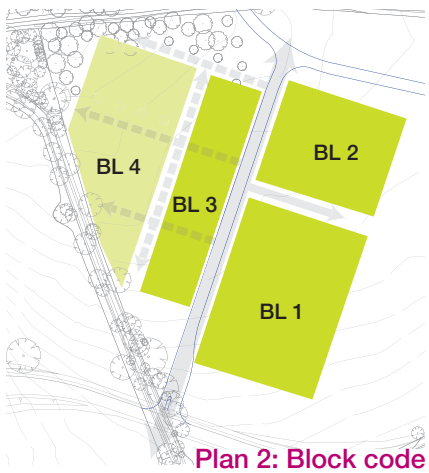
This model highlights the issues to be addressed by the Science Park design code and the structure by which the 'rules' can be articulated. The area of Phase 1 is broadly categorised into streets, blocks, edges and spaces. For each of these categories the key performance criteria and the more specific design criteria are set out in simple and accessible tables. For the final codes these tables would be supplemented by typical plans, sections, materials swatches and block massing/ articulation diagrams. For example, each street code would be accompanied by an illustrative section and plan.



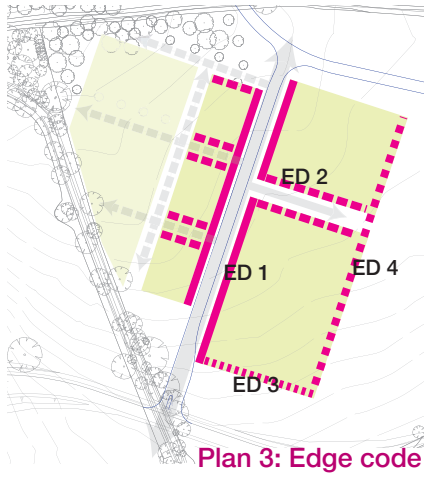
[Figure 140] (Left) Phase 1 location plan
[Figure 141] (Right) Phase 1 coding plan



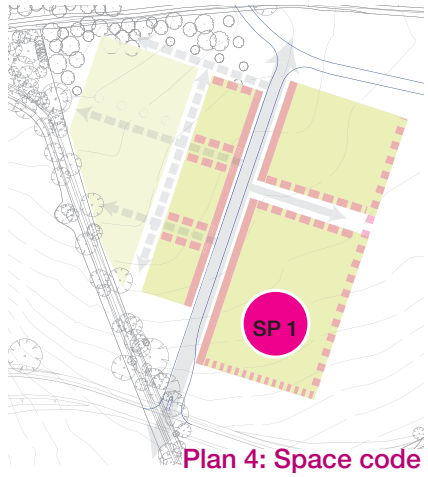
Plan 1: Street code



Plan 2: Block code



Plan 3: Edge code



Plan 4: Space code

Design objectives for streets

	SO 1	SO 2	SO3
Vision	The 'High Street' to Phase 1. An attractive high quality busy street animated by active uses to frontages with pedestrian, cycle and vehicular movements.	A 'side street' accommodating vehicular and pedestrian movement. A quieter street with less activity.	A future 'side street' accommodating primarily pedestrian movement and secondarily vehicular movement. A quieter street with less activity.
Scale			
Typical street width:	Scale to be specified to highlight the importance of the street as the main 'urban' spine	Determined by functional/access requirements	Determined by functional/access requirements
Typical building height:	Building height to be sufficient to create good sense of enclosure.	A variety of building heights acceptable	A variety of building heights acceptable
User Groups	Pedestrian, cyclist, cars, public transport, service vehicles, HGV	Pedestrian, cars, service vehicles	Pedestrian, cars, service vehicles
Street Dimensions			
Carriageway:	Minimum width to meet functional requirements of strategic movement function	Minimum width to meet functional requirements	Minimum width to meet functional requirements
Footway:	Sufficient to create spacious and high quality pedestrian environment. Consideration of suitability for tree planting.	To meet normal pedestrian footway standards	To meet normal pedestrian footway standards
Cycleway:	To meet functional requirements	N/A	N/A
Design Criteria			
Design speed:	Design speed of highway to be specified	Design speed of highway to be specified	Design speed of highway to be specified
Speed Limit:	Speed limit to be specified	Speed limit to be specified	Speed limit to be specified
Vehicle types:	Types of vehicles the street design is to cater for to be specified	Types of vehicles the street design is to cater for to be specified	Types of vehicles the street design is to cater for to be specified
Direction of traffic:	Direction of traffic to be specified	Direction of traffic to be specified	Direction of traffic to be specified
On-street parking:	Agreed approach to provision of managed on street parking	N/A	N/A
Bus access, bus lanes & bus stops:		N/A	N/A

[Figure 142-145] Phase 1 design code plans1-4

Design objectives for blocks

	BL 1	BL 2	BL 3	BL 4
Number of storeys	Range of heights necessary to create visual impact and gateway to site to be specified	Height to create adequate enclosure to street but avoid creating strong visual impact on skyline	Range of heights necessary to create visual impact and gateway to site to be specified	Height to create adequate enclosure to street but avoid creating strong visual impact on skyline and tree canopy.
Suggested use	Preferred location for hotel, conference facilities and initial science park uses. Other complementary uses to be considered	Science park uses	Science park uses	Science park uses
Number of subdivisions	Scale to be specified to highlight the importance of the street as the main 'urban' spine	Determined by functional/access requirements	2	2
Notes	Building height to be sufficient to create good sense of enclosure.	A variety of building heights acceptable	Building height to be sufficient to create good sense of enclosure	A future extension to enlarge BL 3, but should be lower in height to create a smooth schange to the tree canopies

Design objectives for edges

	ED 1	ED 2	ED 3	ED 4
Vision	The 'High Street' to Phase 1. An attractive high quality busy street animated by active uses to frontages, pedestrian/cycle and vehicular movements	A 'side street' accommodating vehicular and pedestrian movement. A quieter street with less activity.	An edge which is visible from the motorway and is also entrance to the site, so it should be prominent and adressable	An edge which is visible from the motorway and creates a strong edge to the Science Park overlooking adjacent farmland.
Architectural drivers	Desire to create active street with mix of uses and entrances at ground floor level.	Good enclosure and overlooking to street	Frontage to be appropriate to building function and creates interest and views	Frontage to be appropriate to building function and creates interest and views
Design Criteria				
Plot width:	Plot width to create rhythm and interest on main street -typical plot width to be specified	Plot width to be appropriate to building function	Plot width to be appropriate to building function	Plot width to be appropriate to building function
Building line:	Building line to create consistent frontage and good enclosure to street	Building line to create consistent frontage	Setback of buildings from highways to respect sight lines. Building line to create consistent frontage	Building line to create consistent frontage
Articulation	Buildings to be articulated to create and interest and diversity to street.	Buildings to be articulated to create and interest	Buildings to be articulated to create and interest	Buildings to be articulated to create and interest
Materials:	Typical materials to be specified.	Typical materials to be specified.	Typical materials to be specified.	Typical materials to be specified.

Design objectives for spaces

	SP 1
Vision	Creation of public space to act as a focal point to the development
Dimensions	Scale to be specified regards to building height, to highlight the importance of the space as a focal point to the development.
Materials	Typical materials to be specified to work with surounded building

THE REDHAYES RIDGE

Streets (S01 etc)

- No major all-mode streets to be provide in this area ;
- Blackhorse lane to be retained as pedestrian and cyclist route;
- Shared space provided for service and access to development plots.

Blocks (BL1 etc)

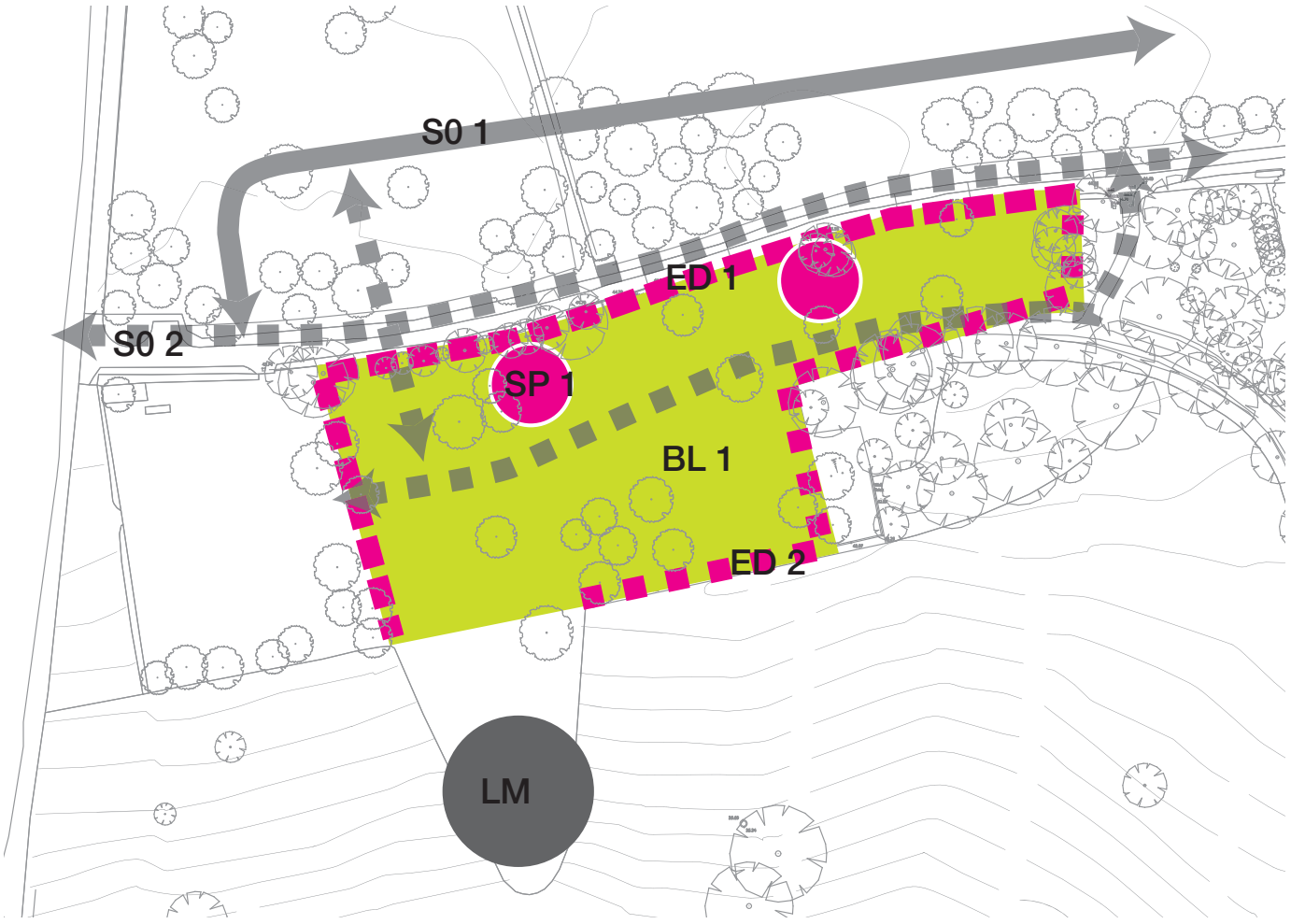
- Trees to take precedence over development – building blocks to be created amongst the strong tree and vegetation structure;
- Scale and mass of buildings minimised to avoid impact on wooded skyline of Redhayes Ridge and particular silhouette as seen from the M5 and the north;
- Opportunity for major landmark building overlooking Junction 29 and Redhayes Parkland.

Edges (ED 1 etc)

- Southern edge to be predominantly soft with buildings subservient to landscape to protect Redhayes Parkland context;
- Buildings on northern edge to overlook Blackhorse lane but be designed to sit sensitively within the wooded ridge top and avoid visual impact or prominence in views from the north;
- Small spaces within the area to be enclosed with active uses which may include a café, restaurant or Science Park 'community' uses.
- Appropriate materials and articulation of facades to be agreed.

SP1

- Small intimate spaces to be created between buildings within the Ridge area. Trees should be retained within these spaces.



[Figure 146] The Redhayes Ridge coding plan

THE SCIENCE PARK CENTRE

Streets

- Main all-mode street and public transport spine to be integrated to create focal high quality street to cluster;
- Vehicular and pedestrian street created within block to provide access to amenities within cluster and parking area;
- Incorporation of Langaton Lane as pedestrian and cyclist spine.

Blocks

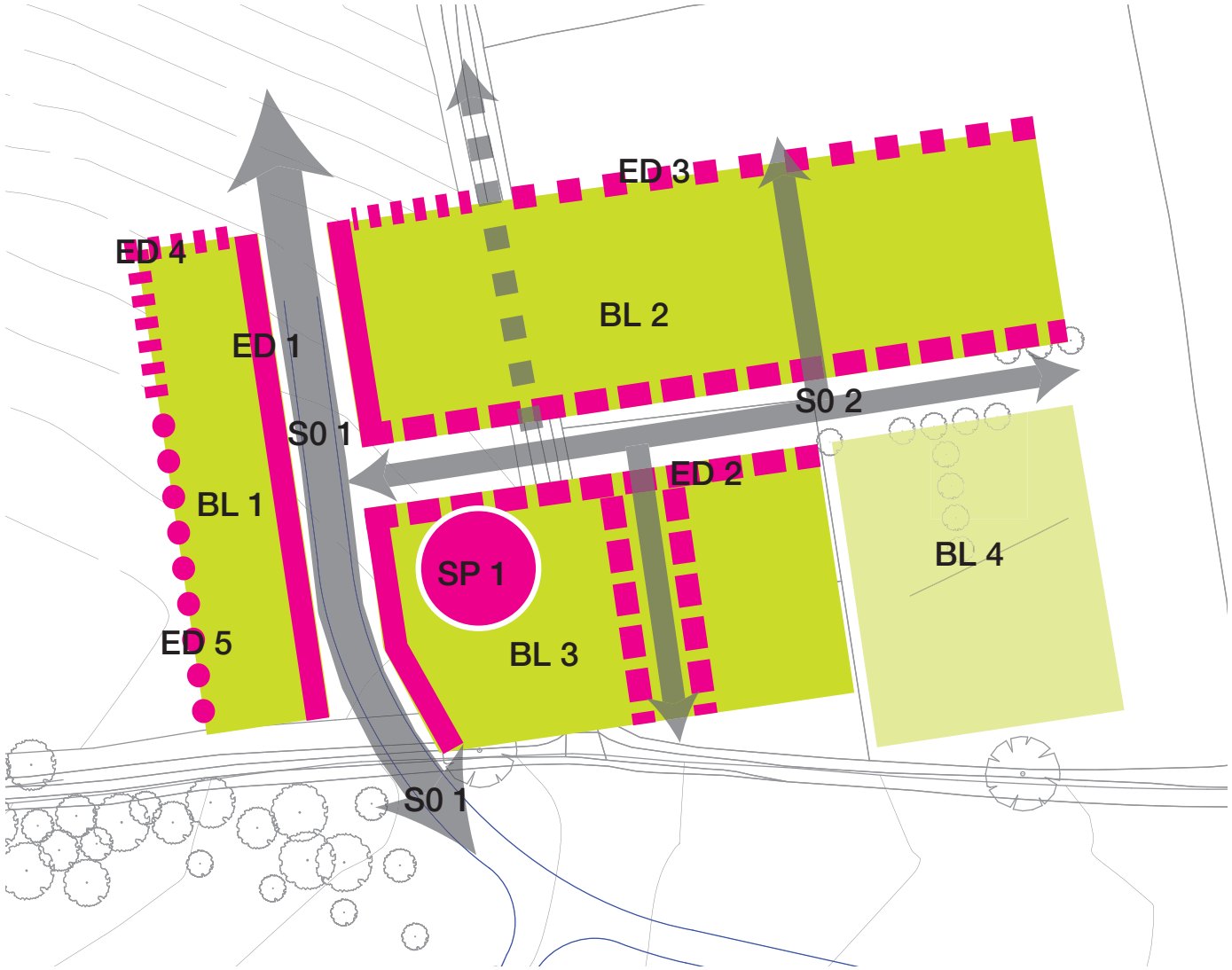
- Diversity of block size and height within limited range;
- Block scale and massing to provide positive mass and composition at the end of the Redhayes Ridge;
- Blocks to be capable of being developmed within the Sunnymead site;
- Diversity of uses encouraged in addition to Science Park uses. Appropriate levels of leisure, retail, food and drink and community facilities considered acceptable;
- Overall development plot ratio to be agreed.

Edges

- Eastern edge to respond to views to and from Clyst Valley and towards East Devon;
- Northern and western edges to be designed to create attractive form and composition when viewed from the M5 and the north;
- Active edges and overlooking to streets and spaces;
- Strong overlooking to Langaton Lane;
- Appropriate materials and articulation of facades to be agreed.

Spaces

- Key Science Park community space at the heart of the cluster;
- Space to be designed to create ‘civic’ focus to the development with high quality design and materials;
- Microclimatic issues to be fully considered to ensure exposed ridge top location to comfortable for pedestrians.



[Figure 147] The Science Park Centre coding plan

The Ridge

Streets

- Vehicular, cyclist and pedestrian street creates link through cluster to parking on Redhayes Ridge;
- Pedestrian and cyclist linkages created to Redhayes Ridge and north to the Tithebarn Lane cluster.
- Low buildings mean that streets and linkages need to be designed to be fairly 'tight' to provide enclosure and shelter.

Blocks

- Low horizontal blocks placed to avoid breaking treeline when viewed from north and north-west;
- Opportunity for subtle part of block to signify cluster to users of M5.

Edges

- Northern and western edge designed to create focus to views from M5;
- Northern edge designed to optimise stunning views;
- Eastern edge creates enclosure to ridge line open space.
- Animation and activity to street and shared space in the heart of the block.

Spaces

- Shared space at heart of block as focus to the Ridge cluster;
- Opportunities for private spaces elsewhere within block.

[Figure 148] The Ridge coding plan

THE TITHEBARN LANE GROUP

Streets

- No major all-mode streets within the block;
- Block dissected by pedestrian and cycle links and appropriate access for servicing and emergency vehicles;
- High quality pedestrian linkages to the heart of the cluster;
- Vehicular linkage to the eastern edge of block providing access to car park;
- Streets to be well enclosed and overlooked.

Blocks

- A range of building heights acceptable within an agreed range to create diversity and interest;
- Blocks subdivided by key pedestrian routes to the ridge, Science Park Centre and the Langaton Lane Cluster.
- Overall plot ratio within cluster to be agreed.

Edges

- Strong well articulated visually interesting edge to north-west and north-east to make most of views in this direction and create positive focus to views from the M5 and north;
- High quality edges to the south east and south west but with less of a requirement to create iconic image to M5;
- Appropriate materials and articulation of facades to be agreed.
- Activity and human scale edges created to internal spaces of block.

Spaces

- Well defined space as ‘heart’ of cluster on pedestrian linkages to adjacent clusters.

[Figure 149] The Tithebarn Lane Group coding plan

The Langaton Lane Group

Streets

- No major all-mode streets within block;
- Langaton lane ultimately incorporated within the block as a pedestrian/cyclist link to the Science Park centre;
- High quality pedestrian linkage of an appropriate scale through the Tithebarn Lane cluster.

Blocks

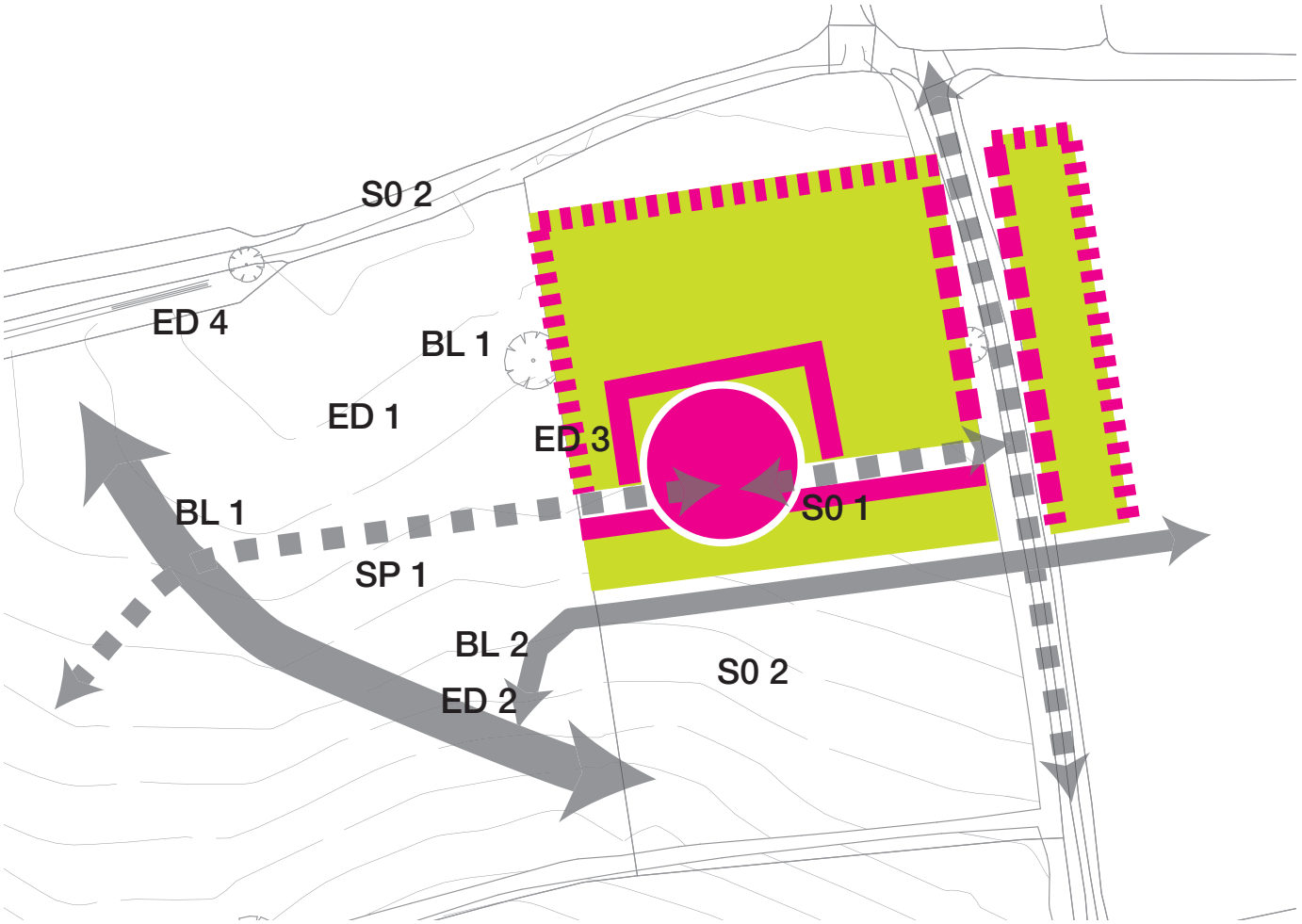
- Variety of building scale and mass within agreed range to create variety and articulation;
- Overall plot ratio to be agreed;
- Sub division of blocks created by main pedestrian connections through the cluster.

Edges

- Well defined high quality edges to the north and west to create positive façade to address M5 and other viewpoints;
- Overlooking and some active edges onto Langaton Lane;
- Appropriate materials and articulation of facades to be agreed.
- Active and more intimate edges onto pedestrian access and space throughout the cluster.

Spaces

- Focal well enclosed space connected to Langaton Lane and connection to the Tithebarn Lane Cluster.



[Figure 150] The Langaton Lane Group coding plan

GeoReports
British Geological Survey

Water Borehole Prognosis

This report is designed for users investigating sites for the abstraction of groundwater supplies.
It contains an evaluation of the expected geological sequence and aquifers beneath the site, potential groundwater yields, water levels and groundwater quality. The report is based on analysis by BGS hydrogeologists of records and maps held in the National Well Records Archive (part of the National Geoscience Data Centre NGDC). For some sites, the latest available records are quite old, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the geology at a site may differ from that described
The report contains geological map extracts taken from the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50). The various geological layers – artificial (man-made), landslip, superficial and solid (bedrock) geology - are displayed separately as 10 by 10cm extracts. The report also
contains an index listing of borehole and water well records held in the NGDC for the area around the site.

Client's Reference: Georeport order of 24.04.08
Location details (see section 1 for map): Exeter
Point centred at: 297220,093638
Required Yield: Not specifed
Proposed Use: Potable water supply
Aquifer thermal energy storage system

Section 2: Water borehole prognosis report

SETTING
The site is near the top of a small hill at an elevation

Section 1: Location map

The grid reference for the site as shown on left

Scale: 1:25000 (1cm = 250m) ● site location

of about 40 to 45 m above Ordnance Datum (AOD) on the outskirts of Exeter, north-east of junction 29 of the M5 motorway. The land slopes to the north towards the Pin Brook which is about 450 m north of the site at an elevation of about 20 m AOD. To the south and east the land slopes towards the River Clyst which is approximately 1.1 km southeast of the site at an elevation of about 8 m AOD. The River Clyst flows south to join the Exe Estuary about 6 km from the site. The sea is approximately 14 km south of the site.

GEOLOGY
There are no artificial, landslip or superficial deposits mapped at the site. The anticipated geological succession beneath the site is as follows:

Bedrock:

Dawlish Sandstone Formation
about 20 to 30 m thick
Sand and sandstone, weakly cemented, with some persistent clay horizons

Monkerton Formation
probably 25 to 40 m thick
Clayey, fine-grained sandstone, often weakly cemented with mudstones and siltstones and minor amounts of clean sand and sandstone

Whipton Formation
about 10 to 15 m thick
Weakly cemented, silty fine-grained sandstone with siltstone, mudstone and breccia

Crackington Formation
several hundred m thick
Shales with thin sandstones

The Dawlish Sandstone Formation mainly comprises sands and sandstones. However, there
is a clay band, a few metres thick, outcropping just north of the centre of the site which is likely to be present within about 5 m of the ground surface.

There are faults within 500 m of the site to the south, northeast and northwest (see Bedrock map in Section 3). It is important to understand the nature

of geological faults, and the uncertainties regarding their precise position at the surface. Faults are planes of movement about which adjacent blocks of rock strata have moved relative to each other. They commonly consist of zones, perhaps up to several tens of metres or greater in width, containing several fractures. The portrayal of such faults as a single line on the geological map is therefore a generalisation.

The strata dip south or southeast at about 5 to 8°.

GROUNDWATER POTENTIAL

The required yield was not specified. Water is required for a potable supply and for an aquifer thermal energy storage system for a proposed commercial development of 160,000 m2.

The site is located on the Dawlish Sandstone Formation of Permian age. The Dawlish Sandstone Formation comprises mainly sands and sandstones and is a productive aquifer in the district. However, the clay horizons can act as confining layers within the aquifer. The following information is mainly based on information provided in Allen et al, 1997, The physical properties of the major aquifers of England and Wales, BGS report WD/97/34. The core porosity of the Permian sandstones in southwest England ranges from 6.5 to 32.5% with an arithmetic mean of 22.8%. Storage coefficients generally indicate semi-confined conditions, although the response can become unconfined in long duration tests. Both intergranular and fracture flow are important; a comparison of field and laboratory data indicates that about 40% of the transmissivity of the Dawlish Sandstone can be attributed to intergranular permeability. Core hydraulic conductivity values for all Permian sandstones in south-west England vary by over 5 orders of magnitude with a median value of 0.4 m/d, with horizontal values several times greater than vertical ones. The permeability declines with decreasing particle size. Empirical estimates of intergranular hydraulic conductivity of the Dawlish Sandstone Formation from particle size distribution vary from 0.3 m/d for medium- to coarse-grained sandstone to 0.01 m/d for fine- to medium-grained sandstone, but these provide lower transmissivity estimates than those based on the lithology penetrated in a borehole. These predict 100 to 300 m2/d from less well cemented sandstone where both intergranular and fracture flow are of importance and correspond well with the values generally obtained in the eastern Crediton trough and Clyst valley.

The nearest transmissivity value to the proposed borehole site for the Dawlish Sandstone Formation is 100 m2/d for a 46 m deep borehole (of which 31 m was saturated) at the St Bridget Garden Centre, Clyst St Mary (SX 9793 9088). This was pumped at 1.7 l/s during a 24 hour test and produced 6.2 m of drawdown. Other local values are 28 m2/d for both a 61 m deep borehole at the Winter Gardens, Broadclyst (SX 988 971) that was pumped at 6.8 l/s for 7.7 m of drawdown and a 136 m deep borehole at Exeter Airport (SY 002 930), commencing in the overlying low permeability Aylesbeare Mudstone Group, that was pumped at 16.2 l/s for 29.5 m of drawdown. No storage coefficients are available for any of these tests due to a lack of observation wells.

There are few other water boreholes in the vicinity of the site that abstract from the Dawlish Sandstone Formation. A borehole at Clystlands (SX 9694 8834) was at an elevation of about 16 m AOD and penetrated 82 m of the Dawlish Sandstone Formation. The rest water level was 4.6 m below the surface and a 24 hour pumping test in 1945 at 5.2 l/s caused 0.9 m of drawdown.

There are two high yielding public supply sources around Stoke Canon in the eastern part of the Crediton trough that both obtain in excess of 40 l/s from the Dawlish Sandstone Formation. The Fortescue Farm borehole (SX 9287 9938) is at an elevation of about 35 m AOD and penetrated 92 m of the Dawlish Formation with a rest water level 15 m below the surface in 1996. In 1967 the borehole was pumped for 14 days at 40 l/s which resulted in 22 m of drawdown. The Burrow Farm borehole (SX 9408 9958) is at an elevation of about 26 m AOD and penetrated 5.8 m of superficial deposits over 89.6 m of Dawlish Sandstone Formation and 27 m of Permian breccias. Water was obtained from both aquifers. In 1960, the rest water level was 3 m below the surface and during a 14 day pumping test it was pumped at 44 l/s inducing a drawdown of 45 m, however the recommended maximum yield was 38 l/s.

At the proposed site, the water level in the Dawlish Sandstone Formation is likely to lie at about 15 to 20 m below ground level and may vary seasonally by up to 5 m, therefore there will probably only be 5 to 10 m of saturated strata present. This means that yields and transmissivity values will both be low. The faults in the area may also have an effect on yields by acting as barriers to flow.

Groundwater quality in the Dawlish Sandstone Formation is generally good with a total hardness of less than 200 mg/l (as CaCO3). Nitrate ion concentrations may be elevated due to agricultural practices in the catchment area. In 1948 water from the Clystlands borehole that lies close to the tidal River Clyst, had a total hardness of 179 mg/l (as CaCO3), of which 121 mg/l was permanent. It had a total dissolved solids concentration of 334 mg/l, a chloride ion concentration of 43 mg/l, a sulphate ion concentration of 58.5 mg/l and a nitrate concentration of 59 mg/l (as NO3). The Exeter Airport borehole had a total dissolved solids content of 252 mg/l and a total hardness of 140 mg/l (as CaCO3), of which 80 mg/l was permanent, in 1943.

There is little hydrogeological information about the Monkerton and Whipton Formations because they are only occur in a small area. It is likely that groundwater will be stored and transmitted in the sandstones but that these aquifers may be less transmissive and productive than the Dawlish Sandstone Formation because there are more low permeability siltstone and mudstone layers. A 46 m deep borehole sited on the Whipton Formation but probably entering the Crackington Formation (SX 9244 9294) at an elevation of about 42 m AOD had a rest water level 15.8 m below the surface and was pumped at 2.5 l/s for 12 hours per day. The drawdown is not reported.

The Whipton Formation unconformably overlies the Crackington Formation of Carboniferous age. The Crackington Formation comprises shales with thin sandstone layers and is not a major aquifer. Groundwater storage and flow is largely restricted to fractures in the sandstones. Borehole yields generally vary from 0.3 to 0.7 l/s for drawdowns in excess of 12 m. A borehole at an elevation of about 102 m AOD at Cheyne Gate (SX 9523 9506) penetrated about 46 m of Crackington Formation and had a rest water level 30.5 m below the surface. In a 2 hour test, pumping at 0.4 l/s induced 13 m of drawdown. Groundwater from

the Crackington Formation is usually moderately soft and usually has a chloride ion concentration of less than 30 mg/l.

In conclusion, due to the small potential saturated thickness it is unlikely that a yield in excess of 5 l/s could be obtained from a borehole drilled to the base of the Dawlish Sandstone Formation beneath the proposed site. However, even a yield of 5 l/s cannot be guaranteed, and the yield may be only a few l/s. The yield might be increased by drilling deeper into the Monkerton and Whipton Formations, however these are likely to be less permeable than the Dawlish Sandstone Formation so it is unlikely that this would more than double the yield. It is unlikely that any substantial contribution could be obtained from the Crackington Formation which would be at considerable depth beneath the proposed site. It is possible that yields might be slightly improved by drilling to the south of the site centre-point where a greater thickness of the Dawlish Sandstone Formation would be present.

It is probable that poorly consolidated sands will be present within the Permian sandstone sequence, in which case a carefully designed and installed filter pack will be required to prevent the borehole from silting up and damaging the pump.

Any borehole should be located upgradient of, and away from, any potential sources of pollution e.g. septic tanks, sewers, fuel stores etc. As a potable supply is envisaged, the water quality should be analysed: the local Environmental Health Officer can advise on this aspect. An adequate and well-maintained disinfection treatment plant would be considered a prerequisite for any potable domestic supply.

If several boreholes were constructed to obtain a larger yield for an aquifer thermal energy storage system, it is possible that interference effects (between the zones of drawdown) could be significant as high rates of abstraction accompanied by large amounts of water level drawdown in the borehole, will be likely to induce drawdown of the water table over a broad zone. This interference will increase the total amount of drawdown in the boreholes and may consequently restrict the yield that can be obtained from each borehole. Interference effects can be minimised by the careful siting of additional boreholes but this requires a detailed knowledge of the aquifer properties beneath the site. Such information can only be obtained from data collected during a carefully conducted aquifer test that includes the monitoring of water levels in observation boreholes. There could also be thermal interference effects between the boreholes.

If it is planned to re-inject water into the aquifer, the injection borehole(s) should be sited as far away as possible from the abstraction one(s), again to minimise interference effects. It is possible that the injection borehole would not accept water at the same rate that it was abstracted at, due to air entrapment and borehole clogging by particulate matter or growth of biofilms. We would recommend that the borehole headworks be installed above ground level to ensure adequate ventilation. Altering the temperature of the water, may alter the solubility
of different minerals and hence the water chemistry.

The hydraulic gradient induced by abstraction (drawdown) and reinjection (hydraulic mound) from two relatively closely spaced boreholes is likely to greatly exceed the natural hydraulic gradient. However, not all the heat added to the water will be dissipated via natural or induced groundwater flow and thermal conduction. A large proportion of the heat will be absorbed and stored in the rocks themselves, and may provide a useable source of heat.

We hold no information on groundwater pollution sites in the National Well Record Archive. The Environment Agency, Southwest Region holds such information and also data on current abstractions in the vicinity of the proposed site.

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty, which includes the standard NERC terms of contract.

While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, Southwest Region. If a borehole is drilled, you should be aware that there is a statutory requirement for the driller (Water Resources Act,1991) to supply full information to the Wallingford office of the BGS for inclusion into the National Well Record Archive. A form for listing the required information is enclosed.

Section 3: Geological maps

Extracts of geology maps around your site are provided in this section, taken from the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50). The first four maps show separately the four main layers of geology that may be present in an area – **artificial (man-made) deposits, landslip deposits, superficial deposits and bedrock.** The fifth 'combined geology' map shows all four rock layers superimposed on the same map, to show the rocks that occur at the surface just beneath the soil.

More information on DigMapGB-50 and how the various rock layers are classified can be found on the BGS website (www.bgs.ac.uk), under the DiGMap and BGS Rock Classification Scheme areas. Further descriptions of the rocks listed in the map keys can also be obtained by searching against the Computer Code on the BGS Lexicon of named Rock Units, which is also on the BGS Website at by following the 'GeoData' link. The computer codes are labelled on the maps to try and help in their interpretation (with a dot at the bottom left hand corner of each label). However, please treat this with caution in areas of complex geology, where some of the labels may overlap several geological formations. If in doubt, please contact BGS enquiries.

The geological formations are listed broadly in order of age in the map keys (youngest first) but only to the formation level (a formation is a package of related rocks). Within formations, please be aware that individual members may not be ordered by age.

Artificial deposits
These include deposits moved and disturbed by man.

● site location Scale: 1:25000 (1cm = 250m)

Key to Artificial deposits:

Map colour	Computer Code	Rock name	Rock type
	MGR	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT

Landslip deposits
These include natural deposits formed by sliding and mass-movement of soils and rocks on hill slopes (an alternative term for Landslip deposits is ‘Mass Movement Deposits’)

● site location Scale: 1:25000 (1cm = 250m)

Key to Landslip deposits:
No deposits are mapped in the search area

Superficial deposits

These include fairly recent geological deposits, such as river sands and gravels, or glacial deposits, which lie on the bedrock in many areas (an alternative term for Superficial deposits is ‘Drift Deposits’)

● site location Scale: 1:25000 (1cm = 250m)

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ALV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	HEAD	HEAD	SAND WITH CLAY AND GRAVEL
	RTD1	RIVER TERRACE DEPOSITS, 1	SAND AND GRAVEL
	RTD2	RIVER TERRACE DEPOSITS, 2	SAND AND GRAVEL
	RTD3	RIVER TERRACE DEPOSITS, 3	SAND AND GRAVEL
	RTD4	RIVER TERRACE DEPOSITS, 4	SAND AND GRAVEL
	RTD5	RIVER TERRACE DEPOSITS, 5	SAND AND GRAVEL

Bedrock

Bedrock forms the ground underlying the whole of an area, upon which the other geological layers listed above may lie (an alternative term for Bedrock is ‘Solid Geology’)

Fault
Coal, ironstone or other mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

● site location Scale: 1:25000 (1cm = 250m)

Key to Beddrock deposits:

Map colour	Computer Code	Rock name	Rock type
	DAS	DAWLISH SANDSTONE FORMATION	MUDSTONE
	DAS	DAWLISH SANDSTONE FORMATION	SANDSTONE
	SHU	SHUTE SANDSTONE FORMATION	BRECCIA
	MKN	MONKERTON FORMATION	SANDSTONE
	WPN	WHIPTON FORMATION	SANDSTONE
	CKF	CRACKINGTON FORMATION	MUDSTONE AND SANDSTONE, INTERBEDDED

Combined ‘Surface Geology’ Map

This map shows all four rock layers overlaid from the previous maps.

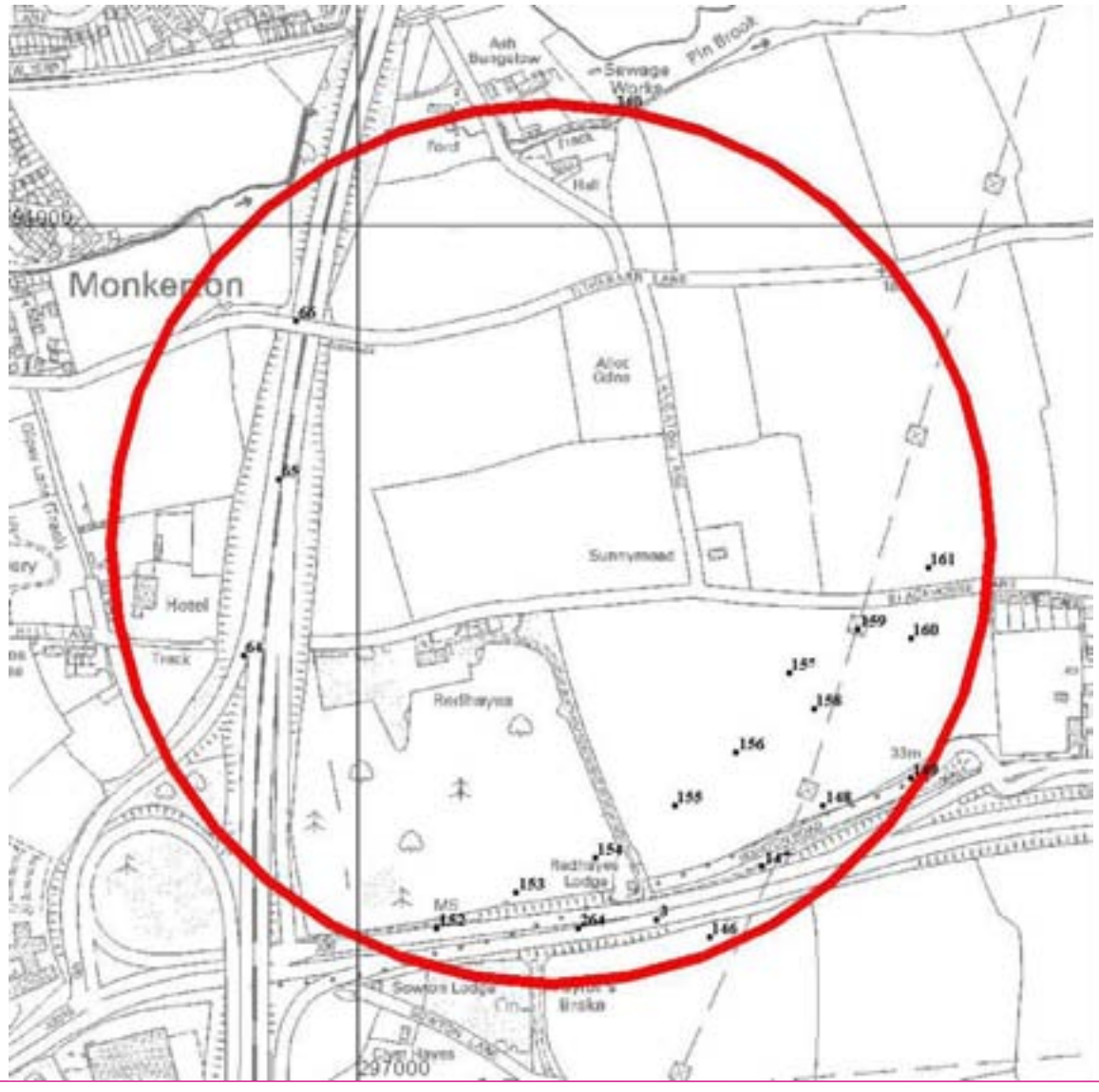
● site location Scale: 1:25000 (1cm = 250m)

Please see the Keys to the Artificial, Landslip, Superficial and Bedrock geology maps.

Section 4: Boreholes located within 500 metres of search point and water wells located within 1 kilometre of search point

Borehole location map:

Scale: 1:8000 (1cm = 80m)



Borehole records
(A blank Length field indicates the borehole is confidential or no depth has been recorded digitally.)
Total number of records: 20
The 'Office' column shows the office at which the records are held and from where copies can be obtained (see contact details later in the report).
KW=Keyworth,
MH & MW=Murchison House,
WL=Wallingford,
EX=Exeter

Regno	Grid reference	Name	Length	Office	SIR
SX99SE3	SX 97340 93210	A30 TRUNK ROAD IRONBRIDGE EXETER 3	15.00	EX	
SX99SE64	SX 96870 93510	M5 MOTORWAY CULLOMPTON PEAMORE F 27A	21.00	EX	
SX99SE65	SX 96910 93710	M5 MOTORWAY CULLOMPTON PEAMORE F 26B	18.00	EX	
SX99SE66	SX 96930 93890	M5 MOTORWAY CULLOMPTON PEAMORE F 26A	10.00	EX	
SX99SE146	SX 97400 93190	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE147	SX 97460 93270	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE148	SX 97530 93340	LONDON PENZANCE TRUNK ROAD A30	4.00	EX	
SX99SE149	SX 97630 93370	LONDON PENZANCE TRUNK ROAD A30	6.00	EX	
SX99SE152	SX 97090 93200	LONDON PENZANCE TRUNK ROAD A30	4.00	EX	
SX99SE153	SX 97180 93240	LONDON PENZANCE TRUNK ROAD A30	7.00	EX	
SX99SE154	SX 97270 93280	LONDON PENZANCE TRUNK ROAD A30	9.00	EX	
SX99SE155	SX 97360 93340	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE156	SX 97430 93400	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE157	SX 97490 93490	LONDON PENZANCE TRUNK ROAD A30	15.00	EX	
SX99SE158	SX 97520 93450	LONDON PENZANCE TRUNK ROAD A30	15.00	EX	
SX99SE159	SX 97570 93540	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE160	SX 97630 93530	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE161	SX 97650 93610	LONDON PENZANCE TRUNK ROAD A30	5.00	EX	
SX99SE264	SX 97250 93200	A30 HONITON TO EXETER E1	4.00	EX	
SX99SE340	SX 97290 94130	CLYST VALLEY DRAINAGE A1A	4.00	EX	

There are no records for Water Well Records in the selected area
There are no records for Boreholes with water level readings in the selected area
There are no records for Locations with aquifer properties in the selected area
Hydrogeological maps (various scales)
Total number of records: 1

Map	Scale
South West England	1:100,000

Description of borehole and water well datasets

Records of boreholes, shafts and wells from all forms of drilling and site investigation work. Some 900,000 records dating back over 200 years and ranging from one to several thousand metres deep.
Currently some 50,000 new records are being added to the collection each year.
A small percentage of the borehole records are held commercial-in-confidence for various reasons and cannot be released without the written permission of the originator. If any of the records you need are listed as confidential apply in the normal way. BGS Enquiry Service staff will release the data where this is possible or provide you with the information needed to contact the originator.
Where records are held in more than one office, the contents may differ. Enquiries principally requiring water related information should contact the Wallingford or Edinburgh office.

How to obtain borehole and water well data and how much it will cost?

Borehole Records – contact BGS Enquiry Service (see end of section)

Copies of borehole records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. Records with additional detailed geological information derived from BGS examination of borehole material may be charged at the current 'value-added' rate. If you have a need for data with particular geological characteristics, the please contact the enquiries office to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records yourself. The Commercial User Ticket (see below) covers inspection of the borehole logs and includes access to a set of relevant documents for one unit area (typically a 5 km x 5 km area). A further charge of £19 (+ VAT) is due for each additional set examined. Data can be freely extracted from the records but any copies requested will be charged as above.

Water wells – contact BGS Enquiry Service

Copies of records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. If you have a need for data with particular hydrogeological characteristics, then please contact the relevant enquiries office (England and Wales =Wallingford, Scotland=Edinburgh) to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records yourself.

Records for England and Wales are held at Wallingford where the visitor charge is £9.50/hour (+VAT, with a minimum charge of £19 (+VAT).

Records for Scotland are held with the borehole records at our Edinburgh office the above Borehole Record charges cover them and apply.

Section 5: Contact Details for hydrogeological enquiries

Wallingford Office
For England & Wales:
Records & Data Enquiries
British Geological Survey,
Maclean Building,
Wallingford,
Oxford OX10 8BB.
United Kingdom
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Murchison House Office:
For Scotland:
Records & Data Enquiries
Murchison House
West Mains Road
Edinburgh
EH9 3LA
Tel: 0131 650 0282
Fax: 0131 650 0252
Email: boreholesnorth@bgs.ac.uk

Section 6: More detailed geological reports available from BGS

This report forms part of a range of reports offered by the BGS Enquiry Service, including reports describing site geology and geological hazards. For details on these please contact:

BGS Central Enquiries Desk
British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham NG12 5GG
Tel: 0115 936 3143
Fax: 0115 936 3276
Email: enquiries@bgs.ac.uk

Or visit the Enquiry Service pages on the BGS website at www.bgs.ac.uk

Section 7: Terms and Conditions

General Terms & Conditions

This report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at www.bgs.ac.uk/georeports and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this report

- The data, information and related records supplied in this report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail, which is clearly defined and accurately depicted on large-scale maps may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.

Copyright:

Mapping sourced from Ordnance Survey®

Report issued by:
BGS Enquiry Service

Ground Source Heat Pump (Basic)

This report is designed for users investigating sites for the installation of ground source heat pumps (GSHP) at residential sites.

Ground source heat pumps (GSHP) can provide low carbon solutions for space heating and cooling of residential and commercial buildings. GSHP systems have relatively low running costs but relatively high installation costs. Much of the cost is associated with installation of the external loop and is strongly affected by the geological and environmental conditions at the site. The site factors can affect both the heating and cooling performance of the heat pump and the drilling-trenching methods and costs.

The report contains a geological map with descriptions of rock types, estimates of mean annual ground temperatures and thermal conductivities. It is for closed loop systems where yields and water quality, unless corrosive are not relevant. The report also contains a listing of the key geoscience data sets held in the National Geoscience Data Centre (NGDC) for the area around the site.

For some sites, the latest available records are quite old, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the geology at a site may differ from that described

Client's Reference: Exeter
Area centred at: 297220,093638
Radius of site area: 500 metres

Section 1: Location map

Scale: 1:25000 (1cm = 250m) ○ site location

Section 2: Geological map

Geological formation and rock type affect the cost of installing GSHP and the subsequent performance of the pump.

A geology map around your site is provided in this section, taken from the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50). The map shows the four layers of geology that may be present in an area – artificial (man-made) deposits, landslip deposits, superficial deposits and bedrock, superimposed on the same map.

Landslip deposits include natural deposits formed by sliding and mass-movement of soils and rocks on hill slopes (an alternative term for Landslip deposits is 'Mass Movement Deposits').

Artificial deposits include deposits moved and disturbed by man.

Superficial deposits include fairly recent geological deposits, such as river sands and gravels, or glacial deposits, which lie on the bedrock in many areas (an alternative term for Superficial deposits is 'Drift Deposits').

Bedrock forms the ground underlying the whole of an area, upon which the other geological layers listed above may lie (an alternative term for Bedrock is 'Solid Geology').

Scale: 1:25000 (1cm = 250m) ○ site location

Please note that in some areas the Superficial Deposits may completely conceal the Bedrock. In such cases, the concealed Bedrock units will still be listed in the map key.

Key to Landslip deposits:

No deposits are mapped in the search area

Key to Artificial deposits:

Map colour	Computer Code	Rock name	Rock type
	MGR	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ALV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	HEAD	HEAD	SAND WITH CLAY AND GRAVEL
	RTD1	RIVER TERRACE DEPOSITS, 1	SAND AND GRAVEL
	RTD2	RIVER TERRACE DEPOSITS, 2	SAND AND GRAVEL
	RTD3	RIVER TERRACE DEPOSITS, 3	SAND AND GRAVEL
	RTD4	RIVER TERRACE DEPOSITS, 4	SAND AND GRAVEL
	RTD5	RIVER TERRACE DEPOSITS, 5	SAND AND GRAVEL

Key to Bedrock geology:

Fault
Coal, ironstone or other mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Map colour	Computer Code	Rock name	Rock type
	DAS	DAWLISH SANDSTONE FORMATION	MUDSTONE
	DAS	DAWLISH SANDSTONE FORMATION	SANDSTONE
	SHU	SHUTE SANDSTONE FORMATION	BRECCIA
	MKN	MONKERTON FORMATION	SANDSTONE
	WPN	WHIPTON FORMATION	SANDSTONE
	CKF	CRACKINGTON FORMATION	MUDSTONE AND SANDSTONE, INTERBEDDED

More information on DiGMapGB-50 and how the various rock layers are classified can be found on the BGS website (www.bgs.ac.uk), under the DiGMap and BGS Rock Classification Scheme areas. Further descriptions of the rocks listed in the map keys can also be obtained by searching against the Computer Code on the BGS Lexicon of named Rock Units, which is also on the BGS Website at by following the 'GeoData' link. The computer codes are labelled on the maps to try and help in their interpretation (with a dot at the bottom left hand corner of each label). However, please treat this with caution in areas of complex geology, where some of the labels may overlap several geological formations. If in doubt, please contact BGS enquiries.

The geological formations are listed broadly in order of age in the map keys (youngest first) but only to the formation level (a formation is a package of related rocks). Within formations, please be aware that individual members may not be ordered by age.

Section 3: Temperature

3.1 Surface Temperature

Mean annual air temperature at the site is important because it provides the basis for an estimate of the temperature variation at shallow depth. This will affect the selection of heat pump for a site.

Mean annual air temperature at sea level in mainland UK varies from about 8-12 °C. Highest values are in the south and south-west, with lower values to the north and at sites of greater elevation. Mean site temperature has been estimated using a model based on the 30 year station averages published on the UK Meteorological Office (UKMO) web site www.metoffice. gov.uk.

Due to it's temperate climate the January-July mean air temperature swing for much of the UK is less than 15° C, despite occasional short periods of very hot or cold weather. This annual swing in temperatures also occurs in the soil layer, but with an amplitude that reduces with depth. In addition, depending on the thermal diffusivity of the soil, there will also be a time delay between the air temperature and soil temperature at any given depth

3.2 Sub-surface temperatures

The temperature variation at shallow depth in the ground is complicated by the effects of diurnal and seasonal changes in solar radiation. However at depths of about 15m the annual temperature variation is less than ±0.1°C and the temperature is approximately that of the mean ground surface temperature.

Soil temperatures

Transmission of the annual temperature cycle at the surface down into the ground depends on the thermal diffusivity of the soil and the partial amplitude of the ground surface temperature variation. This heat transfer means that in the top 15m of ground the annual temperature cycle is reduced in amplitude and lags that of the surface cycle. For instance at a depth of 3.5 m the minimum soil temperature is likely to be in the first two weeks of April and the maximum temperature about the end of October. The range of temperatures at 3.5m depth is also likely to be about one quarter that at the surface.

Soil temperatures at 2m have been estimated using a soil diffusivity of 0.05 m2/day. Annual temperature swing is based on a model of the difference in mean January and July air temperatures derived from published UKMO long term records.

Rock temperatures

At depths below about 15m the temperature profile in the subsurface is affected primarily by
thermal conductivity, heat flux and heat transport by moving groundwater.

Regions with known anomalous heat flow and thermal conductivity are especially likely to have an anomalous geothermal gradient. For many regions the effects of most of these factors are considered small so that a geothermal gradient 0.02 °C/m is a general guide.

Observed equilibrium temperature data for the UK indicate that some areas have stable ground temperatures of 15 °C at depths of 100m. Conversely other regions show stable temperatures at 100m depth of only 7 °C. The mean observed equilibrium temperature for the UK at a depth of 100m is close to 12 ±1.6 °C with a range of about 7-15 °C.

An estimate of the local geothermal gradient and the temperature at 100m and 200m depth has been made using the estimated thermal conductivity of the bedrock geology from the 1:250,000 scale geological map and the estimated heat flow at the site.

Estimated Temperature parameters of the site

Mean annual air temperature	10.5 °C
Mean annual temperature swing	7.5 °C
Estimated mean soil temperature	11.5 °C
Minimum annual soil temperature at 2m	8.2 °C
Maximum annual soil temperature at 2m	14.8 °C
Estimated temperature at 100m depth	13.6 °C
Estimated temperature at 200m depth	15.8 °C

Soil temperatures at 2m estimated using a soil diffusivity of 0.05 m2/day.
Annual temperature swing based on mean January and July air temperatures

Section 4: Thermal conductivity-diffusivity

The temperature difference between the earth and the fluid in the ground heat exchanger drives the transfer of heat. The rate at which heat can be transferred to the heat exchanger from the ground, or to the ground, is determined mainly by the thermal properties of the earth, thermal conductivity and thermal diffusivity.

For a vertical loop ground heat exchanger the properties of the bedrock geology of the site will be important. For a horizontal loop system in a shallow (1-2 m) trench then the properties of the superficial deposits will be important.

Thermal conductivity

Thermal conductivity varies by a factor of more than two (1.5 - 3.5 W/m/K) for the range of common rocks encountered at the surface and can vary significantly for many superficial deposits. It is especially affected by porosity and water saturation.

For superficial deposits and soils the thermal conductivity will depend on the nature of the deposit, the bulk porosity of the soil and the degree of saturation. Superficial deposit and soils are complex aggregates of mineral and organic particles so exhibit a wide range of thermal characteristics. An approximate guide to the thermal properties of the deposit can be made using a simple classification based on soil particle size and composition. In general relatively higher values of thermal conductivity are associated with granular soils containing silt or clay portions than with clean granular sandy soils. Also clean sands have a low thermal conductivity when dry but a higher value when saturated. There is a very significant difference in the thermal properties of silt and clay so this needs to be identified. The following table gives a good general guide to the expected thermal properties of superficial deposits and soils.

Typical values of thermal conductivity and diffusivity for superficial deposits

Class	Thermal Conductivity W/m/K	Thermal diffusivity m^2/day
Sand (gravel)	0.77	0.039
Silt	1.67	0.050
Clay	1.11	0.046
Loam	0.91	0.042
Saturated sand	2.50	0.079
Saturated silt or clay	1.67	0.056

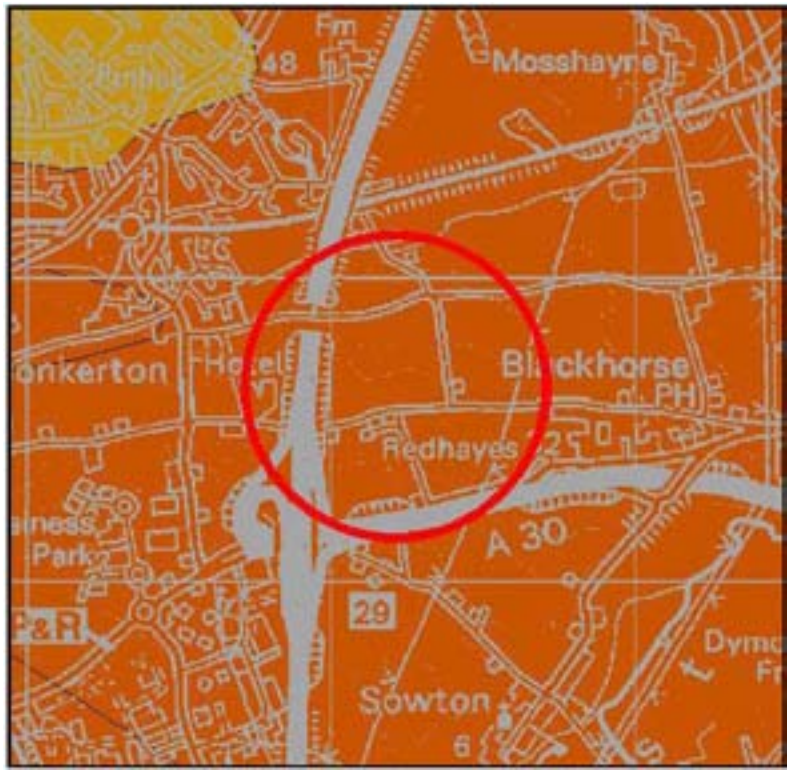
Thermal diffusivity

Thermal diffusivity is a measure of ground thermal conduction in relation to thermal capacity and relates the rock thermal conductivity, the specific heat and the density.

Typical rock thermal diffusivities range from about 0.065 m2 /day for clays to about 0.17 m2/day for high conductivity rocks such quartzites. Many rocks have thermal diffusivites in the range 0.077–0.103 m2 /day

Thermal conductivity-diffusivity (based on 1:250,000 Bedrock Geology)

Scale: 1:25000 (1cm = 250m) ○ site location



Key to Thermal conductivity-diffusivity:

Map colour	Geology	Thermal conductivity W/m/K	Thermal diffusivity m²/day
	EXETER GROUP	2.00	0.0773
	CRACKINGTON FORMATION	2.56	0.0956

This mapping is based on the BGS Digital Map of Great Britain at the 1:250:000 scale (DiGMapGB-250), so the linework and formation names displayed may differ to a certain extent from those shown on the geological maps in Section 2.

Section 5: Groundwater

The thermal conductivity of rocks is greatly affected by the degree of saturation, which is controlled by the porosity of the rock and the location of the water table and its annual fluctuations.

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers.

In upland areas underlain by metamorphic and granitic rocks, higher precipitation and water storage in weathered surface layers, soils and bogs will tend to maintain relatively shallow water levels as drainage is poor due to the low fracture porosity of these rocks. Exceptions are found where porous sandstone or limestone, with solution-enlarged fractures, drain rapidly to the adjacent base stream level.

Perched water tables occur where a clay layer in an otherwise permeable sequence, retains a small body of groundwater above the level of the regional water table. These usually occur at shallow depths in alluvial and glacial sediments and are difficult to identify or to assess their extent.

An aquifer is confined when it is overlain by a lower permeability layer that restricts the upward movement of groundwater. When the low permeability layer is penetrated by drilling, the groundwater rises in the borehole to a level controlled by the hydrostatic pressure. This may be above ground level, in which case the borehole flows under artesian pressure. Confined conditions should be anticipated, where possible, in order to plan for the drilling and completion problems that a flowing borehole can generate. However, if a closed-loop system is installed successfully into a confined aquifer then the aquifer will be saturated as will part of the overlying confining layer.

Most GSHP design techniques are based on the assumption that the heat will be dissipated by conduction. If heat advection due to groundwater flow is significant at a site it is likely that this will have a beneficial effect. The significance of advection is controlled by the hydraulic gradient, the hydraulic conductivity and the thermal conductivity of the saturated rock. In most aquifers advection will be significant except where the groundwater gradient is low; e.g. in coastal plains or confined conditions.

The water level at this site cannot currently be predicted automatically but can be estimated in a detailed GSHP GeoReport.

Section 6: Boreholes and water wells located in search area

Scale: 1:10000 (1cm = 100m)

Borehole records

(A blank Length field indicates the borehole is confidential or no depth has been recorded digitally.)
Total number of records: 20.0

The ‘Office’ column shows the office at which the records are held and from where copies can be obtained (see contact details later in the report).
KW=Keyworth,
MH & MW=Murchison House,
WL=Wallingford,
EX=Exeter

Regno	Grid_reference	Name	Length	Office	SIB
SX99SE3	SX 97340 92210	A30 TRUNK ROAD IRONBRIDGE EXETER 3	15.00	EX	
SX99SE64	SX 96870 93510	M5 MOTORWAY CULLOMPTON PEAMORE F 27A	21.00	EX	
SX99SE65	SX 96910 93710	M5 MOTORWAY CULLOMPTON PEAMORE F 26B	18.00	EX	
SX99SE66	SX 96930 93890	M5 MOTORWAY CULLOMPTON PEAMORE F 26A	10.00	EX	
SX99SE146	SX 97400 93190	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE147	SX 97460 93270	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE148	SX 97530 93340	LONDON PENZANCE TRUNK ROAD A30	4.00	EX	
SX99SE149	SX 97630 93370	LONDON PENZANCE TRUNK ROAD A30	6.00	EX	
SX99SE152	SX 97090 93200	LONDON PENZANCE TRUNK ROAD A30	4.00	EX	
SX99SE153	SX 97180 93240	LONDON PENZANCE TRUNK ROAD A30	7.00	EX	
SX99SE154	SX 97270 93280	LONDON PENZANCE TRUNK ROAD A30	9.00	EX	
SX99SE155	SX 97360 93340	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE156	SX 97430 93400	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE157	SX 97490 93490	LONDON PENZANCE TRUNK ROAD A30	15.00	EX	
SX99SE158	SX 97520 93450	LONDON PENZANCE TRUNK ROAD A30	15.00	EX	
SX99SE159	SX 97570 93540	LONDON PENZANCE TRUNK ROAD A30	10.00	EX	
SX99SE160	SX 97630 93530	LONDON PENZANCE TRUNK ROAD A30	3.00	EX	
SX99SE161	SX 97650 93610	LONDON PENZANCE TRUNK ROAD A30	5.00	EX	
SX99SE264	SX 97250 93200	A30 HONITON TO EXETER E1	4.00	EX	
SX99SE340	SX 97290 94130	CLYST VALLEY DRAINAGE A1A	4.00	EX	

Water Well location map
Scale: 1:10000 (1cm = 100m)

Description of borehole and water well datatsets

Records of boreholes, shafts and wells from all forms of drilling and site investigation work. Some 900,000 records dating back over 200 years and ranging from one to several thousand metres deep. Currently some 50,000 new records are being added to the collection each year.

A small percentage of the borehole records are held commercial-in-confidence for various reasons and cannot be released without the written permission of the originator. If any of the records you need are listed as confidential apply in the normal way. BGS Enquiry Service staff will release the data where this is possible or provide you with the information needed to contact the originator.

Where records are held in more than one office, the contents may differ. Enquiries principally requiring water related information should contact the Wallingford or Edinburgh office.

How to obtain borehole and water well data and how much it will cost?

Borehole Records – *contact BGS Enquiry Service (see end of section)*

Copies of borehole records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. Records with additional detailed geological information derived from BGS examination of borehole material may be charged at the current 'value-added' rate. If you have a need for data with particular geological characteristics, then please contact the enquiries office to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records
yourself. The Commercial User Ticket (see below) covers inspection of the borehole logs and includes
access to a set of relevant documents for one unit area (typically a 5 km x 5 km area). A further charge
of £19 (+ VAT) is due for each additional set examined. Data can be freely extracted from the records
but any copies requested will be charged as above.

Water wells – *contact BGS Enquiry Service*

Copies of records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. If you have a need for data with particular hydrogeological characteristics, then please contact the relevant enquiries office (England and Wales =Wallingford, Scotland=Edinburgh) to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records yourself.

Records for England and Wales are held at Wallingford where the visitor charge is £9.50/hour (+VAT, with a minimum charge of £19 (+VAT).

Records for Scotland are held with the borehole records at our Edinburgh office the above Borehole Record charges cover them and apply.

BGS ENQUIRY SERVICE Contact Details:

Keyworth (KW) Office
For Borehole and other records (excluding water well records & hydrogeological data) in England & Wales (excluding Northern England, and Devon & Cornwall):
Records & Data Enquiries
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Fax: 01159 363276

Wallingford (WL) Office
For water well records and hydrogeological data (water levels, water chemistry and aquifer properties) in England & Wales:
Records & Data Enquiries
British Geological Survey,
Maclean Building,
Wallingford,
Oxford OX10 8BB.
United Kingdom
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Murchison House (MH or MW) Office:
For water well records and hydrogeological data for Scotland, and all other records in Scotland & Northern England:
Records & Data Enquiries
Murchison House
West Mains Road
Edinburgh
EH9 3LA
Tel: 0131 650 0282
Fax: 0131 650 0252
Email: boreholesnorth@bgs.ac.uk

Section 7: More detailed geological reports available from BGS

This report forms part of a range of reports offered by the BGS Enquiry Service, including reports describing site geology, hydrogeology and geological hazards. For details on these please contact:

BGS Central Enquiries Desk
British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham NG12 5GG
Tel: 0115 936 3143
Fax: 0115 936 3276
Email: enquiries@bgs.ac.uk

Or visit the Enquiry Service pages on the BGS website at www.bgs.ac.uk

Section 8: Terms and Conditions

General Terms & Conditions

This report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at www.bgs.ac.uk/georeports and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this report

- The data, information and related records supplied in this report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations.

You must seek professional advice before making technical interpretations on the basis of the materials provided.

- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail which is clearly defined and accurately depicted on large-scale maps may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The

nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.

- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- This report was prepared by the British Geological Survey and with support from the Carbon Trust. The publication of this report should not be taken as implying endorsement by the Carbon Trust of any views expressed in the Report or of the services or of the service providers referred to in the report. The Carbon Trust accepts no liability for the accuracy or completeness of, or omissions from, the contents of the Report or for any loss arising from reliance on it.

Report issued by:
BGS Enquiry Service

Technical Review of BGS data

This section sets out the technical review of the BGS Water Borehole Prognosis and Ground Source Heat Pump reports, prepared by the energy consultants Fulcrum.

INTRODUCTION

1. This note outlines the issues and considerations outlined in the British Geological Survey's (BGS) 'Water Borehole Prognosis' and 'Ground Source Heat Pump' Reports.

2. This note is meant to provide a greater understanding of the BGS reports in order to help inform the masterplan design and energy strategy. This should be read in conjunction with the above BGS reports.

KEY DEFINITIONS

'Core' porosity: the proportion (or percentage) of a rock or soil that is void of air or water.

'Effective' porosity: is the actual amount of volume of void space through which water can flow within a rock.

Hydraulic Conductivity: a property that describes the ease with which water can move through pore spaces or fractures measured in metres/second (or metres/day)

Transmissivity: The transmissivity of an aquifer is the combination parameter of hydraulic conductivity and aquifer's thickness which links the potential ground water yield, or measure of how much water can be transmitted through the aquifer , for example to a pumping well - measured as metres2/second (or m2/day)

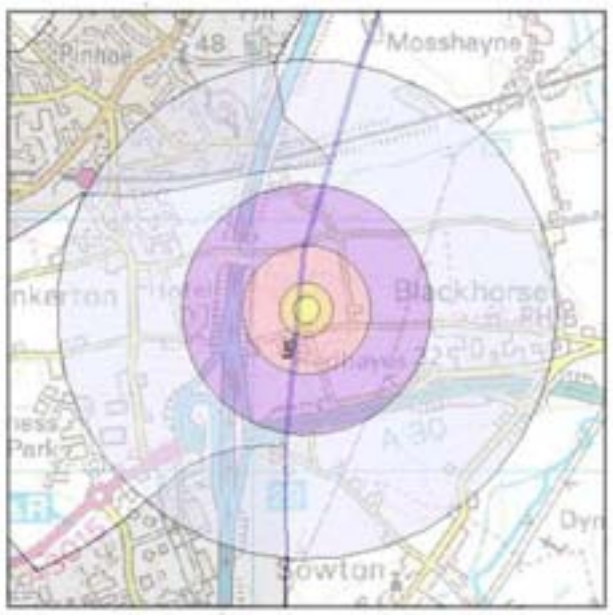
Drawdown: the change in head or water level height due to abstracting/injecting water as compared to the pre-abstracting/injecting conditions - measured in metres

WATER BOREHOLE PROGNOSIS REPORT

Exeter Science Park

3. The Water prognosis centres on a point on the top of the ridge, from which the specific datum is collected within a 100m radius (and beyond) around the site (see opposite figure). It assesses the geology beneath the site and the abstraction (i.e. drawing water) of surrounding boreholes.

4. The geology that exists beneath the proposed Exeter Science Park developments includes Artificial deposits (i.e. moved and disturbed by man), Landslip deposits, Superficial deposits (i.e. soils and gravels over the bedrock), and Bedrock. It is the Bedrock layer that is of most importance for water abstraction.



5. The bedrock will hold different amounts of water depending on its porosity and permeability. Water will flow through and recharge the bedrock depending on the permeability features and the surrounding barriers to flow. The ability to abstract water will depend on the depth of the bedrock and its recharge rate

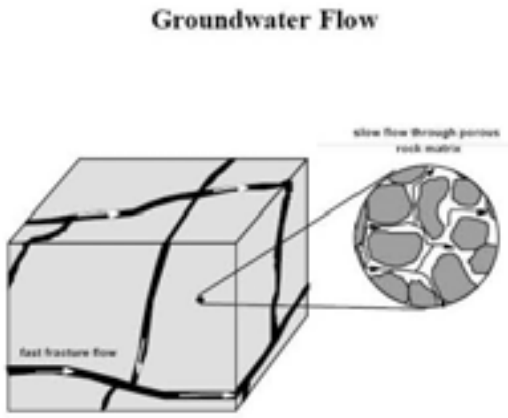
Aquifer Conditions

6. The development site exists largely over what is called the Dawlish Sandstone Formation (DSF), which comprises of sands and sandstones and is a productive aquifer in the district. This formation has a 'core' porosity range (i.e. the volume of air within the material) between 6.5 to 32.5%. This directly affects the amount of water likely held within the rock material and the rate of flow.

7. The BGS report also states that the intergranular and fracture flow (i.e. the flow through the rock and the flow through cracks between the rocks) may be up to 40% of the transmissivity (i.e. the horizontal water flow) (see opposite figure).

8. Clay formations likely exist through the sandstone below the site and could act as confining layers to water flow. This would, in essence, limit the amount of water abstracted as the re-charge rate of the aquifer is reduced.

9. No boreholes pre-exist on the Exeter site, and thus



no data was available from which the BGS could directly identify the likely abstraction rates available and the associated transmissivity and drawdown of a well. However, nearby sites that exist in similar ground type conditions do have data from which some broad estimates can be derived.

10. The surrounding site condition boreholes show that there is a variable amount of water available for abstraction, with a nearby Garden Centre pumping 1.7l/s for a 46m well, a Winter Garden's with 6.8l/s in a 61m well, and at the Exeter Airport with 16.2l/s for a 136m borehole. It should be noted that these have different levels of drawdown (i.e. change in the aquifer water height), and the drawdown at the Exeter Science Park site would be an important factor into how many wells could be drilled and abstracted from.

11. Further from the site in the surrounding Exeter area, abstraction rates from the Dawlish Sandstone Formation continue to vary and are dated, however, they generally show encouraging figures. The issue with having 'old' borehole readings lies with the likely change in aquifer levels due to greater abstraction elsewhere in area.

12. The BGS report estimates that an abstraction rate of 5l/s is potential, but would be dependent on the thickness of the DSF aquifer, the drawdown and transmissivity, and any other limiting factors to water flow (i.e. clay belts).

Water Quality

13. It could be expected that the ground water quality from the DSF is generally good, with a hardness of <200mg/l (CaCO3); however, it would be required to test this water for any contaminates

due to earlier site uses.

Estimated Energy Storage Potential

14. As a very broad estimate, which would be subject to further investigation, the potential for an Interseasonal thermal storage technique, such as an Aquifer Thermal Energy System (ATES) can be derived from the site conditions provided in the BGS report.

15. ATES works by storing heat captured from the building(s) in the summer for use in winter, and cold from winter for use in summer. It is based on the potential water availability from the aquifer and the required heating and cooling load. Typically, ATES systems are based on the cooling demand.

16. A particular feature of an ATES system that must be relatively stable for heating and cooling is the hydraulic conductivity of the aquifer and thickness of the aquifer, which hydraulic conductivity would determine the amount of heat that could be stored for a length of time without dissipating, and thickness of the aquifer would determine the capacity of stored energy.

17. The BGS estimate a yield of 5l/s as being likely. However, surrounding sites yield up to 16l/s.

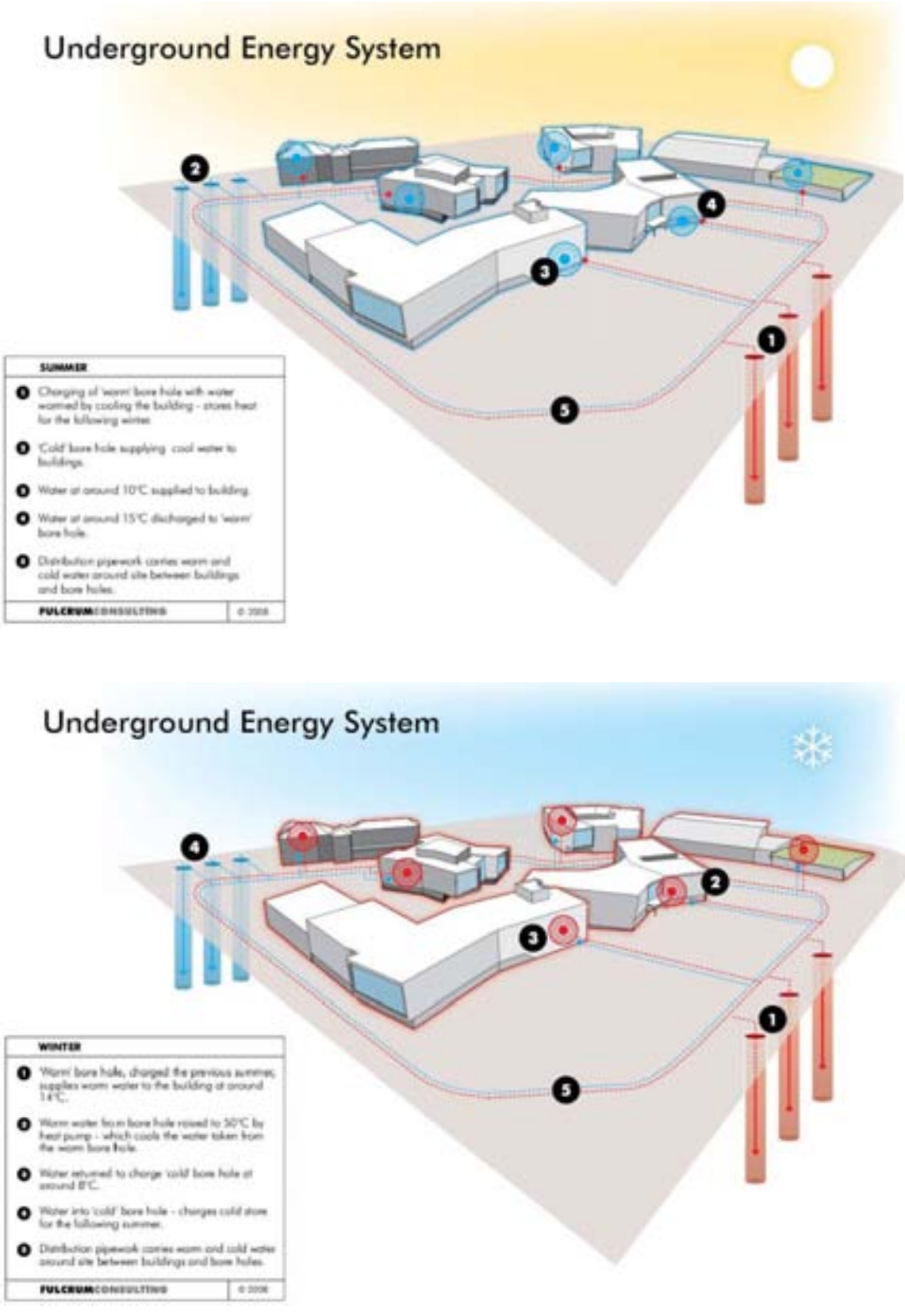
18. It can thus be estimated from the above site conditions and broad heating and cooling demands for 'office' type buildings the number of boreholes needed to deliver cooling for the site.

19. Phase 1, at 18,800m2, may need approximately 8-10 boreholes at a yield of 5l/s. If a higher yield is obtained at 16l/s, then 3-4 boreholes could meet the estimated cooling demand.

20. Phase 2, at 50,000m2, may need approximately 15-20 boreholes at a yield of 5l/s. Again, if a higher yield is obtained at 16l/s, then 6-9 boreholes could meet the estimated cooling demand.

21. The boreholes would tend to be spaced 50m apart and can be located near or within buildings or an energy centre. Given the size of the development (50ha site) there is likely sufficient space to accommodate the system requirements.

22. It would be necessary for a full aquifer test, including borehole drilling and monitoring to be investigated in order to have a better understanding of the full potential of an ATES system.



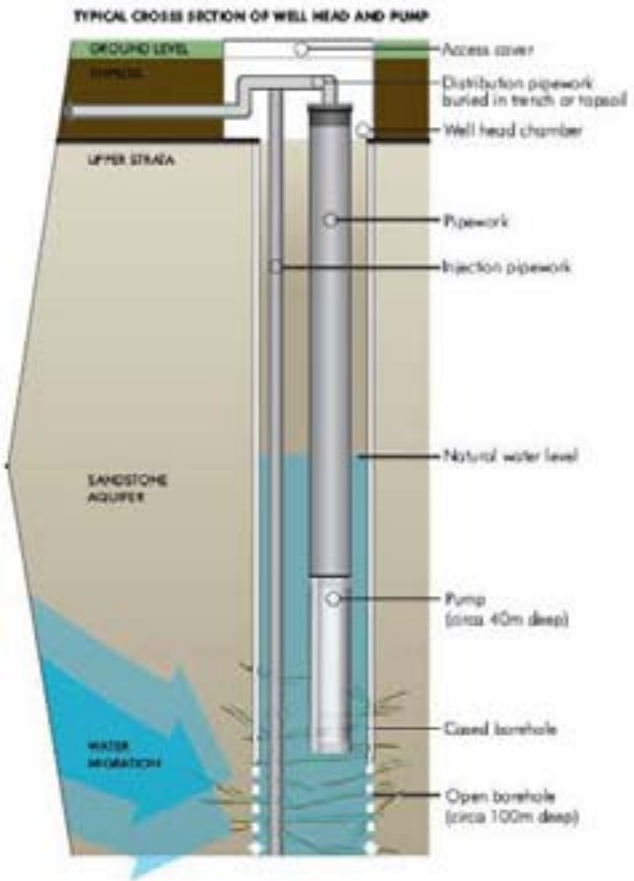
IMPLICATIONS FOR THE MASTERPLAN

23. The use of borehole water is a method of reducing the amount of water brought onto the site from South West Water. Depending on the commercial setup of the utilities provision, an onsite water supply company could operate under an 'inset agreement' for which an onsite borehole could provide a proportion of the necessary water supply.

24. Low carbon cooling to the Science Park development may have potential via borehole ATES depending on further investigation into the technical and logistical feasibility. Where Phase 1 may require between 3 to 10 boreholes and Phase 2 may require 7 to 31 boreholes depending on yield.

25. The necessary space required for the boreholes and the associated infrastructure would be required, but this may consist of a pump house station and the necessary heat exchanger components (which could be included in an energy centre building).

26. This system is an excellent method of delivering very low carbon cooling potential and could help the Science Park meet their aspirations of a zero carbon development in conjunction with well designed low energy buildings and efficient services.



LDADESIGN

LANDSCAPE

URBAN

ENVIRONMENT

ECOLOGY