UNIVERSITY OF CAMBRIDGE

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HERITAGE ECOSYSTEM IMPACT ASSESSMENT:
A pilot study of East West Rail's preferred Route E (Cambourne to Cambridge), South Cambridgeshire

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Suggested Citation:

Hoffmann, T., D. Viejo-Rose, B. Davenport, A. Santikarn, A. Chan (2025). *Heritage Ecosystem Impact Assessment: A Pilot study of East West Rail's preferred alignment Route E (Cambourne to Cambridge), South Cambridgeshire*. University of York and University of Cambridge.

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List of Acronyms and Abbreviations

AONB	Area of Outstanding Natural Beauty
BFARe	Bedford for Re-consultation
CIA	Cultural Impact Assessment
DCO	Development Consent Order
DfT	Department for Transport
EIA	Environmental Impact Assessment
ES	Environmental Statement
EWR	East West Rail
HEIA	Heritage Ecosystems Impact Assessment
HGVs	Heavy goods vehicles
HS2	High Speed Rail 2
LNR	Local Nature Reserve
NIMBY	Not in my back yard
NSIP	Nationally Significant Infrastructure Projects
P14	Participant number 14
PI1	Participant Interview number 1
REAm	Rapid Ethnographic Assessment methods
SAC	Special Area of Conservation
SoCC	Sites of Special Scientific Interest
SSSI	Sites of Special Scientific Interest

1. EXECUTIVE SUMMARY

The Heritage Ecosystem Impact Assessment (HEIA) project had three goals. The first was to attempt to make a heritage ecosystem visible, the second to devise a methodology to assess impacts to the heritage ecosystem, and the third to pilot the methodology to test its effectiveness and application.

Within the context of this project **a heritage ecosystem is defined as the reciprocal relationships between people and place, and their collective pasts, presents, and futures.**

The HEIA methodology was designed to be used by community members to express their concerns for the relationships that matter to them. This methodology is timely given growing UK government commitments to large-scale Nationally Significant Infrastructure Projects (NSIP) and the documented failure of many of these projects to adequately record and mitigate impacts to local peoples and places (Clifford and Morphet, 2023). A principled methodology designed to identify relationships within the context of proposed project-related impacts can assist in the design and implementation of more nuanced and effective decision making, and if a project is slated to proceed in the face of local objection, of more responsive and appropriate mitigation measures.

The HEIA methodology proceeds through three integrated stages. Stage 1 identifies and records the heritage ecosystem. This includes identifying the 'Valued Components' (which are the tangible and intangible aspects essential to the definition and creation of the heritage ecosystem) and the conditions that maintain and sustain the Valued Components. Stage 2 draws from the Stage 1 results to contextualise the heritage ecosystem in all its forms, including the identification of 'Valued Areas' or places particularly vital to sustaining the heritage ecosystem. Stage 2 also documents the physical proximity and probability of impact (via a 'comparative project' summary) of a proposed project to the heritage ecosystem. Stage 3 examines the most likely impacts and determines whether they will have a low, moderate, or high level of impact on the heritage ecosystem.

Pilot Study Results: The South Cambridgeshire Heritage Ecosystem and East West Rail

The HEIA sets out to better understand the impact of the preferred route of the Cambourne to Cambridge segment of the East West Rail (EWR) on a heritage ecosystem of South Cambridgeshire. Over 80 people participated in the pilot study either through the community mapping sessions and/or in semi-structured interviews. Analysis of project participants' responses identified three primary Valued Components and the conditions and Valued Areas required to sustain them. The Valued Components are:

Connectivity: The ability to create and sustain connection. Among the many conditions required to sustain connectivity are the presence of intact, healthy habitats, and places that facilitate opportunities for 'everyday' encounters with other people, and/or with wildlife. Valued Areas include footpaths and historic roadways, ancient woodlands, and waterways.

Legacy: The actions, activities, behaviours, choices, and places that foster, support, sustain intergenerational transmission of knowledge and/or experience between and among humans and other species. The conditions identified as necessary to support legacy emphasise the consistency of access and the long term presence of particular habitats. Valued Areas include hills, wooded areas, hedgerows, orchards, and play areas.

Wellbeing: The places, activities and feelings that are known or perceived to support mental and physical health (of both human and non-human species). Some of the conditions required to sustain wellbeing include the ongoing presence of established, often historic, routes, and the presence of intact ecosystems. Valued Areas include hills, footpaths and cycle routes, and habitats found in woodlands, waterways, and farmland.

This study found that the South Cambridgeshire heritage ecosystem reported by study participants consists of a complex layering of people/place relationships that create and sustain connectivity, foster legacy in the form of intergenerational and interspecies knowledge transfer and sustain the wellbeing of inhabitants (human and non-human alike).

Study participants listed 43 distinct impacts associated with EWR, some of which have already been experienced, and many of which are anticipated. Through an analysis of impact pathways, impacts were found to be highly interlinked, especially for the planning and construction phases of the EWR project. The HEIA finds that there will be high levels of impact to the Valued Components and the majority of Valued Areas identified by study participants. The HEIA concludes that EWR will result in a fundamental change in the 'without project' trajectory of South Cambridgeshire–a change which, according to the study participants, will be overwhelmingly negative. Over the long term, the sum total of impacts and their experienced and anticipated effects show that the East West Rail project represents a threshold of change, particularly in consideration of cumulative impacts, that could mean the transformation of the South Cambridgeshire countryside into something much different than the primarily agricultural landscape that persists today.

The HEIA represents a departure from standard environmental and socio-economic impact assessment insofar as it employs 'relational thinking' that takes seriously the interconnected and reciprocal relationships that exist between people and place (and the species that inhabit them). Within the realm of impact assessment, thinking 'relationally' has implications for how impacts are measured and mitigated. The HEIA works from the assertion that the true costs of development-related impact are best determined by those who will bear them. This pilot study shows that understanding impacts through the lens of the heritage ecosystem provides an opportunity to fully comprehend the effects that the EWR project will have on the long term viability of local people/place relationships. The relationships highlighted in the HEIA pilot study demonstrate that local people have embedded knowledge about what 'counts' for them and the places they care about. This accounting can be used at all levels of decision making to facilitate more considered development planning, or if development is to proceed in the face of local opposition, to more meaningful mitigation of development impacts.

1.1 Acknowledgements

We would like to acknowledge and thank those who supported and contributed to this project. The project was initially conceived of at the Cambridge Heritage Research Centre and funded through one research and one impact grant from the McDonald Institute for Archaeological Research at the University of Cambridge. Later stages of the project were funded through the University of York. We acknowledge the financial support of the Leverhulme Trust, particularly Emma Waterton's Leverhulme International Professorship [LIP-2021-003], which funds the Heritage for Global Challenges Research Centre at the University of York. We would especially like to thank Dr. Matthew Davies, Deputy Director of the McDonald Institute for Archaeological Research at the University of Cambridge, and Professor Emma Waterton and Dr. Hayley Saul, Co-Directors of the Heritage for Global Challenges Research Centre at the University of York for championing this project through to completion. A special note of thanks to Ari Chan who, under the guidance of David Redhouse, translated hand drawn maps into digital format and digitally rendered the maps included in this report.

The HEIA would not have been possible without the collaboration of over 80 project participants, most of whom live in South Cambridgeshire villages within close proximity to the proposed East West Rail (EWR) project. We thank each and every one of them. A particular note of thanks to local Haslingfield historians John Beresford and Maria Stringer who spent several hours over several cups of coffee detailing the major trends in Haslingfield's last 100 years of history. Cambridge Professor of Medieval Archaeology Susan Oosthuizen generously contributed her extensive knowledge of the South Cambridgeshire historical landscape encouraging us to think about the long-term environmental, geographic and social implications of people/place relationships. The farming community of South Cambridgeshire has been particularly involved in this project. We thank the farmers and their families for their candour and their willingness to take time out of their busy schedules to participate. Finally, we thank the East West Railway Company for showing interest in the project objectives, and for allowing us to conduct mapping sessions outside their community consultation meeting venues.

2. INTRODUCTION

The Heritage Ecosystems Impact Assessment (HEIA) pilot project had three primary goals. The first was to identify and then make visible a 'heritage ecosystem', the second to create a methodology for assessing impacts to heritage ecosystems, and the third to pilot the methodology in hopes of identifying its efficacy and future application. The HEIA methodology differs from environmental, heritage, and socio-economic impact assessment methodologies insofar as it prioritises the relationships that people and 'place' sustain with one another. In other words, the HEIA values how people shape place, but equally how place shapes people.

The idea of applying heritage ecosystem thinking within an impact assessment context arose out of a desire to find better ways to capture and present instances of co-productive, interconnected, often reciprocal relationships between people and places that do not feature in standard approaches to impact assessment. The need for such a methodology was made clear as the report authors were made aware of community concerns over the impact of a Nationally Significant Infrastructure Project (NSIP) in the form of a proposed new rail line between Oxford and Cambridge, the whole of which is scheduled to be operational by 2030. Though much of the route has been achieved by upgrading existing rail corridors, the southeasternmost segment will require construction of new rail line through the South Cambridgeshire countryside. Construction of the new segment is planned to commence upon the receipt of a Development Consent Order. From the first public consultation sessions held in 2019 to the present day, affected community members residing in South Cambridgeshire remain frustrated with the consultation process itself, since it appears to them that the developer dismisses many of their concerns as expressions of NIMBYism (not in my back yard).

Given growing government commitments to large-scale NSIPs and the documented failure of many of these projects to adequately record and mitigate impacts to local peoples and places (Clifford and Morphet, 2023), there seemed to us a need to design a methodology that could be used by community members to better express their concerns for the relationships that matter to them. A better understanding of these relationships within the context of proposed project-related impacts can assist in the design and implementation of more nuanced and effective decision making, or if a project is slated to proceed in the face of local objection, of more responsive and appropriate mitigation measures. The HEIA methodology presented here was designed with these objectives in mind.

This report proceeds as follows. First, we define the term 'heritage ecosystem' and locate the concept within existing scholarship about people/place relations. Second, we assess the potential contribution that the HEIA methodology can make to impact assessment of projects in the United Kingdom, looking specifically at some of the most obvious policy implications and possibilities. After defining some terms, we present the HEIA methodology. Next, we present the results of an HEIA pilot study of the preferred route proposed by East West Rail (EWR), followed by a discussion of project limitations and next steps. We conclude the report by circling back to how the HEIA methodology might be implemented to address ongoing challenges of NSIP consultation as decision-makers look to weigh the economic needs of the Nation against the very real impacts such projects may have on local people/place relationships.

2.1 What is a heritage ecosystem?

Celebrated British forest ecologist Oliver Rackham (1986: xiii) writes "The ordinary landscape of Britain has been made both by the natural world and by human activities, interacting with each other over many centuries. This is not an easy idea to grasp", yet it is with the heritage of this fundamentally reciprocal relationship that this project engages. Over the past twenty years scholarly thinking about heritage has undergone a quiet revolution. Heritage, originally thought of in terms of artefacts, sites, monuments and buildings, now encompasses a suite of broader critiques about how the past is used in the present. In a field once defined by binary categories where heritage was seen as natural or cultural, tangible or intangible, movable or not, recent changes have inspired calls to consider the entanglements of heritage, to focus on its interconnected contexts, and its relational dimensions through time. One such proposal (Viejo Rose, 2019) suggests applying an ecosystems model as a way of emphasising those interconnections and relations. Other scholarship looks to extend heritage beyond the human toward 'heritage ecologies' that consider the role that other-than-human actors play in heritage making (Bangstad and Petursdottir, 2022). Still more scholarship looks at heritage as an active "heritage assemblage", where heritage is framed as living, emergent, and often contested network of relationships that are continually made and remade (Harrison, 2012). All of this scholarship calls for moving away from the categorisations that were stultifying both thought and action in the heritage field toward approaches that prioritise relationships between and among people, place, and non-human species. This project draws upon these scholarly works and, within the context of this project, a **heritage ecosystem is defined as the reciprocal relationships between people and place, and their collective pasts, presents, and futures.**

The heritage ecosystem contemplated by the HEIA methodology also expands the definition of 'place' to include not just the geographical features of a landscape, but all the species and elements that reside within and enliven it. This definition of 'place' presents an opportunity to understand place as a site of people/place connection where relationships reside, develop, and change over time. The significance of people/place relations over time is expressed through the myriad ways in which people and places engage in reciprocal "place-making". Thinking about reciprocal place-making is not new and an expansive literature exists in western scholarship, notably in anthropology (Gupta and Ferguson, 1997; Ingold 2009, 2012; Ward 2003; Wieczorek, 2019), and geography (Anderson, 2021; Cresswell, 2014, 2008;), planning (Akbar and Edelenbos, 2021; Keidar et al., 2024) and increasingly in heritage studies (Bangstad and Pétursdóttir, 2022; Harrison, 2015; Pettantti, 2022; Viejo-Rose, 2019; Waterton, 2018). These literatures move us beyond 'representational' definitions (where landscapes are depicted in ways aimed at the accurate portrayal of visual elements as they appear in reality) toward the "more-than-representational". Understandings of "more-than-representational landscape" define landscape as the dynamic, actively produced space that is the result of the interplay of human interactions, practices, and the non-human elements within it (Waterton, 2018). This thinking acknowledges the complex and multi-sensory experiences of a place and views the landscape as "more than" just what can be visually represented.

In more-than-representational landscape literature 'place' is understood to extend beyond mere physical location to encompass the meanings, emotions, and social associations attributed to a location, often by local people. Place attachment develops as people form an emotional bond with a location to a point where their relationship with that place can contribute to an individual's sense of self and identity. It follows that when these places are threatened, people engage in 'place protective action' that can range from individual responses to collective action (Devine-Wright 2009). But what if, as Oliver Rackham suggests, this place-making is reciprocal, and the places themselves and the species within them depend upon, or at the very least, respond to people, and people to them?

The idea that there should exist interdependence of people and place is a key feature of Indigenous theories of people-place relations. Arguably, thinking about place-making is expanding via critiques offered by Indigenous scholarship, especially explanations of what Vanessa Watts (2013) terms 'Indigenous Place-thought' – defined as the ways in which Indigenous cosmologies provide theories and paradigms that show how people learn not just about, and from, but also *through* their lands and waters. Though Indigenous scholarship provides theoretical insights into how Indigenous peoples sustain reciprocal relationships with place,

it is the critiques of the powerful global minority that afford an invaluable source of reflection on the ways and means through which dominant modes of thinking promote certain capitalist logics that inform decision-making about what does and should constitute 'progress' (Simpson 2014, Watts 2013). These critiques are particularly relevant to an impact assessment methodology designed to assess impacts to relationships (as opposed to component parts of those relationships like individual species or archaeological sites for example) that arise from projects often justified via narratives of 'progress'. Though the scope of this project does not allow for a fulsome review of this literature, questions arising from Indigenous critiques of dominant worldviews inspired and informed the creation and application of the HEIA. Specifically, through the HEIA we examine how relationships are expressed in and by the landscape, through non-human and human species interactions and interdependencies.

2.2 The potential of heritage ecosystems for UK impact assessment

The need for an Impact Assessment methodology based in 'relational' thinking is timely, as calls for 'whole system' approaches to the identification and mitigation of impact increase (Hanna and Arnold, 2022). The Heritage Ecosystem Impact Assessment methodology aims to provide a clear and principled approach to advance decision-making through the identification of a more nuanced representation of people/place relationships. It addresses a call for a better understanding of the environment from a holistic perspective, and in doing so responds to recent calls from ecologists and impact assessors to move beyond accounting for 'what nature does for humans' (through monetising 'ecosystems services' for example) toward better understanding the integral role of human/place relations in shaping and sustaining biodiverse ecosystems (Gibson, 2017).

Specifically, the Heritage Ecosystem Impact Assessment (HEIA) methodology takes seriously the interconnected and reciprocal relationships between people and place that underlie 'place protective action' (Devine-Wright, 2009). The HEIA foregrounds the deep connections that make and sustain these relationships, recognising human who sustain the heritage ecosystem to be the experts in its value at the local scale. In doing so, HEIA marks a powerful departure from current UK environmental, heritage, and landscape impact assessments, where expert assessors' consideration of impacts is almost exclusively focused on tangible aspects of a 'representational' environment typically focused through separate lenses of ecology (e.g. habitat biodiversity), heritage assets (such as architectural heritage and archaeological sites), or quantitative measures of impact to socio-economic baselines (employment figures for example).

From a policy and governance perspective, the Heritage Ecosystem Impact Assessment methodology also answers a call for a more nuanced understanding of local opposition to development. Such intervention is needed given the tendency to characterise local opposition as NIMBY-ism. However, NIMBY – a label used to dismiss local opposition to change as selfish, irrational, or ignorant – fails to account for the complex psychological and social processes underlying such opposition (Batel & Devine-Wright, 2020; Devine-Wright, 2009; Harrison 2019). In detailing the inadequacy of the NIMBY moniker, Devine-Wright (2009) suggests instead that 'place-protective action' should be used to capture local opposition to impacts that threaten both individual emotional attachments to place and place identity.

The HEIA places the assessment of impacts in the hands of those who anticipate and experience them most keenly–local peoples and places. The HEIA methodology provides methods for communities to document and assess the value of reciprocal people/place relationships. It also provides avenues for community members to first determine then communicate how a proposed development will impact their heritage ecosystem. Finally, the HEIA provides the basis upon which local people can make recommendations and propose mitigation measures that provide, in their eyes, meaningful strategies to offset impacts to their heritage ecosystem.

2.2.1 The HEIA and Environmental Impact Assessment methodology

The HEIA methodology itself is inspired by and draws upon the Cultural Impact Assessment Methodology developed by the Mikisew Cree and the Firelight Group. This cutting-edge methodology has been adopted by the Canadian Government as the best practice approach to the assessment of impacts to Indigenous Rights in a Canadian development context (Gibson 2017). Owing to

the particular geo-political and cultural milieu in which the Mikisew Cree and Firelight methodology was developed, and the fact that it looks to assess impacts to Aboriginal Rights in a Canadian context, the methodology is not directly transferable to local communities in the United Kingdom. However, since the methodology places relationships at its centre, it presents a framework upon which to base the HEIA methodology providing inspiration for a different set of questions upon which to both identify and assess impacts to people/place relationships in the UK.

The HEIA specifically aims to address some of the shortcomings of current Environmental Impact Assessment (EIA) scope and methodology. In terms of scope, critique of EIAs of linear developments in particular suggest they tend to focus on narrowly delimited study areas, often arbitrary in nature, whilst failing to reference far-reaching impacts like habitat fragmentation (Benson, 2003; Glasson & Therivel, 2013). There is a need to move beyond study areas that look at the impacts restricted to assessment of a narrow corridor along the infrastructure, to one where the study area is "dictated by the expected spatial influence of the impacts" (Geneletti, 2006, p. 259). EIAs also tend to prioritise existing conservation areas thereby overlooking the ecological significance of habitats outside of conservation zones but which are of value to local people and species (Treweek, et al. 1998 cf Geneletti, 2006). Finally, regarding its ability to address impacts to people/place relationships, the EIA process as it currently exists is largely inadequate for truly inclusive decision-making and needs to evolve beyond its traditional focus on construction impacts to embrace a more democratic process that addresses a broader range of concerns (Rozema & Bond, 2015). By taking a proactive approach and encouraging public scrutiny much earlier in a project lifecycle, many of the downstream costs of the current planning process might be avoided (Hakimian, 2022).

2.2.2 Policy implications and possibilities

The HEIA has potential to provide a way to collate community interests concerning development impacts in a productive manner to compliment the government's desire to streamline the development approval process. Currently Nationally Significant Infrastructure Projects (NSIPs) follow a defined development consent process under the Planning Act 2008, as regulated by the Planning Inspectorate (PINS). Public consultation is a critical component of this process and occurs in several key stages but primarily in the legally required pre-application stage. In addition to consulting with prescribed statutory consultees (e.g. local authorities, Natural England, etc.), under Section 47 of the Planning Act (2008) the developer must consult with the local communities and summarise the outcomes of consultation in a Statement of Community Consultation or SoCC (Planning Inspectorate, 2023), which then forms part of their application for a Development Consent Order (DCO). Though not legally required, many developers initiate a voluntary, informal non-statutory phase of consultation prior to the statutory consultation phase. Developers typically initiate non-statutory consultation to build early relationships with affected communities, refine design proposals, reduce risk of delay or opposition, improve the quality of the statutory consultation design, and fulfil commitments to industry best practice standards.

The degree to which the opinions and concerns of local peoples are considered in development planning varies according to development type. It is more likely that place-specific local concerns will be considered in small scale planning applications than in large scale infrastructure developments for example (Natarajan et al. 2018). However, acquiring a fulsome understanding of local community concerns is particularly important for NSIP projects since they tend to have large footprints whose negative impacts are felt locally but whose benefits most often accrue nationally. Pointing to the need to do better in addressing local impacts of NSIP projects, Sir John Armitt, Chairman of the National Infrastructure Commission recently argued that "more consideration be given to the impact on those people who don't benefit from that National Infrastructure which is going to go past their community. So to what extent can we compensate them,...[for the fact] that they are putting up with something which is going to impact them, but the direct benefit is felt by people many hundreds of miles away..."(BBC 2024). Part of the solution proposed by Sir Armitt is to locate better, more transparent dialogue on the full range of impacts a community might expect.

The need to identify the means for transparent dialogue with affected communities is particularly timely given recent government announcements regarding Environmental Impact Assessment and NSIP planning. The Environmental Impact

Assessment (EIA) process plays a central role in informing the approval of Nationally Significant Infrastructure Projects (NSIPs) in the UK. It ensures that the environmental consequences of a proposed project are properly assessed and considered during decision-making under the Planning Act 2008. In January 2025, the UK's Labour Government confirmed intentions to overhaul the Environmental Impact Assessment process, streamlining the current assessment process by replacing Environmental Impact Assessments with Environmental Outcome Reports. According to the government, the transformed process would allow development to proceed at pace and in doing so unlock economic opportunity for UK workers, all while protecting the environment. Highlighting the motivation for a streamlined process that includes opportunity for local input the Chancellor of the Exchequer, Rachel Reeves, noted the government's continued requirement for local community consultation suggesting "Of course, there is room for robust debate and challenge and it's right that developers are required to consult local communities and expert bodies when making planning decisions" but that a revised process "will be simpler and much clearer, which will support growth by saving developers' time and money, whilst still protecting the environment" (Horton, 2025).

Results generated through use of the HEIA methodology can be used by communities to articulate proposed impacts to the people/place connections they care about during both the non-statutory and statutory consultation phase. The HEIA can also be used by the Examining Authority and/or the Planning Inspectorate to review and consider the effects a NSIP may have on heritage ecosystems, understanding that heritage ecosystems sustain the people/place connections that are vital to meeting the current Government's stated commitments to ensuring local people have a say in development that also protects the environment. The results of an HEIA could be used in a proactive approach to development engineering. For example, local people often hold detail knowledge about ground conditions and specific ecosystem functions (including water tables, location of previously unrecorded sensitive habitats, etc.) understanding of which are critical to development planning and engineering. Upfront integration of local knowledge gathered through the HEIA can be used to avoid costly design revision, and any unavoidable impacts can be meaningful addressed through mitigation strategies that are 'baked in' to all phases of a development.

2.2.3 A word about words

This methodology represents a departure from impact assessment methodologies that separate the measure of impacts to places from the assessment of impacts to people. Looking for terms that capture the accountabilities and outcomes of the reciprocal relationships between people and place (i.e. the heritage ecosystem) more generally has proven challenging. Within the HEIA we suggest using the following terms and definitions:

- Baseline: The conditions under which the heritage ecosystem currently exists.
- Habitat: A set of bio-physical conditions that support communities of living organisms, including humans. Habitats within the context of a heritage ecosystem include eco-cultural expressions of place.
- Heritage Ecosystem: The reciprocal relationships between people and place, and their collective pasts, presents, and futures.
- Impact: A positive or negative change to baseline conditions.
- Place: A living, storied, and relational entity---shaped through ongoing, reciprocal relationships between people, non-human beings, histories, heritages, and land. It is not merely a geographic location but an emergent and ethical space of connection, memory, responsibility and belonging.
- Valued Component: environmental, health, social, and economic conditions that define and sustain the heritage ecosystem.
- Valued Area: Specific places (e.g. specific, often named, woodlands) or types of places (e.g. woodlands in general) deemed important to sustain the Valued Components of the heritage ecosystem.

3. THE HEIA METHODOLOGY

The Heritage Ecosystem Impact Assessment (HEIA) methodology brings together theoretical frameworks of the heritage ecosystem and heritage ecologies with a 'whole system' approach inspired by Indigenous approaches to cultural impact assessment.

The HEIA methodology takes inspiration from the Cultural Impact Assessment methodology developed by the Mikisew Cree First Nation, the Canadian Environmental Assessment Agency, and the Firelight Group (CEAA and Mikisew Cree First Nation, n.d). Though the HEIA is inspired by this ground-breaking collaborative methodology, it does so in full recognition that impacts to Indigenous peoples' rights in Canada arise out of a distinctive socio-political and historical context. Given this fact, this project does not seek to replicate the CEAA and Mikisew Cree First Nation methodology's emphasis on Indigenous rights, instead we draw inspiration from the relational theory embedded in the methodology to craft questions that could be asked about people/place relationships as they exist within a UK context.

3.1 HEIA methodology: Three stages

The HEIA Methodology proceeds through three stages (Figure 1). Each stage builds upon the results of the last and for that reason should be conducted in order. Each stage is described in further detail below.

3.1.1 Stage 1: Establish baseline – identifying and recording the heritage ecosystem

Stages 1 and 2 should be dedicated to establishing a baseline and the context upon which to eventually assess impact (Stage 3). In Stage 1 the focus is on identifying and recording the heritage ecosystem. There are several steps required to do this, including identifying 'Valued Components'. Within a standard impact assessment context, Valued Components are defined as those aspects of biophysical and human environment considered by government, scientists, or other technical experts to have ecological, economic, cultural, social, historic, scientific, or other value. Valued Components identified in standard environmental impact assessments can include things like air, water, and vegetation. Within the context of a heritage ecosystem, Valued Components are defined differently since they look to capture valued aspects of *relationships* between and among people and place, rather than just the individual elements that experts' value within a particular biophysical or human environment. Thus, within the HEIA Valued Components are those tangible and intangible

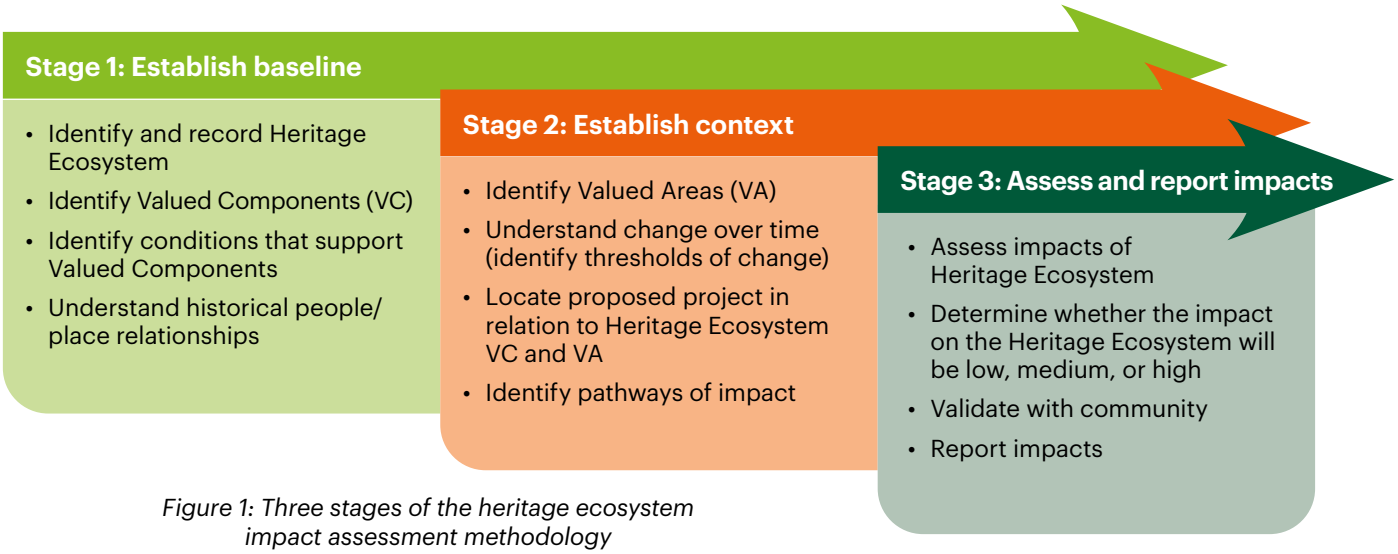

Figure 1: Three stages of the heritage ecosystem impact assessment methodology

aspects of people/place relationship identified by participants as essential to the definition, creation, and maintenance of the heritage ecosystem. It is also critical in Stage 1 to locate the *conditions* (i.e. the circumstances or factors) that maintain and sustain the Valued Components. Finally, a baseline created for Stage 1 should include an historical element that describes people/place relations over an identified period of time. This historical narrative establishes they ways in which the heritage ecosystem has changed in response to various environmental, societal, and economic stimuli over time. Guiding questions to identify heritage ecosystem Valued Components, conditions, and change over time that combine to define the heritage ecosystem include:

1. What relationships exist between people and place in a given study area?
2. What tangible and/or intangible conditions are essential to the creation of these relationships?
3. What tangible and intangible conditions are critical to sustaining a heritage ecosystem?
4. What relationships between people and place have existed over time?

The HEIA methodology relies on working with community members to capture elements of the heritage ecosystem and the conditions that support its creation and maintenance. There are several methods that can be used to do this, some of which are listed below:

- Back casting.
- Discourse Analysis (eg. of media sources, government policy).
- Community mapping.
- Ethnographic Observation.
- Focus Groups.
- Semi-structured Interviews.
- Visioning.
- Questionnaires.
- Combined Methods (eg. Rapid Ethnographic Assessment methods [REAm]).

There are many other community-based methods at the impact assessor's disposal, and we suggest accessing the following sources for further information: Leavy, 2014; Denzin & Lincoln, 2011; Taylor et al., 2015.

3.1.2 Stage 2: Establishing context – what people / place relations reveal themselves in the heritage ecosystem

Stage 2 should draw from Stage 1 results to contextualise the heritage ecosystem in all its forms. Key is identifying what landscape areas are vital to the relationships that sustain the heritage ecosystem. This includes identification of Valued Areas. The value of areas relative to the heritage ecosystem are signalled by characteristics like the intensity, frequency, and diversity of use, inter-generational use and the uniqueness of an area (is there a feature that is irreplaceable and/or unique to the landscape or the relationships?). The context should also explore existing people/place relationships.

Stage 2 should also introduce the project anticipated to impact the heritage ecosystem. This introduction includes documenting the physical proximity of the project to the heritage ecosystem, especially documenting proximity of the physical footprint to Valued Areas. In this stage there should also be an attempt to assess the most probable impacts, and the pathways that impacts could take. One way to predict a suite of those impacts is to locate a project of similar scope and design (a 'comparative project') and summarise the impacts realised through the planning, construction, and ideally operation of that project. Since governmental policy and environmental conditions can change over time, this 'comparative project' should be one that has taken place relatively close in time to the one being assessed.

Here are key questions to ask at this stage:

1. What Valued Areas are key to the heritage ecosystem?
2. What areas are particularly valued as essential to the future maintenance of the heritage ecosystem?
3. Thinking about change over time, what events or developments have dramatically changed the relationships at the heart of the heritage ecosystem? What happened as a result of those changes?
4. What is the proposed project?
5. Were is the proposed project located in relation to the Valued Areas?
6. How does the proposed project relate to the future vision of the heritage ecosystem?

7. What impacts (positive or negative) to the heritage ecosystem do community members anticipate will arise from the planning, construction, and operation phase of the proposed project?
8. How do community members perceive the project impacts?
9. Examining the comparative project, what impacts were anticipated and experienced by community members during planning, construction, and operation of the project?
10. Looking at the outcomes of the comparative project, what is the likelihood of anticipated impacts becoming a reality for the proposed project?
11. What are the pathways of impact?

3.1.3 Stage 3: Assessing project impacts – understanding how a proposed project can impact a heritage ecosystem

The third and final stage of the HEIA requires assessing the degree to which the proposed project will impact the heritage ecosystem. Baseline conditions identified at Stage 1, along with context established at Stage 2, especially that concerning change over time, help in determining the probable response to the change that will occur as a result of the proposed project. Understanding the probability of impacts by studying the impacts that definitely occurred in a similar project (comparative project) helps to both understand whether an anticipated impact is likely to occur, and if so, how the impact will occur ('the impact pathway'). At Stage 3 therefore, one examines the most likely impacts and determines whether they will have a low, moderate, or high level of impact on the heritage ecosystem. Consideration should be given to impact factors like spatial extent, magnitude, duration (temporal extent), and degree of reversibility (probability of mitigation/reversibility) for each identified impact. Key questions to ask in Stage 3 include:

1. What are the most likely impacts for each project stage (planning, construction, operation)?
2. What is the spatial extent, magnitude, duration, and degree of reversibility of each identified impact?
3. How will impacts arising from each project stage affect the heritage ecosystem?

We turn now to the pilot study to better explore the feasibility of the HEIA methodology, and to assess how this methodology might be applied and improved upon in future.

4. PILOT STUDY: EAST WEST RAIL AND A SOUTH CAMBRIDGESHIRE HERITAGE ECOSYSTEM

This document presents the results of a heritage ecosystem impact assessment of a Nationally Significant Infrastructure Projects (NSIP) – in this case the proposed Cambourne to Cambridge segment of the East West Rail (EWR) project (Figure 2). This pilot study had three objectives:

1. Attempt to identify and make visible a heritage ecosystem within a portion of South Cambridgeshire.
2. Assess the efficacy of the proposed HEIA methodology within the context of the EWR project impacts on that heritage ecosystem.
3. Provide South Cambridgeshire village community members participating in the study with an alternate avenue through which to communicate their assessment of experienced and anticipated impacts of the proposed EWR project.

4.1 Why pilot the methodology in South Cambridgeshire?

UK Government commitments to Nationally Significant Infrastructure Projects (NSIP) like High Speed Rail 2 (HS2) and EWR signal its belief in the correlation between investment in transportation infrastructure and major economic growth. This belief is not without merit since major infrastructure projects are known to create short term jobs, especially during construction, and facilitate other forms of development over the longer term (Lerner, 2018). The widely held assumption that infrastructure brings economic benefit is especially held with respect to linear transportation developments like new rail and roadways, the belief being that they facilitate the movement of goods, services, and people between existing hubs and otherwise less accessible or previously less developed areas (Chen & Vickerman, 2018).

Linear developments come with a particular suite of impacts, many of which are cumulative and long-term (Cascetta, et al. 2020; Howitt & Jackson, 2020; Raiter et al., 2017). Linear transportation projects are documented to facilitate a range of cumulative impacts including increased urbanisation and industrialisation (Hull, 2012; Yu et al., 2022). The more direct impacts arising from linear development construction are better documented and include a wide range of environmental and socio-economic changes, that when properly mitigated can alleviate some negative impacts and enhance positive benefits.

Though they often result in high levels of impact, the negative impacts of linear developments are notoriously difficult to effectively mitigate (Van Der Ree et al., 2015). Like the infrastructure itself, project budgets for linear development are spread over a range of unique geographies and equally unique communities, each with their own specific mitigation requirements. Thus, it can be difficult to effectively mitigate impacts to these unique places. Instead projects often default to 'one size fits all' mitigation strategies (such as curb/rail side tree planting, or roadside fencing), many of which fail over the long term (Salisbury et al., 2022; Sloman et al., 2017; Ward et al., 2015). Other significant barriers to meaningful mitigation arise from lack of data about long-term post-construction or operations phase impacts (Gilhooly et al., 2019; Glista et al., 2009). For example, the impacts of railways on wildlife population movement and mortality are not well understood (Borda-de-Água et al, 2017; Dorsey et al., 2015; Popp and Boyle, 2017). In summary, lack of specific data results in generalised mitigation efforts whose efficacy remains unproven (Ward et al., 2015).

4.2 The proposed project: East West Rail

In 2017 the Department for Transport (DfT) formed the East West Rail Company (EWR) and tasked them with developing, designing, and delivering a rail link between Oxford and Cambridge. As currently conceived, the overall EWR project requires the upgrading of existing rail lines between Oxford and Bedford, and construction of a new rail line between Bedford and Cambridge (Figure 2).

The portion of the East West Rail project that is the focus of this study concerns the segment planned to connect the South Cambridgeshire village of Cambourne with the city of Cambridge (Figure 2). From Cambourne, the railway is planned to extend eastward, crossing the A428 then proceeds south east towards Cambridge. The line will approach Cambridge from the south. The new railway would continue around the southern edge of Harston joining the Shepreth Branch Royston Line by a new Hauxton Junction. Then the eastbound EWR alignment would continue north integrating with the West Anglia Main Line at Shepreth Junction. Apart from a new station at Cambourne, and the Cambridge South station currently under construction independent of EWR, no other stations are planned along the segment of the route that is the focus of this pilot study.

EWR (2024) have thus far conducted three public non-statutory consultations. The first consultation, launched in 2019, asked the public to consider 5 proposed route options for the new rail segment linking Bedford with Cambridge. In 2020 the Secretary of State announced Route Option E as the preferred option (EWR 2024). In 2021 a more detailed set of 9 proposed alignments within Route Option E was circulated for public input. In combination the 2019 and 2021 public consultation periods garnered 100,000 responses and the identification of 160,000 individual issues (EWR 2024). However, before announcing the results of the consultation, in 2021 the Department for Transport and EWR Co. initiated the Affordable Connections Project to assess the strategic case for the project (EWR 2024). Based on the results of the Affordable Connections Project, which confirmed there remained a strategic case for the project overall, combined with the result of the 2021 public consultation, in May 2023 EWR announced that Option E remained their preferred route. Most recently EWR has engaged in a third non-statutory consultation, held from 14 November 2024 to 24 January 2025. This latest stage of consultation provided further detailed preliminary design within Route Option E, seeking the public's feedback on rail alignment, station design, road and river crossings, solutions for existing level crossings, and avoidance or reduction of environmental impact (including mitigation options). There will be a statutory consultation held before EWR apply for a Development Consent Order (DCO). The DCO is part of the process that the government has put in place to approve Nationally Significant Infrastructure Projects (NSIP). At the time of writing, the statutory consultation phase is scheduled for late 2025 or early 2026 (Longhorn, 2025).

In response to some of the many concerns raised by local village residents and farming families residing within the area impacted by the Comberton to Harston segment of the longer Cambourne to Cambridge alignment, EWR (2024, p. 198) have made some broad commitments including suggestions that they will:

- Conduct a landscape and visual impact assessment to better understand impacts and devise appropriate mitigation. They do however concede that plans for high embankments and viaducts will likely impact existing views. In response to public feedback a proposed tunnel beneath Chapel Hill will further reduce visual impact.
- Assess impacts to water quality, groundwater, and water characteristics including proposed crossings over chalk streams and institute a formal code of conduct and practice to mitigate construction impacts on water courses and groundwater.
- Mitigate biodiversity and habitat impacts, particularly with regard to the sensitive barbastelle bat populations, through measures to ensure habitat connectivity and foraging enhancement. Measures will include a tunnel in place of a cutting at Chapel Hill.

A detailed assessment of the alignment and its proposed impacts, along with EWR responses to their concerns, has been carried out by various concerned community groups including but not limited to, Cambridge Approaches and Bedford for Re-consultation (BFARe). These reviews have been conducted both within and outside of formal consultation processes initiated by EWR. Rather than conduct an assessment of EWR's proposals themselves, the HEIA project was designed to capture community perspectives on impacts they

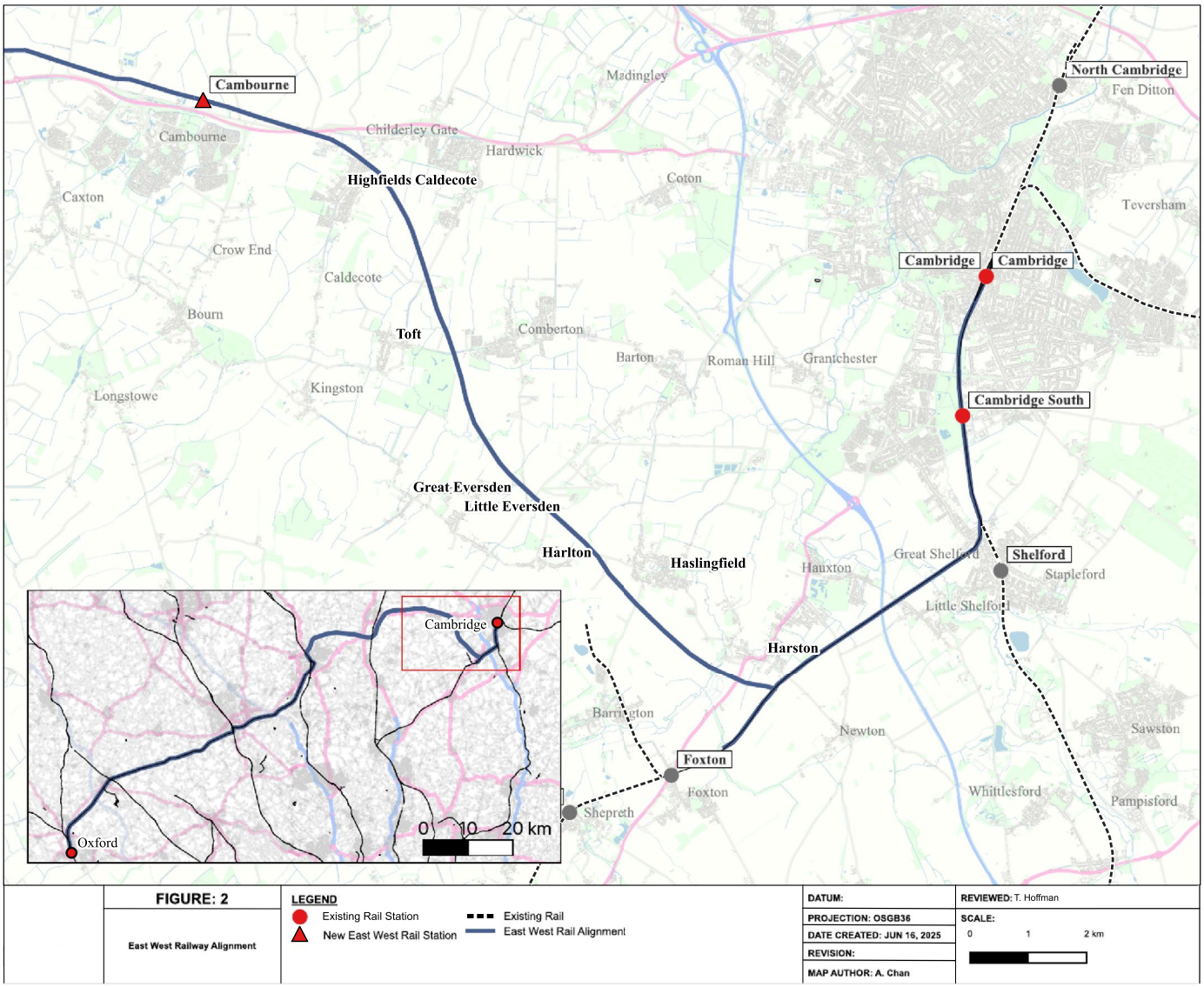

Figure 2: EWR preferred route (Cambourne to Cambridge) with inset showing the entire EWR corridor

have experienced and/or anticipate in hopes that doing so will provide an opportunity to reveal more nuanced assessments of impact from those who stand to be indirectly and directly impacted with the goal, should the project proceed, of providing more responsive mitigation options. The following sections of this report detail the impacts to the heritage ecosystem as identified by study participants.

4.2.1 Stage 1: Establish baseline – identifying and recording a South Cambridgeshire heritage ecosystem

What relationships exist between people and place in South Cambridgeshire?

In 2022 the study team reached out to community groups actively challenging the underlying logic of the EWR Project, and more specifically the assumptions used to justify the selected route. Through participation in community-based protest groups such as Cambridge Approaches and the BFARe, local people were signalling to EWR their desire to engage in crucial conversations about their concerns. Having spoken to community members of affected villages, the study team felt the HEIA may be of service in efforts to articulate a more fulsome understanding of EWR's potential impacts on the places local people care about. The following sections first describe the scope of the East West Rail project as it affects South Cambridgeshire and outlines the steps we took to engage with community members to begin the process of articulating their heritage ecosystem.

The first stage of the pilot study looks to identify the heritage ecosystem thereby establishing a

baseline upon which to assess impacts. Here we outline the methods and results of Stage 1 of the pilot study. To facilitate reader understanding of the overall methodological approach of an HEIA, results are presented as responses to the key questions outlined in the first section of this report.

4.2.2 Methods: Mapping and coding to identify the heritage ecosystem

Since the HEIA looks first to understand the relationships that exist amongst people and place, we selected to undertake a community mapping exercise asking participants to reflect on the relationship they have with the areas in which they live, work, and play, and to tell us about what they value about those areas and why. Community mapping also provides opportunity for people to indicate what places and conditions they believe to be of value to other species, such as biodiverse habitats or intact migration routes. We ordered base maps consisting of 1:10,000 scale OS maps centred on the village of Haslingfield and the town of Cambourne. The proposed rail corridor route was not included on the map, nor were there any boundary restrictions placed on the maps (apart from the map edges themselves). This allowed participants to consider areas of import to them without the imposition of 'study area boundaries' linked to East West Rail.

The community mapping for the HEIA proceeded as follows. Having informed EWR representatives of our presence and intentions, we set up a table outside EWR community information sharing events in the following villages on the corresponding dates:

- Haslingfield: 16 October 2022.
- Little Eversden: 22 June 2023.
- Harston: 26 June 2023.
- Cambourne: 11 July 2023.

We encouraged people entering or emerging from the EWR session to stop by our table and indicate on a map places that are of significance to them. We shared a project information sheet and confidentiality form and then provided each participant with a discrete set of numbers written on a lined sheet of paper. We laid a 1:10,000 scale Ordnance Survey map on the table, covered it with a clear plastic sheet, and provided permanent markers to participants, encouraging them to circle or otherwise indicate areas of significance on the clear overlay. Each time they indicated an area they labelled it with one of their assigned numbers, then wrote notes on the lined sheet regarding each area's significance next to the corresponding number. The mapping session produced maps of overlapping polygons and lines (Figure 3), along with corresponding notes.

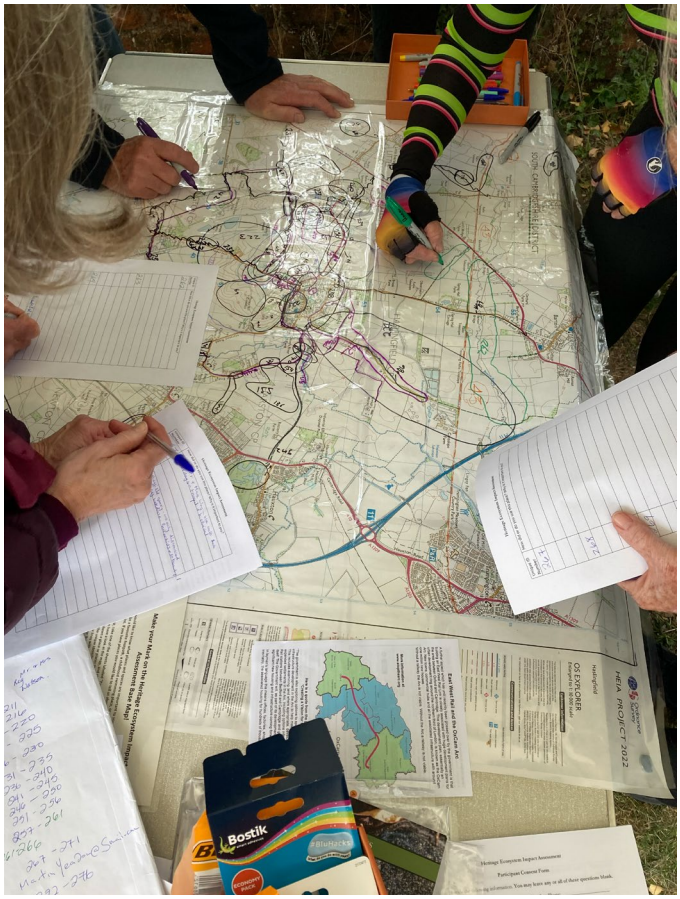

Figure 3: Community mapping session

The handwritten notes from each participant for each mapping session were transcribed and entered into an Excel spreadsheet with their corresponding participant number, polygon numbers and associated remarks. To maintain confidentiality each participant was given a discrete participant number and their names were disaggregated to another file that is kept on a password protected database at the University of Cambridge. The transcribed excel sheets with participant number, polygon number, and associated notes were imported into a qualitative data analysis software (NVivo R1 2020) for data analysis. Disaggregated attribute data for each participant (in this case basic demographic data such as age, gender, residential postcode) derived from participant consent forms was entered into NVivo for later analysis.

During the mapping exercise we asked participants to indicate if they would be willing to participate in

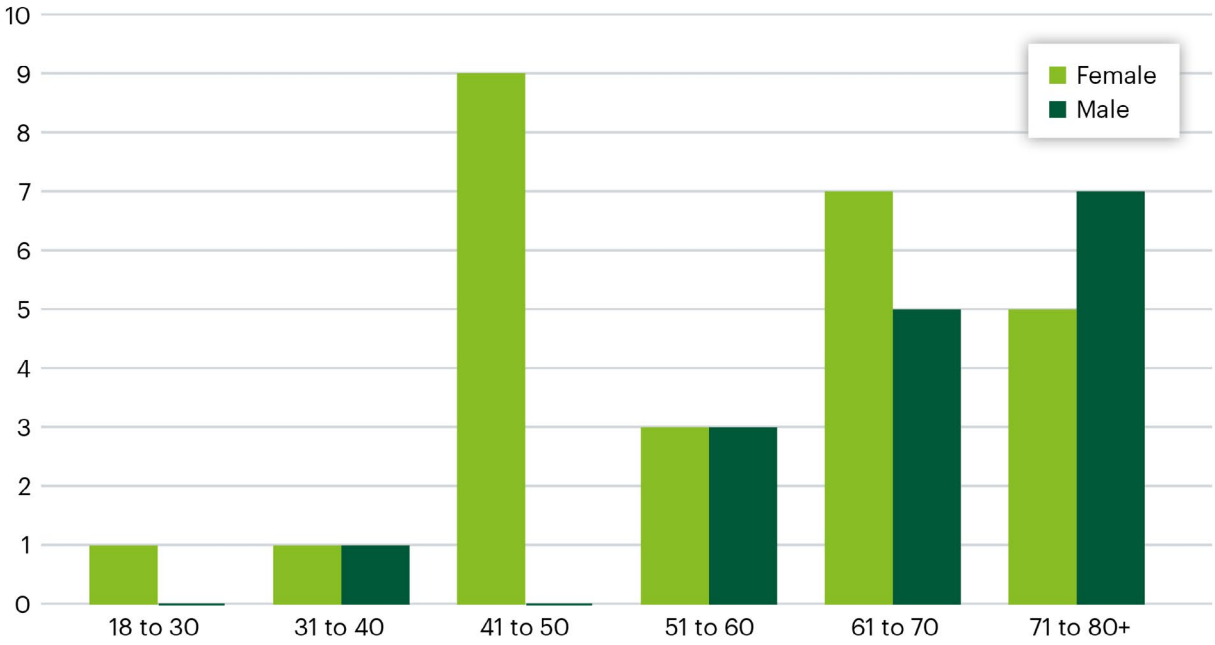

Figure 4: Participants by age and gender

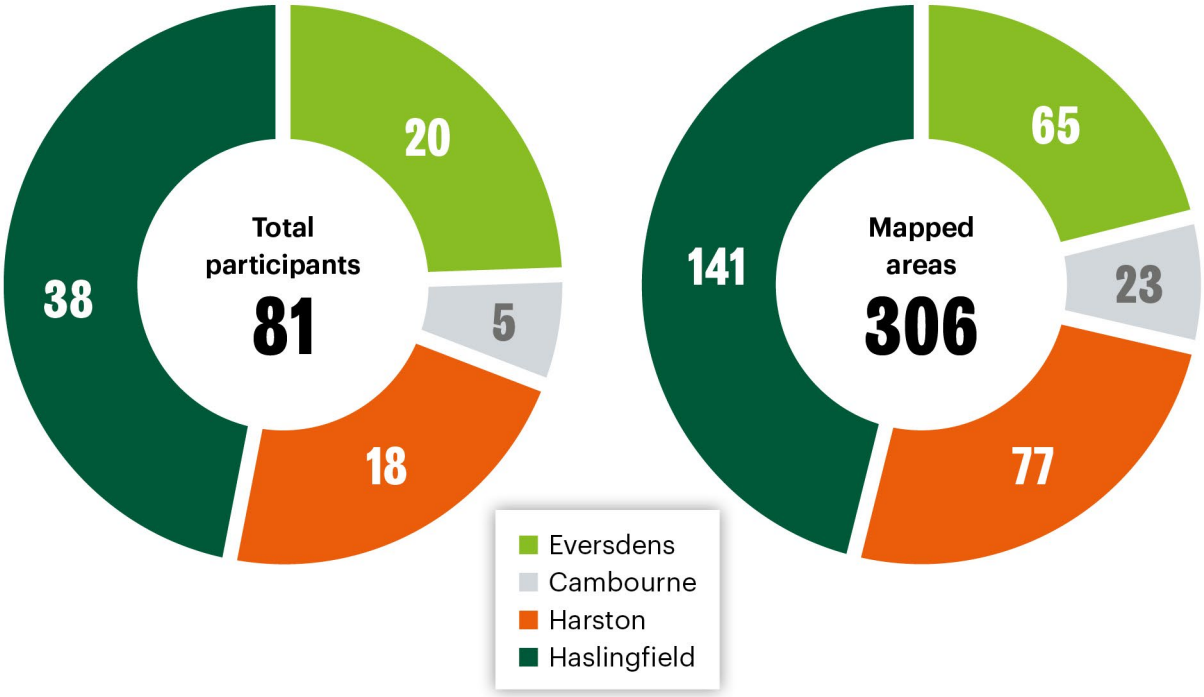

Figure 5: Number of mapped areas contributed by participants for each mapping session

a follow up interview. In the following months, four interviews totalling 8 hours of interview time were conducted with 6 participants, three of whom are local farmers, and three of whom are residents of South Cambridgeshire villages. Interviews were recorded and transcribed then imported into NVivo for analysis. Consent forms were obtained from all interview participants, though names were disaggregated from transcripts so as to retain participant anonymity.

Qualitative analyses were used to identify the relationships between and among people and places that constitute a heritage ecosystem. Data analysis in NVivo began with line-by-line coding using a hybrid

method (i.e. both inductive and deductive coding).[1] Following careful, repeated reading of community mapping contributions and interview transcripts, descriptive codes were used to label places, structural codes to identify impacts, and values codes to identify the attitudes, beliefs, and values participants expressed about their relationships to the places in which they live. A coding guide, which includes definitions, is included in Appendix A, but codes are listed in Table 1. Successive reading and multiple rounds of increasingly refined coding followed by matrix queries and word frequency analyses were used to refine results and locate Valued Components. Mapped polygons generated during community mapping were transferred onto digital base maps using QGIS. Polygons were labelled with values codes and analysis of layering of polygons was used to identify Valued Areas. These map results are illustrated and discussed in later sections of this report.

4.2.3 Community participation: Mapping results

Community mapping recorded 306 mapped polygons from a total of 81 participants.

Of those (n=42 or 56% of participants) that provided basic demographic information, most were aged 41 or older, and more females than males contributed to the mapping exercise (Figure 4).

Maps drawn at the Haslingfield session had the greatest number of participants (n=38) who recorded 141 mapped areas, followed by Harston with 18 participants providing 77 mapped areas, and Little and Great Eversden ('the Eversdens') who had 20 participants and who contributed 65 mapped areas. Cambourne had the fewest number of participants, with a total of 5 participants contributing 23 mapped areas (Figure 5).

4.2.4 Identification and comparison: Coding results

Comments associated with mapped areas were coded in NVivo. Table 1 lists the type of coding used, what each code identifies, and the codes themselves. For example, map comments referred to types of places on the landscape (e.g. Footpath, Historic Site, House, Wood) and others identified by their use (e.g. Driving Route/Roadway, Play Area, Walking Route) were coded to 15 descriptive codes. Structural coding (in this case a predetermined set of terms used to identify impacts) resulted in 11 codes. Finally, value coding, that is coding that looks to capture behaviours, attitudes, beliefs, and values, resulted in 7 overarching value codes. Word frequency searches and matrix comparisons across codes (especially place and value codes) resulted in the articulation of Valued Components and Valued Areas. These processes and their outcomes are described in further detail below.

Coding type	**Descriptive codes (inductive coding)**
Code for	**Place (type)**
Codes	
Driving Route/Roadway	
Farm	
Footpath	
Habitat	
Historic Site	
House	
Local Place name	
Orchard/Meadow/Forage	
Play Area	
Religious or Spiritual	
Viewpoint	
Village Amenity	
Walk/Run/Cycle Route	
Water	
Wood	

1 Coding is the process of systematically labeling and categorizing data to identify or reveal themes, patterns, and relationships. Inductive coding is a data-driven approach where codes (labels or tags) are assigned to themes or other meaningful patterns that emerge from the data itself, whereas deductive coding uses pre-defined codes based on existing theories or frameworks.

Coding type	Structural codes (deductive coding)
Code for	Impacts
Codes	
Access Loss	
Alienation and Marginalisation	
Arable Land Loss	
Community Disconnection	
Habitat Loss	
Home Loss	
Noise	
Pollution and Degradation	
Safety	
Species Loss	
Traffic Change (increase/detour)	

Coding type	Values codes (inductive coding)
Code for	Values (relationship)
Codes	
Connectivity People (CP)	
Connectivity People Place (CPP)	
Connectivity Places (CPL)	
Legacy Inter-generational (LIG)	
Legacy Inter-Species (LIS)	
Wellbeing Human (WBH)	
Wellbeing Place (WBP)	

Table 1: List of inductive and deductive codes by coding type

4.2.5 Methods for mapping and analysing the heritage ecosystem

The base map for Figures 9, 10, and 11 was compiled from publicly available data sources listed in Appendix B. Scans of the original physical OS base maps were then pieced together and imported into QGIS. These were subsequently georeferenced with multiple points. Digital polygons were replicated from the hand-drawn mylar overlays provided by the participating community members. Polygons were given new unique identification numbers and assigned tags for one or more of the Valued Component codes (i.e. CP, CPP, CPL, LIS, LIG, WBH, WBP). This process was repeated for each data set (Cambourne, The Eversdens, Haslingfield and Harston).

Polygons from each participant data set were allocated different colours and plotted onto the digital basemap, and one map showing all polygons for each Valued Component and sub-component (Connectivity, Legacy, Wellbeing) were plotted onto separate maps. Next, for each map, polygons were colour coded to reflect the place type associated with each polygon.

Finally, an image of the railway plan derived from EWR publicly available engineering plans was loaded into QGIS and georeferenced in order to create a new vector layer for the proposed rail alignment and its associated construction areas.

4.3 Stage 1: How coding and mapping results reveal the heritage ecosystem

What tangible and/or intangible conditions are essential to the creation of a heritage ecosystem?

Analysis of mapped and coded results reveal three primary Valued Components: Connectivity, Legacy, and Wellbeing. Valued Components are the tangible and intangible aspects of relationship formation and maintenance essential to the definition and creation of the heritage ecosystem. In this case Valued Components were revealed through repeated reading and coding of mapped and interview data. The Valued Components of the participants' heritage ecosystem are described in further detail below.

Connectivity: A consistent theme throughout all data, participants refer to connectivity as the ability to create and sustain connection. This can refer to the ability to maintain a physical connection between places (coded as 'place connectivity'), with other human beings (coded as 'people connectivity'), or with a place and its inter-species dimensions. This third connectivity also refers to the value of seeking, feeling, experiencing

connection with the natural world (coded as 'people place connectivity'). Participants most frequently mention the value they place in having opportunities to connect with place. Of the 192 areas participants indicated as important for connectivity, 115 (69%) were places they felt were vital to sustain their relationship with the natural world. Participants valued connectivity between people (42 or 21%), and places (35 or 18%) as nearly equal priorities.

Legacy: This Valued Component references actions, activities, behaviours, choices, and places that foster, support, sustain intergenerational transmission of knowledge and/or experience (intergenerational legacy). Legacy can be between species, for example between people who steward or protect habitats for flora and fauna over generations of human and other lives (inter species legacy). Legacy can also reference the act or desire for human inter-generational experience or knowledge transmission between family members. Legacy has an important time dimension, since it joins up what are usually fragmented categories of past, present, and future. For example, participants value the act of walking along paths that have been walked for centuries and caring for land over generations. These acts of connecting with the legacies of the past are deeply intertwined with the desire to ensure these same acts (and the places they are connected to) are available to future generations. Interestingly, foraging of wild foods and/or harvesting of foods from allotments or orchards for example often featured as a practice through which intergenerational knowledge was passed on. Participants value very highly the places (hedgerows, meadows, forests) and species (e.g. sloe bush [blackthorn], blackberry bushes, sweet chestnut trees, elderberry) that provide them with seasonal wild foods. Of the 91 areas participants suggested were important for inter-generational knowledge transmittal or experience, 72 (79%) were identified as areas vital to experiences that pass along information to their own family members or other people in the village. The remaining 19 areas were identified as important to multiple generations of other species including plants and animals.

Wellbeing: This Valued Component references places, activities, feelings, that are known or perceived to support mental and physical health. Wellbeing can apply to relationships within the heritage ecosystem that support human health (in the case of places and relationships that sustain mental-health for example), but it also applies to the conditions that support the wellbeing of wildlife and/or plant species, whether they be rare or everyday. Participants identified 92 areas valued as places important to the creation and maintenance of wellbeing. Most of the places (69 or 79%) were identified as important to sustaining their own or other peoples' mental and physical health. The remaining 23 areas were identified as places (habitats for example) that support the wellbeing of other species.

The matrix analysis function in NVivo compares one set of variables against another to reveal patterns. Matrix analysis comparing Valued Components (connectivity, legacy, wellbeing) against place type (e.g. footpath, woodland, play area) revealed conditions (the circumstances or factors) that participants felt created, fostered, and sustained the relationships key to each valued component. The matrix analysis results are explained further in Section 4.3.1 below.

4.3.1 Conditions of the heritage ecosystem

What tangible and/or intangible conditions are essential to sustaining a heritage ecosystem?

Having established Valued Components and Valued Areas, it is also critical at this stage to locate the conditions that maintain and sustain the heritage ecosystem. Conditions can include the ongoing presence of specific Valued Areas. The conditions that participants identified as critical (see 4.4.1 below) to sustaining the Valued Components of the Heritage Ecosystem are listed below.

4.3.2 Conditions that sustain connectivity

The conditions that facilitate connectivity between and among people include:

- Maintained presence of physical routes that encourage or facilitate 'everyday' encounters with other people.
- Presence of a variety of village facilities and amenities.
- Presence of, and access to, formal (e.g. village green) and informal (e.g. riparian areas along stream banks) common areas.

The conditions identified as supporting connectivity between places (i.e. between villages, village amenities) include:

- Networks of footpaths, bridleways.
- Established and maintained roadways for vehicles and cycling.

The conditions identified as supporting connectivity between people and place (where place includes landscape features, wildlife habitat, species of flora and fauna) include:

- Presence of intact habitats.
- Intact wildlife corridors.
- Intact waterways.
- Game trails and flyways.
- Viewpoints.
- Routes that facilitate opportunities to encounter wildlife (e.g. footpaths, bridleways).
- Private gardens or allotments.
- Fields and meadows.
- Orchards.

4.3.3 Conditions that sustain legacy

The conditions that foster the intergenerational transmission of knowledge between and among people, and the indicators that can be used to identify those conditions, include:

- Consistency of place over time.
- Consistency of access over time.
- Consistency of (historic) practice over time.

The conditions that participants feel is required to facilitate intergenerational knowledge of and between species (flora and fauna) include:

- Intact healthy habitats.
- Connected habitats.
- Availability of fruit, berry, mushroom, and root species in non-polluted areas that provide healthy forage.

4.3.4 Conditions that sustain wellbeing

Participants suggest the following conditions are necessary to the maintenance of places, activities, feelings, that are known or perceived to support mental and physical health.

Conditions required to support human wellbeing include:

- Places that provide opportunities to connect with others through 'everyday' encounters (e.g. walking on footpaths) or through more formal engagement.
- Places that provide opportunities to view and/or encounter wildlife.
- Presence of and access to cycling, running, and walking routes.

Those conditions identified as required to support wellbeing of places and the species that rely on them include:

- Ecosystem integrity (intact habitats that are safe from historic, ongoing, and planned disturbance, e.g. Sites of Special Scientific Interest [SSSI], Local Nature Reserve [LNR]).
- Ecosystem longevity.

4.4 Stage 2 Establishing context

What Valued Areas are key to the heritage ecosystem?

What areas are particularly valued as essential to the future maintenance of the heritage ecosystem?

4.4.1 Identifying heritage ecosystem 'Valued Areas'

Working with what the participants identified as Valued Components and the conditions required to support each of them, the next step is to identify areas on the landscape that participants consider as 'Valued Areas'. Valued Components are linked to mapped areas (since they were derived from comments provided by participants during the community mapping) and once in GIS all polygons were overlaid onto an Ordinance Survey base map. Key Valued Areas were identified by looking at frequency (how many landscape features/places were coded to Valued Components), intensity (how often participants indicate they use a particular area or landscape feature), and rarity (how many of the same landscape feature or area are included within the heritage ecosystem landscape). The following sections look at how, when cross-referenced with place and value codes, measures of frequency, intensity, and rarity, reveal Valued Areas.

Frequency

The frequency with which certain places are associated with different codes reveals interesting patterns. These patterns are described here, however, their significance within the context of the Heritage Ecosystem Impact Assessment are discussed in Section 4.6 of this report.

The following figures illustrate the number of times a place type was coded against a Valued Component code. For example, walk, run and cycle routes (place type) were interpreted as associated with Valued Components for Connectivity Place (22 times), Connectivity People (17 times) and Connectivity People Place (55 times) (Figure 6). Thus, the frequencies represented in the charts below represent the number of times places were assigned different codes, rather than the number of times they were mentioned by participants. In addition, the charts below list the frequency of place types coded for each Valued Component.

Place types most frequently coded as Valued Components of Connectivity indicate that participants view walk, run, and cycle routes as key to sustaining connectivity between people (e.g. neighbours, family members), between people and places (e.g. between children and play areas, community members and foraging places), and between places themselves (eg. between neighbouring villages) (Figure 6). One participant noted that "walks are very important and part of the rural landscape –they link our villages" (P57). Viewpoints are also frequently mentioned in comments related to creating and sustaining connectivity between people and place, as are woods, orchards, meadows, foraging places, and natural habitats. One participant writes:

> *The view and peace from top of our field. To get away from it all...we picnic up here. We invite all that we know to come up here to rest too. It's a refuge for everyone. There are so few high places in this area. Getting up high is so valuable. It is my place of PEACE [sic] and [it is for] many others too. It's a community asset we want to share. Foxes, badgers, bats, rabbits, muntjac, pheasants, buzzards, red kites, kestrels, skylarks, all live here! (P16).*

Village amenities are frequently mentioned as key to sustaining connectivity between and among people as they are often the sites of community gatherings.

Places most frequently assigned Legacy codes suggest that walk, run, and cycle routes play an important role in sustaining intergenerational contact (Figure 7). Water (creeks, ponds, streams, brooks), play areas, and woods are also listed as nearly equally important to inter-generational legacy. One participant writes about Hardwick Wood "...full of dens where kids make huts out of found wood. When they grow up, they'll take their kids there to do the same" (P81). Where inter-species legacy is concerned, habitat, water, and wood are the place types most frequently associated with sustaining connection between and among species (including human / wildlife interaction), though play areas and historic sites are also mentioned.

The creation and maintenance of human wellbeing is overwhelmingly associated with walk, run, and cycle routes, though viewpoints also feature significantly in human wellbeing (Figure 8). One participant identified a "regular walk both with my family and on my own. Place to get away from troubles. Enjoy the peace and quiet. I had a time when I really struggled with anxiety and this walk was one of the things that helped me recover" (P3). Many participants reflected on the link between their wellbeing and access to the countryside during Covid-19 lockdowns. With respect to the importance of a local wood to human wellbeing one participant noted "Lovely wood, pretty, ancient. The people of the village practically decamped here during lockdown. Beautiful bluebell wood in the spring. Children particularly played here during lockdown, making dens with the wood, it's a wonderful resource." Wellbeing of places themselves are associated (p7) with habitat areas, though walk, run, and cycle routes are also identified as being associated with the maintenance of the wellbeing of place.

Intensity (how regularly do participants use certain areas?).

Place types used most intensively are listed below in descending order, from those visited daily to those visited less regularly, as reported by the majority of participants:

- Footpaths and other walking routes (daily)
- Village Amenities (rec grounds, church, allotments etc.) (daily or weekly)

- Historic sites (including religious sites) (weekly)
- Play Areas (weekly)
- Woods (weekly).
- Habitat areas (nature reserves) (weekly).
- Viewpoints (weekly).
- Water (seasonally).
- Orchard, meadow, forage areas (seasonally).
- Farm (permissive access or regularly via public right of way).

Rarity

An assessment of rarity focuses on how many of the same landscape feature (e.g. hill, quarry) or place type (e.g. wood, footpath) are featured within the heritage ecosystem. Place types considered by participants to be rare and vital include hills and woodland. Other place types, such as footpaths and water courses, are also vital but more abundant so are not included here as 'rare'.

Hills are particularly valued since they are a rare feature in the otherwise flat and uniform South Cambridgeshire countryside. From hills one has "views from all over, phenomenally important. Good for mental health, as well as physical..." (P57). Another participant notes the significance of the view offered from the base of a rare hillside "I've got an open view of the open countryside up the hill. Most of Cambridgeshire is quite flat so to have the view of the rising hill is important...I love the view..." (P71). Similarly, another participants notes that "I especially love the top of the walk [up the hillside] where you can look out over the countryside ([from where you] can see Addenbrookes, landmarks of Cambridge in the distance), but mostly it has a bracing wind that I

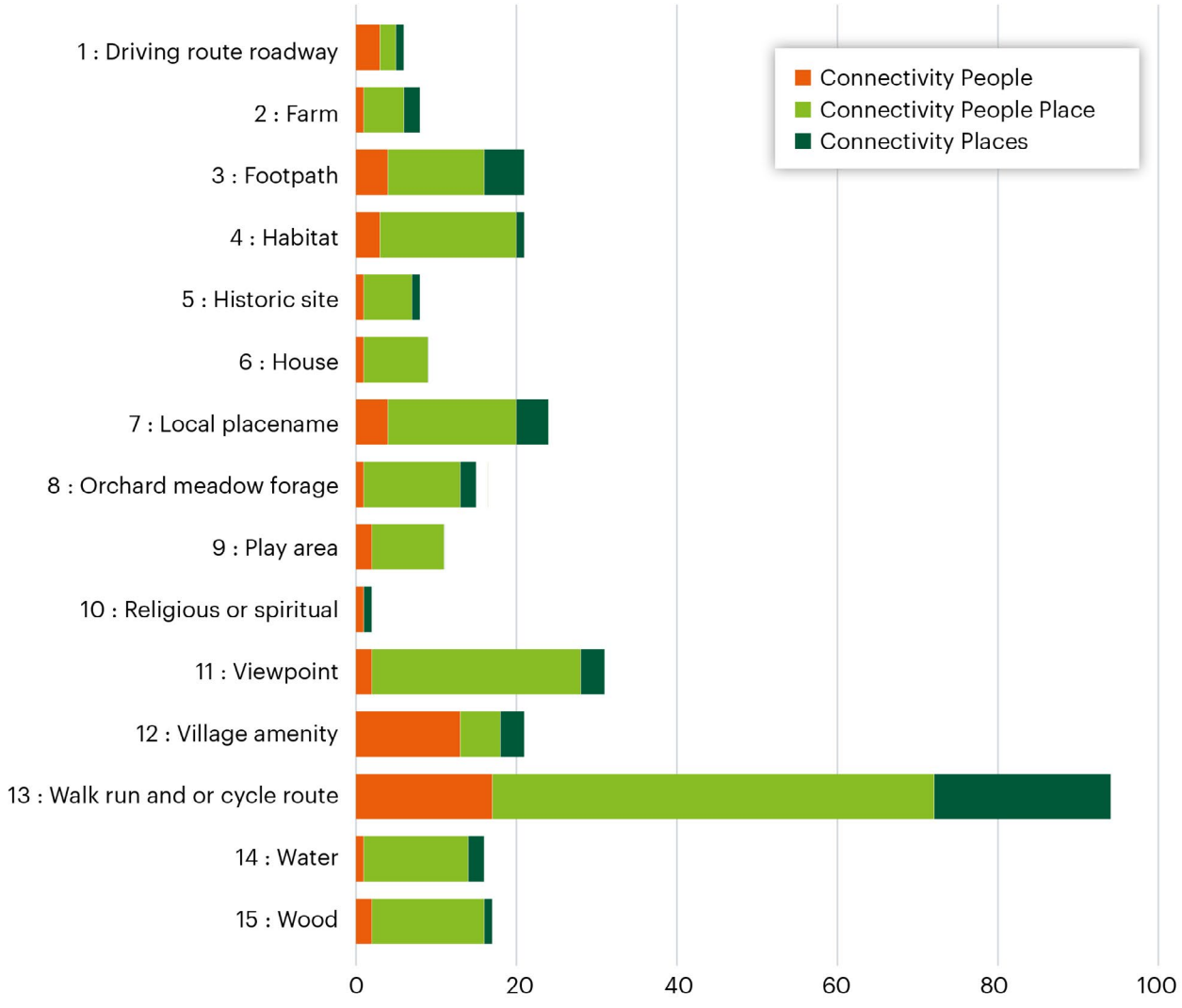

Figure 6: Valued area types supporting connectivity

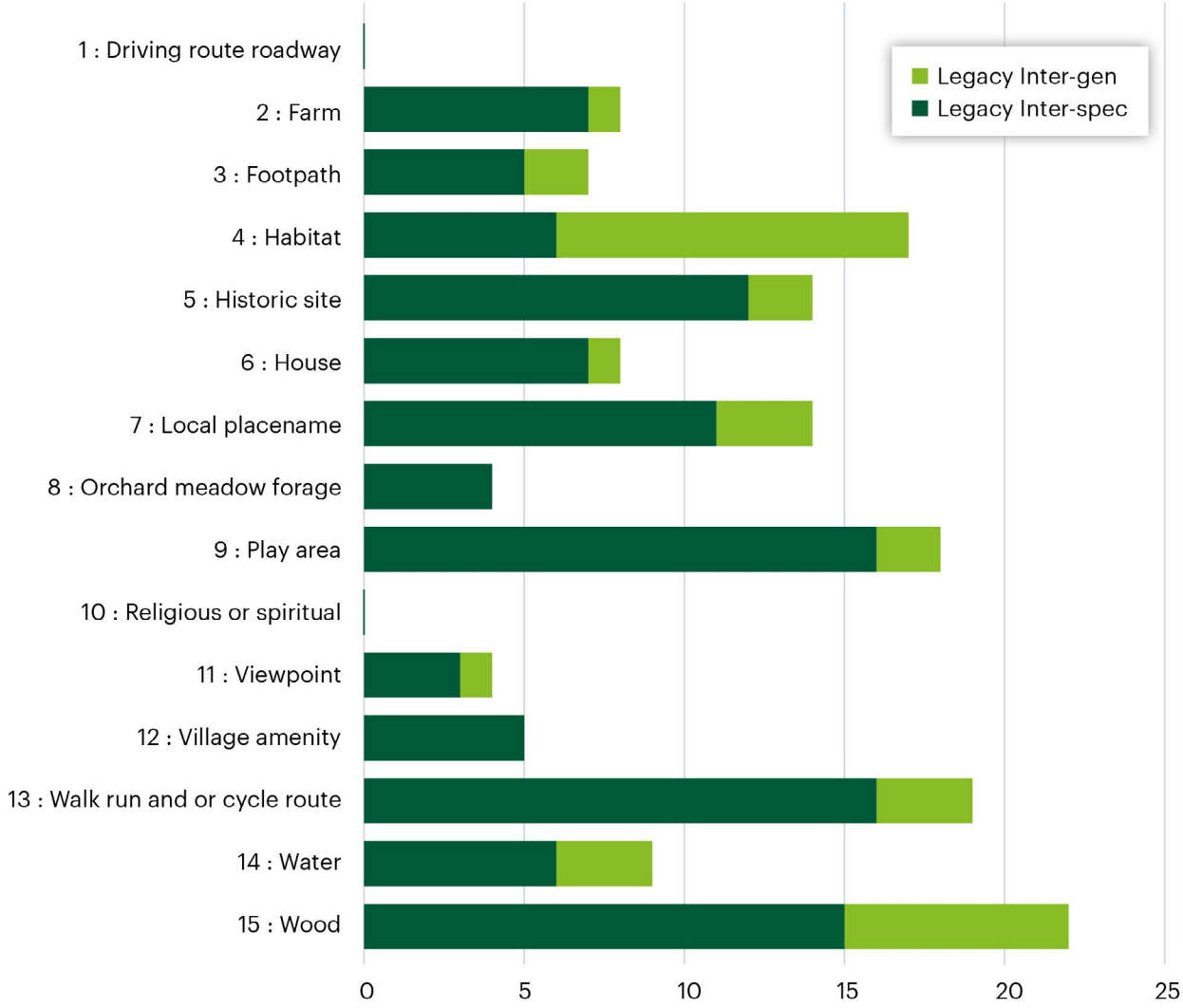

Figure 7: Valued area types supporting legacy

just love" (P3). Hills mentioned frequently as unique markers of the heritage ecosystem include:

- Chapel Hill.
- Money Hill.
- Mare Way.
- The Drift.
- Rowley's Hill.
- St. Margaret's Mound.
- 'Claypit hill'.

Woodlands are also a relatively rare feature of the South Cambridgeshire countryside which, as we have established, is dominated by farmland. Woodlands are valued by participants because of their rarity, but also because they tend to be small, often fragmented, and for these reasons particularly vulnerable to impact. Wooded areas do not have to be ancient to be valued though participants suggest that ancient woodlands are irreplaceable and therefore more vital to the heritage ecosystem. Woodlands are valued as important refuges for plants and wildlife but also as vital to human wellbeing, providing opportunity for people to connect to nature, one another, and to pass along that connection to their children. Participants pointed out the significance of the following woods and wooded areas:

- Hardwick wood.
- Harlton wood.
- Great Eversden wood.
- Wooded areas on Mare Way.
- Haslingfield wooded areas (along Back Lane).
- Harlton Woods.
- Butler's Spinney.
- Rectory wood.

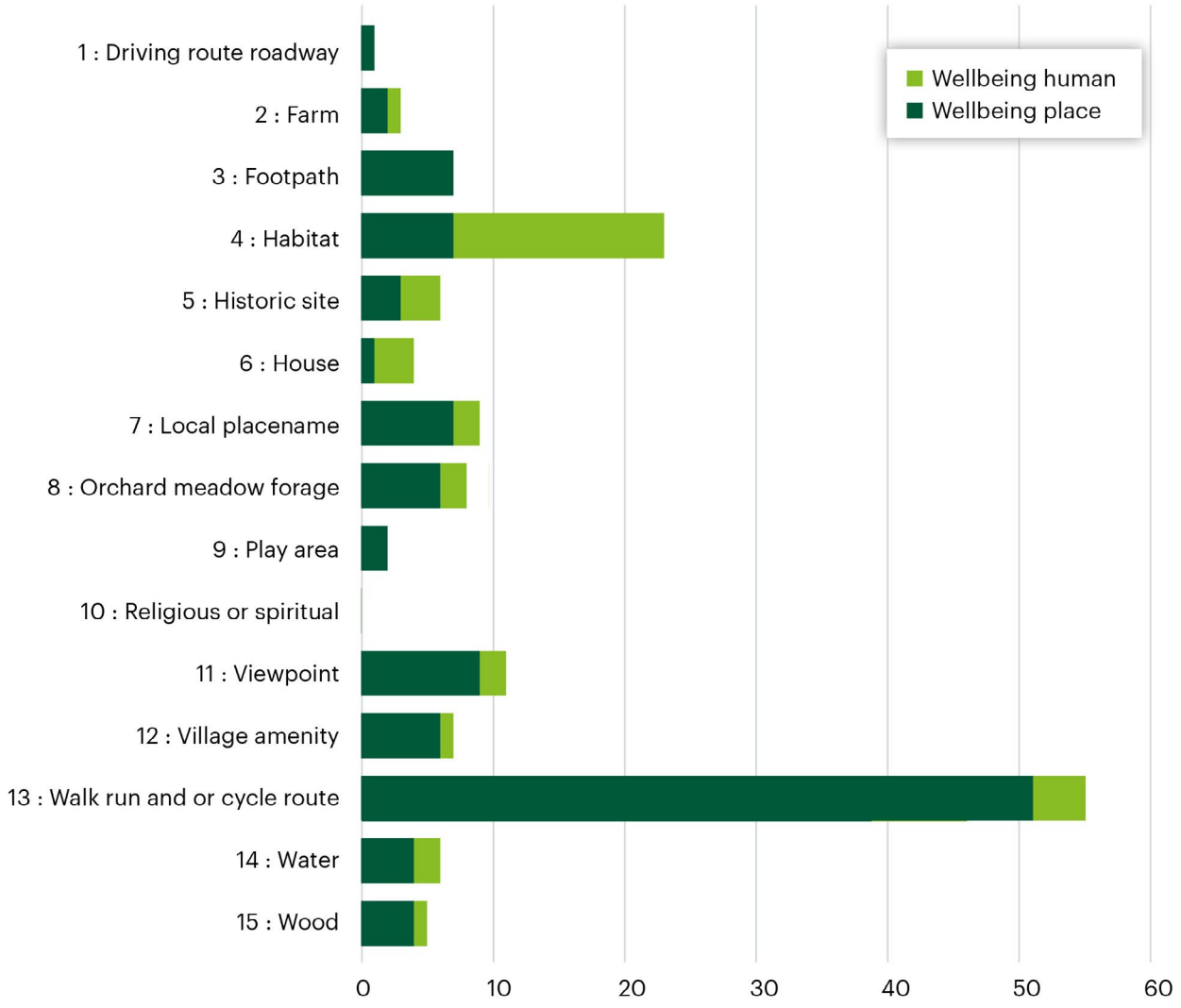

Figure 8: Valued area types supporting wellbeing

Areas mapped by participants in the HEIA for each Valued Component are illustrated in Figures 9 to 11.

4.5 Change over time: Establishing a baseline

Thinking about change over time, what events or developments have dramatically changed the relationships at the heart of the heritage ecosystem?

What happened as a result of those changes?

Understanding change over time is one way to reveal how people and place navigate impacts to their reciprocal relations. Over the past 100 years the South Cambridgeshire countryside, like much of England, has changed in response to global, international, national and regional geo-political and environmental dynamics. A detailed articulation of the impacts themselves, and the pace and influence of response is beyond the scope of this study, so we chose to focus on the changes experienced over the past 100 years by a single village within the study area (Haslingfield) with the understanding that those changes were somewhat representative of the influences of, and responses to, change in neighbouring communities and surrounding countryside.

The Parish of Haslingfield is located in South Cambridgeshire some 5 miles south of Cambridge itself. The Bourn Brook forms the north, and the Rhee the east boundaries of the parish (Figure 12). To the west lies the village of Harlton and to the South the higher ground of Chapel Hill between Haslingfield and the neighbouring village of Barrington. In the late Mediaeval period Haslingfield was a place of pilgrimage and "The cult of Our Lady of White Hill attracted many offerings including a pair of gyves [shackle or fetter] offered by one

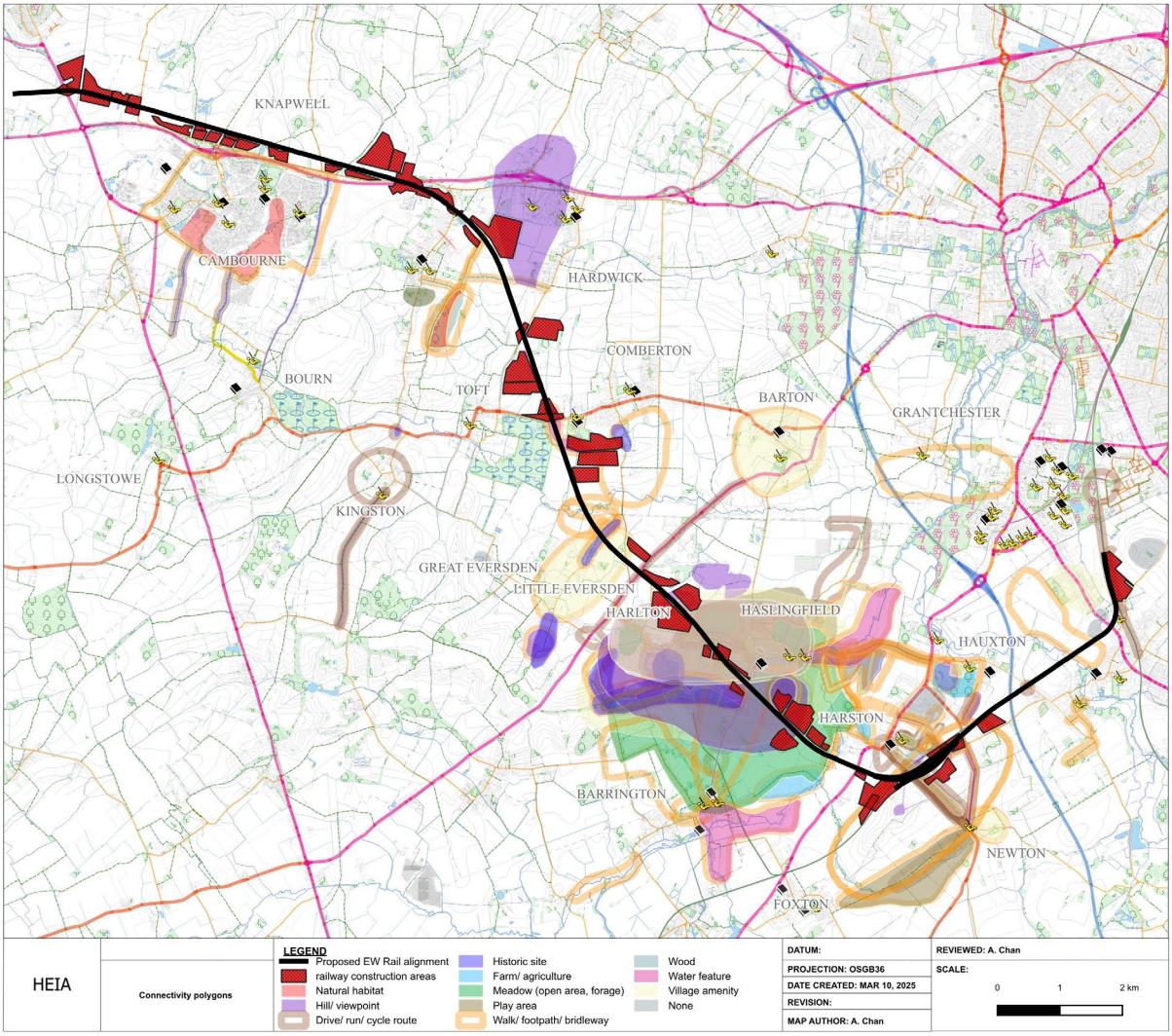

Figure 9: HEIA Connectivity valued area polygons

of the Lord Scales in thanksgiving for deliverance from French captivity....The site of the chapel is preserved in the name Chapel Bush [Hill]..." (BHO, 1968, p. 351).

Haslingfield village occupies an oval area of approximately 100 acres and its perimeter is delineated by a series of lanes and paths some of which were established hundreds of years ago and most of which remain today (Figure 13 and 14). The oval layout of the village perimeter reflects the presence of a large village green, which itself is a remnant of an 'ancient' landscape that has since been in-filled (Oosthuizen, 2002). Prior to enclosure several mostly 17th Century houses and dwellings were built in the village, many along or within the central oval (BHO, 1968). A post-enclosure building phase included a number of detached houses and some small terraces (BHO, 1968).

Haslingfield has existed as a place of human activity for thousands of years as attested by the presence of several Bronze Age round barrows situated on 'Money Hill'. The view from Money Hill/ Chapel Hill has long been valued by local residents and visitors. It is the landscape featured in Rupert Brooke's poem "the Old Vicarage Grantchester". The view's significance for the surrounding area is demonstrated by the fact that it was one of the preserved views of Cambridge that contributed to the definition of the Green belt in the 1950s (Thompson, 1992; LUC, 2021, p. 81).

The village of Haslingfield itself is recorded in the Domesday Book. Indeed, in Domesday Book records of 1086 Haslingfield had a recorded population of 79 households (listed under 6 owners), a fact that ranked it among the largest 20% of settlements recorded in Domesday. Villagers of Haslingfield were impacted by land

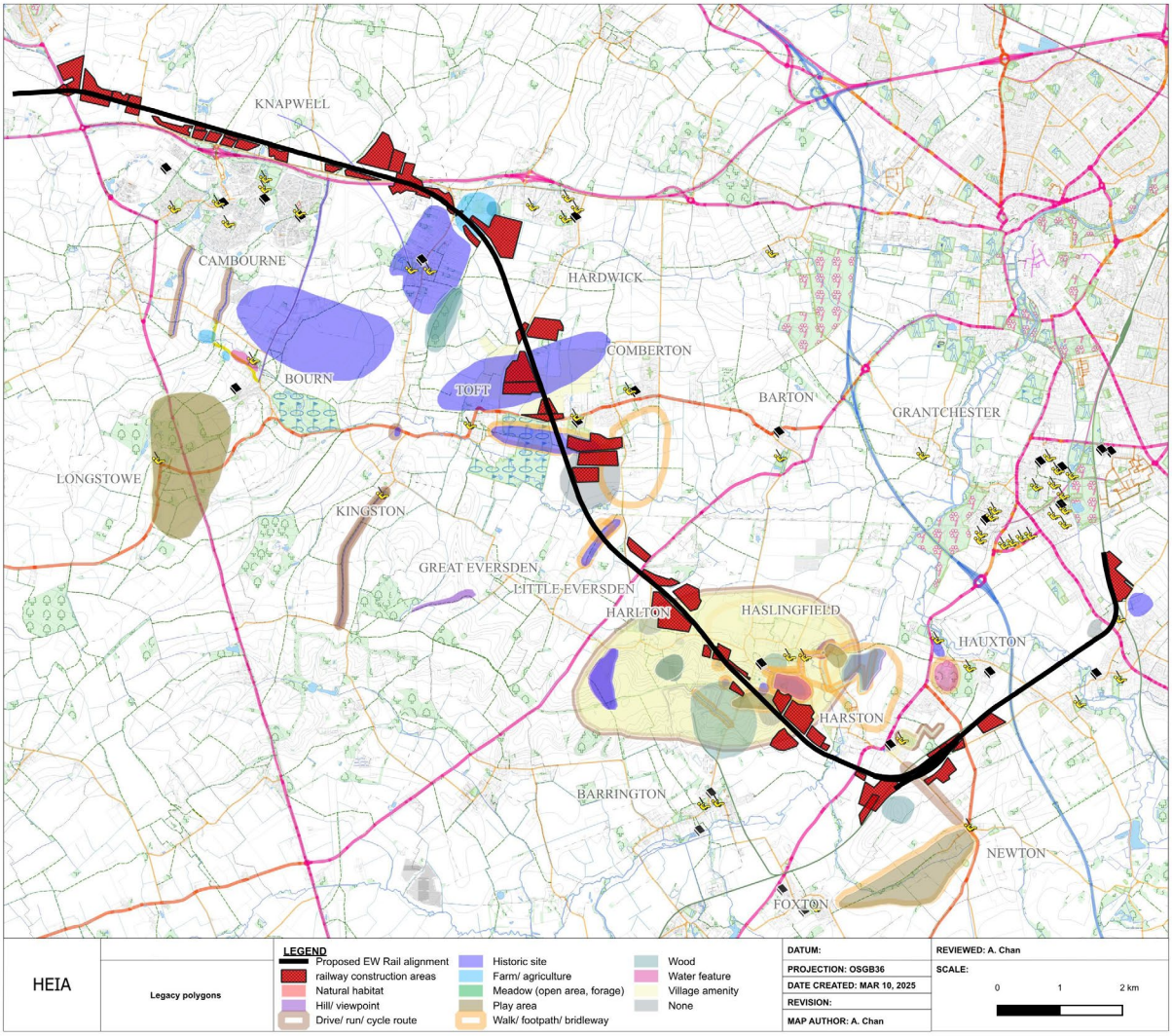

Figure 10: HEIA legacy valued area polygons

ownership reconfiguration during the period of Enclosure, most particularly in the 18th and 19th Centuries, though village configuration would indicate initial Enclosure may have dated to the 16th century (BHO 1968). Despite the indication of early enclosure, through to 1770, when the Enclosure Act for Cambridge was passed, the majority of the lands in and around Haslingfield remained as open fields, or 'commons' where villagers were free to keep and graze livestock (Beresford, 2013). The Enclosure Act initially enabled cereal growers to place fences around their fields to prevent damage by livestock, but it was not until 1820 that common lands were allocated to those landowners with a claim to land in the village (BHO, 1986). According to local historian John Beresford (2013, p. 1) "Allocation entailed the building and upkeep of roads in and out of the village, and the roads we now use to Harston, Barrington and Barton were a result of this." Enclosure also had a profound effect on the ecology of the countryside as habitats long sustained through common lands management were irrevocably altered through shifts in land management (Oosthuizen, 1996; Wittering, 2013).

For the vast majority of its history, Haslingfield has remained a farming community, a pattern replicated for villages throughout the South Cambridgeshire countryside, and indeed throughout many parts of England. In the lands north of Bourn Brook, which forms the North boundary of the village, ancient ridge and furrow remains in the once open fields show evidence of intensive cultivation dating possibly as far back as the eighth or ninth century (Oosthuizen, 1996, 2006). Indeed, until the early 1900s life in the village revolved around agriculture, marked through the early 20th Century by the presence of several larger farms (among them Cantelupe Farm and Spring Hill Farm) and a series of orchards and smallholdings. Farmers throughout

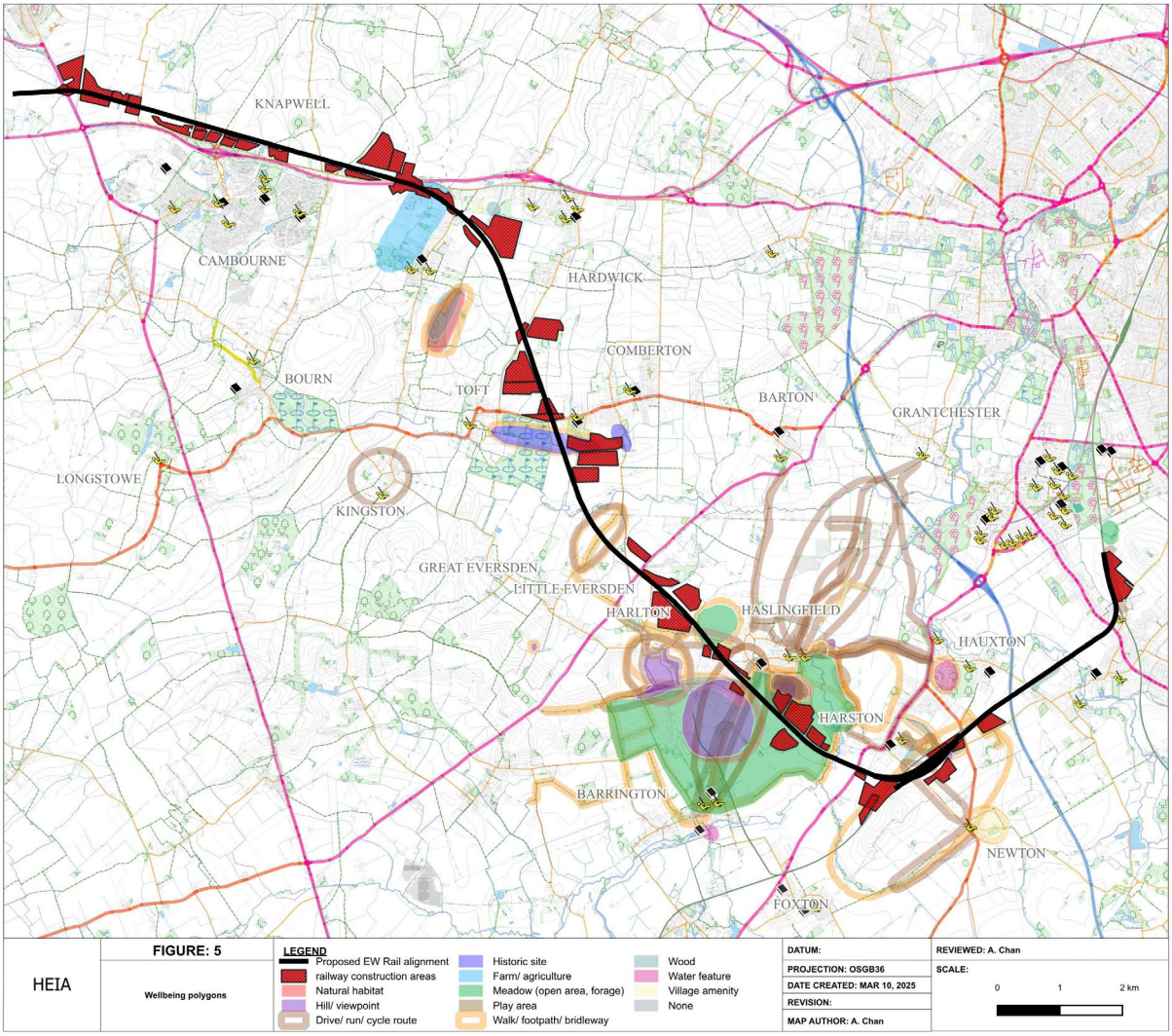

Figure 11: HEIA wellbeing valued area polygons

the UK, including in and around Haslingfield were affected by a farming depression which, caused by a catastrophic decline in grain prices resulting from cheap American imports, began in 1870 and did not resolve until after the Second World War. Farming practices changed dramatically during the World Wars. Intent on ensuring maximum productivity, the state began exercising power over production and began large-scale intensification of farming (Howkins, 2003). Pastures were ploughed up and fields amalgamated through the grubbing up of hedgerow boundaries and orchards. High levels of production introduced through this new system were entrenched in the 1947 Agriculture Act which guaranteed prices and instituted agricultural subsidies. For Haslingfield this new regime meant a massive change in how the countryside 'looked and felt' insofar as the smaller field systems and often ancient hedgerow boundaries were transformed into the agricultural landscape of large arable fields that exists today.

Despite war-time changes to agriculture practice, village life remained largely unchanged and farming remained the primary industry throughout WWI. WWII brought significant demographic changes further compounded by the gradual mechanisation of farming and an attendant reduction in the availability of farm employment. Accounts of a comprehensive series of Haslingfield school registers suggest that between 1873 and 1916, approximately 35 families contributed nearly 58% of the students recorded in the school intake. Through the decades from 1917 to 1943 fourteen of the original 35 families did not have children at the school, a situation reflecting the movement of people from one South Cambridgeshire village to another exhibiting historical patterns of rural migration. From 1943 to 1980 a further two of the original 35 families were absent in school records, but upwards of 10% of the 35 families are still sending children to the school. "The figures show

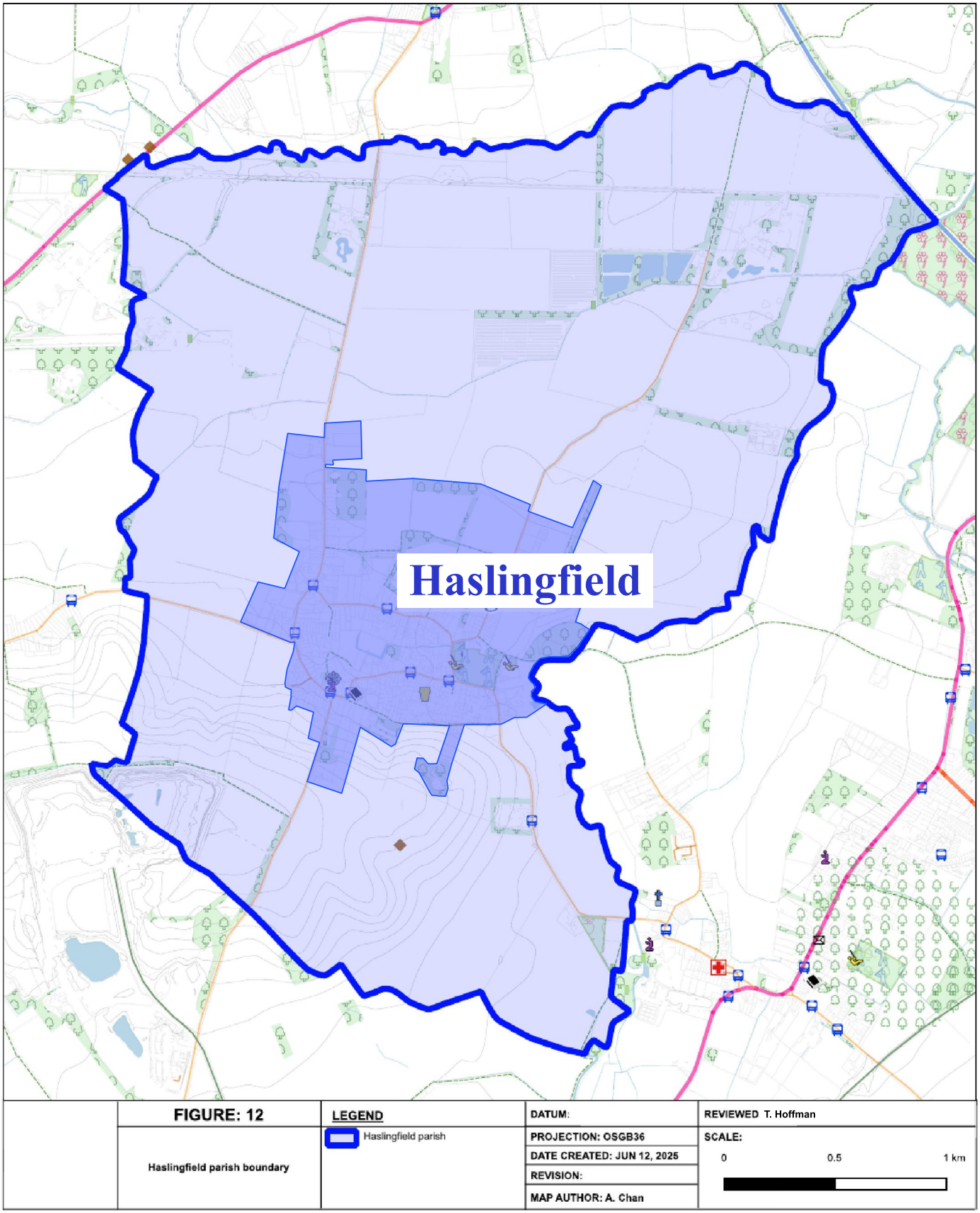

Figure 12: Haslingfield Parish boundaries

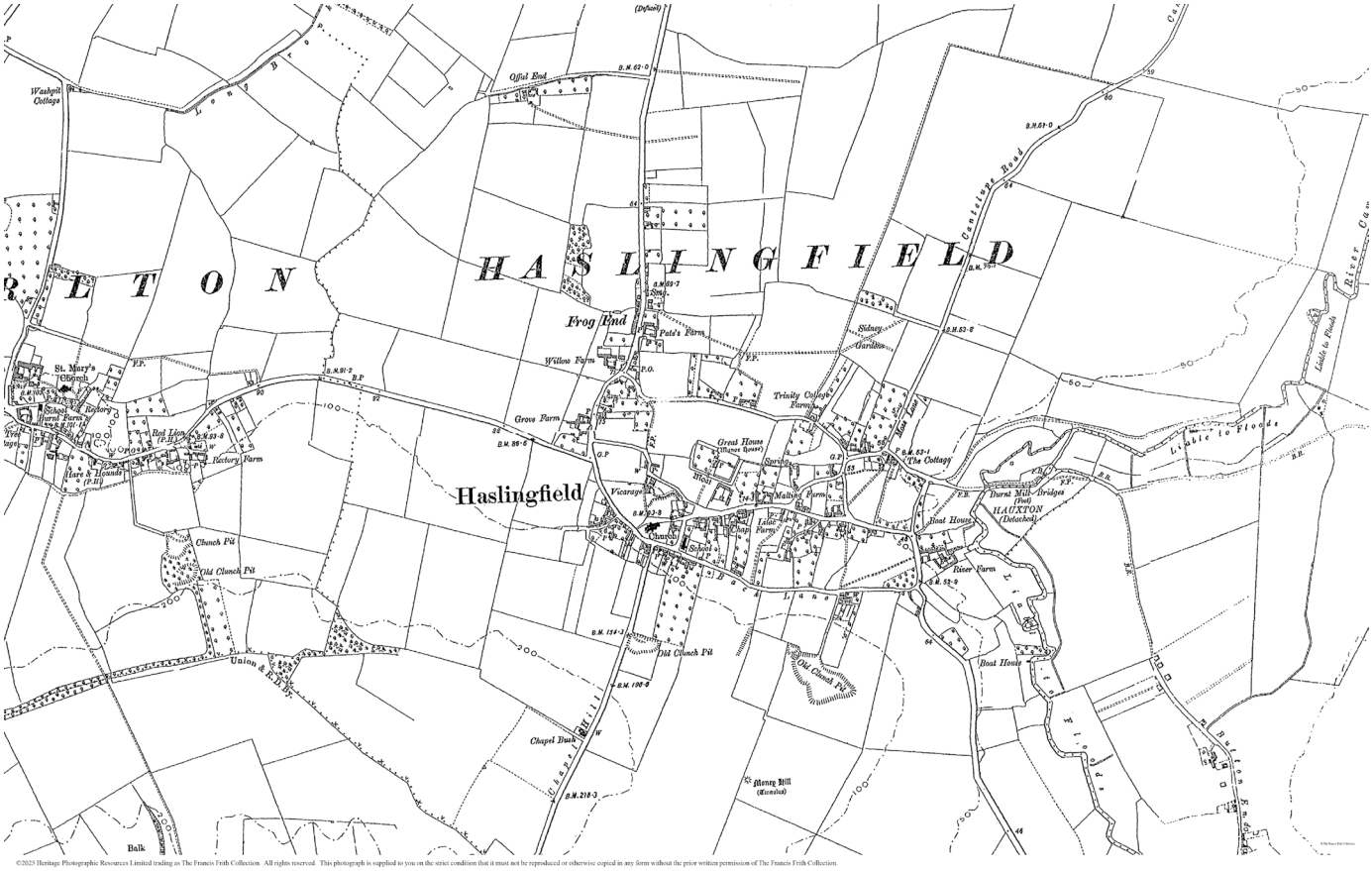

Figure 13: Haslingfield 1885-1886 (© The Francis Frith Collection)

Figure 14: Google Earth Haslingfield (2024)

the growth of Haslingfield from a self-contained and perhaps self-sufficient village into a community that has embraced large numbers from the outside world" (Beresford, 2010, p. 1).

Until the 1980s life revolved around the village and "In spite of differences of religion, politics or class, Church or Chapel, Liberal or Tory, all shared in a common heritage" (Cannell 1983, p. 2). This heritage was grounded in large part in relationships with the countryside itself as articulated by a long term village resident in her recollection of walks in the countryside with her father:

> *Every year, one Sunday evening before harvest, father would take us for a long walk instead of taking us to church. He would take us along the fields of golden standing corn, over the ditches, through the hedges and up onto the hill by the plantation at the top. Looking down across the valley we would pick out familiar landmarks, the distant spires of the city churches and colleges and, occasionally, the towers of Ely Cathedral... Wandering on, observing and commenting, Father would stop to pick an ear of corn, rubbing it between his hands to test if it was ready for harvesting. The sudden flight of a partridge or a pheasant from the corn would indicate to us that a nest was near. How we hoped it would be vacated before the corn was cut. Often a rabbit or a hare would cross our path...Soon we descended to the Quarry with its winding paths and overhanging shrubs, and here there grew a profusion of wild flowers: the elusive bee orchid, purple orchid, bluebells, thyme, mignonette, dog daisies, ladies' hair and many more. We gathered them at random, struggling to reach them in crevices of the hewn clunch. Clunch is the local name for the chalk escarpment. Later it was used as hard core for cattle yards and pens, et cetera. Hewn out of the hillside with pick and shovel, it was an arduous task and often dangerous. The local people had access to the quarrying of the clunch when they needed it. Emerging from the Quarry into the land with its wide hedges of white- and blackthorn, bramble and wild rose, we were glad to rest for a while at the cottage of a relative." (Cannell, 1983, p. 5-6).*

Interpreting this account as representative of a heritage ecosystem reveals several key connections central to people/place relationships. The first is that for this family, a walk in the countryside during harvest season was done in lieu of attending church – an action that suggests this family at least felt that a purposeful walk through the countryside was an appropriate substitute for spiritual communion. This walk was not along established paths but instead took a 'over ditches and through hedges' meant the family walk literally 'through' the countryside to reach an elevated point and reacquainting themselves with familiar landmarks so as to ground their place in the wider landscape. A stop to test the readiness of corn, noting and observing the relationship between the lifecycles of animals and that of the harvest, the family then descend to the ancient Quarry to learn and observe plants that depend upon the quarried landscape to make their home. The quarrying of clunch represents a common resource where access to those who needed it is a reminder of the commons governance structures that existed for many hundreds of years before Enclosure. In summary, this account centres people, this family in particular, within the rhythms of a landscape that has been formed and is sustained as a direct result of relationships between people and place over many generations.

The post-war years saw more houses built in Haslingfield and the introduction of paved roads to accommodate increasing numbers of personal vehicles and mechanised farm machinery. Interestingly, few new main roads were built, instead existing tracks were simply widened and tarmacked. Consequently, even today travel by car around the village follows the same routes that have existed, in many cases, for hundreds of years.

There is also a history of rail transport in South Cambridgeshire. The Varsity Line was a railway line connecting Oxford and Cambridge from 1845 until its closure in 1968. During its operation it functioned as a major route for freight but interestingly seems to have had little material impact on transportation for the villagers of Haslingfield. Though at least one participant noted the use of the train station at Lords Bridge was used by some through the 1950s and 1960s to access schools and shops in Cambridge. While EWR reuses some sections of the old Varsity Line (notably Oxford–Bicester–Bletchley), it diverges elsewhere due to a combination of the following factors: physical loss of the original trackbed,

inability of old line to meet modern rail standards (due to gradient etc.), the desire to serve growing communities (e.g., Cambourne), and environmental constraints including the presence of the Mullard Radio Astronomy Observatory (MRAO) which partially occupies segments of the old Varsity line rail bed near Lords Bridge, north of Haslingfield (EWR, 2024).

The late 1980s into the 1990s marked another threshold of major change for Haslingfield. This change is illustrated most dramatically by the construction of new housing. Though housing was added incrementally in the 1920s (the first council houses) through the post-war periods, in the 1990s many land owners sold off portions of large gardens or farm lands to developers who were looking to meet the housing demands of a changing population (Figure 15 and 16). This housing boom has meant that since the 1990s many people have moved to the village of Haslingfield from other villages, cities, or countries. Most of these relative newcomers commute daily to workplaces in Cambridge or even London, though the COVID-19 pandemic has anecdotally at least meant more people are likely to work from home.

Like many South Cambridgeshire villages, as demand for housing has increased so too have housing prices and many older generations of villagers lament the fact that their children cannot afford to stay in or move back to live in the village they grew up in. However, despite the challenges of affordability and the influx of newcomers, Haslingfield residents (both long term and new) maintain a village identity and the village sustains a thriving community choir and theatre group, both of which also draw from residents of neighbouring villages. During the COVID-19 pandemic villagers report the strengthening of inter-village relationships during everyday (but socially distanced) encounters on well-trodden roads and footpaths.

There is no doubt that life in Haslingfield has changed over the past 100 years (Figure 13 and 14). Yet despite these changes, much has stayed the same. Haslingfield remains physically connected to surrounding countryside through a series of footpaths, tracks, and roadways that follow their original historic routes. The village itself remains surrounded by arable fields, some of which are part of multi-generation family farms. The clunch pit continues to anchor people to a common resource and while the clunch ceased to be mined by the early 1900s, the pit itself remains a 'commons' resource of sorts providing a well-known local walk and wildlife observation area. The clunch pit is also home to a variety of fauna and flora, including rare species of orchids. A walk along the ancient pilgrimage trail to the top of Chapel Hill, though no longer a formal religious experience for most, remains a vital local route and landmark providing views not often afforded by the flat Cambridgeshire countryside. Though changes to agricultural practices, most dramatically during the post-war period, have altered agricultural landscapes, those landscapes remain valued by farmers and villagers alike. The village of Haslingfield demonstrates a pattern exhibited by most villages in South Cambridgeshire – that of response and adaptation to outside change, but the maintenance of a central village character. The surrounding countryside exhibits a similar pattern where response to change, particularly the dramatic landscape alterations caused by the industrialisation of farming post WWII, has retained its broader agricultural identity.

The future of South Cambridgeshire 'without project', that is without the East West Rail, will likely continue a pattern of incremental change for some areas, with more rapid rates of change concentrated in others (on the edges of Cambridge and growth target related to new settlements in Northstowe, Bourn Airport, West Cambourne, and Waterbeach for example). In the context of EWR's proposed route, it is worth mentioning that most of the planned new settlements are located north of Cambridge, apart from Bourn Airport and West Cambourne, both of which are located in or very near the existing town of Cambourne.

A future 'without project' will continue to be influenced by global changes including impacts of climate change. For the farmers of South Cambridgeshire in particular, changes to weather patterns continue to influence and impact their farming operations. As one farmer noted, climate induced change over the last 20 years has "...been impactful and drainage and looking after your soil and everything is just becoming more and more important...in Norfolk there's so much properly underwater, and there's large swathes of Grade One land [there] that in 20 years' time will not be farmable. We're in an area that is reasonably high in comparison, and we will be land that is productive and can be farmed and is producing a lot of grain" (PI1). The implication being that as climate change impacts continue, farmlands in South Cambridgeshire will become increasingly critical to UK food security.

Figure 15: Haslingfield 1946 (©Historic England, raf_106g_uk_1718_rp_3155)

Figure 16: Haslingfield 2017 (source: Historic England Archive, 33195_022)

Detailed plans (exclusive of EWR) envisioned for the next decades of change are included in the South Cambridgeshire District Council Adopted Local Plan (2018) and the Greater Cambridge Local Plan published on 4 January 2023 (Greater Cambridge Shared Planning, 2023), which constitutes a master plan for the Greater Cambridge area to 2041. A March 2025 update to the Local Plan highlights some of the limitations for planned growth that include concerns over water scarcity, sustainable transport, waste-water treatment, and anticipated National Planning reforms (South Cambridgeshire District Council, 2025). The update also raises particular concerns over the Labour government's December 2024 announced intention to "...significantly increase levels of development in Cambridge beyond the levels the councils have outlined in the emerging Local Plan as being needed. Government said in December its vision for Cambridge includes proposals for "northwards" of 150,000 new homes as part of a major new expansion of the city." These targets far exceed those of the councils whose own evidence suggested the need to build 50,000 new homes to support 66,000 new jobs between today and 2041. The March 2025 update notes that "The councils are seeking to understand how and in what way the Government's ambitions will interact with, and impact on, the Local Plan process."

4.5.1 Comparative project: HS2 Anticipated and experienced impacts

Examining the comparative project, what impacts were anticipated and experienced by community members during planning, construction, and operation of the project?

One way to anticipate the range of impacts (positive and negative) resulting from a given project is to summarize the impacts realised by a similar project. Taking into account that no two projects are ever exactly the same, important insights into the probability of anticipated impacts actually occurring can be derived from a critical assessment of a similar project. In this case a summary of realised impacts (those impacts that have occurred and been documented) from Stage 1 of the High Speed 2 (HS2) rail project provide some indication of what types of impacts are most likely to occur in the planning, construction, and operation phases of the EWR project. The HS2 project was chosen as a comparative project over recently completed segments of the EWR corridor because, unlike the rest of the EWR route which constitutes an upgrade to an existing rail line in most places, significant portions of the Phase 1 HS2 line represent a brand new transport corridor constructed through the countryside. This is particularly true of the HS2 segments that bisect the countryside and agricultural landscapes of Buckinghamshire for example.

In 2009 the UK government announced their intentions to construct a new high-speed rail network linking London with cities to the north through greater connectivity with Birmingham, Manchester, East Midlands Parkway, Leeds and York. Phase 1 would extend from London's Euston Station and extend to the West Midlands. Phase 2a would link the West Midlands with Crewe, and 2b link Crewe to Manchester, and the West Midlands with Leeds and York. In October 2023 spiralling costs forced the cancellation of Phase 2a and 2b. At the time of writing the Phase One of HS2 is approximately 40% complete with an anticipated opening date of 2030. Though HS2 Ltd. is working with their contractors to record and ensure mitigation of environmental and other impacts (including noise and air quality impacts during construction for example) the full suite of impacts will not be known until after the project completion date, and even then only if there is an appetite on the part of government to record and understand them. Nonetheless, several impacts have been identified by national environmental charities and organisations (Wildlife Trusts, 2020, 2023), by independent assessors (Glaister, 2021; Tetlow and Shearer, 2021; Preston, 2023), by HS2 Ltd., and by some politicians responding to reports of their constituents. Indeed, such is the concern over the impacts to the wellbeing of those affected by the HS2 project, Cambridge Centre for Health Services Research have launched a major multi-year project focused on HS2, but which is intended more broadly to identify the impacts of major transportation development on mental health and wellbeing (Morley et al., 2024). Because HS2 is still under construction, reported impacts have centred around the planning phase of the project, and as experienced by the construction thus far.

Though there exist reports documenting the socio-economic impacts felt and anticipated by the operation of high-speed rail (Preston, 2022), an HEIA is particularly interested in the impacts local people experience when a project stands to alter their heritage ecosystem. The following impact summary focuses specifically on recorded impacts to people/place connections during the planning and

construction phases of a new rail line that people report affecting their connections to the places that they value.

A fulsome review of anticipated and realised impacts of HS2 was not possible given the timeline for this pilot project. However, to gauge the range of anticipated impacts the 1925 petitions submitted to the HS2 Select Review Committee were uploaded into Google NotebookLM with the query: What are the major categories of impact identified by the petitioners? The results of this query are summarised below. Where reported, anticipated impacts that have been realised since the start of HS2 planning and construction are also identified. To facilitate a baseline comparison, impacts identified by petitioners are divided into those anticipated or experienced during consultation and planning, construction, and operations phase. These impacts are summarised in bullet points below, and further expanded upon in Appendix C.

4.5.2 HS2 impacts: Consultation and planning phase

Petitioners' concerns about the consultation and planning phase of the HS2 project primarily revolve around inadequate consultation, a lack of transparency and information, and the perceived failings of the Environmental Statement. Specifically, petitioners have expressed the following:

- Inadequate consultation results in loss of detailed local knowledge relevant to planning.
- Environmental statement inadequacies lead to failure to address specific concerns.
- Poor Environmental Statement conflates mitigation and compensation measures.
- Hierarchical consultation process forestalls meaningful engagement with affected communities.
- Lack of project detail results in lack of understanding concerning project impacts.
- Errors and omissions in Environmental Statement.
- Unclear enforcement mechanisms available for communities to address environmental impacts.
- Insufficient consideration of cumulative impact.
- Insufficient consideration of project (e.g. upgrade of existing lines) and design (e.g. bored tunnels as opposed to cut and cover).
- Lack of community involvement in creation and implementation of code of construction practice.

4.5.3 HS2 impacts: Construction phase

Petitioners identify numerous impacts arising from the construction of the HS2 railway, which can be categorized into several key areas. These concerns are primarily related to disruptions to daily life, environmental damage, economic impacts, and safety issues. Construction related impacts are summarised in bullet form below, and expanded upon in Appendix C.

- Traffic and transportation disruption related to heavy good vehicles on local roads will cause congestion, delays, and difficulties in accessing essential services.
- Increased HGV traffic will reduce road safety.
- Increased HGV traffic will result in an increase wildlife mortality.
- Noise and vibration will disrupt sleep.
- Dust and air pollution will negatively impact human health.
- Visual impacts during construction will detract from beauty of the area.
- Construction will have a negative impact on local business through access disruption and potential business displacement.
- Farms will be impacted to the point where they become economically unviable.
- Construction will cause major environmental damage to sensitive habitats (ancient woodlands, waterways for example).
- Pollution of local water supply.
- Waste disposal will have a negative impact on air quality.
- disruption of community life and loss or loss of access to community assets.
- Disruption of access to footpaths and bridleways.
- Increased construction traffic reduces road safety.
- Excessive waste generation, removal and disposal will have deleterious effects.
- Property values will decline.
- Construction will extend beyond the anticipated timeline.

4.5.4 HS2 impacts: Operations phase

Petitioners identify a variety of long-term impacts arising from the operation of the HS2 railway, which can be categorized into several key areas. These concerns primarily relate to noise and vibration,

visual impacts, environmental damage, and disruptions to daily life and community wellbeing. The impacts are summarised in bullet form below and in detail in Appendix C.

- Noise and vibration caused by passing trains will disrupt sleep and negatively impact quality of life.
- Noise levels will exceed levels established by the World Health Organization.
- Rail infrastructure will dominate the landscape and permanently alter the character of the area.
- Natural habitats will be permanently lost or severed which will have an impact on species dependent on those habitats.
- Disruption of water courses and water tables has long term implications for water availability and flood control.
- Potential damage to chalk streams and drinking water supplies.
- Dust and light pollution will be long term.
- Communities will be divided and community members restricted from access to village amenities.
- Daily routines will be permanently disrupted impacted quality of life for vulnerable community members.
- Stress, anxiety, and mental health issues will arise from noise, visual impacts, and disruption to daily lives.
- Properties will be 'blighted' and will lose market value.
- Business will be negatively impacted over the long term through displacement.
- Visual intrusion of railway infrastructure will impact landscape and decrease tourism.
- Railway will negatively impact road safety.
- Compensation is inadequate to address the full range of issues and impacts.

4.5.5 Summary of HS2 impacts to relationships that are valued by petitioners

Within the petitioners catalogue of impacts experienced and anticipated are those specific to the relationships they sustain with the places they value. The description of these impacts is particularly important to the HEIA. Petitioners express a variety of relationships to the places impacted by HS2, with many emphasizing the deep connections they have to their homes, communities, and the surrounding environment. These relationships are summarized below.

Impacts to Home. Many petitioners are residents and homeowners who express a deep attachment to their properties and the areas they live in. They are concerned about the loss of their homes through compulsory purchase. They express fear over property blight and the devaluation of their properties due to the project. They worry about the disruption to their daily lives, including sleep disturbance, and stress and anxiety caused by the project. They emphasize the loss of peace and tranquility in their homes and communities. Many petitioners express emotional distress associated with losing their homes and communities. Some petitioners note that they have chosen to live in the Chilterns AONB for its unique character and are worried that the railway will permanently alter their environment. Farmers are worried about the severance of their farms and the impact on their ability to run their businesses.

Impacts to Community. Petitioners often express a strong sense of community and are concerned about the impacts on their social connections and local amenities. They are alarmed about community severance, where the railway line will divide their communities and make it difficult to access local amenities. They worry about the loss of community assets, such as schools, green spaces, recreational facilities, and public rights of way. They express concern about the disruption to local facilities such as churches and social clubs. They also note the disruption to local transportation networks, including bus and rail services.

Impacts to Environment. Many petitioners express their role as environmental stewards and in doing so demonstrate a deep concern for the natural environment and the impact of HS2 on it. They are particularly concerned about the damage to the Chilterns Area of Outstanding Natural Beauty (AONB). They are worried about the destruction of ancient woodlands, loss of farmland, and damage to wildlife habitats. They are concerned about the impact on water resources. They express concern about the visual impact of the railway and associated infrastructure on the landscape. They are concerned about spoil removal and storage, and its visual and environmental impacts. Some petitioners are concerned about the impact on cultural heritage, including listed buildings and archaeological sites.

These relationships highlight the diverse ways in which people are connected to the areas impacted by HS2. The variety and depth of petitioners' concerns underscore the need for an impact assessment methodology that is capable of recording and expressing the people/place relationships that local communities value.

4.6 Experienced and anticipated impacts – East West Rail

What impacts (positive or negative) to the heritage ecosystem do community members anticipate will arise from the planning, construction, and operation phase of the proposed project? And how do community members perceive the project impacts?

The impacts experienced and anticipated by participants in the HEIA often mirror those reported (especially by landowners subject to compulsory purchase orders) by those impacted by the HS2 project. It is vital to recognise that the HEIA works from the standpoint of **impacts as identified then anticipated and/or experienced by the community members who have contributed to the project**. This means that the impacts are characteristically broad (for example, the impact of noise on quality of life) and do not include a detailed categorisation of impacts identified by outside experts via technical impact assessment criteria (for example the noise in decibels that exceeds "Lowest Observed Adverse Effect Level"). The broad characterisation of impacts is partly because few community members are experts in railway design, implementation, and operation, nor are they impact assessors themselves. However, this does not mean that the impacts they identify and have either experienced or anticipate are unimportant or irrelevant. Furthermore, as documented in further detail in Section 4.6 of this report, the overwhelming majority of the impacts both experienced and anticipated by study participants are negative. A very few participants agreed (often begrudgingly) that the proposed railway would facilitate 'growth' but what EWR might bring in terms of a 'good thing' (jobs, new housing) could, given the limits of the natural environment of the South Cambridgeshire area to absorb rapid growth, devolve into a negative impact unless carefully planned and managed over the longer term. Impacts identified by HEIA participants according to EWR project phase (planning, construction, and operation) are summarised in further detail below.

4.6.1 EWR experienced and anticipated impacts – planning phase

Impacts occur from the day a project is announced. The impacts that occur because of project announcement and subsequent planning (including public consultation) are often overlooked in standard impact assessment. This despite the fact that the impacts caused during project planning announcement and early planning phases have lasting effects on individuals, communities, and ultimately, we argue, on heritage ecosystems. Participants describe the planning phase of the EWR project as it relates to public consultation as a combination of inadequate, disingenuous, callous, hierarchical, dismissive, alienating, frustrating, and purposefully opaque. The lack of transparency and a seeming unwillingness of EWR representatives to reveal the decision-making process behind route selection and design have been among the most frequently reported sources of frustration and fear. Though EWR (2024) acknowledges that community members have expressed concern about a wide range of impacts, this pilot study found that participants characterise their experience with EWR planning using vocabulary that far exceed expressions of mere concern. For example, participants whose lands and homes fall under compulsory purchase order have stated they experience high levels of stress and anxiety caused by uncertainty, coupled with grief and a sense of disbelief over the fact that they could be losing their houses and farms. Participants note that these feelings are further exacerbated by the callous manner in which EWR first approached them. Letters addressed to 'the homeowner' deposited anonymously through the letterbox to villagers and farmers whose properties fall under the compulsory purchase orders created persistent feelings ranging from profound shock and grief, to intense frustration and anger. These same range of feelings are expressed by many participants who will feel the impacts less directly (in that they are not subject to compulsory purchase orders), but no less profoundly.

The perceived and experienced impacts from the planning phase of the project influenced the actions participants have subsequently taken. In response to the felt impacts of the planning phase, concerned community members have come together to challenge the logic of EWR, scrutinising EWR planning and public consultation materials. Concerned community members have embarked on a series of 'place-protective actions' including media campaigns, demonstrations at

EWR public consultation sessions, and detailed technical review of EWR reports and engineering plans. Participants report that the outcomes of the critical review completed by concerned citizens has been met with a less than enthusiastic response by EWR representatives. Undaunted, concerned villagers, many of whom participated in this study, continue to challenge the social, economic, environmental, and engineering logics that underpin EWR decision-making as they seek a third-party independent review of the preferred route as it is currently conceived. Specific impacts of the project announcement and planning phase as identified by participants in this study (through mapping and interviews) include:

- Lack of transparency creates mistrust and increases anxiety all of which detracts from meaningful collaboration with affected people and places.
- Lack of transparency creates mistrust and increases anxiety all of which forestalls the creation of meaningful mitigation options.
- Hierarchical planning decisions create a sense of frustration, alienation, and in some cases fear and grief.
- Lack of meaningful community collaboration means valuable local knowledge is ignored in the planning process, leading to unnecessary impacts to Valued Components and Valued Areas.
- Current methods of contacting and notifying affected people (and their properties) are perceived as callous and disingenuous, all of which leads to emotional distress including feelings of anger, frustration, and grief.
- Response to community concerns perceived as dismissive or deliberately opaque leading to a sense of frustration and anger.
- Community concerns over lack of detailed project planning means community members devote their energies to place-protective action that they would have otherwise devoted to community-based projects and activities.
- Community demands to understand accountabilities for budgetary and/or construction timeline 'slippage' appear to be dismissed creating a sense of alienation, frustration, and anger.
- Government and EWR's seeming lack of interest in fully examining alternate routes, or disclosing the full results of such examination, lead to frustration and anger, and feelings of helplessness.
- Concerns over 'blighting' of property include loss of financial value of property.
- Compulsory purchase creates feelings of grief, loss, and helplessness.
- Compulsory purchase and destruction of homes/farmland will impact the wellbeing of the species that depend upon garden/farmland 'intactness'.

4.6.2 EWR experienced and anticipated impacts – construction phase

Impacts of the construction phase anticipated by study participants can be thought of in three distinct categories. These include traffic and roadway related concerns, environmental impacts, and concerns regarding impacts to farmers and farmlands. A common theme punctuating all these anticipated impacts is a concern over construction timelines. As noted above, participants place little trust in the information provided by EWR and based on knowledge of similar projects (HS2 particularly) express serious concerns over the scheduling and duration of construction. Participants suggest that they predict construction impacts will persist for between 5 and 7 years, perhaps longer in some areas.

There are several farms who will be heavily impacted by construction. Despite assurances that fields or portions of fields slated to be used as construction staging areas will be returned post-build, farmers note that heavy machinery and storage of construction materials will compact, pollute, and otherwise negatively impact what are in many cases, the healthiest and most productive soils on their respective farms. Due to their need to understand the soils upon which their livelihood depends, combined with the very nature of South Cambridgeshire soils themselves, local farmers possess highly detailed knowledge about soil quality and drainage. Farmers express frustration that EWR seems unwilling to consider the cumulative impacts construction and operation of the railway will have on farming and farm lands well beyond the rail corridor itself: "...whatever [mitigation] happens, as a consequence [of railway constructions] the fields are going to be in a worse state than they are now. Even if the land [used for construction] is returned to us...the fact that if any machine runs over it, it's going to be damaged...with a major infrastructure project [running through the fields] nearby ditches and streams are not going to run in the same way that they did before. And that will impact fields outside the width of the infrastructure..."

[PI1]. Furthermore, the severing of farmlands, no matter how temporary will create inefficiencies and reduce yield over a 5-year period at minimum, the combined effects of which will affect the economic viability of the farms themselves. Many farmers also cite the efforts they have undertaken in recent years to enhance the biodiversity of their farmlands, including the protection of hedgerows, the enhancement of field boundaries, and the careful avoidance of riparian areas around water courses and ditches. In many areas the construction of EWR will remove or impact these zones, whilst having the knock-on effect of severing existing wildlife corridors and habitats. As part of the most recent non-statutory consultation phase several farmers affected by the proposed construction have submitted a collective, detailed plan to alleviate these impacts in both the long and short term.

Many participants note that negative impacts on wildlife habitats, especially ancient woodland, and on species, most particularly the endangered Barbastelle bat population, will be most acutely felt during construction. Many participants express a strong connection to the countryside and to their role in sustaining the health of wildlife and habitats. These stewardship practices range from efforts to feed wildlife through the winter months, to ensuring gardens have sustainable habitat for various species, to monitoring the health of insect (especially bees), newt, toad, frog, bat, badger, fox, and various bird species that frequent their own gardens or properties. Construction impacts are anticipated to both directly and indirectly affect important habitats and the participants' ability to carry on often long-term stewardship activities. One participant declared "I've got nesting deer, golden crested newts, badgers, bats...I've created a lovely haven for these animals –they're my responsibility. EWR thinks they can do what they want. The loss of that is disgusting" (P62). Participants also predict that runoff of mud and silt from roadways frequented by construction vehicles, coupled with compaction and re-routing or severing of long-standing drainage ditches could pollute watercourses and cause flooding of important habitats. Many participants also expressed grief over the loss of Valued Areas including ancient woodlands, wild swimming spots, hedgerows, and footpaths, many of which will be destroyed to facilitate construction.

The potential impact of construction traffic is cited as a key concern. Participants anticipate that HGV and construction vehicles on narrow village roads will create unsafe conditions for walkers and cyclists, a situation further exacerbated by the concern that construction-related road closures will increase traffic volumes on narrow country lanes never designed to act as major thoroughfares. All the increased and re-routed traffic also raises the risk of wildlife mortality. Construction activities themselves are anticipated to create a decrease in air quality and increase in noise pollution, both of which are anticipated to have an overall impact on the quality of life for everyone and everything living within proximity to the construction zone.

Specific impacts participants anticipate during the construction phase of the EWR project include:

Traffic/roadway impacts

- Temporary and/or permanent closure of roadways, trackways, and footpaths reduces ability for access to neighbours, neighbouring villages and their amenities and/or countryside.
- Increased HGV traffic decreases road, bike, sidewalk safety.
- Increase in HGV traffic could increase wildlife mortality.

Environmental impacts

- Runoff from increased mud and debris on roadways can impact health of water courses, hedgerows, and verges.
- Grubbing and clearing of lands to create staging areas results in habitat loss which further impacts insect populations that are key food sources for many species, including barbastelle bats.
- Storage of construction materials (including fill and/or spoil heaps) create increase in airborne pollution (dust) affecting wellbeing of people and place (and the plants and animals that reside in them).
- Destruction (including partial destruction) of ancient woodland results in permanent loss of Valued Areas.
- Destruction (including partial destruction) of valued habitats (including hedgerows, verges, gardens, veteran trees etc.) results in permanent loss of Valued Areas used for forage and play.
- Construction noise will impact the countryside (possibly alienating people and other species from Valued Areas) and particular species including barbastelle bats who are especially sensitive to noise, vibration and artificial light (e.g. vehicle headlights, construction compound security lighting).

- Loss of community assets (both formal and informal) such as recreational areas, wild swimming locales, foraging areas, gathering places, etc.
- Permanent loss of heritage sites (including ancient landscape features and built heritage) impacts ability to transmit local knowledge.
- Alternation of ditches and water courses will impact groundwater and water flow.

Farms/farmland impacts

- Temporary removal and/ or severing of arable lands reduces economic viability of farms.
- Temporary removal of arable lands reduces opportunity for local people to connect with countryside.
- Temporary loss of arable lands reduces habitat.
- Long-term damage to once highly productive arable lands (used as constructions staging areas) impacts economic viability of local farms.
- Long-term damage to arable lands has potential to impact the future of 'healthy' soil creation and/ or maintenance.

4.6.3 EWR experienced and anticipated impacts – operations phase

Participants anticipate that the permanent presence of a rail line running through the South Cambridgeshire countryside through the north end of Highfields Caldecote and in most cases passing within 1 km or less of the villages of Cambourne, Toft, Comberton, Little Eversden, Harlton, Haslingfield, Harston, Hauxton, and Great and Little Shelford will have several long-term direct, indirect and cumulative effects. By far the most frequently mentioned impact was that of loss of connectivity. Many participants anticipate that with the temporary and in some cases permanent closure of roadways coupled with the visual disruption of the rail line infrastructure itself, villages that have remained connected in the landscape, whether physically via roads and footpaths, or visually from hills or the vantage points they afford, will be irrevocably disconnected. This disconnection will, participants suggest, alter the very environmental and social fabric of the countryside they love and care for likening the railway to "the desecration of the landscape" (P61). Another participant summed up the concern expressed by many stating "...the train will block the long-distance views. [and] how will people get from Barrington to Harston? They [EWR] talk about connectivity, but it's disconnectivity – it's the complete opposite [of connectivity]!" (P74).

Disconnection will be at least in part due to the presence of the railway infrastructure itself. Engineered embankments and overpasses in what is a generally flat landscape impact previously uninterrupted and historic (in many cases ancient) sightlines, and permanently alter the historic agricultural aesthetic of the countryside. This same infrastructure in some cases results in the temporary severing of roadways that connect villages following routes that have existed in some cases for hundreds of years, essentially foreclosing, at least for the few years of construction, the easy access to village amenities (including schools, pubs, and recreational grounds) that sustain many villages and village businesses.

Participants predict that both temporary and permanent closure of roadways necessary to accommodate the rail line will alter traffic patterns, pushing greater volumes of traffic onto narrow village roads and country lanes, with an attendant decrease in pedestrian and cyclist safety. Over the long term, participants also anticipate a permanent rise in noise levels from trains, particularly freight trains, as they pass by villages. Following the EWR's anticipated completion of 2030, there is concern that regular trains travelling through the countryside will interrupt the lives of endangered barbastelle bats and could result in an overall increase in wildlife mortality. As currently envisioned, the rail line is planned as a 100mph line that will accommodate both passenger and freight services. Freight trains up to 775 long (and possibly longer) will operate throughout the day and night, but with more regular frequency in hours not used for passenger service. Participants also express concern over impacts to students at the Comberton Village College from noise and vibration of passing trains. Participants note that the permanent removal of arable land to accommodate the rail line will sever farm operations, thereby reducing farming efficiencies and crop yield, both of which could impact the economic viability of the farming businesses. There is also a concern that an increase in areas of hardstanding coupled with permanent truncation of drainage ditches and impacts to the flow of the Bourn Brook could further exacerbate climate-change induced flooding of land and property.

Cumulative impacts raised by participants include concerns over the creation of 'islands' of severed properties and farmland, that post-construction are no longer viable for farming and instead become available for housing development. Participants raised anticipated impacts resulting from unchecked development that range from land speculators purchasing and then driving up land prices, to unsustainable pressures that new developments might place on already stressed water resources. Participants worry that the removal of valued arable lands to accommodate the rail line, but also the massive development projects that it will bring, will reduce the amount of UK grain yield, and have a marked negative impact on UK food security. As one participant noted "These beautiful high grade arable lands are VITAL! 50% of the nation's wheat is grown within 50 miles of Cambridge. With the war in the Ukraine and loss of wheat shipments our wheat is even more vital now. We must protect it" (P16).

The impacts identified by participants anticipated to arise from the operations phase of EWR include:

- Severing of historic inter and intra village connectivity.
- Presence of large engineered infrastructure (e.g. railway embankments and overpasses, tunnel entrances and exits) alters the historic agricultural aesthetic of the countryside.
- Temporary closure of roadways, bridleways, and footpaths impacts historical inter-community connection.
- The railway will impact wildlife, including a possible rise in species mortality.
- Permanent closure of roadways will alter traffic patterns.
- Noise of passing trains will impact peace and quiet of countryside.
- Railway corridor could impact wildlife corridor connectivity and integrity.
- Presence of railway will remove efficiencies that make farming a viable economic enterprise.
- Permanent removal and/ or severing of arable lands reduces economic viability of farms.
- Permanent removal of arable lands reduces opportunity for local people to connect with countryside.
- Permanent loss of arable lands reduces habitat.
- Increase in areas of hardstanding will impact drainage and lead to more flooding of villages and farmland.

4.6.4 Proximity of EWR to heritage ecosystem Valued Areas

Where is the proposed project located in relation to the heritage ecosystem including to Valued Areas?

Figures 10 to 12 illustrates the areas study participants consider vital to the creation and maintenance of their heritage ecosystem. The greatest number of participants were present at the Haslingfield mapping session, thus many of the polygons are clustered around and in Haslingfield itself. For purposes of assessing the impacts related to the physical proximity of the rail line itself, the 'project footprint impact area' is defined as the rail corridor itself (represented by the black line), the ancillary properties identified by EWR as needed during construction (represented as red polygons), plus 500 m either side of the rail line. It should be noted that impacts will occur beyond this 500 m buffer, but Valued Areas within this buffer are more likely to be subject to direct physical impacts (especially during construction and operation phases).

The implications of the proximity of the proposed rail line and ancillary impact areas (staging areas etc.) to the heritage ecosystem Valued Areas is discussed further below. However, the proximity of the rail line and its attendant construction areas is only one consideration when assessing the likelihood, frequency, permanence, duration, and spatial extent of anticipated and experienced impacts, which are detailed below.

4.7 Stage 3: Assessing impacts

Looking at the outcomes of the comparative project, what is the likelihood, frequency, permanence, duration and spatial extent of anticipated impacts becoming a reality for the proposed project?

The next stage in the impact assessment is to determine the likelihood, frequency, permanency, duration, and spatial extent of experienced and anticipated impacts. Tables 2, 3, and 4 show the impacts identified as both experienced and anticipated by the participants in the HEIA. Impacts are rated according to several impact criteria including duration, frequency, permanence, and spatial extent. The overall magnitude of each

identified impact as it relates the participants' understanding or experience of impacts is included. Each criteria includes an 'impact score' depending upon the degree to which each impact meets each criteria. For example, duration refers to the amount of time the impact is likely to persist. A duration criteria score of 1 indicates a low (less than 1 year) duration, whereas a 3 indicates the impact will likely persist for 6 years or more. Other impact criteria such as likelihood were assessed using the results of the comparative project. For example, the HS2 project construction has resulted in severe impacts to farms and farmers (NFU 2014; Case 2023). Given the similarities in scope and location relative to local farms, it is likely that the EWR project will have a similar level of impact on some South Cambridgeshire farms and farmers. All criteria and their respective definitions and scores are detailed in Appendix D.

Table 2: Impact criteria planning phase EWR

Phase	Impact number	Impact	Anticipated (A), Experienced (E)	Likelihood	Duration	Frequency	Permanence	Spatial extent	Total impact score 1-5 = Low, 6-10 = Moderate 11-15 = High
Planning	1	Lack of transparency creates mistrust and increases anxiety all of which detracts from meaningful collaboration with affected people and places.	E	3	3	3	2	3	14
	2	Hierarchical planning decisions create sense of frustration, alienation, and in some cases fear and grief.	E	3	3	3	2	3	14
	3	Lack of meaningful community collaboration means valuable local knowledge is ignored in the planning process, leading to unnecessary impacts to Valued Components and Valued Areas.	E	3	3	3	2	3	14
	4	Current methods of contacting and notifying affected people (and their properties) are perceived as callous and disingenuous, all of which leads to emotional distress including feelings of anger, frustration, and grief.	E	3	3	3	2	3	14
	5	Response to community concerns perceived as dismissive or deliberately opaque leading to a sense of frustration and anger.	E	3	3	3	2	3	14
	6	Community demands to understand accountabilities for budgetary and/or construction timeline 'slippage' appear to be dismissed creating a sense of alienation, frustration, and anger.	E	3	3	3	2	3	14
	7	Government/EWR seeming lack of interest in fully examining alternate routes, or disclosing the results of such examination, lead to frustration and anger, and feelings of helplessness.	E	3	3	3	2	3	14
	8	Concerns over 'blighting' of property include loss of financial value of property	A	3	3	3	2	2	13
	9	Compulsory purchase creates feelings of helplessness.	E	2	3	2	3	2	12
	10	Compulsory purchase and destruction of homes/farmland will impact the well-being of the species that depend upon garden/farmland 'intactness'	A	3	3	2	3	2	13
	11	Time and energy spent in attempts to communicate concerns with EWR and Government detract from participation in other activities.	E	3	2	2	2	2	11
	12	Invasive testing or closures required in advance of construction means impact access inter- and intra-village accesses.	A	3	2	2	2	2	11

Table 3: Impact criteria construction phase EWR

Phase	Impact number	Impact	Anticipated (A), Experienced (E)	Likelihood	Duration	Frequency	Permanence	Spatial extent	Total impact score 1-5 = Low, 6-10 = Moderate 11-15 = High
Construction	13	Temporary removal and/ or severing of arable lands reduces economic viability of farms.	A	3	2	2	3	2	12
	14	Temporary removal of arable lands reduces opportunity for local people to connect with countryside.	A	3	2	2	3	2	12
	15	Temporary loss of arable lands reduces habitat.	A	2	2	2	1	2	9
	16	Long-term damage to once highly productive arable lands (used as constructions staging areas) impacts economic viability of local farms	A	3	3	2	2	2	12
	17	Long-term damage to arable lands has potential to impact the future of 'healthy' soil creation and/or maintenance.	A	3	3	2	2	2	12
	18	Temporary closure of roadways, trackways, and footpaths reduces ability for access to neighbours, neighbouring villages and their amenities and/or countryside.	A	3	2	3	1	2	11
	19	Increased HGV traffic decreases road, bike, sidewalk safety.	A	2	2	2	1	2	9
	20	Runoff from increased mud and debris on roadways can impact health of water courses, hedgerows, and verges.	A	2	2	2	1	2	9
	21	Increase in HGV traffic could increase wildlife mortality	A	2	2	2	1	2	9
	22	Grubbing and clearing of lands to create staging areas results in habitat loss.	A	3	2	2	2	2	11
	23	Storage of construction materials (including fill and/or spoil heaps) create increase in airborne pollution (dust) affecting well-being of people and place.	A	2	2	2	1	2	9
	24	Destruction (including partial destruction) of ancient woodland results in permanent loss of Valued Areas.	A	3	3	2	3	2	13
	25	Destruction (including partial destruction) of valued habitats (including hedgerows, verges, gardens, etc.) results in permanent loss of Valued Areas.	A	3	3	3	3	3	15
	26	Construction noise will impact the countryside (possibly alienating people and other species from Valued Areas)	A	3	2	2	2	2	11
	27	Loss of community assets (both formal and informal) such as recreational areas, wild swimming locales, foraging areas, gathering places, etc.	A	3	3	2	2	2	12
	28	Permanent loss of heritage sites (including ancient landscape features and built heritage) impacts ability to transmit local knowledge.	A	3	3	2	3	2	13
	29	Alternation of ditches and water courses will impact groundwater and water flow.	A	3	3	2	2	2	12
	30	Restricted access to viewpoints during construction removes opportunity for inter-community interaction with people and wildlife.	A	3	2	2	3	3	13

Table 4: Impact criteria operations phase EWR

Phase		Impact	Anticipated (A), Experienced (E)	Likelihood	Duration	Frequency	Permanence	Spatial extent	Total impact score 1-5 = Low, 6-10 = Moderate 11-15 = High
Operation	31	Presence of large engineered infrastructure (e.g. railway embankments and overpasses, tunnel entrances and exits) alters the historic agricultural aesthetic of the countryside.	A	3	3	3	3	3	15
	32	Permanent closure of roadways, bridleways, and footpaths severs historical inter-community connection.	A	3	3	3	3	3	15
	33	The railway will impact wildlife, including a possible rise in species mortality.	A	3	3	3	2	3	14
	34	Permanent closure of roadways will alter traffic patterns.	A	3	3	3	2	2	13
	35	Noise of passing trains will disrupt the peace and quiet of countryside.	A	3	3	3	3	3	15
	36	Railway corridor could impact wildlife corridor connectivity and integrity.	A	3	3	3	1	3	13
	37	Presence of railway will remove efficiencies that make farming a viable economic enterprise.	A	3	3	3	3	2	14
	38	Permanent removal and/ or severing of arable lands reduces economic viability of farms.	A	3	3	3	3	2	14
	39	Permanent removal of arable lands reduces opportunity for local people to connect with countryside.	A	3	3	3	3	3	15
	40	Permanent loss of arable lands reduces habitat.	A	3	3	3	3	2	14
	41	Increase in areas of hardstanding will impact drainage and lead to more flooding of villages and farmland.	A	2	3	3	2	3	13
	42	Impacts of railway will combine with climate change to create cumulative effects to increasingly fragile ecosystems.	A	3	3	3	3	3	15
	43	Permanent loss of woodland reduces overall biodiversity in immediate and adjacent impact zone.	A	3	3	3	3	3	15

Scores were applied by combining the review of HS2 impacts with those anticipated and/or experienced by the HEIA participants. For example, if the impact was experienced during HS2 and is also experienced or anticipated to occur during the EWR project, it was given a higher likelihood score. Finally, a combined score was added up across the criteria for each impact. Combined scores of 11 or over mean that the impact will likely occur, with considerable frequency, is unlikely to be reversible, and will impact over 50% of the Valued Areas identified in the Heritage Ecosystem. Of the 43 impacts participants' identified, 36 (83%) scored in the high impact category. The opportunity for effective mitigation figures heavily in reducing the remaining 7 impacts from high to moderate.

4.7.1 Impact pathways: Assessing how impacts occur

What are the pathways of impact?

Most impact assessments look to identify then mitigate individual impacts. In contrast, the HEIA understands impacts to people/place relationships as highly interdependent. Impact pathways illustrate *how* impacts are interconnected, and how they work to influence the conditions participants suggest are required to support the Valued Components and Value Areas that make up the Heritage Ecosystem. Figures 17, 18, and 19 illustrate impact pathways for each of the three Valued Components of the Heritage Ecosystem (Connectivity, Legacy, Wellbeing).

Tables 5, 6 and 7 summarize the Valued Components and the conditions participants identify as required to sustain them. Valued Components and conditions are also cross-referenced with the specific Valued Areas identified by study participants. These tables go on to list the impacts that have or are anticipated by study participants as they relate to the conditions required to support each Valued Component. These results are weighed against the proximity of the proposed project (EWR) and the impact criteria assessment (based in part on the comparative project [HS2]), to reveal how impacts will occur (impact pathways). Finally, along with an understanding of the 'without project' trajectory of the South Cambridgeshire area (baseline), all of these data culminate to provide the information needed to assess how participants view EWR impacts to the integrity of their heritage ecosystem.

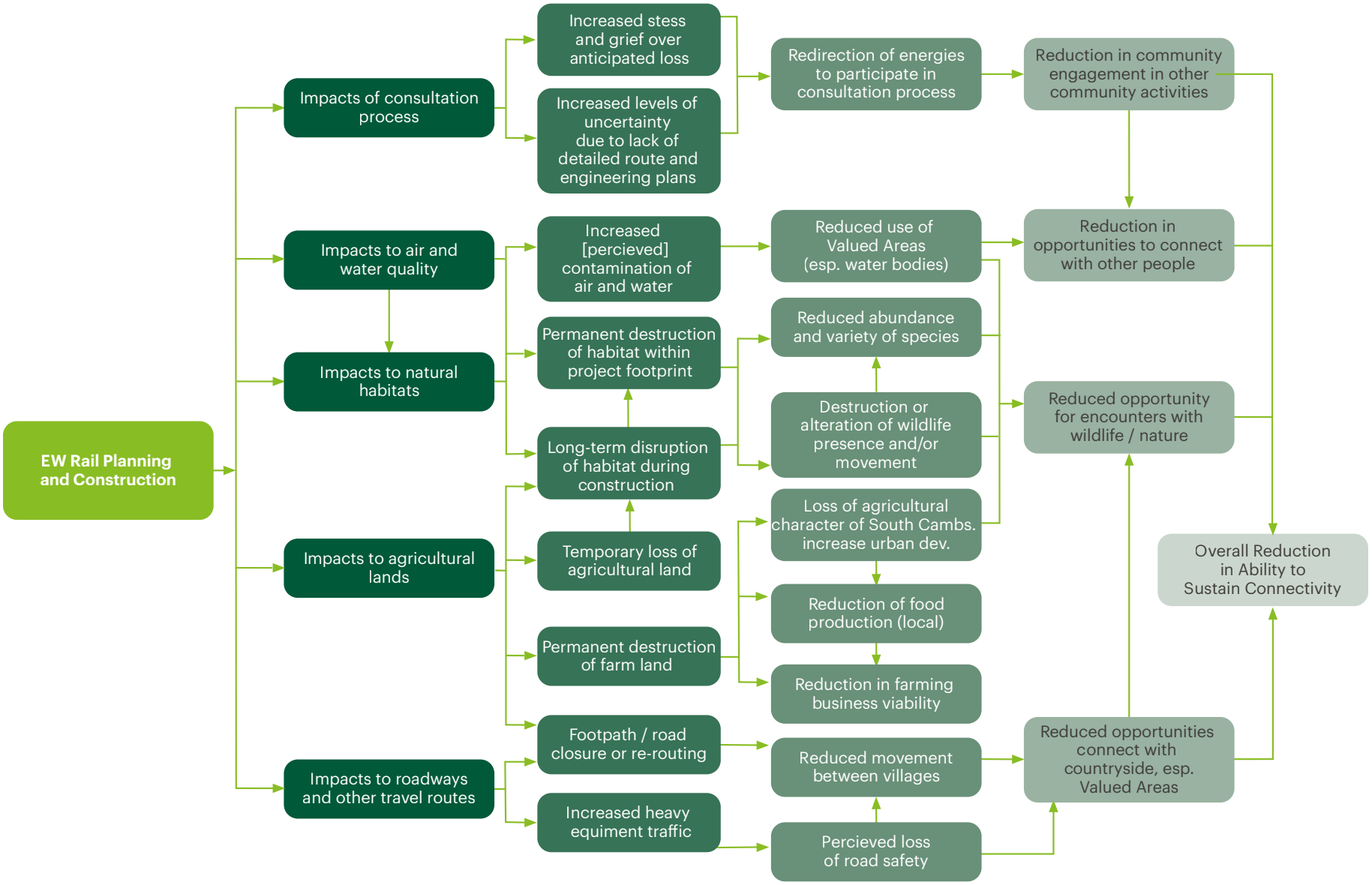

Figure 17: Impact pathway connectivity

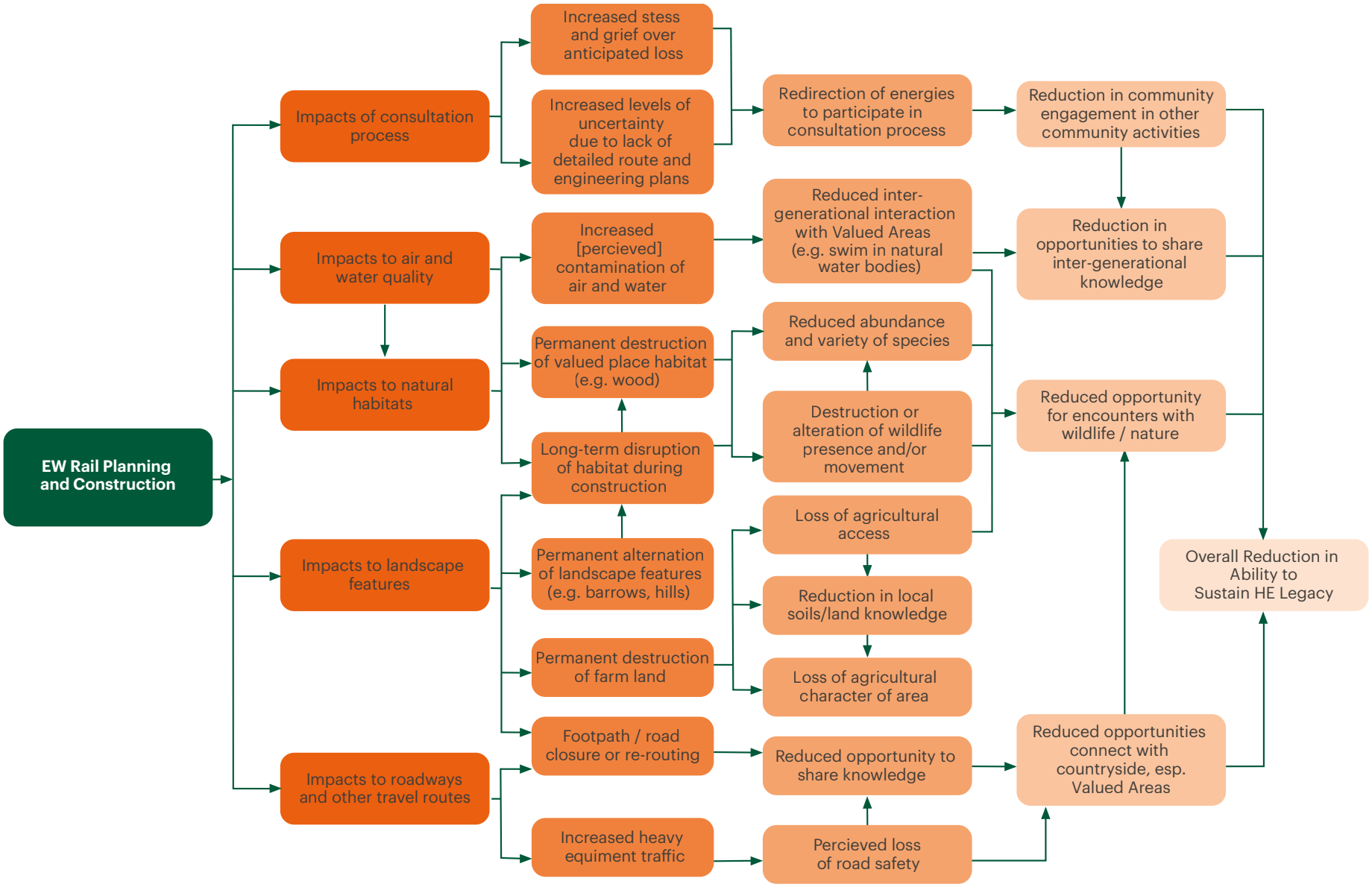

Figure 18: Impact pathway legacy

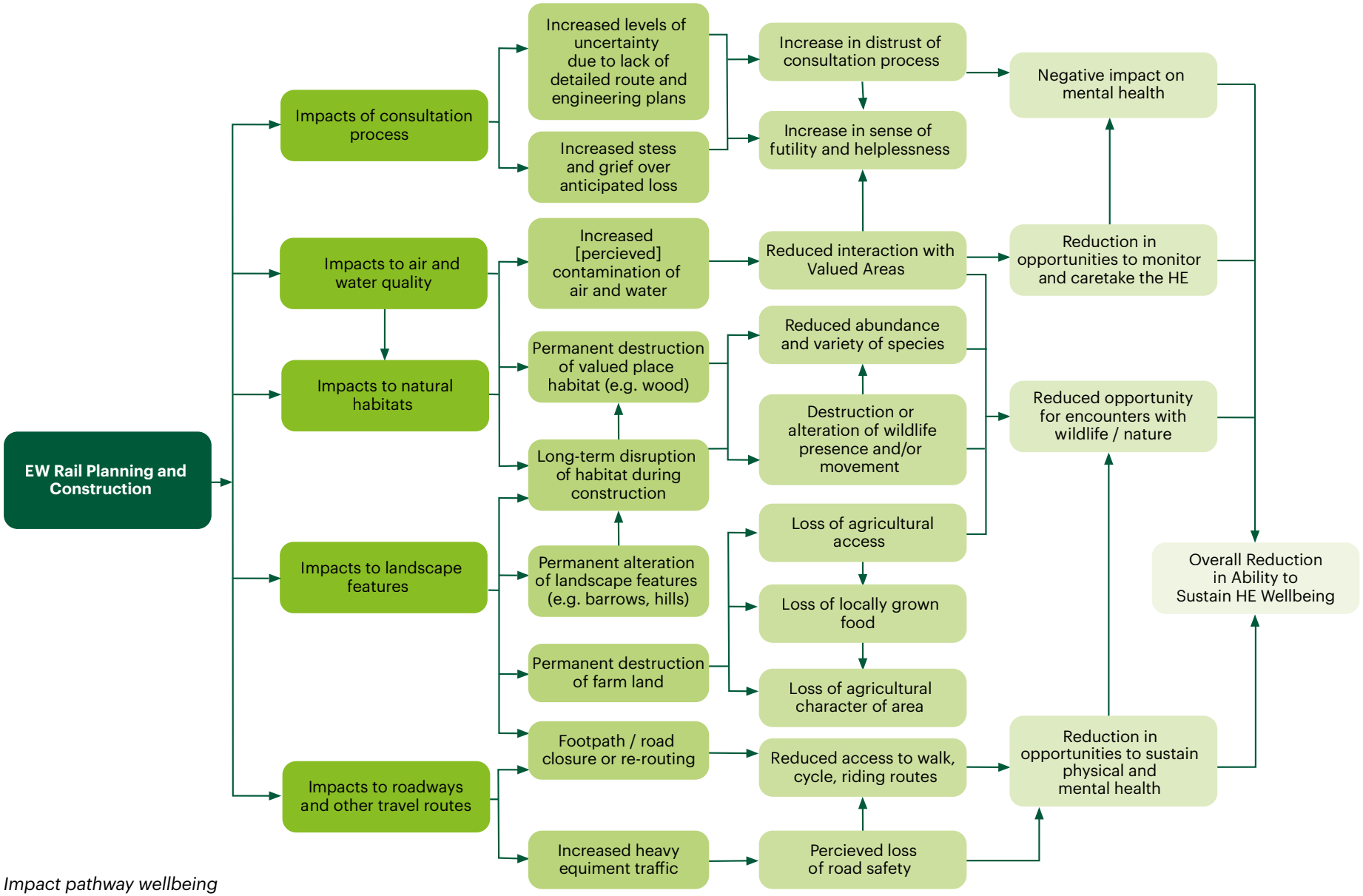

Figure 19: Impact pathway wellbeing

Table 5: Summary of EWR impacts to conditions required to support valued component connectivity

Valued component	Indicator	Place types that support indicator	Total VA / place type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to place types that support Valued Areas P= Planning, C=Construction, O= Operation phase, [Impact number see Tables 2, 3, 4]	Summary of how experienced and anticipated impact(s) will affect conditions (indicators)
Connectivity	The conditions identified as supporting **connectivity between people and place** include: • Intact, healthy habitats • Intact wildlife corridors • Intact, healthy waterways • Game trails and flyways • Viewpoints and intact viewscapes • Existing routes / places that facilitate opportunities for human/wildlife encounter The conditions identified as supporting **connectivity between and among people** include: • Maintained presence of physical routes that encourage or facilitate 'everyday' encounters with other people • Village facilities and amenities • Presence of, and access to, common areas	Walk Route/ Footpath/ Bridleway	36	25	69%	P [12], C [18], O [32]	Temporary closure and permanent route (including footpath) closure or alteration reduces availability of common areas.
		Hill/ Viewpoint / Viewscape	6	5	83%	C [30], O [31]	Construction impacts (esp. tunnel construction) and long term (tunnel entrance) presence means reduction in common areas and intact habitats and viewscapes.
		Natural Habitat	3	1	33%	C [17,20,21,22], O [33, 36, 40]	Permanent loss of existing intact habitat and wildlife corridors reduces opportunity for wildlife encounter, affects health and intactness of habitats.
		Drive/Run/Cycle Route	16	8	50%	C [18, 19, 25], O [32]	Temporary closure and permanent route (including cycle route) closure or alteration reduces opportunity for encounter.
		Wood	6	5	83%	C [22], O [43]	Permanent loss of woodland means loss of intact healthy habitats that foster connection.
		Meadow (orchard, garden)	1	1	100%	C [27]	Permanent loss of existing meadow, orchard and gardens means loss of areas that foster connection.
		Historic Site	5	4	80%	C [28]	Alteration to historic site, including loss of access reduces availability of areas for everyday encounters, and opportunities for wildlife encounters.

Valued component	Indicator	Place types that support indicator	Total VA / place type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to place types that support Valued Areas P= Planning, C=Construction, O= Operation phase, [Impact number see Tables 2, 3, 4]	Summary of how experienced and anticipated impact(s) will affect conditions (indicators)
Connectivity	The conditions identified as supporting connectivity between places (i.e. between villages, village amenities) include: • Networks of footpaths, bridleways • Established and maintained roadways for vehicles and cycling	Play Area	2	2	100%	C [27]	Permanent loss of existing play areas (esp. water and woodland) means loss of everyday encounters and village amenities.
		Water (Pond, Brook)	4	3	75%	C [27,29],	Impacts to water table, and water health reduces number of intact healthy habitats that foster opportunities for everyday encounters with people and wildlife.
		Village Amenity	9	7	77%	C [18]	Temporary loss of access to village amenities reduces overall opportunities for encounters.
		Farm	3	3	100%	C [13-17], O [37-40, 43]	Short and long term impacts to habitats on farmland (esp. those that function as wildlife corridors) and farm businesses result in loss of opportunity for wildlife encounters.
		Total	91	64	**OVERALL IMPACT: HIGH** Via the permanent loss or alteration of the integrity of conditions (indicators), the experienced or anticipated project impacts will have a **high level of impact on the Valued Areas that support the conditions needed to sustain the Connectivity Valued Component.**		

Table 6: Summary of EWR impacts to conditions required to support valued component legacy

Valued component	Indicator	Place types that support indicator	Total VA / place type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to place Types that support Valued Areas P= Planning, C=Construction, O= Operation phase, [Impact number see Tables 2, 3, 4]	Summary of experienced and anticipated impact(s) on conditions (indicators)
Legacy	The conditions identified as supporting **intergenerational legacy** (between people): • Consistency of place over time (e.g. village boundaries, farms, viewscapes, landscape features, natural play areas) • Consistency of access over time (i.e. consistent property rights that also facilitate 'right to roam' including footpaths) • Consistency of practice over time (e.g. farming, foraging, coppicing, hedgelaying) • Maintenance of access to areas required for practices (e.g. farming, foraging, coppicing, hedgelaying, gardening)	Walk Route/ Footpath/Bridleway	14	12	86%	P [3, 8]	Temporary closure and permanent route (including footpath) closure or alteration affects consistency of travel routes, especially those used to access areas of longstanding practice (e.g. farming, forage).
		Hill/ Viewpoint / Viewscape	4	0	0	C [27, 30], O [31]	Temporary and permanent loss of access to viewpoints Alteration of viewscape affecting historic agricultural aesthetic of the landscape.
		Historic Site	10	6	60%	P [1], C [28], O [31]	Alteration / destruction of ancient places, historic landscape features, and/or permanent changes to access means interruption of intergenerational knowledge transfer, and impact to health and integrity of habitats that depend upon historic site ecologies (e.g. orchids that grow in the clunch pit).
		Drive/Run/ Cycle Route	6	3	50%	C [21],	Temporary closure and permanent route (including footpath) closure or alteration of historic travel routes.
		Wood	7	7	100%	C [22, 27], O [36, 43]	Permanent loss of ancient woodland and natural areas impacts integrity of habitat and availability of forage for human and non-human species.
		Meadow (orchard, garden)	0	0	N/A	C [25, 26, 27], O [36, 40, 43]	Permanent loss of existing meadow, orchard and gardens impacts integrity of habitat and availability of forage for human and non-human species.
		Historic Site	10	8	80%	C [28], O [33]	Alteration to historic site interrupts transmittal of intergenerational knowledge, removes integrity of the historic landscape.

Valued component	Indicator	Place types that support indicator	Total VA / place type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to place Types that support Valued Areas P= Planning, C=Construction, O= Operation phase, [Impact number see Tables 2, 3, 4]	Summary of experienced and anticipated impact(s) on conditions (indicators)
Legacy	The conditions identified as supporting **interspecies legacy** (between people and place): • Intact healthy habitats • Connected habitats and place (e.g. hedgerows, brooks, even ditches) • Availability of fruit, berry, mushroom, and root species in non-polluted areas (away from major roadways for example) that provide healthy forage	Play Area	9	8	88%	C [27]	Permanent loss of existing inter-generational play areas (esp. water, farms, meadows, and woodland) affects intergenerational knowledge transfer.
		Water (Pond, Brook)	2	1	50%	C [12, 18],	Impacts to water table, and water health impacts ability of species to thrive, reduces availability of forage foods.
		Village Amenity	6	5	83%	C [18]	Possible loss or pollution of gardens and gardening plots (allotments) impacts health and integrity of food and forage, interrupts intergenerational knowledge transfer.
		Farm	3	1	33%	P [9, 10], C [13 -17], O [37,38]	Short and long-term impacts to farming sustainability (through loss of farmland, pollution, soil degradation) and economic viability (lower and poorer yields impacts habitat and soil integrity, intergenerational knowledge transfer, and food security.
		Total	71	50	**OVERALL IMPACT: HIGH** Via the permanent loss or alteration of the integrity of conditions (indicators), the experienced or anticipated project impacts will have a **high level of impact on the Valued Areas that support the conditions needed to sustain the Legacy Valued Component.**		

Table 7: Summary of EWR impacts to conditions required to support valued component wellbeing

Valued Component	Indicator	Place Types that Support Indicator	Total VA / Place Type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to Place Types that support Valued Areas P= Planning, C=Construction, O= Operation Phase, [Impact number see Tables 2, 3, 4]	Summary of Experienced and Anticipated Impact(s) on conditions (indicators)
Wellbeing	The conditions identified as supporting **human wellbeing** include: • Maintenance of places that provide opportunities to connect with others through 'everyday' encounters • Ongoing presence of places that provide opportunities to view and/or encounter wildlife • Presence of and access to cycling, running, and walking routes The conditions identified as supporting **wellbeing of places** and the species that inhabit them include: • Ecosystem integrity • Ecosystem longevity	Walk Route/ Footpath/Bridleway	14	13	92%	P [12], C [18]	Temporary closure and permanent route (including footpath) closure or alteration reduce opportunities for everyday encounters with other people, or with wildlife that facilitate good mental health.
		Hill/ Viewpoint / Viewscape	2	2	100%	C [26, 30	Permanent alteration landscape (alteration of viewscape) will negatively impact the integrity of valued countryside views.
		Natural Habitat	1	1	100%	C [20, 21, 22], O [33], O [35]	Permanent loss of existing intact habitat and wildlife corridors decreases opportunities to encounter wildlife.
		Drive/Run/Cycle Route	20	18	90%	C [19], O [33, 34]	Temporary closure and permanent route (including footpath) closure or alteration reduces access to areas important for physical wellbeing.
		Wood	2	1	50%	C [20, 22, 24], O [43]	Permanent loss of woodland (both ancient woodland and local wooded areas.) leads to overall reduction in ecosystem integrity and species presence/ longevity.
		Meadow (orchard, garden, forage)	4	4	100%	C [20, 22]	Permanent loss of existing meadow, orchard and gardens reduces habitat integrity and results in reduction in availability of local food. Perceived air and water pollution to veg. gardens, forage area reduces willingness to eat foraged or locally grown foods.
		Historic Site	4	3	75%	C [22]	Damage to or alteration of historic sites and habitats associated with them reduces ability to encounter or view wildlife.

Valued Component	Indicator	Place Types that Support Indicator	Total VA / Place Type	Number of VAs within EWR impact zone.	Percentage of VAs in project impact zone	Impacts to Place Types that support Valued Areas P= Planning, C=Construction, O= Operation Phase, [Impact number see Tables 2, 3, 4]	Summary of Experienced and Anticipated Impact(s) on conditions (indicators)
Wellbeing		Play Area	3	2	66%	C [18, 27]	Permanent loss of existing play areas (esp. water and woodland) reduces outdoor play considered vital to mental and physical wellbeing
		Water (Pond, Brook)	3	1	33%	C [20, 22, 29], O [41]	Impacts to water table, and water health reduce habitat health and integrity, and may result in avoidance of wild swimming or other activities considered vital for personal wellbeing.
		Village Amenity	3	1	33%	C [18]	Temporary loss of access to village amenities means loss of outdoor activities or opportunities for encounters with community, all of which have a negative impact on wellbeing.
		Farm	2	2	100%	C [13 – 17], O [40]	Short and lon term impacts to habitats on farmland and farm businesses mean loss of soil health, wildlife and habitat integrity (e.g. wildlife corridors), and reduction in opportunities to view or encounter wildlife.
		Total	58	48	**OVERALL IMPACT: HIGH** Via the permanent loss or alteration of the integrity of conditions (indicators), the experienced or anticipated project impacts will have a **high level of impact on the Valued Areas that support the conditions needed to sustain the Wellbeing Valued Component.**		

5. RESULTS: UNDERSTANDING EWR'S IMPACTS TO A SOUTH CAMBRIDGESHIRE HERITAGE ECOSYSTEM

The heritage ecosystem of South Cambridgeshire consists of a complex layering of people/place relationships that create and sustain connectivity, foster legacy in the form of intergenerational and interspecies knowledge transfer and sustain the wellbeing of inhabitants (human and non-human alike).

Each of these characteristics and EWR's impacts to the relationships that sustain them are summarised below with specific reference to Tables 5, 6 and 7.

In Section 4.4., Figures 6, 7, and 8 illustrate the number of Valued Area types that support the Valued Components. These numbers represent the number of times people identify the types of places (e.g. footpath, wood, play area) that are key to creating and sustaining Valued Components. In many cases, the same place (e.g. Chapel Hill, or Harwick wood) was selected by different participants as important to the same Valued Component. For example, walk, run, cycle routes were mentioned 55 times as the types of places that create or sustain the Valued Component of People Place Connectivity (Figure 6). Looking at Figure 6 in conjunction with the mapped areas related to connectivity (Figure 9), we can see that there are 36 polygons that indicate the physical location of the place type. Of those 36 Valued Areas, 25 (69%) are within the project impact zone and therefore likely to be directly impacted by one or more of EWR's planning, construction, and operations phases.

Though vital to understanding overall impact, the proximity of the infrastructure to Valued Areas that support Valued Components is only one way to assess impacts of a project. It is also critical to note that as engineering details become available, there will likely be alterations to the route and construction staging areas as mapped on the 2022 technical drawings, though EWR gives no indication that these alterations will be substantial (insofar as they will choose a completely different route option). As shown, impact criteria including likelihood, duration, frequency, permanency, and spatial extent of both experienced and anticipated impacts must be considered alongside the ways in which the impacts are interrelated (via impact pathways). Ultimately, the impact assessment must consider how assessment of impact criteria, interrelatedness (pathways), and the physical proximity of a proposed development affect the *conditions* participants identify as supporting the presence and future of Valued Components (in this case Connectivity, Legacy, and Wellbeing). The following sections (5.1 to 5.3) bring together all of these criteria to consider how participants suggest that EWR has and will impact the heritage ecosystem. Each section addresses impact via summary of impact criteria, impact pathways, and impact proximity to conditions that support each of the three Valued Components.

5.1 Connectivity

> *"We're one community in two parts, but they [EWR] don't know that." [P73]*

> *"I especially love the top of the walk [on the hill] where you can look out over the countryside, but mostly it has a bracing wind that I just love. I'm terrified of losing this with the new railway." [P3]*

Participants value the heritage ecosystem as a source and facilitator of connectivity. Many look to the countryside itself, including the habitats sustained by people/place interaction over time (e.g. ancient coppiced woodlands, historic orchards, intergenerational farmland), and historic access routes (e.g. footpaths, roadways) as vital to maintaining this connectivity. Especially interesting are the number of times that hills and their attendant viewscapes are mentioned as important places (Valued Areas) of connectivity – whether that be for encountering neighbours on the walk to and from the hill, or through opportunities to view or engage with wildlife, or with the chance to appreciate the rare views of the overall landscape afforded by the hills themselves (Figure 6). Inter-village connectivity is also frequently mentioned as essential to the heritage ecosystem since many participants access amenities (recreation grounds, schools, shops) in neighbouring villages. The free movement of people between villages, often on routes that have existed for hundreds of years, is a highly valued component of the heritage ecosystem for many participants.

All phases of the proposed EWR project (i.e. planning, construction, and operation) will impact the Valued Component of connectivity. A comparison of the proposed EWR project impact zone (according to maps rendered in 2022) against the physical places (Valued Areas) that support the conditions identified as key to connectivity suggest that 70% or 64 of the 91 Valued Areas fall within the EWR project footprint impact zone (Figures 6 and 9). In terms of impact criteria (Table 5) and pathways (Figure 17), the EWR project has already impacted connectivity. The majority of study participants describe the public consultation undertaken by EWR as inadequate at best, and deliberately misleading at worst. Direct experiences of the consultation phase have created impacts to wellbeing. The time and energy many participants report they feel obligated to devote to challenging the logic upon which EWR's necessity is justified has diverted their energy away from other activities that would have supported their connectivity with the places they are trying to protect. Construction impacts will have the greatest short to mid-term impact on connectivity. Of these the temporary closure of footpaths, and roadways that serve as vital arteries of inter and intra-village connectivity, as well as (in the case of footpaths and bridleways) providing corridors for wildlife, are cited by participants as particularly harmful to the maintenance of connectivity. Mapped Valued Areas suggest that all or a portion of the 25 (69%) of the 36 walk (footpath, bridleway) and cycle routes fall within the physical footprint impact zone of the EWR project. Furthermore, footpaths and bridleways provide essential opportunities for people to encounter natural places.

Though hedgerows, verges, and copse of trees may not constitute officially recognised conservation areas, participants indicate access to and maintenance of 'unofficial' natural areas are of vital importance to facilitating encounters between human and non-human species that ground people/place connectivity. The construction of EWR will necessitate the permanent grubbing and clearing of vegetation over large sections of landscape, and temporarily in many areas well beyond the width of the rail corridor itself. Through well planned, sensitive, and locally relevant mitigation some of these impacts can be mitigated, at least for the temporary staging areas required during construction. However, participants note that the long-term impacts of the presence of the rail line itself in areas previously important to the wellbeing of many species amounts to a permanent negative impact to the conditions necessary to support connectivity.

The operations phase of EWR stands to have the longest lasting impacts, some of which are cumulative in nature. The presence of a massive linear infrastructure development that will effectively sever parts of one village from another for several years (in the case of tunnel construction through Highfields Caldecote), or dramatically alter historic road routes between villages (in the case of Eversdens to Harlton), are among the negative impacts to conditions supporting connectivity most frequently cited by participants. Closure of routes of all types that connect villages disrupts the movement of people between villages, lessening the ease of inter-village connectivity that could

result in the closure of important village amenities including schools, shops, pubs, and surgeries. The presence of the infrastructure itself, particularly its visual impact, is cited as among the most damaging impacts to connectivity. Described by some as a 'blight on the landscape' large embankments and tunnel entrances and egresses will permanently alter the established viewscape so valued as a source of connection between people and place. Mapping (Figure 9) indicates that 5 (83%) of the 6 hill/viewscape Valued Areas fall within the EWR physical footprint impact zone.

5.2 Legacy

> *"It's where I live. We walk here and feel a sense of history and belonging, I have a feeling of pride at the green hills and blue sky, but also a feeling of pain at their loss" [P70]*

> *"It's a walk that we've done for the whole life of my son, so it's linked in my mind with him at different stages [of his life] – struggling to climb up [the hill in] the mud when he was little, splashing in the ditch at the top when it was filled with water, hunting for the badgers at dusk, watching the bats over the field, finding bee orchids and man orchids, the giant Roman snails, sledging both in the old quarry and the field..." [P3]*

Legacy in the context of this project refers to the relationships that support intergenerational knowledge transfer between and among people, but also those habitats that sustain generations of plants, wildlife, and landscape features critical to the South Cambridgeshire heritage ecosystem. Valued Areas (places types) that sustain the relationships essential to the Valued Component of Legacy include walking routes (footpaths, bridleways) and play areas, which in turn are often associated with ancient and less formal woodlands, and water features like Bourn Brook. Unsurprisingly given their intergenerational origins, historic sites also feature heavily in participants' understanding of what is required to sustain knowledge of people/place relationships over time. One such feature is the clunch pit on the outskirts of Haslingfield where during the medieval period building materials were mined and used in the construction of local buildings, including Haslingfield's All Saints Church. The quarry was still in use through to the early 1900s and is now known as the home of thriving populations of birds and rare orchids, among many other species. Participants suggest that this site is emblematic of other places in the South Cambridgeshire landscape that represent the long-term reciprocal relationship between human activity that results in the creation of habitat for non-human species. Other examples include coppiced woodlands and historic farms.

Mapping of Valued Areas associated with the Legacy Valued Component suggests that of the physical places associated with Legacy, 71% (50 of the 71 polygons) fall within the EWR physical footprint impact zone (as of 2022). In addition, several areas, notably hill/viewscapes play a vital role in this Valued Component and while none of the 4 hills and viewscapes are identified as directly within the project impact zone (meaning most will not be physically impacted), their use and enjoyment will nonetheless be impacted by the transformation of the viewscape itself. Given that consistency of access and practice over time is a critical condition of the Legacy Valued Component, access restrictions that will occur during the EWR construction phase, coupled with the potential for permanent loss of currently frequented routes of access once the rail corridor is finalized means that the construction and operation of EWR will have a permanent negative impact on the conditions required to support Legacy. It should also be noted that Chapel Hill, which is identified as a key Valued Area required to sustain Legacy falls almost entirely within the project impact zone.

Participants' contributions via community mapping and interviews highlight the role agriculture and farms themselves play a role in sustaining the Legacy Valued Component, especially when it comes to intergenerational farming knowledge. Farmers report that generations of mutual care between farmers and farmlands have resulted in the soils that sustain some of the highest producing arable lands in the country. Farmers interviewed for the project also detail the obligation they feel toward caretaking for lands that in some cases have been in the same family for 5 or more generations. This obligation reflects accountabilities to previous generations, but also to address the need to secure future UK food security in times of climate change. In terms of the legacy of places and their non-human inhabitants, farmers

in South Cambridgeshire are increasingly re-introducing practices grounded in knowledge that in many cases reflect farming practices that predate the post-war industrial farm transition. The reintroduction of farming practice informed by intergenerational knowledge of land, coupled with new farming technologies contributes to biodiversity enhancement, water and flood management, and soil health. In combination these actions provide the basis upon which to increase food production resilience in the face of increasingly unpredictable weather patterns.

As expressed in detail in Section 5.0 of this report, participants have experienced and anticipate a number of impacts arising from all phases of the EWR project, several of which will impact the relationships that sustain the Legacy Valued Component. Specifically, participants suggest there is a strong likelihood that EWR will truncate the continuity over time that is critical to sustaining intergenerational knowledge transmission and to supporting the long term presence and health of non-human species.

On a heritage ecosystem scale, there are several key impacts that could fundamentally alter the sustainability of the Legacy Valued Component and the Valued Areas upon which it depends. For example, construction impacts to woodlands will, in many cases, include tree removal, grubbing of ground cover, and removal of soils. These actions represent a permanent interruption of the conditions of consistency of access and opportunities to maintain practices essential to the continuation of intergenerational and interspecies legacies. Though mitigation efforts considered within the scope of an Environmental Impact Assessment will undoubtedly look to replace the biodiversity loss from the destruction of woodland and other ecosystems through various means, it is probable that some if not all of the relationships that sustain Legacy in several specific Valued Areas will be lost forever. This is particularly true of impacts to woodlands, waterways, and meadows (foraging areas). Many participants note their lifelong, and in some cases multi-generational, relationships with specific wooded areas and woodlands and their particular features. These same participants frequently cite their desire to pass along knowledge of their own experiences to future generations in the hopes of sustaining an appreciation of and respect for these special and valued environs. The removal of specific woodlands and wooded areas means the removal of these relationships now and for the future. Thus, while the removal of woodland is significant in terms of its impact to environmental integrity, it is as, if not more, significant in its impact to the integrity of the heritage ecosystem. According to detailed maps dated 2022, of the 7 woodlands identified as Valued Areas critical to supporting the Valued Component of Legacy, and which are mapped on Figure 10, 100% fall within the EWR project impact zone.

5.3 Wellbeing

> *"My favourite walk. High and wild. Spacious. No noise, no pollution. A lockdown salvation." [P16]*

> *"The destruction of these fields would be disastrous to me and to the flora and fauna. [P21]*

There are several Valued Areas of the heritage ecosystem that participants note play a critical role in creating and sustaining the wellbeing of both human and non-human species. However, it is both the presence of Valued Areas and their level of intactness and health that participants deem as critical. Footpaths and bridleways, combined with running, and cycle routes are among the most frequently cited as place types that foster a sense of wellbeing. Figure 11 illustrates the location of all Valued Areas that participants suggest support Wellbeing. Of the 58 places indicated as Valued Areas, 48 (82%) are within the EWR project impact zone. More specifically, of the 14 walk, run, cycle routes that support the conditions required to sustain wellbeing (Figure 8), 13 (92%) fall within the EWR project impact zone.

The wellbeing supported by relationships with the heritage ecosystem is of both a psychological and physical nature. Indeed, there exists an expansive literature confirming the correlation between heritage sites, green spaces, and wellbeing (Darvil et al. 2019; Gesler 1992; Reilly et al. 2018; Power and Smyth 2016; Sofaer et al. 2021). Despite this well-established correlation, coupled with the inevitable impact linear developments have on greenspace, very little systematic data is available to properly predict and assess impacts to wellbeing that arise

from large scale linear development projects. In response, Cambridge Centre for Health Services Research (Morley et al., 2024) have announced a major, 10 year integrated longitudinal, mixed-method "Wellbeing Impact Study of HS2 (WISH2)" which seeks to study the mental health and wellbeing impacts of major transport infrastructure using HS2 as a case study.

Participants in the HEIA draw direct correlation between Valued Areas and their own wellbeing. Participants note that Valued Areas are places they retreat to in times of stress, either to alleviate feelings of loneliness through almost guaranteed encounters with other people while out on a walk, run or cycle, or the opposite, as places of refuge to find peace in the solitude of a walk to a favourite viewpoint, woodland, or water way. A number of participants suggested that their personal physical health relies on access to Valued Areas. Chapel Hill, Money Hill, and the Mare Way are frequently mentioned since they are among the few hills that provide a physically challenging cycling and/or walking route in an otherwise level landscape. Impacts to these key Valued Areas will vary over the different phases of the EWR project, but the impacts to the conditions that sustain human wellbeing, including the maintenance of places that provide opportunity for everyday encounters with other people, will likely be particularly marked during the construction phase. Temporary closure of walking, running, and cycling routes, combined with construction noise, and the (short to mid-term) marring of landscape that is an inevitable part of major infrastructure development will negatively impact the maintenance and ongoing presence of Valued Areas key to supporting human wellbeing.

The emphasis on wellbeing as a function of place intactness extends to non-human species. Many participants noted that different species of plants and animals depend upon the Valued Areas of the Heritage Ecosystem, the ongoing integrity of which is necessary to support the Valued Component of Wellbeing. For example, the rare and protected Barbastelle bats (*Barbastella barbastellus*), found only in Southern England and Wales, colonies of whom reside in the Wimpole and Eversden Woods Special Area of Conservation (SAC) (EWR 2021) but who forage over large areas of the adjacent landscape, are cited as a species of particular concern for many participants. The degree to which the landscape remains intact (in its current state) is viewed by participants as vital to the wellbeing of this critical and valued species. The overall impression given is that the barbastelle bat, however small, elusive, and rarely seen, acts like a heritage ecosystem 'keystone species'.[2] Meaning that the bats play a critical role in the heritage ecosystem such that their disappearance would mark a fundamental shift in heritage ecosystem structure and function. Other species falling within this same keystone category include the four species of orchid, including the increasingly rare and endangered Man orchid (*Orchis anthropophora*) whose habitat is restricted to chalk grasslands including those of the Haslingfield Clunch Pit (Jacquemyn et at., 2011). Colonies of the largest land snail in the UK known as the Roman snail (*Helix pomatia*) live in the Haslingfield Clunch Pit are descendants of the populations brought over by the Romans for culinary purposes (Witcher, 2013). Both the Man orchid and Roman snail are protected under the Wildlife & Countryside Act 1981. Still more potential heritage ecosystem keystone species include the exceptionally rare Cambridge Elm (*Ulmus cantabrigiensis*), found nowhere else in the world but which can be found growing in Cambridgeshire hedgerows, some of which are threatened by EWR.

With respect to Chapel Hill, a key Valued Area, EWR plans to mitigate impacts to bats by constructing a tunnel through the hill, thereby avoiding destruction of habitats and interruptions of flight paths that would be the effect of alternate options, such as a massive cutting. Participants suggest that a tunnel may lessen impacts to the bats but will not alleviate them entirely. Experiences with EWR during the planning phase have resulted in a level of distrust amongst participants. This distrust has led participants to believe that EWR is deliberately obscuring data about the impacts to bats, releasing only that which supports their plan to mitigate

2 Within ecology, the term 'keystone species' refers to those species that have a disproportionately large impact on the ecosystem relative to their abundance. Their presence (or absence) influences the dynamics of the entire ecosystem of which they are a part. The idea that non-human species play a critical role in the maintenance of culture is well developed in Indigenous scholarship. Here we borrow from Garibaldi and Turner (2004:1) who define "cultural keystone species" as those "plants and animals that "form the contextual underpinnings of a culture". We apply the term 'heritage ecosystem keystone species' to indicate the plants and animals that could be critical to the creation and maintenance of the heritage ecosystem.

impacts via the construction of a tunnel. Local expert knowledge of bat behaviour and presence suggests that the foraging areas upon which the bats depend will be severely impacted during construction. Furthermore, permanent removal of vegetation in the rail corridor itself will impact the insect populations upon which the bats depend for survival. In sum, participants report that the temporary and permanent loss of any vegetation within a 7km radius of the bat's maternity roost, otherwise known as the SAC Core Sustenance Zone (CSZ), will materially impact the long-term survival of the Barbastelle possibly leading to their eradication. The range of impacts resulting in the loss of this heritage ecosystem keystone species ultimately impact the integrity of the heritage ecosystem itself. Here we see how planning stage impacts (perceived and experienced lack of transparency on the part of EWR, resulting in distrust among participants) are linked to participant perception of construction impacts and their proffered mitigation options.

In summary, study participants overwhelmingly perceive all phases of the EWR project as having negative impacts on their heritage ecosystem, and on the Valued Components that define it, and the Valued Areas and conditions that sustain it.

6. CONCLUSION: THE FUTURE OF THE SOUTH CAMBRIDGESHIRE HERITAGE ECOSYSTEM

> *"I've seen lots of change over time, but this is the most enormous." [P74]*

> *"My view will go, but that's not important–it's what it's doing to the countryside." [P61]*

> *"In some ways, I sort of feel that you're almost letting down your predecessors by the fact that you are the one that has allowed [the farm] to be taken away, cut through, destroyed, ...I think there is emotion there, and a responsibility that you feel for the land." [PI1]*

As revealed by study participants, their heritage ecosystem consists of a complex layering of reciprocal people/place relationships. These relationships bolster connectivity, foster legacy in the form of knowledge transfer between multiple generations, and sustain the wellbeing of all inhabitants (human and non-human alike). There are a number of conditions that participants identify as necessary to sustain the Valued Components of the heritage ecosystem. These conditions range from the ongoing presence of historic travel routes, to the preservation of valued viewscapes, to the maintenance of intact habitats. Valued Areas critical to sustaining the heritage ecosystem include viewpoints, watercourses, and woodland. Some of these Valued Areas rate as rare and frequently used in the creation and maintenance of all Valued Components. Specific sites include the Mare Way, Money Hill, Chapel Hill, woodlands such as Hardwick Wood, Harlton Wood, Wimpole Wood, and Great Eversden Wood, and habitats for the Barbestelle bat and orchids, among others.

A summary of the past 100 years of Haslingfield village history illustrates that the trajectory of change in South Cambridgeshire over the past 100 years, bar the effects of major geo-political events such as the World Wars, has been largely incremental. This indicates that the South Cambridgeshire heritage ecosystem identified by study participants has absorbed change in a way that preserves the essential character of the area, rather than responding in a way that produces a complete transformation that results in a totally different set of relationships.[3]

The HEIA has shown that impacts are likely to be severe through all phases of the project and will result in a fundamental change in the 'without project' trajectory of Cambridgeshire, change which according to the study participants will be overwhelmingly negative. The sum total of impacts and their experienced and anticipated effects show that the East West Rail project represents a threshold of change, particularly in consideration of cumulative impacts, that could mean the transformation of the South Cambridgeshire countryside into something much different than the agricultural landscape that exists today.

At risk in the short to medium term are the ways in which people connect to one another, to the places that they care for, and that in turn care for them. Many participants suggested that their relationship to the natural world outside their doorstep has bolstered, and in times of anxiety and extreme stress (including during the COVID-19 pandemic) literally saved lives. Over the longer term, opportunities to share this relationship of respect for the countryside with their children or future generations will be fundamentally altered by the presence of a massive infrastructure which passes through or near many of the places where this knowledge transfer has or is hoped to take

3 For example, though the scale and methods of farming shifted after the wars to a more industrial model, the overall agricultural character of South Cambridgeshire was retained.

place. Among the chief concerns of participants are for their relationships with other species. This is not a shallow notation of a species whose presence is seen to serve a political agenda, but a deep abiding concern for non-human neighbours, from barbastelle bats to rare orchids, whose presence is monitored and whose habitat is cherished and protected by local people. In a recent reaction to Rachel Reeves' attempt to argue that bats are getting in the way of economic growth, broadcaster and nature campaigner Chris Packham notes that Reeves' argument represents a "PR disaster for Labour". Packham goes on to say "Do they not realise millions of people in the UK love wildlife; more people are members of the RSPB than all the political parties put together?..." (Horton, 2025).

A comparative analysis of impacts of the HS2 project shows that there is a strong likelihood that many of the negative impacts anticipated by participants will come to pass. The question that remains is whether local communities should be expected to bear the brunt of the negative impacts of a project intended to serve national interests, the benefits of which largely accrue elsewhere. For some participants who see a present and future influenced by the unpredictable dynamics of climate change, there are even broader questions at play. Namely whether government infrastructure planning decisions should weigh economic benefit against a more fulsome suite of costs, including for example the potential threat projects such as EWR have for long term food and water security. Local peoples' challenges to the economic drivers that scaffold political and capitalist logics used to justify infrastructure development are especially timely given the need to create a resilient food system capable of effectively safeguarding the UK's food supply in light of increasing global political and climate pressures (Lang, 2025).

The role of agriculture in shaping the heritage ecosystem of South Cambridgeshire cannot be underestimated. Many participants express their appreciation of the agricultural nature of the countryside and the views it affords. Still others trace their own family heritage to historic farms. The farmers themselves have articulated their concerns for the economic viability of their businesses given the potential impacts of EWR, but particularly relevant to the heritage ecosystem are their concerns for the wellbeing of the soils and waters upon which they depend. A recent DEFRA (2024) report suggests that factoring in climate change means that approximately 64% of grade 1 agricultural land is at risk of flooding from rivers and the sea by 2050. A significant percentage of the next best, grade 2, lands are located between Bedford and Cambridge, and will be directly impacted by the construction and operation of EWR. Farmers point out that the loss of grade 1 lands due to climate change induced flooding makes grade 2 lands all the more important to future food security. Farmers who participated in this study also seek to emphasise the role that South Cambridgeshire, and especially the farms slated to be directly impacted by EWR construction, play in provision of grain at a national and international level. These farmers suggest that global geo-political and climate stressors make, in their mind, the ongoing and future protection of South Cambridgeshire's arable lands of paramount importance. The threat to food security posed by EWR's permanent destruction of rich arable soils is compounded by the helplessness farmers feel when anticipating the destruction of generations of relationships their families sustained with the land.

The true cost of impact is best determined by those who will bear it. This pilot study shows that understanding impacts through the lens of the heritage ecosystem provides an opportunity to delve beyond categories of impact often dismissed as NIMBYism, to fully comprehend people/place relationships, and to avoid the pitfalls of HS2 and other projects that failed to do so (Brock & Goodey, 2022). Within an HEIA methodology the emphasis is on the degree to which a given project will impact the *relationships* that sustain the heritage ecosystem valued by affected community members. Participants in this study clearly anticipate that EWR will transform the character of the South Cambridgeshire countryside and in doing so irrevocably alter the heritage ecosystem and the relationships that sustain it.

In conclusion, the Heritage Ecosystems Impact Assessment successfully legitimises and values curated relationships between people and place. The pilot HEIA summarises how EWR constitutes a source of persistent shock that will transform the fabric of South Cambridgeshire countryside. Yet, there remains the possibility that development planning which considers the ongoing and future maintenance of heritage ecosystems can begin to redefine definitions of 'progress' not least because, as Justice Berger (1977) noted several decades ago:

> *There is a tendency to underestimate the dimensional and cumulative aspects of human impacts on the ...landscape and to overestimate the capacity of the environment to absorb them. The concentration of polluting activities that follow projects of a linear nature...means that such impacts are not only becoming more extensive but also that they are becoming interlocking and interdependent... How often and in how many locations can "acceptable" levels be tolerated before cumulative impact has produced an "unacceptable" level? This question is important.*

As the EWR project advances through the pre-construction phase in preparation for their Development Consent Order (DCO) application, there exists a rare opportunity for EWR to use the results of this project to work with affected community members to change course, or at the very least plan detailed mitigation strategies. The degree to which these efforts achieve meaningful mitigation will depend in part upon the seriousness with which EWR takes the relationships revealed by this project. EWR has the opportunity to set a new precedent for linear development by working with local knowledge holders to move beyond commitments informed by compartmentalised assessment and broad-based 'standard' approaches to mitigation, to instead assess and address the ways in which their proposed development will impact the *relationships* that ground the heritage ecosystem that is specific to the South Cambridgeshire countryside.

6.1 HEIA study limitations and future possibilities

6.1.1 Study limitations

This HEIA is a pilot study and as such its primary objective was to assess the effectiveness of the HEIA methodology itself, hoping to also provide participants with results that might capture relationships between people and place, and highlight impacts to those relationships not addressed in other forms of impact assessment. As a pilot project however, there are constraints that inform the process and results, and if addressed in future studies would provide a more detailed and nuanced understanding of heritage ecosystems. It should be noted that despite the limitations listed below, the study team is confident that the relationships that inform the heritage ecosystem identified by study participants is fair, if preliminary, in its description. Further interviews, mapping sessions, and other methods (see Section 3.0) could provide even greater insight into the intricacies of heritage ecosystems. Some of the constraints influencing the outcomes of this assessment include:

- The results of this heritage ecosystems impact assessment are intended to act as a guide to better understand and express impacts to people/place relationships (heritage ecosystem). However, given the unique nature of every community's heritage ecosystem, these results are specific to the people/place relationships of those who participated in this study and should be understood as such.
- The majority of our mapping sessions were coordinated with the EWR information sessions and as a result drew upon an audience already invested in understanding the impact (positive or negative) of EWR. Mapping sessions held independently of EWR information sessions could attract a different group of participants and therefore solicit different perspectives on impacts.
- Only one mapping session was held in each village location. Multiple return mapping sessions would have increased the overall study representativeness.
- Mapping methods varied and some mapped information was less detailed than others.
- Participation was fairly even across the 3 villages where impacts are perceived to be negative, but only a small number of people participated in Cambourne where there are indications that villagers, owing to the proximity of a planned station, may conceive of the rail line as having positive impacts on their lives.
- A summary of the impacts of the HS2 project on local residents, farmers, and other concerned citizens was derived from contributions of petitioners who were largely against the project. This skewed the summary of HS2 toward the negative impacts of the project.
- Change over time could benefit from a more detailed analysis of the drivers and consequences of various socio-political factors and local, regional, and national events over the long term

- By most socio-economic indicators the participants in this study are among the most privileged – a fact participants readily acknowledge. The HEIA methodology should be tested in areas where there exists a more wide-ranging socio-economic demographic.

6.1.2 Future possibilities

The HEIA methodology fills a gap in UK impact assessment provision in that it focuses on the impacts to relationships between and among people and place, moving away from a compartmentalised assessment of impacts. Arguably the Environmental Impact Assessment process is moving toward a whole systems based approach to assessing impacts to certain kinds of relationships (between species and habitat, or landscape and natural features, for example) but the HEIA further extends this thinking. As the UK government looks to revise the Environmental Assessment process, the HEIA can work alongside Environmental Assessment Orders to capture local knowledge we argue is essential to development planning in precarious times. Other applications of, and refinements to, the HEIA are detailed below.

- The idea that specific species could act as 'heritage ecosystem keystone species', or indeed that particular Valued Areas might function as 'heritage ecosystem keystone places' deserves further consideration. Future implementation of the HEIA could target methods aimed at the documentation of people/species interaction to consider places where these interactions are especially visible (for example habitats that have arisen in spaces exhibiting outcomes of people/place interaction such as flora that thrive in former quarries, coppiced woodland, ancient hedgerows, and animal and insect species that flourish in areas of past and/or ongoing human intervention, including farmlands).
- Given more time this HEIA pilot study would have quantified some of the indicators that signal the presence of conditions required to support Valued Components. For example, the Valued Component of Legacy depends in part upon the consistency of place over time. Indicators that could be used to quantify this condition (consistency of place over time) include, but are not limited to, the percentage of historic routes (roadways) within village boundaries, the number of multi-generation farms still in operation, and total hectares of natural play areas. Sources of data can include historic maps, ordnance surveys, census records, and 'walking ethnographies' with participants.
- A fulsome consideration of mitigation options and recommendations was not part of the HEIA project scope, however, the results included here could provide opportunities for creative, nuanced approaches to mitigation. With the HEIA results in hand, EWR has the opportunity to work with local communities to avoid the one-size-fits-all, often ineffective, mitigation strategies typical of linear development. Mitigation strategies informed by the HEIA take local knowledge seriously to design highly localized and meaningful options. For example, an HEIA mitigation strategy places the onus on EWR to achieve biodiversity gain targets as close to the site of loss as possible, rather than counting biodiversity gains achieved in places far beyond the heritage ecosystem itself.
- In June 2024 the United Kingdom ratified the UNESCO 2003 Convention for the Safeguarding of the Intangible Cultural Heritage. This ratification was accompanied by a series of consultations conducted by the World Heritage Lead at the Department for Digital, Culture, Media and Sport (DCMS) on different themes (e.g. on oral traditions and culinary traditions) with stakeholder groups. Throughout these, a recurrent theme in the expressions of intangible heritage was how their uniqueness was embedded in the places that the expressions had emerged from and been sustained in. Regardless of whether the discussion revolved around cheese manufacturing, storytelling, or particular crafts, it was clear that these forms of cultural heritage were inseparable from the heritage ecosystems that fostered and nurtured them. As the UK implements the Convention and formally designates expressions of intangible heritage for the purposes of listing and inventorying it will be crucial to account for, make visible and care for these connections. The Heritage Ecosystem Impact Assessment offers a means to do so.

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8. APPENDICES

Appendix A: Coding Guide www.hgc.hosted.york.ac.uk

Appendix B: MAP DATA www.hgc.hosted.york.ac.uk

Appendix C: HS2 petitioner Anticipated and Experienced Impacts www.hgc.hosted.york.ac.uk

Appendix D: Impact Criteria Definitions

Appendix D

	Definition	Low (score 1)	Moderate (score 2)	High (score 3)
Likelihood	The probability with which an impact is likely to occur.	The impact is unlikely but could occur.	The impact is likely to occur.	The impact has occurred or is certain to occur.
Duration	The length of time the impact will be experienced by the heritage ecosystem.	The impact lasts less than 1 year.	The impact will last 2 to 5 years (the likely duration of construction).	The impact will last 6 or more years, including those impacts that will last for the lifetime of the project.
Frequency	The frequency with which the impact will occur (e.g. weekly, monthly, annually).	The impact is likely to occur rarely or highly infrequently (e.g. 6 times or less over the lifetime of the project)	The impact will occur semi-regularly over the lifetime of the project, and/ or is concentrated within a single phase of the project (e.g. within the planning, construction, operation phases)	The impact will occur regularly throughout more than one phase of the proposed project.
Permanence	The degree to which the impact is permanent. To have low permanence, the impact must be reversable in situ through means including but not limited to meaningful and appropriate mitigation. **Reversibility does not apply to mitigation that that occurs elsewhere (e.g. habitat replacement outside the Heritage Ecosystem).	The impact will create little to no modification to the Heritage Ecosystem, and/or any change it does influence is almost entirely and immediately reversable.	The impact will result in significant modification of the Heritage Ecosystem but any change can, with appropriate mitigation measures, be reversed to some extent over the short to moderate term.	The impact will result in permanent, irreversible change to the Heritage Ecosystem.
Spatial Extent	The geographic/ spatial area of the Heritage Ecosystem over which the impact will extend.	The impact is highly localised and/or occurs within a single place (VA) in the Heritage Ecosystem.	The impact is concentrated but slated to occur in more than one area (VA) of the Heritage Ecosystem.	The impact is large and will affect more than 50% of the geographic extent of the Heritage Ecosystem.

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