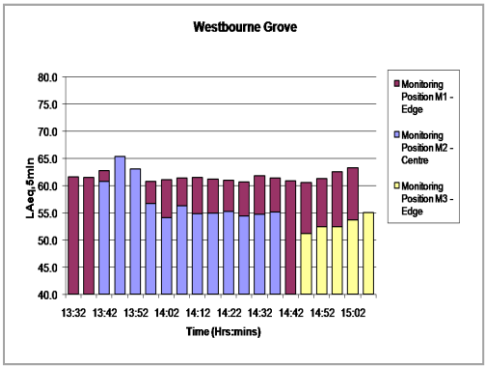
The Economic Value of Quiet Areas
Final Report

March 2011



Prepared for

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Study team (in alphabetical order):
Christos Anastasopoulos (URS/Scott Wilson)
Shibani Bose (URS/Scott Wilson)
Professor Abigail Bristow (Professor of Transport Studies, Loughborough University)
Petrina Rowcroft (URS/Scott Wilson)
Paul Shields (URS/Scott Wilson)
Chris Skinner (URS/Scott Wilson)
Stuart Woodin (URS/Scott Wilson)

With contributions from James Allan, Robert Burrell and Andy Nash.

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URS/Scott Wilson
6-8 Greencoat Place
London
SW1P 1PL
United Kingdom

Tel: +44 (0) 20 798 5000
Fax: +44 (0) 207 798 5001

www.urs-scottwilson.com

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Table of Acronyms

AMI	Acute Myocardial Infarction
BCC	Bristol City Council
CABE	Commission for Architecture and the Built Environment
CBA	Cost-Benefit Analysis
CLG	Department for Communities and Local Government
CPRE	Campaign for the Protection of Rural England
CVM	Contingent Valuation Methodology
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EC	European Commission
EEG	Electroencephalogram
END	Environmental Noise Directive
EPSRC	Engineering and Physical Science Research Council
EPUK	Environmental Protection UK
EU	European Union
GDP	Gross Domestic Product
HA	Highways Agency
HPA	Health Protection Authority
HPM	Hedonic Pricing Method
IGCB (N)	Interdepartmental Group on Costs and Benefits (Noise Sub-Group)
ISRIE	Instrument for Soundscape Recognition, Identification and Evaluation
NEA	National Ecosystem Assessment
NEF	New Economics Foundation
NENW	Natural Economy North West
NPSE	Noise Policy Statement for England
NSDI	Noise Sensitive Depreciation Index
NWDA	North West Development Agency
ONS	Office for National Statistics
PSP	Positive Soundscapes Project
SC	Stated Choice
TCM	Travel Cost Method
TEV	Total Economic Value
TRL	Transport Research Laboratory
WAG	Welsh Assembly Government
WHO	World Health Organisation
WTP	Willingness to Pay

Executive Summary

Background and Study Rationale

While the adverse impacts of high levels of noise on health, quality of life and well-being are relatively well understood and have been specifically acknowledged in environmental noise policy-making in England for over 45 years[1], the beneficial effects of access to quiet are less well understood and are therefore often overlooked or undervalued in decision-making. The debate on noise impacts stimulated by the emergence of EC noise policy has raised concern about other spaces, particularly those used for recreation, that currently enjoy a peaceful environment, referred to as 'quiet areas'. Some Member States have become concerned that attempts to improve the noise climate in areas of high exposure may lead to a spreading of noise across areas that currently experience low levels of environmental noise. This has generated a perceived need to protect these quiet or tranquil areas.

The Noise Policy Statement for England (NPSE) published by Defra in early 2010[2] provides a broad framework aimed at enabling noise management decisions to be made that ensure noise levels do not place an unacceptable burden on society. More specifically, it requires that noise is effectively managed and controlled within the context of Government policy on sustainable development to:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

While the first two aims require that measures need to be taken to avoid or limit adverse impacts of noise, the third aim requires that consideration is also given to identifying and implementing measures to protect quiet places and quiet times, or that enhance the acoustic environment thereby delivering health and well-being benefits to society.

'Quiet' and 'quiet areas' contribute to economic welfare through the generation of human well-being and prevention of illness and ecosystem decline that inflict costs on society. However, most of the benefits of quiet are not directly priced in the market and therefore risk being under-valued with resulting degradation or total loss of 'quiet' or 'relatively quiet' areas.

The economic valuation of public open spaces (including quiet areas) is very difficult to quantify since, from an economic perspective, these services are classic public goods without a market price. Their lack of value expressed in monetary terms, prevents these spaces from being properly evaluated in cost-benefit analyses of public policy.

Government guidance set out in The Green Book[3] requires that all new policies, programmes and projects are subjected to a comprehensive but proportionate appraisal to ensure that interventions enacted by public sector bodies are in the best interest of society overall. In order to provide as full an account as possible of potential outcomes, a key component of appraisal is the comparison of the total benefits of a proposal to the full costs incurred by Government and society. In this regard, The Green Book requires that all relevant costs and benefits are valued in monetary terms so that the overall net benefit of the proposal can be calculated. Typically the outcomes of interest are changes in the quality or quantity of the environmental good or service.

[1] For example, the Noise Abatement Act came into law in 1960 and the Report from the Committee on the Problem of Noise was published in 1963 (the Wilson report)
[2] Defra (2010) Noise Policy Statement for England. March 2010 [online] available at http://www.defra.gov.uk/environment/quality/noise/policy/documents/noise-policy.pdf (accessed 22 December 2010).
[3] HM Treasury (2003) The Green Book; Appraisal and Evaluation in Central Government. Treasury Guidance. TSO: London [online] available at http://www.hm-treasury.gov.uk/d/green_book_complete.pdf (accessed 10 March 2011)

While the costs of providing 'quiet areas' are relatively straightforward to obtain, estimating the benefits is far more difficult, largely because these are not routinely traded in the market place and therefore do not have well established monetary values.

In light of the above, Defra commissioned this piece of work to identify, quantify and monetise (as far as possible) the benefits that people derive from 'quiet areas' and to develop a 'framework' or 'tool' that can be systematically and consistently applied by policymakers to assess the benefits that people derive from quiet areas or conversely, the costs of loss of access to these areas. Essentially, this requires a value to be placed on how residents, workers and visitors value publicly accessible quiet areas. Ultimately, the research findings will contribute to the ongoing work of the Interdepartmental Group on Costs and Benefits Noise Sub-Group. This work also puts Defra at the forefront, internationally, of efforts to understand and quantify the health and quality of life benefits from particular acoustic environments, such as parks and quiet areas. The project was completed over a 4-month period between December 2010 and March 2011.

Approach

There are two possible starting points to the study. The first looks at identifying evidence around the types of benefits that we might expect people to derive from quiet areas in general (and potentially uncovering additional benefits in the process). The second uses a definition or typology of quiet areas as a starting point and then identifies the range (and where possible, significance) of benefits associated with each type of quiet area. A hybrid of the two approaches has been used here.

A comprehensive review of over 80 studies was undertaken to collate evidence on the nature and significance of the benefits that people derive from quiet and relatively quiet areas.

Given the number of potential benefits from 'quiet areas' (including those that are relatively quiet compared to the surroundings), the scope of the review was necessarily broad and looked at (i) areas whose primary purpose is quiet and (ii) how quiet contributes to the overall quality of urban open spaces. This includes:

- Areas that are absolutely quiet in terms of dB(A) levels (i.e. below a certain threshold);
- Areas that are relatively quiet i.e. they are significantly less noisy than surrounding areas (an urban park with plenty of trees or other open spaces);
- Areas that are quiet but not necessarily considered tranquil (an urban waste land);
- Areas that should be quiet but are not (a side street which is used as a rat run); and
- Areas that are sensitive to noise but may or may not be quiet (churchyards and cemeteries).

The report is essentially concerned with environmental noise arising from external sources such as road vehicles and aircraft impacting the general outdoor environment. Noise from neighbours, and that generated inside the home, inside buildings or vehicles and at the workplace are all excluded except in so far as evidence from research on the effects on health of noise from these sources can form part of the context in which environmental noise is considered.

In considering the evidence, a set of research questions was developed and used to guide the scope of the literature review. These included:

1. What benefits do people derive from quiet areas?
2. Do people derive different types of benefits from different types of quiet area (e.g. parkland vs. open spaces in urban settings vs. graveyards vs. quiet corridors, etc)?

3. What evidence is available (i.e. in the form of case studies) to illustrate both the nature of benefits and their significance?
4. What significance do people attach to the benefits identified (e.g. are preferences expressed in monetary values or is there at least a ranking of benefits)?
5. How might values vary with purpose (e.g. walking route, place for pursuing recreational activities, lunch break area, and/or duration)?
6. Are there any other factors that influence the nature and significance of the benefits derived from quiet areas?
7. Are there any absolute thresholds (e.g. levels of noise) at which people no longer benefit from quiet or relatively quiet areas? Is an increase in noise valued in the same way as a decrease in noise? Are thresholds relative to surrounding noise levels? Or are there no strict thresholds? What about marginal changes in noise?

Defining Quiet and Quiet Areas

Approaches taken to identify quiet and quiet areas generally fall into four distinct categories:

- Quantitative methods based on noise levels. These use measured and/or predicted noise levels and may relate to absolute or relative quiet, i.e. how quiet an area is relative to its surroundings or an absolute threshold above which an area is deemed not to be quiet. Different values may apply for daytime and night-time periods;
- Quantitative methods based on location, or distance from major noise sources, etc. Such approaches may be appropriate in a rural context, but are unlikely to be applicable to urban quiet areas;
- Subjective methods based on users' identification with, and use of, quiet areas; and
- Subjective methods based on audibility of acoustic features, natural sounds, etc.

The research relating to the value of quiet is consistent in asserting the complexity of "quiet" and that one's experience of 'quiet environments' is inextricably linked with overall perceptions of the character and quality of the landscape or context in which it is present, on the soundscape and, to a certain extent, with prior expectations.

In light of the findings presented, it is suggested that a subjective definition of quiet should be used for the purposes of this project. Many previous surveys use such a method implicitly as quiet is not specifically defined, and left open to the respondents' interpretation.

The following key defining points, or tests of quiet, are considered appropriate:

- Natural sounds are audible and not masked by man-made sounds – the **sound quality** test;
- For relative quiet, the area is noticeably less noisy than its immediate surroundings – the **relatively quiet** test;

For a subjective definition of quiet areas, the key test is considered to be the **potential use** test, i.e.:

- An area users choose to visit due to its quiet nature (whether absolutely or relatively quiet); and

- An area used for quiet activities such as reading, strolling, meditation and reflection[4].

The outline for an objective definition of quiet areas, based on recommendations from the literature reviewed is included below. The precise figures in this definition are reviewed and tested within the context of a case-study in this project:

- Minimum area constraint to prevent the inclusion of large numbers of very small areas (e.g. area meeting noise criteria must be at least 1 ha);
- The Local Authority should shortlist suitable public open spaces as candidate quiet areas;
- Maximum noise level of 55 dB L_{day}. This level would apply at the perimeters of the space, and ideally levels within the space would be well below this level. Areas that are quiet for parts of the time (when they are likely to be used) should also be considered; and
- For relatively quiet areas, the noise level across the majority of the area must be at least 10 dB(A) below the noise levels of the surrounding areas (e.g. possibly defined as the noise levels associated with all dwellings within a 200m radius).

In implementing such an approach, it is recommended that some initial area selection is carried out to identify potential quiet areas before testing these against the above criteria. This would include the selection of all public open spaces, riverside/canal-side areas, churchyards, etc. which could then be tested against these criteria based on available noise mapping or monitoring data.

To test this approach, some initial area selection was carried out (together with Westminster City Council) to identify potential quiet areas within the City of Westminster before these were tested against the above criteria. The quiet areas selected included a large public park (St. James's Park), a smaller park bounded by a canal on one side in a residential area (Westbourne Green) and a paved urban space (Golden Square) off a busy road. Noise monitoring was conducted at each of these sites (see Appendices 4-6) and used to refine the above objective (absolute and relative) approaches to defining quiet and relatively quiet areas in the context of available noise data and local knowledge and to determine which areas would be subjectively considered as quiet or relatively quiet areas.

The Benefits of Quiet and Quiet Areas

The literature suggests that quiet (or absence of unnecessary or inappropriate sounds) has a number of important and often co-related benefits to human well-being, including improved creativity, problem solving, mental health, concentration and undisturbed sleep. In addition to the direct economic benefits that human well-being confers (in terms of, for example, savings on health costs and increased worker productivity), access to "quiet areas" also offers other services of economic and social value including impacts on property values (people generally prefer to live in "quiet" neighbourhoods) and benefits to the wider community, including children and the elderly.

The Value of Open Spaces: Survey Findings

To complement the literature review, two surveys were undertaken: a field survey amongst users of open space in central London and an on-line survey amongst UK-based employees of URS/Scott Wilson.

The field survey was conducted amongst users of different types of three urban spaces in the City of Westminster: St. James's Park, Golden Square and Westbourne Green. The purpose of this survey was to try and establish the relative value of quiet within different types of urban open spaces and to identify the types of noise (or noise thresholds) that would discourage people from using these open spaces. Ultimately, the survey was designed to inform the derivation of a noise-sensitive demand curve for urban open spaces.

[4] Consideration should also be given to the fact that some 'quiet areas' may also be used for criminal activities (e.g. mugging).

Key findings from the field survey were that:

- 'Escape from hustle/bustle' was most frequently ranked as the most important benefit that respondents obtain from urban open spaces (25% ranked it as being of highest importance) whilst 'creativity' was seen as one of the least important benefits of open spaces;

- Fewer than 4% of all respondents listed quiet as the highest ranking feature of urban open spaces, yet quiet ranked more highly than both social/visual contact with people and creativity. However, the value of 'quiet' or 'relatively quiet' is implicit in 'escape from hustle/bustle' and 'rest/relaxation' which both score highly;

- When asked to rank the factors that detract from their enjoyment of urban open spaces, over 50% of respondents ranked 'an attack or verbal abuse' as the most important annoyance factor. Over 80% of respondents listed 'an attack or verbal abuse' as one of the top five (out of 8) annoyance factors while litter and noisy people (80% and 74% respectively) also ranked highly. More people are disturbed by crowds of noisy people than by noise from mechanical equipment (confirming that public open spaces are rival goods), and people are more sensitive to these sources of noise than they are to background noise filtering into the open space from elsewhere (e.g. traffic noise);

- When asked specifically about the types of noise that would prompt the respondent to move on or leave the open space, noisy people (particularly mobile phone users) featured most prominently. Construction noise and noise from mechanical equipment were also frequently cited. Road traffic noise, which can be expected to be a relatively permanent feature, appears to be much less of a concern amongst open space users;

- There would be no significant change in frequency of use amongst respondents if the open space were to become significantly quieter than at present; and

- As may be reasonably expected, people are more sensitive to louder sounds, particularly where these are intrusive and un-natural or man-made

The online employee survey revealed 'visual appeal' as the most important attribute of urban open spaces (32% ranked this as most important). This was closely followed by 'escape from hustle/bustle' (29%) and 'rest and relaxation' (21%). Answers to an open question about other important benefits that respondents derive from urban open spaces clearly demonstrated that access to 'quiet' or 'relatively quiet' areas is important to people. A significant number of respondents alluded to the importance of urban open spaces as offering a less stressful/quieter way of walking into town/to work and providing relief from urban life and the monotony of the urban environment.

Conceptual Approaches to Valuing Quiet and Quiet Areas

Most of the valuation evidence relates to noise, rather than quiet, possibly reflecting the difficulties in separating the contribution that "quiet" makes to amenity value relative to other attributes.

There are a large number of papers that have studied the impacts of an increase or decrease in noise levels on amenity values. These typically use the housing market (i.e. HPM) to estimate implicit prices for quiet. These studies fail, however, to capture the value of quiet areas to those who (i) may not be able to afford to live in 'quiet' neighbourhoods and arguably, for whom, a quiet space in a noisy neighbourhood would be more highly valued and/or (ii) those who may work in a noisy environment and seek refuge from the 'hustle and bustle' during the day.

In light of the findings, three possible approaches to valuing quiet and quiet areas were identified:

- Using a range of urban green spaces as a proxy for "quiet areas" to identify an upper range estimate of the value of quiet areas. This would draw on several recent initiatives (e.g. by CLG, CABE, etc)

and other HPM and CVM studies on green open space to estimate, through the process of benefits transfer, the economic value of urban open spaces[5]. It would also rely on studies to assess the impacts or opportunity costs of proposed (or actual) developments on greenfield sites and how these may impact on 'quiet' and/or the types of activities (e.g. recreation, reading, meditation, etc) that take place in these spaces;

- Estimating the opportunity costs of maintaining undeveloped sites; and
- Making use of existing values for noise disturbance in the home (i.e. based on the webTAG values). This would, however, only be applicable to a change in the level of noise/quiet and would not therefore reflect the value of those 'quiet spaces' that are actively sought. While such an approach could at least provide a starting point, it is important to note that it would be open to a lot of criticism.

None of these approaches is perfect but they are believed to make best use of the available evidence to provide an indicative measure of the economic value of quiet areas. The results derived from any of these approaches would need to be heavily caveated and the extent to which they over- or under-value quiet clearly highlighted. The first approach (using open space values as a proxy for quiet or relatively quiet areas) is conceptually preferred and once the method is established, values and classifications could be further refined as more evidence becomes available.

Application of an Approach to Estimating the Economic Value of Quiet Areas

Using information from noise mapping, the literature review and primary research, the benefits transfer approach was applied to estimate an economic value for Westbourne Green, an open space in west London that exhibits clearly discernible changes in noise level from the centre of the open space to the surrounding area.

It is estimated (on the basis of a short observational survey) that around 2,000 people visit Westbourne Green each day. This includes both those for whom the Green is a destination in itself and those who use it as a thoroughfare. In addition to the users, there are also a number of non-users who may nevertheless value the space. These include people who live in the vicinity of the space and may therefore benefit from increased property values as a result of having a pleasant outlook or a quieter environment, as well as people who simply value the existence of the open space. The case study is limited to use values only.

Under a baseline scenario, the use value of Westbourne Green is estimated to lie between £1.18 and £7.40 per visit, or between £861,400 and £5,402,000 per year. This could reasonably be considered as an upper bound for the use value of the park.

A hypothetical change scenario is then introduced to examine the impact of the development of a new road scheme to the south of the Green which will result in a substantial increase in traffic flows along the A40 and an associated increase in noise levels within Westbourne Green. One third of all survey respondents in Westbourne Green said that they would move out of the open space altogether if subjected to continual loud traffic noise. Assuming a complete loss of utility to these users, the resulting welfare loss is estimated to lie between £284,130 and £1,782,660 per year. This estimate does not, however, account for those users who simply relocate to alternative quiet spaces nearby (with little or no change in utility) and those who continue to use Westbourne Green (perhaps because there are no convenient alternatives or choose instead to spent time in quieter parts of the space) but whose use values have been reduced as a result of the increase in noise.

The case study is a necessarily crude illustration of one approach to valuing quiet using available information on the value of urban open spaces. It ignores non-use values and does not account for those users who may continue to use the space but whose willingness-to-pay (WTP) to use the space is diminished by the increase in traffic noise, or those who are able to make use of alternative open spaces.

[5] The focus is necessarily biased towards urban green spaces as this is where most of the published evidence lies.

Using a similar approach, it is possible to derive an aggregate estimate for the value of quiet in England as a whole. An ICM poll conducted in 2009 found that 31% of the population regularly visits quiet areas. Without a definition of 'regular' two scenarios are assessed: the first assumes one visit per person per year giving a total of 16.12 million visits per year nationally. The second assumes one visit per person per month giving up to 193.44 million visits per year. There is, however, a high degree of uncertainty around the number of visits specifically motivated by a desire for quiet, not excluding of course those trips made for other reasons but where quiet is a critical component of the package of experiences. Once again employing the use values of £1.18 to £7.40 per visit (which are themselves highly caveated and reflect the use value of green space in its entirety), the total use value for visits to quiet areas for England as a whole is estimated to lie somewhere between £19.02 million and £1.4 billion per year.

This estimate covers a wide range and includes only those who visit open spaces expressly for the purpose of experiencing quiet. These estimates do not include the value held by those users who visit open spaces for other reasons but gain added utility from the quiet and the non-use values held by those who may not necessarily visit quiet areas but derive benefit from knowing that quiet areas exist and/or from a premium on the value of properties located in or near to quiet areas.

Conclusions and Recommendations for Further Research

As is evident from the review findings, very little research has sought to evaluate the benefits of quiet, taking 'quiet' or 'relative quiet' as the starting point. Rather, studies have typically focused on the effects of noise or the impacts of changes in environmental noise levels above a 55 dB L_{day} threshold. Suggestions for areas of further research are provided within this report.

More broadly, it is clear from both the review and study findings that much more effort is needed to ensure that acoustic factors (including noise, soundscape, quiet and tranquillity issues) are included on the agenda when considering open space. While 'quiet' does not explicitly feature as one of the most highly ranked attributes of urban open spaces amongst users, it is an implicit feature of other benefits that are considered very important including 'an escape from hustle/bustle' and a place for 'rest and relaxation'. This suggests too that quiet areas are valuable and need to be protected and enhanced.

1 Introduction

1.1 Background

1.1.1 Noise is generally defined as "any unwanted sound" and as such is reliant upon the subjective perception of being unwanted or harmful. Continued exposure to unacceptable levels of noise is associated with a wide range of adverse impacts on human health, public amenity, productivity and ecosystems[6]. At the time the European Commission (EC) Green Paper on Future Noise Policy (COM(96) 540) was published in 1996, it was estimated that around 20 percent of the EU's population, or close on 80 million people, suffered from noise levels that scientists and health experts consider unacceptable. With increasing demand for all forms of transport and development, and despite technological advances that have reduced the noise generated by mechanised transport, there is continued erosion of areas that are free from the intrusion of noise created by road, rail and air travel, industry, power generation and mechanised and large scale recreational activity.

1.1.2 There are many different sources and types of noise. The Noise Policy Statement for England (NPSE) distinguishes between environmental noise, neighbour and neighbourhood noise and occupational noise[7]. Environmental noise includes noise arising from transportation sources, neighbour noise includes noise from inside and outside people's homes and neighbourhood noise includes noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street.

1.1.3 There has been significant progress in the quantification and valuation of environmental noise impacts over the past decade, as well as advances in spatial modelling, allowing estimation of average noise exposure across the UK. Until the formation of the Interdepartmental Group on Costs and Benefits Noise Sub-Group (IGCB (N)) in 2008, valuation of noise pollution in the UK was centred on amenity impacts[8] through the Department of Transport's (DfT) webTAG values for annoyance[9]. These values are derived from hedonic pricing analyses[10] that examine the impact on property prices of households' exposure to road and rail noise and represent only a subset of the total value of noise impacts.

1.1.4 The IGCB (N)) was therefore established with a remit to develop and disseminate best practice economic approaches to valuing a wider range of the impacts of changes in environmental noise across all areas of government policy. The first report of the IGCB (N)[11] set out a general framework for simultaneously evaluating four broad groups of impacts: health, amenity, productivity and ecosystem and recommended that the health impacts of noise should be a priority area for further research given the potential scale of negative impacts resulting from noise pollution, the strength of the evidence base and how much the development of a health impact

[6] Defra (2008) *An Economic Valuation of Noise Pollution – developing a tool for policy appraisal*. First report of the Interdepartmental Group on Costs and Benefits, Noise Subject Group [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcb-first-report.pdf (accessed 28 January 2011)
[7] Defra (2010) Noise Policy Statement for England (NPSE) available at http://www.defra.gov.uk/environment/quality/noise/neighbour/ (accessed 21 March 2011)
[8] Amenity impacts are defined by the IGCB (N) as the conscious annoyance or negative reaction to noise exposure.
[9] See http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.3.2.pdf
[10] See particularly Bateman, I.J., Day, B.H. and Lake, I. (2004) The Valuation of Transport-Related Noise in Birmingham. Department for Transport [online] available at http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/economics/rdg/birmingham/ (accessed 28 January 2011).
[11] Defra (2008) *An Economic Valuation of Noise Pollution – developing a tool for policy appraisal*. First report of the Interdepartmental Group on Costs and Benefits, Noise Subject Group [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcb-first-report.pdf (accessed 28 January 2011)

assessment tool would add to the existing policy framework and enable a more comprehensive analysis of the costs and benefits.

1.1.5 The second report of the IGCB (N)[12] recommends methodologies to include established health impacts in policy, programme and project appraisal insofar as these relate to acute myocardial infarction (heart attack), amenity, hypertension, sleep disturbance and hearing impairment.

1.1.6 While the adverse impacts of high levels of noise on health, quality of life and well-being are relatively well understood and have been specifically acknowledged in environmental noise policymaking in England for over 45 years[13], the beneficial effects of access to quiet are less well understood and are therefore often overlooked or undervalued in decision-making. It is worth noting here that the absence of high noise levels is not necessarily equivalent to the presence of quiet. Quiet and relatively quiet areas confer a range of benefits that changes in noise levels above or below a certain noise threshold would not reflect. This is an important point when considering changes in noise levels that transcend certain noise thresholds where, for example, some benefits (such as opportunity to escape from hustle and bustle) may be conferred (when moving below a noise threshold) or lost altogether (when moving above a noise threshold).

1.1.7 The debate on noise impacts stimulated by the emergence of EC noise policy has raised concern about other spaces, particularly those used for recreation, that currently enjoy a peaceful environment, referred to as 'quiet areas'. Some Member States have become concerned that attempts to improve the noise climate in areas of high exposure may lead to a spreading of noise across areas that are currently almost free from environmental noise. This has generated a perceived need to protect these quiet or tranquil areas.

1.2 Policy Drivers for the Protection of Quiet Areas

1.2.1 In recognition of the effects that exposure to noise can have on human well-being, the European Parliament and Council published the Directive for Assessment and Management of Environmental Noise 2002/49/EC[14], more commonly referred to as the Environmental Noise Directive (END). The END requires a more strategic approach to control, by focusing on those exposed to environmental noise and places a requirement on Member States to:

- Determine the noise exposure of the population through noise mapping for major roads, railways and airports and in agglomerations (large urban areas);
- Make information available on environmental noise to the public; and
- Adopt Action Plans based on the mapping results, to reduce noise levels where necessary, and to preserve environmental noise quality where it is good.

1.2.2 Increasing attention is therefore being given to not only reducing noise levels where they are high, but also protecting “quiet areas”.

1.2.3 In England, the Directive is implemented through the Environmental Noise (England) Regulations 2006 (as amended).

[12] Defra (2010) Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure. The second report of the IGCB (N) [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcn-noise-health-response100707.pdf (accessed 24 March 2011)

[13] For example, the Noise Abatement Act came into law in 1960 and the Report from the Committee on the Problem of Noise was published in 1963 (the Wilson report)

[14] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, Official Journal of the European Communities 18.7.2002 [online] available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:189:0012:0025:EN:PDF (accessed 4 February 2011)

1.2.4 In March 2010, Defra published Noise Action Plans for 23 agglomerations in England. Part E looks at the definition of Quiet Areas, stating that:

> *"The Competent Authority will only identify as Quiet Areas those open spaces which provide significant and important benefits because they are quiet; it is expected that such open spaces will already be regarded as special and that they may already be managed to sustain their quietness. The Competent Authority will consider identifying as a Quiet Area part of an open space as long as it meets the requirements".*

1.2.5 For those spaces designated as quiet, Local Authorities will be expected to adopt policies to manage the local noise environment so as to protect the quietness of these spaces and avoid increases in noise from those sources of noise covered by the Action Plan (i.e. road, rail, aircraft and industry).

1.2.6 The NPSE published by Defra in early 2010[15] provides a broad framework aimed at enabling noise management decisions to be made that ensure noise levels do not place an unacceptable burden on society. More specifically, it requires that noise is effectively managed and controlled within the context of Government policy on sustainable development to:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

1.2.7 While the first two aims require that measures need to be taken to avoid or limit adverse impacts of noise, the third aim requires that consideration is also given to identifying and implementing measures to protect quiet places and quiet times, or that enhance the acoustic environment thereby delivering health and well-being benefits to society.

1.2.8 In order to achieve these aims, and to ensure that nature and significance of any trade-offs are identified and properly accounted for in decision-making, requires that the benefits of quiet and access to quiet areas can be valued and incorporated into widely used and understood appraisal tools such as cost-benefit analyses (CBA).

1.3 Study Rationale

1.3.1 'Quiet' and 'quiet areas' contribute to economic welfare through the generation of human well-being and prevention of illness and ecosystem decline that inflict costs on society. However, many of the benefits of quiet are not directly priced in the market and therefore risk being under-valued with resulting degradation or total loss of 'quiet' or 'relatively quiet' areas.

1.3.2 This is largely because 'quiet', like many other environmental goods and services, is subject to several forms of market failure. Market failures relating to 'quiet' are linked to the 'public good' nature of publicly accessible 'quiet areas', the existence of externalities, and lack of information, all of which provide a strong rationale for government intervention in the form of policies, programmes and/or projects. These are described in more detail in Box 1 below.

[15] Defra (2010) Noise Policy Statement for England. March 2010 [online] available at http://www.defra.gov.uk/environment/quality/noise/policy/documents/noise-policy.pdf (accessed 22 December 2010).

Box 1: Sources of market failure

'Quiet areas' as public goods

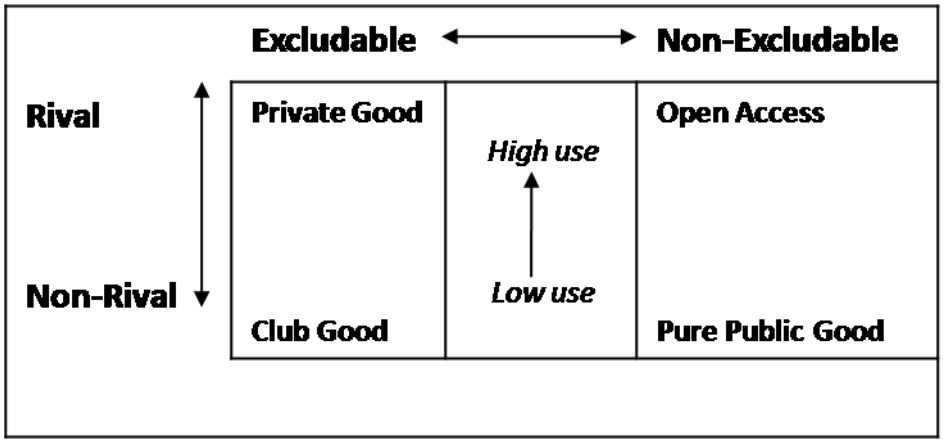
'Quiet areas' exhibit public good characteristics which account for their under provision. There are two main features of public goods.

- Firstly, they are **non-rival**, meaning that the consumption of a public good or service by one individual does not preclude consumption by another individual.
- Secondly, consumption is **non-excludable**. This means that consumption by one individual makes it impossible to exclude any other individual from having the opportunity to consume.

For example, an urban park may provide ecosystem services in terms of noise screening and pollution reduction for neighbouring properties. In this case, one individual benefiting from improved air quality and lower noise levels is not going to affect other individuals benefitting (non-rival) and no individual can be excluded from these benefits (non excludable). These characteristics mean that although there is value in these services, there are insufficient incentives to pay to maintain these services (free riding). Typically, government intervention is required to ensure these services are maintained.

In economic terms, the marginal cost of providing a pure public good to an extra user is zero, and this implies that, in order to achieve allocative efficiency, the charge for the product should be zero. Of course, in this situation, private sector businesses are unlikely to consider providing pure public goods because they will not be able to make any profit at a zero price, and many consumers can take a free ride on such goods because of non-excludability. The provision of pure public goods is therefore a cause of market failure. Left to the free market, public goods are under-provided and under-consumed leading to a loss of social welfare.

There are few examples of pure public goods as in the real world, consumption by one individual typically reduces the level of consumption that may be enjoyed by another. Publicly accessible 'quiet areas', particularly where these are in short supply, are therefore more likely to suffer from the '**open access**' problem where multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource (i.e. quiet) even when it is clear that it is not in anyone's long-term interest for this to happen. This has been most discussed in the context of national parks and siting of car parks at beauty spots.



Externalities

A key aspect of market failure relates to externalities – where use of a resource by individuals and firms does not take into account the full social costs or benefits. Many environmental services fall into this category. For example, decisions to develop in or near public open spaces may not reflect the full range of impacts on, or benefits obtained by, users of those spaces and will not therefore be taken into account in decisions on land conversion or other development. This will lead to external costs imposed on society and results in under-provision of the benefits concerned. The provision of quiet can also be described in the context of positive externalities - for example, a public open space that provides stress relief for nearby workers or residents or that inspires creativity may be external from the perspective of the land manager.

In this respect, the concept of Total Economic Value (TEV) provides a useful framework for considering the range of use and non-use values that people may derive from environmental assets (see Box 5). By accounting for both indirect use and non-use values through the TEV framework, it is possible to internalise many externalities.

Information failure

Limited understanding of the complex array of factors that determine how people value 'quiet areas' or of the value that 'quiet' has amongst a range of other benefits that people derive from public open spaces is likely to be playing a key role in the loss of 'quiet areas'. Information failures can occur when the necessary information for people or firms to make optimal decisions is incomplete or difficult/costly to acquire. As a result, existing opportunities to protect or improve both economic and environmental outcomes may not be realised.

1.3.3 Government guidance set out in The Green Book[16] requires that all new policies, programmes and projects are subjected to a comprehensive but proportionate appraisal to ensure that interventions enacted by public sector bodies are in the best interest of society overall. In order to provide as full an account as possible of potential outcomes, a key component of appraisal is the comparison of the total benefits of a proposal to the full costs incurred by Government and society. In this regard, The Green Book requires that all relevant costs and benefits are valued in monetary terms so that the overall net benefit of the proposal can be calculated. Typically the outcomes of interest are changes in the quality or quantity of the environmental good or service.

1.3.4 While the costs of providing 'quiet areas' are relatively straightforward to obtain, estimating the benefits is far more difficult, largely because these are not routinely traded in the market place and therefore do not have well established monetary values.

1.3.5 In light of the above, Defra commissioned this piece of work to identify, quantify and monetise (as far as possible) the benefits that people derive from 'quiet areas' and to develop a 'framework' or 'tool' that can be systematically and consistently applied by policymakers to assess the benefits that people derive from quiet areas or conversely, the costs of loss of access to these areas. Essentially, this requires a value to be placed on how people value publicly accessible quiet areas. Ultimately, the research findings will contribute to the ongoing work of the IGCB (N). This is, however, a novel area of research and is likely to require significant further study in order to refine any results. This work also puts Defra at the forefront, internationally, of efforts to

[16] HM Treasury (2003) The Green Book; Appraisal and Evaluation in Central Government. Treasury Guidance. TSO: London [online] available at http://www.hm-treasury.gov.uk/d/green_book_complete.pdf (accessed 10 March 2011)

understand and quantify the health and quality of life benefits from particular sound environments, such as parks and quiet areas.

1.3.6 The particular challenge here is to develop a method of quantifying the value of quiet that goes beyond the subjective associations and benefits experienced when, for example, entering a lovely park from a noisy urban environment. The research question is therefore, if an individual could no longer escape the high noise level of their road or workplace into a nearby park or garden, what would be the loss? In addition to losses experienced by users, there are also potential non-user costs to be considered (i.e. some people may value 'quiet areas' for reasons not related to their use of it). An important, but non-trivial, starting point is to define what is meant by 'quiet' and 'quiet areas' and, more specifically, how to characterise and value different types of 'quiet areas' that reflect local preferences, and which may be fleeting, relative, mood related and complex in terms of actual soundscape, in such a way that is meaningful and practical for the purposes of policy- and decision-making.

1.3.7 The overall aim of this paper is to describe a practicable methodological framework for estimating the economic value of 'quiet' and 'quiet areas' in urban areas on the basis of existing published evidence. More specifically, it:

- Sets out the criteria used to measure areas of 'quiet' or low levels of environmental noise;
- Outlines the range of services provided by, or benefits that people derive from, 'quiet' and 'quiet areas', including inspiration and creativity, convalescence, stress relief, concentration, meditation and amenity. This includes identifying other features that may influence people's preferences for 'quiet' and 'quiet areas' (e.g. accessibility, safety, etc);
- Evaluates the existing valuation literature relating to 'quiet' and 'quiet areas';
- Proposes and tests an approach linking changes in amenity value to changes in environmental noise levels based on both the review findings and a survey of open space users in London;
- Demonstrate the importance of quiet and quiet areas;
- Identifies sensitivities and uncertainties in the proposed methodology; and
- Provides recommendations for addressing gaps in the evidence and ultimately strengthening the robustness of the valuation approach.

1.3.8 The study was completed over a four-month period between December 2010 and March 2011. Given the short timeframe over which the study was conducted, the scope of the research was necessarily restricted to a review of the existing evidence. This nevertheless provides an important starting point for identifying what further research is required to develop a more robust model for estimating the economic value of quiet areas.

1.4 Structure

1.4.1 The remainder of the paper is structured as follows:

- **Chapter 2** briefly describes the conceptual underpinnings and approach to the development of the methodology;
- **Chapter 3** sets out the definitions of 'quiet' and 'quiet areas' used to guide the scope of the study;

- **Chapter 4** presents the key review findings in terms of the range of benefits derived from different types of 'quiet area', organised around the four broad groups of noise impacts identified by the IGCB (N);
- **Chapter 5** describes various conceptual approaches to valuing 'quiet' and 'quiet areas' and sets out the evidence that may be used to derive monetary values for 'quiet' and 'quiet areas'. It also presents the findings of a survey amongst users of different types of public open spaces in London; and
- **Chapter 6** draws together the findings and sets out a recommended approach for a preliminary methodology for arriving at an indicative value of 'quiet areas' based on the available evidence. It also highlights the gaps in the existing evidence that would need to be addressed in order to develop a more robust estimate of the economic value of 'quiet areas'.

2 Approach to the Study

2.1 Overview

2.1.1 This chapter outlines the conceptual framework and approach to developing the valuation methodology.

2.1.2 There are two possible starting points to the study. The first looks at identifying evidence around the types of benefits that we might expect people to derive from quiet areas in general (and potentially uncovering additional benefits in the process). The second uses a definition or typology of quiet areas as a starting point and then identifies the range (and where possible, significance) of benefits associated with each type of quiet area. A hybrid of the two approaches has been used here.

2.1.3 The value of quiet and quiet areas is then assessed on the basis of published evidence. Where marginal values have been identified, these are combined with primary data generated through a field survey of three types of urban open spaces in central London and an online survey amongst employees to estimate a social demand curve for quiet areas.

2.2 Review of Existing Evidence

2.2.1 There is growing literature to support the existence of “positive sounds”, from which amenity, health and productivity benefits are derived. A systematic review (see Appendix 2 for the detailed review protocol) was undertaken to collate evidence on the nature and significance of the benefits that people derive from quiet and areas.

Review Scope

2.2.2 As there is no single agreed definition of “quiet areas”, an important part of the review exercise was to begin to identify the acoustic and non-acoustic criteria that may be used to help delineate quiet areas, or the characteristics of spaces for which “quiet” is a notable and valued attribute. The study focuses on “quiet areas” within an urban setting and is limited to those areas or spaces that provide respite from neighbourhood, traffic and industrial noise.

2.2.3 Given the number of potential benefits from ‘quiet areas’ (including those that are relatively quiet), the scope of the review was necessarily broad and looked at (i) areas whose primary purpose is quiet and (ii) how quiet contributes to the overall quality of urban open spaces. This includes:

- Areas that are absolutely quiet in terms of noise levels (i.e. below a certain threshold)
- Areas that are relatively quiet i.e. they are significantly less noisy than surrounding areas (e.g. an urban park with plenty of trees or other open spaces)
- Areas that are sensitive to noise but may or may not be quiet (churchyards and cemeteries).

2.2.4 Consistent with the NPSE, the report is essentially concerned with environmental, neighbour and neighbourhood noise. As noted in paragraph 1.1.2, this includes noise from transport, noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street; and noise from inside and outside people’s homes. Noise from inside buildings or vehicles and at the workplace is excluded except

in so far as evidence from research on the effects on health of noise from these sources can form part of the context in which environmental noise is considered. Noise exposure from leisure activities, including from fireworks and music, is also excluded from the scope.

Research Questions

2.2.5 In considering the evidence, a set of research questions was developed and used to guide the scope of the literature review. These included:

1. What benefits do people derive from quiet areas?
2. Do people derive different types of benefits from different types of quiet area (e.g. parkland vs. open spaces in urban settings vs. graveyards vs. quiet corridors, etc)?
3. What evidence is available (i.e. in the form of case studies) to illustrate both the nature of benefits and their significance?
4. What significance do people attach to the benefits identified (e.g. are preferences expressed in monetary values or is there at least a ranking of benefits)?
5. How might values vary with purpose (e.g. walking route, place for pursuing recreational activities, lunch break area, and/or duration)?
6. Are there any other factors that influence the nature and significance of the benefits derived from quiet areas?
7. Are there any absolute thresholds (i.e. levels of noise (dB(A)) at which people no longer benefit from quiet or relatively quiet areas? Is an increase in noise valued in the same way as a decrease in noise? Are thresholds relative to surrounding noise levels? Or are there no strict thresholds? What about marginal changes in noise?

2.2.6 Chapters 4 and 5 of this report assess the available evidence in light of these questions. Chapter 6 highlights areas where there is significant uncertainty or where further evidence is required to develop a robust and more logically defensible economic value of quiet areas.

3 Defining Quiet and Quiet Areas

3.1 Overview

3.1.1 This chapter of the report covers the approach used in the present study to arrive at a definition of "quiet" and "quiet areas". More specifically, it sets out some of the criteria that may be used in identifying "quiet areas" or areas that are valued because they are perceived to be quiet or to offer a respite from noisier surroundings.

3.2 Approaches

3.2.1 Unlike air quality, there are currently no European or national noise limits which have to be met, although there can be specific local limits for specific developments. Furthermore, sound only becomes noise (or "unwanted sound") when it exists in the wrong place or at the wrong time such that it causes or contributes to some harmful or otherwise unwanted effect, like annoyance or sleep disturbance. In contrast to many other pollutants, noise pollution depends not just on the physical aspects of the sound itself, but also the human reaction to it.

3.2.2 There is therefore, at present, no universally agreed definition of "quiet" or "quiet areas". The Environmental Noise Directive (END) places requirements on Member States to identify and protect quiet areas. Under the END, a "quiet area":

- in an agglomeration, is a space in an urban area that is delimited as such by a competent authority and, for example, is not exposed to noise levels above a certain limit.
- in open country, is an area that is undisturbed by noise from traffic, industry or recreational activities.

3.2.3 However, the END left it to Member States to come up with appropriate methodologies for the identification and definition of quiet areas. Unsurprisingly, this has resulted in the emergence of a range of approaches to defining quiet areas. While some general recommendations have been made by various Working Groups established by the European Commission to support the implementation of the END, the definition, identification and protection of quiet areas in urban locations is still under discussion, not only with respect to acoustic criteria (i.e. when an area can be objectively defined as "quiet") but also with regard to issues such as future land use and public access.

3.2.4 Approaches taken to date to identify quiet and quiet areas generally fall into four categories:

- *Quantitative methods based on noise levels*. These use measured and/or predicted noise levels and may relate to absolute or relative quiet, i.e. how quiet an area is relative to its surroundings or an absolute threshold above which an area is deemed not to be quiet. Different values may apply for day- and night-time periods;
- *Quantitative methods based on location, or distance from major noise sources*, etc. Such approaches may be appropriate in a rural context, but are unlikely to be applicable to urban quiet areas;
- Subjective methods based on users' identification with, and use of, quiet areas; and

- Subjective methods based on audibility of acoustic features, natural sounds (green acoustics), etc.

3.2.5 This study identifies strengths and weaknesses with the different approaches and there are clearly advantages to considering a more composite definition in the UK. Table A1-1 in Appendix 1 provides a summary overview of the studies reviewed dealing with definitions of quiet and quiet areas. Some of the key findings are described in more detail below.

Objective approaches

3.2.6 To date, the focus has been primarily on defining critical thresholds or levels based on acoustic criterion at which noise becomes a disturbance or harmful.

3.2.7 The World Health Organisation (WHO) Guidelines for Community Noise (1999)[17], for example, provide guideline values arranged according to specific environments and critical health effects. The guideline values consider all identified adverse health effects for the specific environment, where an adverse effect of noise refers to any temporary or long-term impairment of physical, psychological or social functioning that is associated with noise exposure. Specific noise limits have been set for each health effect, using the lowest noise level that produces an adverse health effect (i.e. the critical health effect). More generally, it suggests that noise levels should not exceed:

- 50 dB $L_{Aeq,16hr}$ for avoidance of moderate annoyance; and
- 55 dB $L_{Aeq,16hr}$ for avoidance of serious annoyance

3.2.8 A research project undertaken by Symonds Group, and aimed at investigating the "Definition, Identification and Preservation of Urban and Rural Quiet Areas"[18], made recommendations for the definition of quiet areas in both urban and rural areas, with a specific focus on the requirements of the END. With this focus, the report provided a quantitative approach to the identification of quiet areas and tried to provide guidance on noise levels which could be used to identify these.

3.2.9 Specifically the Symonds project report recommended the use of an upper limit of 50 dB L_{den} for urban quiet areas with a "gold standard" level of 40 dB $L_{den.}$ For rural quiet areas, an upper limit of 40 dB $L_{Aeq,24hr}$ was recommended. Given the difficulty of achieving these levels within the majority of urban areas in the UK and the social benefits that are still apparent at levels in excess of 50 dB(A), the END requirement may take us down an avenue that limits scope to treat quiet areas holistically.

Subjective approaches

3.2.10 Subjective methods based on what areas people perceive to be quiet or which they identify and/or choose to use as quiet have been used for the purpose of identifying the benefits of quiet in this study. Typical subjective definitions of quiet include:

- Where natural sounds are not masked by man-made sounds; and

[17] WHO (1999) Guidelines for Community Noise. Geneva [online] available at: http://www.who.int/docstore/peh/noise/guidelines2.html (accessed on 8 December 2010)

[18] Symonds Group (2003) Definition, Identification and Preservation of Urban & Rural Quiet Areas. Final Report (ENV,C, 1/SER/2002/0104R), July 2003 [online] available at http://www.cyprus.gov.cy/moa/agriculture.nsf/All/AFAFD70A94392BEDC22572F70063924B/$file/Definition,%20Identification%20and%20Preservation%20of%20Urban%2W0&%20Rural%20Quiet%20Areas.pdf?OpenElement (accessed 13 January 2011).

- An area where people specifically go for quiet relaxation

3.2.11 In 2006, Defra commissioned the Transport Research Laboratory (TRL) to develop appropriate criteria for the identification of Quiet Areas in agglomerations and in open country in the UK in accordance with the requirements of the END and other policy objectives. Following a comprehensive review of relevant UK and worldwide research, legislation and guidance covering many different fields including health, physical and psycho-acoustics, and environmental psychology, TRL concluded that:

> *"…there is too little research information available to allow the identification of Quiet Areas purely on the basis of acoustical criteria. In urban areas, noise levels below 55 dB(A) can be identified from noise maps although other work in Birmingham and Westminster has identified that there are very few significant green urban spaces in these areas with noise levels below 55 dB L_{den}. There are therefore further considerations relating to landscape quality and public access that need to be considered in defining a Quiet Area"*[19].

3.2.12 In response to this finding, TRL adopted an alternative approach based on defining *procedures* for identifying Quiet Areas. These procedures were developed to offer flexibility so that local requirements and availability could be taken into account, allowing access to Quiet Areas for as much of the population as possible whilst keeping the number of areas requiring protection to a manageable level. We believe that this is also a useful starting point for the present study as it helps ensure that the working definition agreed here, is consistent with, or at least advances, the guidance set out in earlier research.

3.2.13 Around the same time, the Campaign to Protect Rural England (CPRE) undertook a tranquillity mapping exercise with the aim of providing the information required by decision-makers to allow them better to identify, protect, enhance and reclaim places (particularly rural landscapes) where tranquillity may be experienced[20]. The study built on a series of earlier Tranquil Area maps published by the CPRE and the former Countryside Commission in 1995 (and developed by ASH Consulting on behalf of the Department of Transport in 1991). In these earlier maps, 'Tranquil Areas' were defined as: 'places which are sufficiently far away from the visual or noise intrusion of development or traffic to be considered unspoilt by urban influences'[21]. These places were identified through specific criteria, with Tranquil Areas being found certain distances away from features such as roads, towns, airports and power stations. In 2000, a detailed critique of the original CPRE maps was published[22]. It argued that what was needed was a measure of tranquillity that included all, and only, those sources of disturbance which people feel actually damage tranquillity; and which weighted them in proportion to peoples' perceptions of their relative impacts on tranquillity.

3.2.14 In response to this critique, the CPRE undertook to revise the Tranquil Areas maps by combining more sophisticated mapping with extensive public and stakeholder participation to build a picture of what characterises and detracts from tranquil areas, or areas that enable people to find tranquillity. The study found that while tranquillity may seem to be a highly subjective experience, certain themes emerged strongly and repetitively: people, landscapes and noise.

3.2.15 In 2008, Scott Wilson undertook a tranquillity study in Westminster which developed a typology of spaces and an assessment methodology to measure tranquillity in a wide range of urban

[19] TRL Limited (2006) Research into Quiet Areas: Recommendations for Identification. Project report prepared for Defra (Project reference NANR 202).
[20] See CPRE (2005) Mapping Tranquillity: Defining and Assessing a Valuable Resource. CPRE: London. [online] http://www.cpre.org.uk/library/results/tranquillity
[21] CPRE and the Countryside Commission (1995), Tranquil Areas – England Map; cited in CPRE (2005).
[22] Levett, R. (2000) A headline indicator of tranquillity: definition and measurement issues, Interim Report to CPRE by CAG Consultants, 7 July 2000; cited in CPRE (2005).

situations[23]. Other important findings from this work – and which are relevant to the present study – include:

- An observation that there is **little correlation between sound levels and tranquillity apart from at the extremes** (e.g. the centre of a large park and conversely in public spaces which were essentially traffic islands). Evidence from a survey conducted as part of the study revealed that park users felt a range of factors or 'pillars' of tranquillity were as important as relative or absolute quiet and these included the culture of a place (history and stories), safety record, visual amenity and presence of nature. Five pillars of tranquillity were identified, namely visual or aesthetic, nature, culture, history as well as sound (which would include both overall noise level as well as positive sound features). However, the evidence did reveal the importance to residents, visitors and workers in Westminster of spaces that are 'significantly quieter', although in these spaces noise levels were rarely below 55 dB L_{Aeq}. The study suggested that areas with average noise levels in excess of 55 dB L_{Aeq} still had the potential to trigger tranquillity if the other experiential factors distracted, or masked (i.e. enabled people to switch off) the ambient noise levels.
- **Non-acoustic (or experiential) factors are important to how individuals perceive and benefit from 'quiet' and 'quiet areas'**. Experiential factors in a public space may allow the individual to experience calm even though the background 'noise' (planes, lorries, sirens etc) of the city is still high. An area may be perceived as a tranquil area and valued as such where there is a significant change in the overall character of the space. In addition to a significant drop in noise level, the space may have say a fountain and trees in an otherwise hard surfaced neighbourhood. It may be removed from the prevailing circulation pattern, forming a 'nook'. It may be an enclosed portion of a largely open and undefined area. Or, it might offer a sudden view or vista in an area of otherwise restricted views.

3.2.16 A survey in Amsterdam in 2008[24] asked respondents about their need for quiet and what characterises quiet areas. Outdoor quiet places identified by respondents were predominantly green parks and waterside areas, with quiet streets and small courts and squares.

3.2.17 Other work in Amsterdam[25] has used "low noise maps" showing quieter areas on noise maps, but extending below the 55 dB L_{den} cut off used for the END noise maps, and calculated at 1.5m height rather than the 4m height used for the END mapping exercise. Both these changes are beneficial for the identification of quiet areas as they allow maps to be produced which correspond more closely to the noise levels which would be experienced by people on the ground in these locations. However, it should be noted that equivalent figures for the UK could not be obtained without re-calculation of the END noise maps at the lower height of 1.5m.

3.2.18 This latter research also identified four different types of quiet area in which the expectations and need for quietness is different:

- natural reserves, where natural sounds should dominate;
- green spaces in the countryside, with natural sounds and sounds from agricultural or forestry activities;
- green spaces in cities (such as parks and cemeteries) where unwanted sounds should not dominate; and

[23] Scott Wilson (2009) Westminster Open Spaces Noise Study 2008. Final Report for Westminster City Council [online] available at http://www3.westminster.gov.uk/docstores/publications_store/Westminster%20Open%20Spaces%20Noise%20Study%202008.pdf (accessed 24 March 2011)
[24] Van den Berg, F. and Booi H (2009) The Need for Quiet in Amsterdam: A Survey. Paper presented at Euronoise 2009.
[25] Van den Berg, F. and Brand, A. (2009) Recommendations for public quiet places in Amsterdam. Paper presented at Euronoise 2009.

- quiet built-up areas in cities (such as court yards, squares or resting areas with little traffic) where again the unwanted sounds should not dominate.

3.2.19 Van den Berg and Brand (2009)[26] did not specify quantitative criteria for defining a quiet area in terms of noise levels, but work in Sweden[27] identified limit values of 45-50 dB(A) for quiet areas or a 10-20 dB(A) below the level of surrounding streets for relatively quiet areas. For the purposes of the present research and given the UK context, levels of 55 dB(A) are used to define quiet areas, and 10 dB(A) below the level of surrounding areas to define relatively quiet areas.

3.2.20 Defra worked with Bristol City Council (BCC) as a pilot city to trial the identification and management of quiet areas. BCC had already undertaken public consultation on quiet areas using the "Bristolstreets" map and "AskBristol" website as part of the Citizenscape project (an EU-funded project to help explore new web technologies that can help citizens get more involved with local decision making)[28]. People were asked to plot their chosen quiet places on "Bristolstreets". The data from "Bristolstreets" was used alongside other GIS data including strategic noise maps and qualitative information on open space quality to identify those places in the city where "quietness" is an important characteristic of the area. The purpose of the exercise was to inform Bristol's response to the European Noise Directive. Both internal and external stakeholders were consulted and a list of potential quiet areas submitted to Defra.

3.2.21 A similar approach has been used in Birmingham. Consultation was carried out in the early stages of the project with various stakeholders including the Highways Authority (HA), Birmingham Airport, local transport operators and various local council departments including Education, Transportation, Highways, Housing and Parks. No public consultation took place as resources were not available.

3.2.22 Using its own noise maps (covering all sources of transport noise but not industry), Birmingham attempted to identify quiet areas using the criteria developed by TRL which was parks at least 9 ha total area with at least 4.5 ha <55 dB L_{day}. As this meant that some quite large parks and open spaces did not qualify, another sweep was undertaken using the 4.5 ha criteria alone, e.g. if at least 4.5 ha was <55 dB L_{day} it was considered 'quiet'. No quiet areas were identified within the Birmingham Middle Ring Road using this criterion.

3.2.23 In an attempt to determine the quiet areas within the city, the lower area limit was removed completely. The identification of which areas to look at within the city (i.e. within the Middle Ring Road) was done as the result of a brainstorming session which identified places where people congregate; churchyards and other religious grounds (e.g. the surrounding areas of mosques, temples, synagogues and so on), cemeteries (stand alone ones as opposed to those attached to a church), public open spaces, parks, recreation grounds, canal towing paths and so on. For each one, the area less than 55 L_{day} as a percentage of the total area was identified but without lower limit.

3.2.24 The Welsh Assembly Government (WAG) has recently published a consultation document "Implementing the Environmental Noise Directive in Wales"[29]. Annex A of the document sets out a proposed procedure for the designation of quiet areas in agglomerations which is reproduced in Box 2 below.

[26] Van den Berg, F. and Brand, A. (2009) Recommendations for public quiet places in Amsterdam. Paper presented at Euronoise 2009.
[27] Working group of authorities concerned with noise, "Acoustic quality in natural and cultural environments – Proposal for metrics, indicators and auditing methods", Sweden (2002)
[28] See http://www.bristol.citizenscape.net/core/portal/home for more information.
[29] Welsh Assembly Government (2011) Consultation Document "Implementing the Environmental Noise Directive in Wales – "Designation of quiet areas in agglomerations and Noise Action Planning Priority Areas" Number WAG10-11252. Available at http://wales.gov.uk/docs/desh/consultation/110221noiseimplementen.pdf (accessed 20 March 2011)

Box 2: Procedure for the designation of quiet areas in agglomerations[30]

"In the first draft procedure document at Annex A – Implementation of environmental noise action plans in Wales: Procedure for the designation of quiet areas in agglomerations – we specify a set of conditions that must be met by a candidate quiet area if it is to be confirmed as an official quiet area in our environmental noise action plans. Once its status as a quiet area is confirmed, it will benefit from additional protection from noise under statutory planning guidance.

The first condition that must be met is that a written description of the area should be submitted for consideration by the Welsh Ministers, giving a subjective account of its soundscape, natural, and visual or aesthetic attributes. If it performs well on all these three points, it may be judged to confer a perception of quiet on those who use it.

The second condition is that the area should not appear as excessively noisy on the strategic noise maps prepared earlier in the environmental noise action planning process.

The document also recommends considering several additional factors when nominating a quiet area, such as a sense of personal safety, public access and clean air. Poor performance on these points is likely to detract from the potential health and wellbeing benefits otherwise conferred on local residents by a place being quiet".

3.2.25 The methodology proposed by WAG has merit. It draws on evidence from the Quietening Open Spaces report[31] published by Environmental Protection UK (EPUK) which notes that the WHO guideline of 55 dB(A) was taken as the starting point for looking at the designation of quiet areas. In dense UK urban areas it would be unrealistic to expect early achievement of this standard everywhere, but it has been widely adopted as a longer term aim. This is corroborated by the work undertaken in Birmingham and in Westminster. The EPUK report goes on to say that having a substantial part of an area at least 6 dB below the typical daytime level of its surroundings might be a practical early guideline. The WAG has decided that an area will only be eligible for designation as a quiet area if at least 75 percent of the grid points contained within it on the strategic noise maps are associated with an L_{day} noise indicator value lower than 65 dB, both for road and for railway noise. Areas failing this test are considered to be too noisy to be labelled as quiet.

3.2.26 There is also value in the iterative approach adopted by Birmingham. The Birmingham study would have benefited from stakeholder consultation, however it is recognised that funds were not available to allow this. One disadvantage of using noise maps to identify candidate quiet areas is that they do not necessarily include all the sources that contribute to the total noise level at a given point. The Birmingham noise mapping approach includes all transportation noise sources and industry is excluded as Birmingham City Council considered that industrial noise did not influence the results in this study. While the TRL method presents a straightforward and objective methodology, it does nevertheless have its shortfalls as mentioned above. The initial use of noise maps backed up with noise monitoring, preferably over several weeks or months at candidate sites, would provide a more objective approach. Better still would be to include a quantitative

[30] Welsh Assembly Government (2011) Consultation Document "Implementing the Environmental Noise Directive in Wales – "Designation of quiet areas in agglomerations and Noise Action Planning Priority Areas" Number WAG10-11252. Available at http://wales.gov.uk/docs/desh/consultation/110221noiseimplementen.pdf (accessed 20 March 2011)

[31] Environmental Protection UK (2010) Quietening Open Spaces Towards Sustainable Soundscapes for the City of London. Commissioned by the City of London Corporation, September 2010. Available at http://www.environmental-protection.org.uk/publications/ (accessed 24 February 2011).

measure of sound quality in the assessment; however, this area requires further work to provide a commonly accepted objective assessment methodology.

3.3 Factors Influencing Perceptions of Quiet

3.3.1 Although not a core part of the study, soundscapes and sound quality are considered to be a relatively new, but nevertheless important part of our understanding of what makes a quiet area. In quiet or relatively quiet areas the range of sounds heard and the ability of users to switch on or off those sounds is easier. Quiet areas may therefore allow users to experience positive individual sounds or a different soundscape (compared to outside the quiet area) which in turn adds to the total quality of a quiet area experience and therefore its value.

3.3.2 Soundscapes and sound quality have received much attention from the acoustic community within the past five years and have resulted in a number of high profile projects, such as the Positive Soundscape Project. Recently, there has been a move away from traditional acoustic methods of understanding environmental sound towards a more holistic, and interdisciplinary, approach to the sound environment[32]. In particular there has been much research into understanding how people perceive the soundscape.

3.3.3 The research relating to the value of quiet is consistent in asserting the complexity of 'quiet' and that one's experience of 'quiet environments' is inextricably linked with overall perceptions of the character and quality of the landscape or context in which it is present, on the soundscape and, to a certain extent, with prior expectations. This was born out in a survey of three types of urban open areas in London conducted as part of this study (see Section 5.5) which showed a significant resilience to specific types of noise amongst regular visitors to these open spaces.

Soundscapes

3.3.4 In examining the satisfaction gained from being able to access areas of low noise or relatively low noise, one must consider social preferences around different types of sound. Satisfaction is derived not only from noise levels being low or noticeably lower, but from the types of sounds that are heard. Satisfaction is thought to be highest where sounds considered appropriate to a particular location are evident and are at a comfortable level. Therefore, the importance of context in determining whether a sound becomes noise (i.e. "unwanted" sound) must be understood. Higher decibel levels of pleasant sounds may not be considered noise, whereas lower decibel levels of a less well-liked sound would harm amenity more. For example, evidence suggests that natural sounds are generally preferred by the population in comparison to man-made sounds. This was also apparent in the open areas survey where reaction to loud mobile phone conversations near people showed a particularly strong annoyance factor – even though the actual noise level of such conversations was not particularly high (see Section 5.5).

3.3.5 An interest in action plans based on "positive soundscapes" is growing across Europe and in the UK in particular. Several projects have been funded by the EPSRC, including NoiseFutures[33], the Positive Soundscapes Project (PSP)[34], and the Instrument for Soundscape Recognition, Identification and Evaluation (ISRIE)[35] to promote emerging psycho-acoustic research.

[32] Kull, R. C. (2006). "Natural and Urban Soundscapes: The Need for a Multi-Disciplinary Approach." Acta Acustica United With Acustica 92: 898-902.
[33] See http://noisefutures.org/
[34] See http://www.positivesoundscapes.org/
[35] See http://www.isvr.co.uk/reprints/IoA_Soundscape2008.pdf

3.3.6 The Positive Soundscapes Project which ran between 2006 and 2009, sought to develop a rounded view of human perception of soundscapes by combining methods from several disciplines. The specific objectives of the project were:

- to acknowledge the relevance of positive soundscapes, to move away from a focus on negative noise and to identify a means whereby the concept of positive soundscapes can effectively be incorporated into planning; and
- to evaluate the relationship between the acoustic/auditory environment and the responses and behavioural characteristics of people living within it.

3.3.7 The project set out to give a detailed and rigorous account of human perception of and response to soundscapes and to develop a soundscape evaluation system or tool. The evaluation system would consider what can be measured and how user behaviour can be characterised. This could then be used to identify and monetise benefits and it could also be used to support planning decisions on where and how interventions into the soundscape could be made[36].

3.3.8 To do this it used overlapping methods from a wide range of disciplines, ranging from the quantitative (e.g. acoustics) to the qualitative (e.g. social science) to the creative (e.g. sound art). Qualitative fieldwork (soundwalks and focus groups) determined that people conceptualised a soundscape into three components: sound sources (e.g. a market), sound descriptors (e.g. rumbling) and soundscape descriptors (e.g. hubbub). Lab-based listening tests along with the fieldwork revealed that two key dimensions of the emotional response to a soundscape are calmness and vibrancy. In the lab these factors explain nearly 80% of the variance in listener response. Interview responses from real soundscapes further indicate that vibrancy can be expressed in two sub-dimensions expressing variation over time and over sound mix. Physiological validation of the main dimensions is provided by images of changes in the brain during listening from MRI scans and by changes in heart rate.

3.3.9 Research on soundscapes in Sweden[37] which sought to investigate people's responses to quiet areas found consistent relationships between measured overall sound levels and perceived soundscape quality. However, sound source identification was found to be a stronger predictor of soundscape quality than measured sound levels. Soundscape quality was negatively related to presence of man-made sounds (e.g. traffic) and positively related to the presence of natural sounds. The results suggested that good soundscape quality in urban open spaces would require day-time traffic noise exposure below 50 dB L_{Aeq}. In situations with exposures between 50 and 55 dB(A), soundscape design that promotes positive sounds from nature was thought to be efficient in improving the landscape.

3.3.10 Whilst the focus of this project is predominantly on quiet and not the benefits of specific soundscapes, it is not possible to totally separate these two elements. Quiet (or relative quiet) from other noise sources will be a necessity to experience the benefits of positive soundscapes. From this premise, the ability to hear, and benefit from, positive soundscapes in specific areas may be considered a contributing factor to the definition of quiet or relative quiet. Positive soundscapes may also be of value in distracting people from more irritating sources of noise.

Expectation

3.3.11 What is experienced as an acceptable acoustic environment in a recreational area has been found to be greatly influenced by the type of area concerned and people's expectations of that

[36] For further information see: Davies, W. J., Adams, M. D., Bruce, N. S., Cain, R., Jennings, P., Carlyle, A., Cusack, P., Hume, K., and Plack, C. (2009). "A positive soundscape evaluation system," in Euronoise 2009 (Edinburgh, U.K.).
[37] Nilsson, M.E. (2007) Soundscape quality in urban open spaces. Inter-noise 2007, Istanbul.

area[38]. So, for example, in parks and nearby areas, one would not expect complete freedom from neighbourhood noise. However, in the countryside the expectations are that people will find an objectively quiet environment[39].

3.3.12 Bruce *et al.*[40] examine how expectation and experience form a contributory factor in the perception of soundscapes using fieldwork carried out in London and Manchester, and also a soundscape simulator in a laboratory. They found that a subject's rating of a soundscape is based on a number of factors, of which expectation seems to be prominent. These include type of activity occurring and expected activity in the space, for example just passing through the space, choosing to sit and linger or read in the space. Attitudes towards safety, social norms, accepted behaviour, visual aesthetics and control attributed to the space, form the basis of place expectation and relate to overall perception of the soundscape for each space. When one or more of these factors conflict with a perceived place expectation, then the soundscape is rated less favourably.

3.3.13 Similarly, Memoli *et al*[41] identify expectation as an important factor affecting people's perception of urban parks, green spaces and other natural areas which are often exposed to high levels of noise pollution because of their location, but that are typically expected to be "quiet". In these areas, a wide range of user requirements must be met at the same time as different users could require and expect a different level of "quietness". The authors provide the example of older people who are generally more open to sounds related to nature or human activities while younger people are more tolerant of sounds like street music and mechanical sounds. Similarly, the "quietness" expected by someone who visits a park to read or reflect, is very different from what a family might like to enjoy during a picnic on the grass.

3.4 Our Approach

3.4.1 The definition of quiet areas can be undertaken by two distinct approaches. Firstly, a subjective approach may be most appropriate for the purposes of this review, however, it would also be advantageous to define quiet areas in objective terms to allow for the identification of areas from readily available data.

3.4.2 There are distinct merits in the use of soundscape and sound quality. While in the long term this may be feasible, the size of the evidence base required compared to the level of existing evidence makes such an approach seem impractical at present. To adopt a soundscapes approach would require the estimation of preferences for a huge range of sounds at different levels and potentially in different locations. To date there is neither consensual agreement on a set of tools for quantifying a soundscape nor for defining sound quality. Further work in developing objective, pragmatic and transferable metrics to rate sound quality with respect to perceived quiet / tranquillity is therefore clearly required.

[38] See, for example, Memoli, G., Bloomfield, A. and Dixon, M. (2008) Soundscape characterization in selected areas of Central London. Paper presented to Acoustics 08, Paris; Bruce, N., Davies, B. and Adams, M. (2009) Expectation as a factor in the perception of soundscapes. Paper presented at Euronoise 2009. [online] available at http://usir.salford.ac.uk/2466/1/Bruce_et_al_soundscape_expectation_euronoise_2009.pdf (accessed 31 January 2011).

[39] CPRE (2005) Mapping Tranquillity: Defining and assessing a valuable resource [online] available at http://www.cpre.org.uk/library/campaign/tranquillity (accessed on 12 January 2011).

[40] Bruce, N., Davies, B. and Adams, M. (2009) Expectation as a factor in the perception of soundscapes. Paper presented at Euronoise 2009. [online] available at http://usir.salford.ac.uk/2466/1/Bruce_et_al_soundscape_expectation_euronoise_2009.pdf (accessed 31 January 2011)

[41] Memoli, G., Bloomfield, A. and Dixon, M. (2008) Soundscape characterization in selected areas of Central London. Paper presented to Acoustics 08, Paris [online] available at http://intellagence.eu.com/acoustics2008/acoustics2008/cd1/data/articles/002704.pdf (accessed 13 January 2011)

3.4.3 In light of the findings presented in Section 3.3 above, a subjective definition of quiet was used for the purposes of identifying the benefits and value of quiet and quiet areas through the literature review. Many previous surveys use such a method implicitly as quiet is not specifically defined, and left open to the respondents' interpretation. It is nevertheless recognised that in practice, identifying such areas is likely to include at least one objective element. We conclude that the use of three distinct tests used together or individually would be appropriate here:

- Natural sounds are audible and not masked by man-made sounds – **the Sound Quality test**; and
- For relative quiet, the whole area or part of the area is noticeably less noisy than its immediate surroundings – **the Relatively Quiet test**.

3.4.4 For a subjective definition of quiet areas, we develop one further test, the **Potential Use** test which has two key indicators:

- An area users choose to visit due to its quiet nature (whether absolutely or relatively quiet, or an absence of inappropriate or unnecessary sound, perceived or not – for example escaping the hustle and bustle, whilst not a conscious decision about noise levels, has a very strong association with relative quiet); and
- An area used for quiet activities such as reading, strolling, meditation and reflection[42].

3.4.5 There is no agreement on the definition of quiet areas in the existing literature but the concepts listed below indicate the sort of issues that seem to be emerging for an objective definition of quiet areas. These are reviewed and tested within the context of a case study based on survey findings presented in Chapter 5.

- Minimum area constraint to prevent the inclusion of large numbers of very small areas (e.g. area meeting noise criteria must be at least 1 ha);
- The Local Authority should shortlist public open spaces as candidate quiet areas with suitable community engagement;
- Maximum noise level of 55 dB L_{day}. This level would apply at the perimeters of the space, and ideally levels within the space would be well below this level. Areas that are quiet for parts of the time (when they are likely to be used) should also be considered; and
- For relatively quiet areas, the noise level across the majority of the area must be at least 10 dB(A) below the noise levels of the surrounding areas (e.g. possibly defined as the noise levels associated with all dwellings within a 200m radius).

3.4.6 In implementing such an approach, some initial area selection was carried out (together with Westminster City Council) to identify potential quiet areas before these were tested against the above criteria. The quiet areas selected (all within the City of Westminster) included a large public park (St. James's Park), a smaller park bounded by a canal on one side in a residential area (Westbourne Green) and a paved urban space (Golden Square) off a busy road. Noise monitoring was conducted at each of these sites (see Appendices 4-6) and used to refine the above objective (absolute and relative) approaches to defining quiet and relatively quiet areas in the context of available noise data and local knowledge and to determine which areas would be subjectively considered as quiet or relatively quiet areas.

[42] Consideration should also be given to the fact that some 'quiet areas' may also be used for criminal activities (e.g. mugging).

4 The Benefits of Quiet Areas

4.1 Overview

4.1.1 This chapter provides a summary overview of the literature reviewed on the benefits that people derive from "quiet areas". An early sift of the literature revealed a paucity of studies looking specifically at areas whose primary purpose is quiet and therefore the scope was widened to include studies that investigate the range of values that people attach to urban open areas, green spaces and positive soundscapes. A secondary objective of the review was therefore to examine the importance of "quiet" relative to other attributes that contribute to people's experience, and (where possible) the value they attach to the types of spaces investigated.

4.1.2 The review covers over 80 studies, which are presented in the summary tables in Appendix 1, and in greater detail in the Excel database that accompanies this report (Appendix 8).

4.1.3 The review also revealed a range of terminology to be navigated. For example, the words "quiet", "serenity", "peace", "calm", "tranquillity" are used variously within the literature. In some cases, the terms appear to be used interchangeably (i.e. they do not denote specific properties or refer to different types of experience) whilst in other studies they are carefully defined and refer to very specific properties. For the purposes of the present study, we have retained study findings relating to any of these terms and recorded where the terms have a specific meaning.

4.1.4 In identifying benefits we have to distinguish between having reasonable access to significantly quieter areas and living or working in one. In one the amenity value is more obviously reflected in house prices or the value of a particular employee/job; in the other the amenity value is more fleeting. The role of intrusive noise into noise-sensitive areas such as the home, workplace or accommodation (in case of visitors), is also of consideration here.

4.2 The Demand for Quiet Areas

4.2.1 Before considering the specific benefits that people derive from quiet areas, it is worth considering public preferences for quiet and quiet areas.

4.2.2 In April 2009, an ICM poll commissioned by Environmental Protection UK[43] provided an indication of the importance of quiet areas to UK residents (see Table 1). As one might expect, the demand for quiet areas in London is higher than that of the UK as a whole although the perceived need for protection of these areas is considerably lower.

Table 1: The importance of quiet areas to UK residents (from ICM poll, 2009)

	London	UK wide
% of people that think existing areas of quiet need protecting	62%	91%
% of people who regularly visit quiet areas	40%	31%
% of people who visit a local park to find quiet	73%	40%

[43] ICM telephone poll carried out on a random sample of 1,002 adults in Great Britain from 1-4 May 2009 as part of the ICM omnibus poll.

4.2.3 However, it is important to note that the poll did not control for other factors that may have influenced people's responses including, for example, the framing of the questions and the choices or trade-offs that would have to be considered when deciding whether or not to allocate resources to protecting quiet areas.

4.2.4 Further afield, the Dutch Ministry of Housing, Spatial Planning and the Environment commissioned a one-year study to investigate the properties of existing quiet places and the opportunities for creating new ones in the city of Amsterdam[44]. The study combined an objective assessment of areas characterised by a relative lack of noise (using noise maps produced to meet the requirements of the END) and a subjective assessment consisting of a random survey of the Amsterdam population and a campaign to direct citizens to a website with similar questions as in the survey. The aim of the survey was to capture information on the attributes of respondents' favourite 'quiet places', including small gardens and city parks. The survey revealed that:

- Quiet places are thought of as 'green' (i.e. parks) or 'blue' (i.e. water) and are well maintained;
- 75% of respondents visit a quiet place to relax/recover, walk or cycle;
- About 50% of respondents visit a quiet place elsewhere (in Amsterdam) at least once a week;
- About 50% of respondents think that quiet places should be better protected;
- Quietness is more important for elderly and noise sensitive people; and
- A quiet home is most important, a quiet city is least important and a quiet neighbourhood lies somewhere in between.

4.3 The Benefits of Quiet and Quiet Areas

4.3.1 For the purposes of estimating an economic value for quiet areas, the focus must necessarily be on identifying those benefits that have at least some features capable of being monetised or having a clear economic link. These might include things like arriving to work in a calm state, finding creative inspiration at work, amenity, relaxation and recreation, and the value of 'natural' soundscapes over man-made noise. Where benefits have been identified in the literature with no explicit economic link (i.e. they cannot be readily monetised), these have nevertheless been recorded as they are not only considered important to an understanding of the contribution of quiet areas to human health and well-being, but they have value and also serve to highlight where gaps in the valuation evidence may lie and what this may mean for the usefulness of any derived estimate of total economic value.

4.3.2 It is also worth re-iterating here that quiet and access to quiet areas confers benefits over and above the positive impacts gained through a reduction in loud noise. Amongst other things, quiet and quiet areas provide restorative effects, space for reflection and creativity, and an escape from hustle and bustle.

[44] Van den Berg, F. (2008) Quiet places in Amsterdam. Presentation to Internoise 2008, Shanghai

Typology of Benefits

4.3.3 To ensure consistency with the ongoing work of the IGCB (N), the range of benefits have, as far as possible, been discussed under the four broad groups used by the IGCB (N)[45], namely:

- *Health impacts*, this includes severe health effects such as changes in mortality and temporary effects including tinnitus;
- *Effects on amenity*, which reflect consumers' conscious annoyance from noise exposure;
- *Productivity*, which relates to areas such as reduced work quality through tiredness or noise acting as a distraction; and
- *Environmental*, where noise levels may impact on the functioning of the ecosystems, such as through birds breeding patterns.

4.3.4 Table 2 below summarises the range of benefits deriving from quiet and relatively quiet areas, or areas where one might expect to be quiet. Note that the benefits identified relate specifically to quiet and quiet areas rather than to an absence of loud noise and are described in more detail in the sections that follow.

Table 2: The Benefits of Quiet Areas

Broad Category	Benefits
Health	Mental Psychological well-being, including stress release / relief Physiological well-being (may reduce risk of hypertension) Psychological restoration / recovery
Amenity	Reduced annoyance reflected in property price premiums An escape from the 'hustle and bustle' of surrounding (relatively noisier) areas Relaxation / Recreation Spiritual
Productivity	Creativity and problem-solving Cognitive development
Ecosystems	Biodiversity (habitats for breeding, foraging, etc) Air quality (induced)

Health Benefits

4.3.5 Health effects are defined in a number of ways by different groups. The WHO for example adopts the broad definition "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*", while others use a more restrictive definition of mortality and morbidity. In examining the health benefits of access to quiet, this report follows the lead of the IGCB (N) and taken the narrow definition of health. Impacts on well-being more generally are covered under the headings of amenity and productivity.

[45] It is recognised that there are significant overlaps between these areas therefore in starting analysis on any of these areas there will be need for a clear delineation. This paper has purposely chosen not to rigidly define each of these areas to allow some flexibility in the resultant research.

4.3.6 There is a substantial and growing body of evidence on the link between exposure to high levels of noise and adverse health impacts[46], although there is continued uncertainty regarding the quantification of the relationship[47]. Berry and Flindell identified six key health effects for which statistical associations had been observed: annoyance, mental health, cardiovascular effects, sleep disturbance, cognitive development and hearing impairment[48].

4.3.7 Although the focus of this study is on the benefits of quiet, the adverse impacts on health from exposure to high levels of noise are discussed briefly below in so far as these may provide some insight into the beneficial impacts of 'quiet'.

4.3.8 A recent report by the Health Protection Agency (HPA)[49] on the health effects of noise concludes that whilst some of the available evidence is inconclusive or even contradictory, there is increasing evidence to suggest that exposure to noise from road and air traffic is linked to increased blood pressure and a small increased risk of heart disease, see Box 3. Evidence that environmental noise damages mental health is, however, inconclusive."[50]

4.3.9 For the purposes of this report, impacts on sleep disturbance and cognitive development are classified under the heading of productivity and described in more detail in that section.

Box 3: Effects of noise on health

Cardiovascular effects and hypertension

Acute exposure to noise has been shown to causes physiological activation including increases in heart rate and blood pressure, peripheral vasoconstriction with relative withdrawal of blood from the skin, and increased peripheral vascular resistance. On the whole there tends to be rapid habituation to brief noise exposure so that physiological responses to noise are short-lived but habituation to prolonged noise is less certain[51]. A comprehensive analytical review by Babisch (2006)[52] reveals a statistically significant correlation between road traffic sound levels and acute myocardial infarction (AMI). Based on a meta-analysis, Babisch developed a dose-response function to describe the relationship between road traffic noise – expressed in L_{day} – and the incidence of AMI

[46] See for example, Ad Hoc Expert Group on Noise and Health (2010) Environmental Noise and Health in the UK, report published by the Health Protection Agency [online] http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 13 January 2011); Berry B.F. and Flindell I.H. (2009a) Estimating Dose-Response Relationships Between Noise Exposure and Human Health Impacts in the UK, Final Project Report, BEL 2009-01, report to DEFRA [online] http://www.defra.gov.uk/environment/quality/noise/igcb/documents/project-report.pdf (accessed 13 January 2011); Berry B.F. and Flindell I.H. (2009) Estimating Dose-Response Relationships Between Noise Exposure and Human Health Impacts in the UK, Technical Report, BEL 2009-02, report to DEFRA [online] http://www.defra.gov.uk/environment/quality/noise/igcb/documents/tech-report.pdf (accessed 13 January 2011); Health Council of the Netherlands (2006). Quiet areas and health. The Hague: Health Council of the Netherlands. Publication no. 2006/12. [in Dutch; summary and keynote by Professor AL Brown in English]

[47] Defra (2008) An Economic Valuation of Noise Pollution – developing a tool for policy appraisal. Defra [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/publications/firstreport.htm (accessed 31 January 2011)

[48] Berry B.F. and Flindell I.H. (2009) Estimating Dose-Response Relationships between Noise Exposure and Human Health Impacts in the UK, Final Project Report, BEL 2009-01, report to Defra [online] http://www.defra.gov.uk/environment/quality/noise/igcb/documents/project-report.pdf (accessed 31 January 2011).

[49] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).

[50] HPA (2010) Environmental Noise and Health in the UK, page 92. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 07 April 2011).

[51] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).

[52] Babisch, W. (2006) Transportation Noise and Cardiovascular Risk: Review and Synthesis of Epidemiological Studies, Dose-Effect Curve and Risk Estimation. *WaBoLu-Hefte 01/06. Umweltbundesamt* [online] available at http://www.umweltdaten.de/publikationen/fpdf-l/2997.pdf.

showing that:

- Below daytime road traffic sound levels of 60 dB L_{Aeq} (L_{day}: 6-22 hr), no increase in AMI risk could be detected

- For sound levels greater than 60 dB L_{Aeq}, the AMI risk increases continuously, with relative risks ranging from 1.1 to 1.5, with reference to a baseline of ≤60 dB L_{Aeq}.

Combining the identified dose-response function with several evidenced assumptions, the IGCB (N) has estimated the marginal cost of increased risk of AMI as a result of rising noise levels. The values are provided on a per household per decibel basis and, unlike the link to AMI, the values change linearly with noise levels.

In a paper published in February 2011[53], a group of Danish researchers found that exposure to residential road traffic noise was associated with a higher risk for stroke among people older than 65 years of age. For every 10 decibel increase in noise, the risk of stroke among that age group increased by more than a quarter (27 per cent), accounting for air pollution and other factors like differences in lifestyle.

Hearing Impairment[54]

Dose-response functions for hearing impairment show that typical levels of environmental noise are not high enough to cause any significant hearing loss.

Mental Health

Many studies have reported that noise exposure in industrial and occupational settings is related to individual psychological symptoms. However, noise exposure in occupational settings may be very much higher than that from environmental noise. In addition, many of these studies are difficult to interpret because workers are exposed to other stressors such as dust, heavy work and physical danger in addition to excessive noise, and will not be discussed further. However, some community studies are biased towards over-reporting of symptoms because of an explicit link between aircraft noise and symptoms in the questions inviting people to remember and report more symptoms because of concern about noise. Community surveys have found that a high proportion of people report 'headaches', 'restless nights' and being 'tense' and 'edgy' in high noise areas[55].

Berry and Flindell identify a review by van Kamp and Davies[56] as the most recent and comprehensive research on this area. This review found that new evidence supported the conclusion that there is no direct association between environmental noise and mental health. Other research in this area similarly finds no quantitative link between noise and mental health. As a result, impacts on mental health are excluded from the IGCB (N) evaluation methodology.

[53] Sørensen, M. *et al.* (2011) Road traffic noise and stroke: a prospective cohort study. *European Heart Journal* (advance access copy, 25 January 2011).
[54] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).
[55] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).
[56] Van Kamp, I. and Davies, E. (2008) Environmental Noise and Mental Health: Five-Year Review and Future Directions. 9th International Congress on Noise as a Public Health Problem (ICBEN).

4.3.10 If high levels of environmental noise have adverse effects on health, then one might reasonably assume that an absence of noise confers benefits in the form of avoided health costs. However, as the Babisch study shows, traffic noise levels need to exceed a threshold of 60 dB L_{Aeq} before the physiological health impacts of traffic noise are discernible. There is, however, relatively little documented evidence of the health impacts conferred by areas considered to be quiet or relatively quiet or those health-related benefits (e.g. a place for rest and recovery) that are additional to those that may be gained through a reduction in high noise levels.

4.3.11 The health benefits of quiet spaces are linked mainly to stress release and physiological and psychological well-being. For example:

- Following a series of surveys amongst adults and children, Clark *et al.* (2007)[57] found that opportunities for psychological restoration provided by quiet relaxing areas at or near home reduced may serve as protective factors for reducing children's self-reported annoyance at school and at home as well as reducing their self-reported symptoms and sleep disturbance as a result of aircraft noise.
- Research in Sweden[58] used socio-acoustic surveys to assess the health effects of various soundscapes in residential areas. More particularly, the research was designed to test whether having access to a quiet side of one's dwelling enhances opportunities for relaxation and reduces noise annoyance and other adverse health effects related to noise. The results demonstrate that access to quiet indoor and outdoor areas of one's dwelling produces **a lower degree and extent of annoyance and disturbed daytime relaxation, improves sleep, reduces stress-related psychosocial symptoms and contributes to physiological and psychological wellbeing**[59]. Access to quiet façades (corresponding to a 5 dB ($L_{Aeq,24h}$) reduction in sound levels from the most exposed side) was found to reduce disturbances by an average of 30–50% for the various critical effects. The Scott Wilson noise survey in Westminster in 2008[60] demonstrated that average noise levels at rear façades of dwellings were significantly lower than those at the front façades in Westminster.
- Exposure to tranquil areas of nature is thought to be **stress reducing and have positive effects on physical and mental health**[61]. These effects may be partly the result of exercise but other aspects of the environment may also be important[62], one of which may be quiet. For example, a comprehensive review by the New Economics Foundation (NEF) on well-being and the environment revealed that green space can play an important role in providing 'an escape' from high population density in cities, be this through gardens, allotments or countryside[63].

[57] Clark C, Martin R, van Kempen E, Alfred T, Head J, Davies H, Haines MM, Lopez Barrio I, Matheson M & Stansfeld SA. (2006) Exposure-effect relations between aircraft noise and road traffic noise exposure at school and reading comprehension: The RANCH project. American Journal of Epidemiology, 163 (1), 27-37.

[58] See for example, Öhrström E., Skånberg A.,Svensson H. and Gidlöf-Gunnarsson A. (2006) Effects of road traffic noise and the benefit of access to quietness. Journal of Sound and Vibration 295 40-59; Gidlöf-Gunnarsson A. and Öhrström E., (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. Landscape and Urban Planning 83 115-126.

[59] Gidlof-Gunnarsson, A. & Ohrstom, E. (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. Landscape and Urban Planning 83, 115-126; Ohstrom, E., Skanberg, A., Svensson, H., Gidloff-Gunnarsson, A. (2006) Effects of road traffic noise and the benefit of access to quiet. Journal of Sound and Vibration 295, 40-59.

[60] Scott Wilson (2008) The Westminster Noise Survey 2008 [online] available at http://www3.westminster.gov.uk/docstores/publications_store/The%20Westminster%20Noise%20Measurement%20Survey%202008.pdf

[61] NEF (2005) Well-being and the Environment [online] available at http://www.neweconomics.org/sites/neweconomics.org/files/Well-being_and_the_Environment.pdf (accessed on 14 March 2011)

[62] Pretty J, Peacock J, Sellens M and Griffin M (2005). The mental and physical health outcomes of green exercise. Int J Environ Health Res, 15(5), 319–337.

[63] Chu, A., Thorne, A. and Guite, H. (2004) The impact on mental well-being of the urban and physical environment: an assessment of the evidence. *Journal of Mental Health Promotion* Vol. 3(2) pp.8-17.

- Grahn and Stigsdotter[64] note that "[a]s technology, traffic, artificial light and noise increasingly dominate our towns and cities, **a park or green space can be an oasis of tranquillity and calm that has a genuine effect on stress**." They found that the more often a person visits urban open green spaces, the less often he or she will report stress-related illnesses.
- Song *et al*. (2007)[65] analysed the **potential restorative effects of parks and other recreational facilities on "traffic stress"**, i.e. stress due to high traffic volume, involvement in accidents, etc in Los Angeles. Traffic stress was found to be negatively correlated with gender, age, education and social support, positively correlated with employment and acculturation and uncorrelated with income. The association between traffic stress and general health status was amplified by vehicular burden and major streets but dampened by the ratio of green parklands and the association between traffic stress and depressive symptoms appeared less in neighbourhoods with a higher green parkland ratio.

4.3.12 A report by the Canadian Review Committee[66] specifically refers to the role of quiet in mental health: "Within our communities, the design of buildings, the lack of diversity in structure and form, the lack of access to green space, and high noise levels can have an adverse effect on mental health. They contribute to feelings of insecurity (i.e., fear about safety), social isolation and stress..."

4.3.13 A study by Gardner *et al.*[67] to measure the effect of a scheduled quiet time on noise levels, inpatients' rest and sleep behaviour, and wellbeing found that a quiet time intervention on an acute care hospital ward can affect noise levels and patient sleep/wake patterns during the intervention period. The study also examined the impact of the intervention on patients', visitors' and health professionals' satisfaction, and organisational functioning. The overall strongly positive response from surveys suggested that scheduled **quiet time would be a positively perceived intervention with therapeutic benefit**.

Amenity Effects

4.3.14 The IGCB (N) defines amenity effects as "the direct impact of noise causing annoyance or dissatisfaction"[69]. Amenity effects can occur in any context or situation where noise acts as a distraction or disturbs conversation or activities. For the purposes of this study, amenity covers reduced annoyance, spiritual benefits and relaxation.

"It is vital we can get away from the hustle and bustle. The importance of these oases of calm cannot be underestimated in making our quality of life better. It is right that we explore ways to create, protect and enhance tranquil spots."

Boris Johnson, quoted in *The Times* (10 October 2009)[68]

4.3.15 Berglund and Lindvall[70] found that the human response to community noise begins with perception of the noise stimulus. This perception creates the basis for a possible feeling of annoyance. This feeling may be modified by many psychosocial variables, such as living

[64] Grahn, P. and Stigsdotter U.A. (2003). Landscape planning and stress. *Urban Forestry and Urban Greening* 2 (1): 1-18
[65] Song, Y., Gee, G. C., Fan, Y. & Takeuchi, D. T. (2007) Do physical neighborhood characteristics matter in predicting traffic stress and health outcomes? Transportation Research Part F: *Traffic Psychology and Behaviour*, 10, 164-176.
[66] Canadian Review Committee (date unknown) Our Environment, Our Health.
[67] Gardner, G., Collins, C., Osborne, S., Henderson, A., and Eastwood, M. (2010) Creating a therapeutic environment: A non-randomised controlled trial of a quiet time intervention for patients in acute care. International Journal of Nursing Studies, 46: 778–786
[68] Quiet green spaces needed to reduce stress in cities, study says. *The Times Online*, 10 October 2009 [online] available at http://www.timesonline.co.uk/tol/news/environment/article6868828.ece
[69] Defra (2008) An Economic Valuation of Noise Pollution – developing a tool for policy appraisal. Defra [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/publications/firstreport.htm (accessed 31 January 2011)
[70] Berglund, B. and Lindvall, T. (1995) Community Noise. Archives of the Center for Sensory Research, 2(1), 1-195.

conditions, attitudes towards the noise source, mood, previous noise exposures, socioeconomic variables, etc. Whether or not a feeling of annoyance is ever given behavioural expression depends also on a number of intervening variables. They therefore recommend that, when studying annoyance, both the perceived noise and the perceived quietness should be considered.

Annoyance

4.3.16 According to Clark and Stansfeld[71] "[a]nnoyance is a multi-faceted psychological concept including both evaluative and behavioural components used to describe negative reactions to noise". The WHO[72] cites it as an important health effect of noise. Annoyance is the most reported problem caused by transport noise exposure and is often the primary outcome used to evaluate the effect of noise on communities[73]. Acoustic factors such as noise source, exposure level and time of day of exposure only partly determine an individual's annoyance response: many non-acoustical factors such as the extent of interference experienced, ability to cope, expectations, fear associated with the noise source, noise sensitivity, anger, and beliefs about whether noise could be reduced by those responsible influence annoyance responses.

4.3.17 Some of the recent research in this area is summarised below:

- Research carried out in Sweden[74] examined how adverse health effects of noise are related to individual exposure and perceived soundscapes in residential areas with and without access to quiet sides. Their results showed that **access to a quiet façade of a dwelling reduces noise annoyance by 10-20%**, depending on the sound level from road traffic at the most exposed side. The results suggested[75] that a good urban outdoor soundscape is (a) dominated by positive sounds from nature, and (b) has an overall equivalent sound level below 50 dB(A) during the daytime.
- Access to a high-quality 'quiet' courtyard is associated with less noise annoyance and noise-disturbed outdoor activities among residents. Compared to low-quality 'quiet' courtyards, **high-quality courtyards can function as an attractive restorative environment** providing residents with a positive soundscape, opportunities for rest, relaxation and play, as well as social relations that potentially reduce the adverse effects of noise[76]. However, access to quietness and a high-quality courtyard can only compensate partly for high sound levels at façades facing the streets, thus, 16% and 29% of residents were still annoyed by noise at 58–62 and 63–68 dB, respectively.
- Research carried out in Norway has examined the relationship between localised areas of noise and quiet within a neighbourhood on residential noise annoyance in Oslo[77]. Unlike the findings of the Swedish study above, the Norwegian research found no specific beneficial impacts of quiet neighbourhood areas. The study suggests that noisy neighbourhoods have the potential to increase residential noise annoyance primarily for apartments exposed to low residential noise levels whereas **quiet neighbourhood areas have the potential to**

[71] Clark, C. and Stansfeld, S. (2007) The Effect of Transportation Noise on Health and Cognitive Development: A Review of Recent Evidence. *International Journal of Comparative Psychology*, 20, 145-158.
[72] WHO. (2000) *Guidelines for Community Noise*. Geneva: World Health Organisation
[73] Clark, C. and Stansfeld, S. (2007) The Effect of Transportation Noise on Health and Cognitive Development: A Review of Recent Evidence. *International Journal of Comparative Psychology*, 20, 145-158; Berglund, B. and Lindvall, T. (1995) Community Noise. Archives of the Center for Sensory Research, 2(1), 1-195.
[74] Berglund B, Kihlman T, Kropp W and Öhrström E (2004). Soundscape support to health. Final Report Phase 1, Chalmers University, Gothenburg, Sweden.
[75] Nilsson M E and Berglund B (2006). Soundscapes in city parks and suburban green parks. Proceedings of Euronoise 2006, Tampere, Finland.
[76] Gidlof-Gunnarsson, A. & Ohrstom, E. (2010) Attractive 'quiet' courtyards: a potential modifier of urban residents' response to road traffic noise? International Journal of Environmental Research and Public Health 7, 3359-3375.
[77] Klæboe R (2005). Are adverse impacts of neighbourhood noise areas the flip side of quiet areas? Applied Acoustics

reduce noise annoyance the most at intermediate and high residential noise levels. Furthermore, adverse neighbourhood soundscapes are shown to increase residential noise annoyance after adjusting for possible absence of quiet areas.

- Building on the research undertaken in Sweden and Norway, the European Commission is supporting a large (€500,000) project to pilot a new methodology for assessing traffic noise in cities, including in quiet areas and at quiet façades[78]. The project aims to show how European cities can effectively reduce the harmful effects of traffic noise by offering people noise refuges or routes. The project will use a novel engineering method to measure noise levels at quiet façades and in quiet areas and to produce detailed traffic-noise mapping of cities. It will then estimate the reduction in the numbers of annoyed and sleep-disturbed people as a result of the creation of quiet façades and areas. It is expected that this will show that the **having the option to choose a bedroom on the quiet side of a house reduces the numbers of annoyed/highly-annoyed and sleep-disturbed people**.
- In the Netherlands, reviews of current research has concluded that the percentage of time during which a disturbance is present (or the length of time during which a 'level of quiet' is regarded as acceptable) is generally more important than the actual noise level[79]. Alongside these acoustic criteria, additional criteria about the sounds heard which convey positive or negative feelings, with regard to appropriateness for a given context, are also important.
- Research carried out in Italy to identify indicators to describe perceived soundscapes revealed similar findings to those in the Netherlands, i.e. that annoyance is related to temporal variations in noise[80].
- Noise attenuation is identified as a characteristic of urban forests that provides benefits to residents[81.]
- In a large survey on nearly 3,000 people in 53 residential sites of the Greater London Council, Langdon (1976)[82] found that high neighbourhood quality in terms of attractive appearance, presence of parks and green spaces lowered dissatisfaction with traffic noise to a significant degree. Similar findings are reported by Kastka and Noack (1987)[83].
- **Noise and quiet feature strongly in children's perceptions of what makes a good or bad neighbourhood**. For example, when asked to evaluate the good things about their neighbourhood using an open-ended question followed by a checklist based on responses from pilot testing, 9-11 year old children living in the suburbs of Sydney, Australia frequently cited "quiet streets" (48% of respondents) and "quiet streets for play, bike riding" (45.2%)[84.] In contrast, when asked what was bad about neighbourhoods, 24.1% respondents said "too noisy, dirty, polluted".
- Quietness and tranquillity have been found to contribute to **satisfying lives for older people**[85] and the availability of restorative environments in which to relax and unwind has

[78] See http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3669#RM
[79] van den Berg M M H E and van den Berg G P (2006). Quiet areas: health issues and criteria. Proceedings of Euronoise 2006, Tampere, Finland.
[80] Licitra G and Memoli G (2006). Testing new solutions for action plans in quiet areas. Proceedings of Euronoise 2006, Tampere, Finland.
[81] Tyrväinen, L. & Miettinen, A. (2000) Property Prices and Urban Forest Amenities. Journal of Environmental Economics and Management 39, 205-223.
[82] Cited in Gidlof-Gunnarsson, A. & Ohrstom, E. (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. Landscape and Urban Planning 83, 115-126
[83] Kastka, J. and Noack, R. (1987) On the interaction of sensory experience, causal attributive cognitions and visual context parameters in noise annoyance. *Dev. Toxicol. Environ. Sci*. 15, 345–362.
[84] Although the children may have been using the term 'quiet' to mean an absence of vehicles in which case 'safety' rather than quiet, *per se*, may have been the main concern.
[85] Lawton MP, Nahemow L and Tsong-Min-Yeh (1980). Neighbourhood environment and the wellbeing of older tenants in planned housing. Int J Aging Hum Dev, 11(3), 211–227.

been associated with lower levels of annoyance in children exposed to chronic aircraft noise[86].

- More generally, and as the quotes in Box 4 testify, quiet green areas in urban environments are valued as places where people can go to **escape the 'hustle and bustle', improve quality of life, and reduce stress**.

Box 4: The significance of urban forests

In a study of the values that people attach to urban trees and forests, Dwyer *et al.*[87]: asked visitors to a 1500 acre arboretum on the outskirts of Chicago to describe significant environments and experiences, and to explain the meanings they associate with those environments. For many, the urban forest provides, amongst other things, an opportunity to escape from daily routine and urban stress, as is expressed in the responses below:

"... a place of beauty, peace, quiet excitement, and refuge from the noise, turmoil, pollution, and unpleasantness of traffic and crowded work and living conditions"

"A forest represents to me cool, calm, a place to regain composure".

"*I think of this as a place to contemplate, to stop and use my senses, to remove myself from today's schedule of events*"

"I felt I was somewhere quite far away from the bustle and noise of people and cars"

4.3.18 Research has also found that human-caused noise can detract from the quality of the visitor experience in national parks and wilderness areas, as people not only seek to change the scenery but their acoustic reality.

- A visitor "listening exercise" was conducted in the Muir Woods National Monument in California, where respondents identified natural and human-caused sounds heard in the park and rated the degree to which each sound was "pleasing" or "annoying"[88]. Loud groups, although heard by few people, were rated as highly annoying, whereas wind and water were heard by most visitors and were rated as highly pleasing; and
- In New Zealand, the Department of Conservation recognises the important value of natural quiet in department-managed areas. It defines natural quiet as "the natural ambient conditions or the sound of nature. Natural quiet can range from silence to a thunderstorm and includes the sounds made by animals and plants**. Natural quiet is an important component of visitors' appreciation of department-managed areas along with other qualities such as solitude, space, scenery and clear skies**"[89].

[86] Gunnarsson AG, Berglund B, Haines MM, van Kamp I, Lopez Barrio I, Nilsson M and Stansfeld SA (2003). Psychological restoration in noise-exposed children across three European countries: the RANCH study. In Proceedings 8th International Congress on Noise as a Public Health Problem (RG de Jong *et al.*, eds), Rotterdam, The Netherlands, June–July 2003, pp 159–160.

[87] Dwyer, J.F., Schroeder, H.W. and Gobster, P.H. (1991) The Significance of Urban Trees and Forests: Toward A Deeper Understanding of Values. *Journal of Arboriculture,* 17(10), pp276-284 [online[available at http://joa.isa-arbor.com/request.asp?JournalID=1&ArticleID=2458&Type=2 (Accessed 31 January 2011).

[88] Pilcher, E., Newman, P. and Manning, R. (2008) Understanding and Managing Experiential Aspects of Soundscapes at Muir Woods National Monument. *Environmental Management*, 43(3), pp425-435.

[89] New Zealand Department of Conservation (1996) *Visitor Strategy*. [online] available at http://www.doc.govt.nz/upload/documents/about-doc/role/policies-and-plans/visitor-strategy.pdf (accessed 31 January 2011)

Spiritual Benefit

"Come with me by yourselves to a quiet place and get some rest" (Mark 6:31)

4.3.19 The spiritual benefits of quiet should not go unmentioned and there are now silent retreats offered in the name of almost every belief system[90]. Churchyards, temples and burial grounds (cemeteries, crematoriums etc) and other spiritual centres can provide important quiet areas, used by lay people as well as the faithful for contemplation and meditation.

4.3.20 The Quiet Garden Movement and Trust[91] provides a network of quiet gardens for prayer, stillness, reflection and appreciation of beauty. There are about 300 Quiet Gardens worldwide. The Quiet Garden Movement encourages the provision of a variety of local venues where there is an opportunity to set aside time to rest and to pray. These include in inner city areas which seek to create places of stillness and beauty amidst the hustle and bustle of life, sometimes in apparently unpromising surroundings. These can become a focus for the local community. It is also interesting to note that the trust also provides quiet areas in:

- private homes and gardens - which are open for occasional days of stillness and reflection;
- retreat centres or local churches - which offer within their premises an area of beauty and peacefulness dedicated to quiet prayer and solitude; and
- prisons - providing a tranquil, green space for both staff and prisoners.

Productivity

4.3.21 The effects of quiet and access to quiet areas on productivity include:

- Undisturbed sleep, which contributes to mental alertness and therefore productivity at work;
- Improved concentration;
- Creativity and problem-solving; and
- Cognitive development in children

Undisturbed sleep

4.3.22 A detailed review by the HPA's Ad-Hoc Expert Group on Noise and Health[92] found that during sleep there is no cumulative effect of number of noises and their intensity on sleep disturbance[93]: a single noise can be as disturbing to sleep as multiple noises and whether someone awakes may depend on the time of sleep, the time of the night and the current sleep stage.

4.3.23 Furthermore, anecdotal evidence collated by the Ad-Hoc Expert Group suggests that many individuals habituate or adapt to different night-time noise environments and might only be disturbed by unusual or unexpected events. Unusual events could also include absence of noise where sound levels are much lower than normally experienced. The results of both field and

[90] Prochnik, G. (2010) In Pursuit of Silence: Listening for Meaning in a World of Noise. Doubleday: New York.
[91] See http://www.quietgarden.org
[92] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).
[93] Muzet A (2002). The need for a specific noise measurement for population exposed to aircraft noise during night-time. Noise Health, 4(15), 61–64.

laboratory studies[94] suggest that many residents in noisy areas such as near to main roads and airports are able to adapt to familiar noise such that even though short-term or instantaneous responses can be observed on electroencephalogram (EEG) traces, there might still be little additional behavioural awakening associated with specific noisy events.

4.3.24 Undisturbed sleep is not, however, considered as a benefit in the context of publicly accessible quiet areas and is therefore not discussed further in this report.

An aid to concentration

4.3.25 Concentration and mental work of all kinds are often assumed to require a quiet environment. Evidence for disruptive effects of noise on industrial productivity is unclear and largely dependent upon poorly designed studies[95].

4.3.26 Berglund and Lindvall[96] discuss the effects of noise on performance, looking specifically at task performance and productivity, noise as a distracting stimulus, cognition and reading, and tasks involving motor activities. They note that noise can interfere with complex task performance. Tasks that demand continuous and sustained attention to detail, require attention to multiple cues, and require large working memory capacity are all susceptible to adverse effects of noise.

Creativity

4.3.27 The Alzheimer Society website notes that the brain needs 'quiet' (non-busy) time to assimilate and allow the creative process to happen - the time and space to bring together the raw material and make the surprising connections and leaps of faith that lead to creativity.

4.3.28 Some companies offer a 'quiet room' where employees are allowed to remove themselves from their work area and take time to relax and refocus. Many quiet rooms are furnished with mood lighting, quiet music or sounds of nature playing to help the employee to relax. Some companies provide a walking path for their staff and workers to get outside and benefit from a calm work out in nature. Picnic and break areas, and walking areas with flowers and shrubs provide benefits for enjoyment. Benches placed along the paths allow those interested to sit and enjoy. Such quiet areas can remove stress (especially where this may be caused by noise in the working environment) and improve the productivity of workers[97].

Cognitive effects on children

4.3.29 It has been suggested that children may be especially vulnerable to effects of environmental noise as they may have less cognitive capacity to understand and anticipate environmental stressors, as well as a lack of developed coping mechanisms[98]. Exposure during critical periods of learning at school could potentially impair development and have a lifelong effect on educational attainment and potential earnings. Whilst a recent study suggests that children may

[94] Flindell IH *et al.* (2000). Aircraft Noise and Sleep 1999 UK Trial Methodology Study. ISVR Consultancy Report 6131 R01 and Basner M *et al.* (2004). Effects of Nocturnal Aircraft Noise. DLR-Institut für Luft- und Raumfahrtmedizin, FB 2004-07/E; both cited in HPA (2010)
[95] Berglund, B. and Lindvall, T. (1995) Community Noise. Archives of the Center for Sensory Research, 2(1), 1-195.
[96] Berglund, B. and Lindvall, T. (1995) Community Noise. Archives of the Center for Sensory Research, 2(1), 1-195.
[97] See http://www.salescreators.com/Section4/betterWkPlace.html
[98] See Berglund, B. and Lindvall, T. (1995) Community Noise. Archives of the Center for Sensory Research, 2(1), 1-195.
[98] Cohen, S., Evans, G.W., Krantz, D.S., & Stokols, D (1980) Physiological, motivational, and cognitive effects of aircraft noise on children: Moving from the laboratory to the field. *American Psychologist*, 35:231-243 (1980); Stansfeld, S.A., Haines, M.M., & Brown, B. (2000). Noise and health in the urban environment. *Reviews on Environmental Health*, 15(1-2), 43-82.

not be more susceptible to environmental noise effects on cognitive performance than adults[99], other studies have established that children exposed to noise at school experience some cognitive impairment, compared with children not exposed to noise: tasks affected are those involving central processing and language such as reading comprehension, memory and attention[100].

4.3.30 Berry and Flindell[101] found strong evidence of statistical associations between delayed language and reading skills in children and attendance at schools with higher environmental noise sound levels measured outdoors. However, it is not known to what extent the observed small differences in test scores might have on subsequent development and academic progress. In addition, and while there is some speculation, there is no detailed information on precisely which features of the environmental noise measured outside the school were responsible for the observed differences in test scores. For example, the relative importance of exposure at higher sound levels when outdoors or at lower sound levels (from outdoor sources) when indoors is not known. It is clear that more detailed research is therefore needed before any firm conclusions can be drawn.

Ecosystems

4.3.31 A number of research projects have investigated the impact that man-made noise can have on wildlife. The IGCB (N) briefly summarises some of these as follows:

- Reduced hatching success rates of birds in Florida following the introduction of low-flying supersonic flights;
- Physiological responses and panic and escape behaviour which, when combined, have the potential to cause bodily injury, energy loss, reduced food intake, habitat avoidance or abandonment and reproductive losses; and
- Reduced ability of marine mammals to navigate by echolocation.

4.3.32 However, the evidence is inconclusive and suggests that the impacts depend largely upon:

- The source, volume and duration of noise; and
- The speed at which individuals or populations of species become habituated to noise.

4.4 The Contribution of Quiet to the Quality of Urban Spaces

4.4.1 In the absence of comprehensive evidence on the benefits that people derive specifically from quiet and quiet areas (i.e. over and above those obtained through a reduction in noise levels), the

[99] Boman, E., Enmarker, I., & Hygge. S. (2005). Strength of noise effects on memory as a function of noise source and age. *Noise & Health*, 7(27), 11-26; Clark, C. and Stansfeld, S. (2007) The Effect of Transportation Noise on Health and Cognitive Development: A Review of Recent Evidence. *International Journal of Comparative Psychology*, 20, 145-158

[100] Haines, M.M., Stansfeld, S.A., Job, R.F.S., Berglund, B., & Head, J. (2001a). Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. *Psychological Medicine*, 31, 265-277; Haines, M.M., Stansfeld, S.A., Brentnall, S., Head, J., Berry, B., Jiggins, M., & Hygge, S. (2001b). The West London Study: The effects of chronic aircraft noise exposure on child health. Psychological Medicine, 31, 1385-1396; Evans, G.W., & Maxwell, L. (1997). Chronic noise exposure and reading deficits: The mediating effects of language acquisition. *Environment and Behavior*, 29 (5), 638-656; Cohen, S., Glass, D.C., & Singer, J.E. (1973). Apartment noise, auditory discrimination, and reading ability in children. *Journal of Experimental Social Psychology*, 9, 407-422.

[101] Berry B.F. and Flindell I.H. (2009) Estimating Dose-Response Relationships between Noise Exposure and Human Health Impacts in the UK, Final Project Report, BEL 2009-01, report to Defra [online] http://www.defra.gov.uk/environment/quality/noise/igcb/documents/project-report.pdf (accessed 31 January 2011).

scope of the literature review was broadened to investigate whether or not it is possible to determine the contribution of quiet to the overall quality of urban spaces.

4.4.2 Interest in the social, economic and environmental value of urban spaces has grown considerably over the last decade, with both qualitative and quantitative studies on streets, parks and open spaces. The Commission for Architecture and the Built Environment (CABE) led the field with a number of publications exploring how the design of public spaces could build economic growth, environmental sustainability as well as social cohesion into the fabric of the city.

4.4.3 This section reviews the work done by CABE Space, GreenSpace and others, looking for relevant patterns relating to quiet and urban spaces. Urban space here refers mostly to public open spaces in cities, but has been extended to embrace open spaces within dwellings or institutions (e.g. courtyards in hospitals or office blocks) or shared between dwellings and other uses.

4.4.4 A recent report prepared on behalf of CLG[102] sets out a typology of undeveloped land (see Table 3), based on the principal land use, which may be of use in the present study. Through a systematic review, the study investigates the range and – where possible – significance (measured in monetary terms) of benefits deriving from each of these spaces.

Table 3: Typology of undeveloped land[103]

Category	Description
Private space	Small parcels of land in private ownership that are most likely to become available for, or under pressure from, new development. This land is most likely to comprise of: • Backland development which makes an important contribution to the source of land for new housing development within urban areas. This generally comprises the development of land surrounded by existing properties, often using back gardens. This tends to occur in lower density residential areas; and • Allotments which provide an important source of open space within many urban areas.
Public open space	Used for many activities such as formal and informal recreation and some areas are designated as public open space to create breaks within built-up areas for the purposes of protecting amenity. Within urban areas public open space can take the form of parks, recreation grounds, gardens, sports pitches or can comprise 'green wedges' or 'green chains' as part of an open space network or series of transport corridors that link larger open space areas together. In addition to these areas of public open space there are significant areas of undeveloped land within the larger institutions. This can take the form of hospital or school grounds or churchyards, all of which are considered as redevelopment opportunities within urban areas, particularly following closure or reorganisation.
Previously developed land	Land that was occupied by a permanent structure and any associated infrastructure, including the curtilage of the development, but is now vacant. These sites may require some demolition work or other treatment before they can be developed, and they may occur within both urban and rural settings.

[102] CLG (2010) Valuing the external benefits of undeveloped land [online] available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/158136.pdf (accessed 31 January 2011)
[103] After CLG (2010) Valuing the external benefits of undeveloped land [online] available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/158136.pdf (accessed 31 January 2011)

Category	Description
	This land type will include derelict buildings and land formerly used for defence buildings, mineral extraction and waste disposal.
Agricultural land	Includes areas intensively farmed for crops as well as areas of rough grassland where extensive agricultural practices such as sheep farming dominate.
Forestry land	Refers to land under the cover of commercial or amenity forests
Natural and semi-natural land	Refers to land which has not been extensively cultivated or grazed, and which has not been used for any form of built development

4.4.5 The study identifies tranquillity (defined as the role of undeveloped land in reducing exposure to noise, vibration, and excessive light for local residents) as one of eight key benefits deriving from undeveloped land.

4.4.6 Interestingly, while tranquillity is identified as an important benefit, the review was unable to identify any valuation studies addressing tranquillity although it speculates that the value of tranquillity may be considered as part of the overall recreational experience of visiting an undeveloped site and is therefore captured in studies looking at recreation value.

Evidence that 'quiet' contributes to the quality of urban open spaces

4.4.7 Environmental Protection UK recently completed a review[104] of best practice in protecting quiet spaces for a liveable city, including recommendations for potential projects that may be applied to specific spaces in the City of London, and cities more widely across the UK. As a starting point, the research sought to understand public attitudes to and perceptions of quiet open spaces. This revealed that noise is just one element influencing perceptions of whether a space is tranquil or peaceful. This in turn suggests that many of the measures that will improve the acoustic environment may also have additional benefits for environmental quality, and support a wide range of policies and initiatives aimed at improving the local urban environment, improving environmental health, and increasing both the aesthetic and monetary value of an area. Furthermore, suitable non-acoustic measures can enhance the sense of tranquillity, or even of perceived 'quiet', including in places where clearly measurable noise reduction is not immediately practicable.

4.4.8 The literature confirms to a degree that quiet, or quietness, is one of the key attributes of urban spaces that contribute to their beneficial qualities. Most of the evidence presented here relates to green space within cities, which are generally understood to be relatively quieter than the surrounding urban environment. While 'quiet' is acknowledged as an important attribute, few attempts have been made to assess the value of quiet, relative to other attributes that together make up the total economic value of urban open spaces.

4.4.9 A fact sheet prepared by Centre for Public Health at Liverpool John Moores University[105] summarises the benefits of open green spaces as follows:

[104] Environmental Protection UK (2010) Quietening Open Spaces: Towards Sustainable Soundscapes for the City of London. Report prepared for the City of London Corporation [online] available at http://www.environmental-protection.org.uk/assets/library/documents/Quietening_Open_Spaces_july2010_lower_res).pdf (accessed 12 January 2011)

[105] Centre for Public Health (2010) Health and Sustainability Fact Sheet 6: Urban Green Space and Public Health. Liverpool John Moores University [online] available at http://www.cph.org.uk/showPublication.aspx?pubid=618 (Accessed 31 January 2011).

- **physical benefits**: urban green spaces provide attractive locations for a huge range of sporting and recreational activities, including walking, cycling, football and running, as well as more gentle activities such as picnicking or photography
- **mental benefits**: urban green spaces provide areas of quiet and solitude where people can escape from the stresses of life
- **spiritual benefits**: urban green spaces can help bring about a sense of place and provide areas for contemplation, reflection and inspiration
- **social benefits**: urban green spaces provide areas where social clubs and organisations can hold events. They can also help individuals enhance their own personal social network
- **environmental benefits**: urban green spaces help to preserve ecosystems and biodiversity, mitigate atmospheric pollution and reduce the urban heat island effect. They encourage carbon sequestration, provide some degree of defence against flooding and encourage human interaction with the natural environment.

4.4.10 This suggests that "quiet" or "perceived quiet" is an implicit attribute of open green spaces and offers important mental and spiritual benefits.

4.4.11 Some of the direct and implied references to quietness in the literature are as follows:

- **'Quiet and enjoyable'** were among the qualities of the highest scoring streets in CABE's Paved with Gold[106], which scores a number of London high streets from a pedestrian perspective.
- GreenSpace's Park Life Report 2007[107] reveals that a high proportion of people in Britain visit parks to **relax and think** (25%), or for **peace and quiet** (21%).
- A study of symbolic meanings of urban parks in the context of Greenwich, London, highlights **'peace and quiet'** as a clear motive for visiting public parks[108]. From another perspective, a study in the USA[109] concludes that '**noise reduction**' is a benefit of urban parks.
- A valuation study in Guangzhou, China explored users' motivations and preferences in using urban green spaces[110]. In the study, '**quietude' rated second highest (after relaxation) out of nine factors in respondents' reasons for visiting green spaces**.
- A study in the USA sought to distinguish between tranquillity and preferences for different types of environmental settings[111]. Preference was defined as 'how much you like the environment depicted, for whatever reason', while tranquillity was defined as 'how much ... you think this environment would encourage relaxation, peace of mind, escape from the strains of living'. The study found that the two concepts are related but that there is a discernible difference between them that is more pronounced in some settings than others.

[106] CABE (2007) Paved with gold: The real value of good street design [online] available at http://www.cabe.org.uk/files/paved-with-gold.pdf (accessed on 25 January 2011).
[107] GreenSpace (2007) The Park Life Report [online] available at http://www.green-space.org.uk/downloads/ParkLifeReport/GreenSpace%20Park%20Life%20Report%20-%20Sector.pdf (accessed 28 January 2011)
[108] Burgess, J., Harrison, C.M., Limb, M. (1988) People, Parks and the Urban Green : A Study of Popular Meanings and Values for Open Spaces in the City. Urban Studies, 25, pp455-473 [online] available at http://www.usj.sagepub.com/content/25/6/455.full.pdf (accessed 28 January 2011)
[109] More, T.A., Stevens, T. and Allen, P.G. (1998) Valuation of urban parks. *Landscape and Urban Planning*, 15 (1988), pp139-152.
[110] Jim, C.Y. and Chen, W.Y. (2006) Recreation–amenity use and contingent valuation of urban greenspaces in Guangzhou, China. *Landscape and Urban Planning*, 75, pp81–96.
[111] Herzog, T. and Bosley, R. (1992) Tranquility and Preference as Affective Qualities of Natural Environments. *Journal of Environmental Psychology*, 12, 115 127

- CABE Space publication, 'Does Money Grow On Trees'[112] starts with the premise that urban green spaces offer 'relaxation, recreation, refreshment and relief', which are in short supply in cities, and this contributes to their high valuation. According to this publication, urban green spaces 'provide places for quiet contemplation and reflection, for relaxation, informal recreation, peace, space and beauty'. Quiet is implicit in this description of the benefits of open spaces and green spaces; such descriptions are typical of academic papers in this subject area.

4.4.12 Quiet-related descriptions of open and green spaces seem to reinforce the typology of benefits identified in Table 2 (p23). In the following sections, our findings are organised according to the typologies identified.

Health

4.4.13 Apart from the important role of green spaces in urban areas in terms of providing opportunities for exercise, recreation and connection with nature, the 'relative quiet' offered by such spaces is also recorded as conferring important health benefits:

- From a public health perspective[113], addressing the need for quiet areas for sitting and reading is seen as an important factor in successful park design.
- Nearby green areas buffer the adverse health effects of exposure to road traffic noise[114].
- Opportunities to easily escape a heavily trafficked and noisy surrounding and to perceive a more positive tranquil sound environment might help to reduce noise-induced stress and other adverse effects of traffic noise exposure[115]
- Connection with the natural order of things bringing perspective to mental health issues.

4.4.14 Research by CABE cites improvements in both physical and mental health associated with access to quality green space[116]. The research identified health benefits ranging from reduced anxiety to increased physical activity, resulting in a lower risk for strokes, heart disease, diabetes, obesity and certain types of cancer.

Amenity

4.4.15 Besides important environmental services such as air and water purification, wind and noise filtering, or microclimate stabilisation, natural areas provide social and psychological services, which are of crucial significance for the liveability of modern cities and the well being of urban dwellers. A park experience may reduce stress[117], enhance contemplativeness, rejuvenate the city dweller, and provide a sense of peacefulness and tranquillity[118]. Hypotheses around the restorative function of natural environments have been tested in many empirical studies[119].

[112] CABE (2005) *Does Money Grow on Trees*? CABE Space, London [online] available at http://www.cabe.org.uk/files/does-money-grow-on-trees.pdf (accessed 31 January 2011)
[113] Howard Frumkin, (2003) Healthy Places: Exploring the Evidence. *American Journal of Public Health*, 93(9), 1451-1456 [online] available at http://ajph.aphapublications.org/cgi/reprint/93/9/1451 (accessed 28 January 2011)
[114] Gidlof-Gunnarsson, A. & Ohrstom, E. (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. *Landscape and Urban Planning* 83, 115-126.
[115] Gidlof-Gunnarsson, A. & Ohrstom, E. (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. *Landscape and Urban Planning* 83, 115-126.
[116] CABE (2010): Community green: Using local spaces to tackle inequality and improve health [online] available at http://www.cabe.org.uk/publications/community–green (accessed 11 January 2011)
[117] Ulrich, R.S., 1981. Natural versus urban sciences: some psycho-physiological effects. *Environ. Behav*. 13, 523–556.
[118] Kaplan, R., 1983. The analysis of perception via preference: a strategy for studying how the environment is experienced. *Landscape and Urban Planning*, 12, 161–176.
[119] Chiesura, A. (2004) The role of urban parks for the sustainable city. *Landscape and Urban Planning*, 68 (2004) 129–138.

4.4.16 Amenity benefits are generally associated with feelings of relief and escape in urban open spaces; i.e. non-consumptive uses:

- Increasing empirical evidence indicates that the presence of natural areas contributes to the quality of life in many ways. Besides many environmental and ecological services, urban nature provides important social and psychological benefits to human societies, which enrich human life with meanings and emotions. Results confirm that the experience of nature in urban environment is source of positive feelings and beneficial services, which fulfil important immaterial and non-consumptive human needs.[120]
- The majority of urban forest benefits represent non-consumptive use values, which include benefits derived from pleasant landscape, clean air, peace and quiet and screening, as well as recreational activities[121]. Noise attenuation by urban forests is identified as a characteristic that provides benefits and is reflected in higher property values[122].
- Opportunities to experience quietness - or more accurately - to experience freedom from unwanted sounds and a natural soundscape has been shown to play an important role in recreation experiences[123].

4.4.17 Chiesura[124] examines the importance of urban nature for citizens' well-being and for the sustainability of the city they inhabit. Using a survey of visitors to an urban park in Amsterdam, she investigated people's motives for experiencing urban nature, the emotional dimension involved in the experience of nature and its importance for people's general well-being. Results confirm that the experience of nature in urban environment is source of positive feelings and beneficial services, which fulfil important non-consumptive human needs.

4.4.18 Renema *et al.*[125] also found relaxation as an important need fulfilled in nature, along with fascination, beauty, peace and freedom. The needs to experience nature and to escape from the stressful rhythm of the city also constitute important reasons for people's visits to the park. In a study about stakeholders' perception of a city park respondents mentioned, among others, the value of "*isolation from the din of the city*"[126].

4.4.19 Bishop *et al.* (2001, p. 119)[127] also recognise that "green spaces in a city play an important role in helping residents and visitors to escape temporarily from the crowded streets and buildings: it provides a place to relax". The sense of "escape from the city" has also been found among the most important benefits of wildlife experiences[128]. Furthermore, findings show that the experience of nature in the city is source of a large array of positive feelings to people. Freedom, unity with nature, and happiness are among the most frequently mentioned, along with beauty and silence.

[120] Chiesura, A. (2004) The role of urban parks for the sustainable city. *Landscape and Urban Planning*, 68 (2004) 129–138.
[121] Tyrväinen, L. (1997) The Amenity Value of the Urban Forest: an application of the Hedonic Pricing Method. Landscape and Urban Planning 37, 211-222.
[122] Tyrväinen, L. & Miettinen, A. (2000) Property Prices and Urban Forest Amenities. Journal of Environmental Economics and Management 39, 205-223.
[123] Gidlof-Gunnarsson, A. & Ohrstom, E. (2007) Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. Landscape and Urban Planning 83, 115-126.
[124] Chiesura, A. (2004) The role of urban parks for the sustainable city. Landscape and Urban Planning 68 (2004) 129–138.
[125] Renema, D., Visser, M., Edelmann, E., Mors, B., 1999. De wensen van Nederlanders ten aanzien van natuur en groen in de leefomgeving (The Wants of the Dutch for Nature and Green in the Living Environment) (in Dutch). Wageningen, DLO-Staring Centrum.
[126] Gobster, P.H., 2001. Visions of nature; conflict and compatibility in urban park restoration. Landsc. Urban Plan. 56, 35–51.
[127] Bishop, I.D., Ye, W.S., Karadaglis, C., 2001. Experiential approach to perception response in virtual worlds. Landsc. Plan. 54, 115– 123.
[128] Rossman, B.B., Ulehla, Z.J., 1977. Psychological reward values associated with wilderness use. Environ. Behav. 9 (1), 41–65.

In Klijn *et al*. (2000)[129], freedom and silence also appear as central values in people's appreciation of nature.

4.4.20 A recent study by Gensler and the Urban Land Institute[130] used the results of an online survey of 350 investors, developers, property advisors and public sector workers in 33 European countries to establish the importance of urban open spaces (public parks, squares, outdoor public venues, open waterfront, small landscaped areas between buildings, roof terraces) and their commercial value. Survey respondents rated greenery, restful spaces and security as the most important elements of successful open spaces. Recreational and cultural spaces then ranked fourth followed by water, lighting, food and beverage and Wi-Fi provision.

4.4.21 Researchers have been attempting to identify the informational, aesthetic or affective qualities of sound which help to confer quality on a given landscape since the late 1960s:

- Southworth (1969)[131], for instance, in a pioneering study which charted the reactions of different population groups during a tour round Boston, showed that people's evaluation of a city's sound environment depends on three aspects: the information contained in the sound, the context in which it is perceived and its level.
- Anderson *et al*. (1983)[132] found that any appraisal of a given place depended largely on the sounds heard there. The authors used a variety of procedures such as in situ evaluation, questionnaires setting out verbal descriptions of sounds, and slides accompanied by recorded sounds. Herrington *et al*. (1993) studied the validity of different media for representing landscapes with significant dynamic elements.
- Viollon and Lavandier (1997)[133] studied the influence of visual on auditory components in urban landscapes. Their findings were that visual conditions modify the auditory perception of subjects to a significant degree.
- Carles *et al.* (1999)[134] studied the influence of the interaction between visual and acoustic stimuli on perception of the environment by presenting 36 sound and image combinations to 75 subjects. The sounds and images used were of natural and semi-natural settings and urban green space. Affective response was measured in terms of pleasure.

4.4.22 Generally speaking the results of these studies indicate that both the emotional meaning attributed to a sound and the importance of the context in which it occurs determine the degree of liking felt for a particular landscape.

Productivity

4.4.23 Little evidence has been found so far that directly links access to urban open spaces with productivity, but anecdotal evidence exists across a number of studies, confirming that a short break in a quiet and peaceful place can boost productivity and refocus productive energies.

[129] Klijn, J.A., Buij, A.E., Dijkstra, H., Luttik, J., Veeneklaas, F.R., 2000. The Forgotten Values of Nature and Landscape. Use and Appreciation Measured in Money and Emotional Value. Alterra Green World Research, Wageningen.
[130] Gensler and the Urban Land Institute (2011) Open Space: An asset without a champion? [online] available at http://www.gensler.com/uploads/documents/Open_Space_03_08_2011.pdf (accessed 9 March 2011)
[131] Southworth, (1969) The sonic environment of the cities. *Environment and Behavior*, 1, 49-70.
[132] Anderson, L.M., Mulligan, B.E., Goodman, L.S., Regan, H.Z. (1983) Effects of sounds on preferences for outdoor settings. *Environment and Behaviour* 15(5), pp539-566.
[133] Viollon, S., and Lavandier, C. (1997) Etude de l'influence de la vision sur l'audition en contexte urbain. In: Actes du 4ième Congrés Francais d'Acoustique, vol. 1, pp.311-314.
[134] Carles, J.L., Barrio, I. and de Lucio, J.V. (1999) Sound influence on landscape values. *Landscape and Urban Planning,* 43, pp191-200

Ecosystems

4.4.24 Open spaces in urban areas provide a range of important ecosystem services. The ongoing work of the UK National Ecosystem Assessment (NEA)[135] seeks to identify and quantify the value of ecosystem services provided by eight broad habitat types, including urban areas. The NEA identifies noise regulation as an important (yet deteriorating) service provided by green infrastructure in urban areas[136].

4.4.25 A 2007 study in Sweden investigated the significance of environmental benefits (noise and air quality control) from urban green space by age and noise level. According to the study, noise decreases the experienced social quality of areas, while the importance attached to the environmental benefits of urban green space increases with age[137]. Overall, the environmental benefits were viewed as less important than social benefits.

4.4.26 The Environmental Protection UK report[138] identifies several benefits that may be realised as a result of measures to quieten open spaces. These include:

- Improvements in air quality as a result of tree planting and traffic reduction measures
- Providing a habitat attractive to birds and insects, whose sounds can distract attention from noise, as a result of appropriate planting for noise mitigation
- Educational/interpretative opportunities where, for example, plants used as noise mitigation measures could form part of an educational network. These could also offer a positive diversion for city workers and visitors.

4.5 Summary

4.5.1 To date, most research effort has been dedicated to understanding the relationship between noise, annoyance and health. There is comparatively little focusing specifically on the benefits of quiet and access to quiet areas. This may be partly as a result of the complexity of defining quiet and quiet areas. Nevertheless, using a combination of evidence from the literature on the influence of noise on people's enjoyment of urban open spaces, it is clear that both 'quiet' and access to 'quiet areas' (or opportunities to experience freedom from unwanted sound) make an important contribution to human health and well-being, with growing interest in the restorative benefits.

4.5.2 Productivity and ecosystem benefits have been less-well studied although the emergence of the ecosystems approach is likely to encourage further work in this area.

4.5.3 While it is evident that 'quiet' is an important attribute of public open spaces and that it is actively sought by many open space users, it is not possible to determine an overall 'rank' for quiet among different elements of urban spaces from existing studies as methodologies vary widely.

4.5.4 One particular gap in the evidence base is where quiet ranks amongst the many different features of urban open spaces and whether removing quiet (i.e. allowing more noise into such

[135] See http://uknea.unep-wcmc.org/
[136] Watson, R. and Albon, S. (2010) UK National Ecosystem Assessment : Draft synthesis of current status and recent trends [online] available at http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=UlQr0mgTWWU%3d&tabid=82 (accessed 14 December 2010).
[137] Tyrväinen, L., Makinen, K., Schipperijn, J. (2007) Tools for Mapping Social Values of Urban Woodlands and other Green Areas. Landscape and Urban Planning 79, 5-19.
[138] Environmental Protection UK (2010) Quietening Open Spaces: Towards Sustainable Soundscapes for the City of London. Report prepared for the City of London Corporation [online] available at http://www.environmental-protection.org.uk/assets/library/documents/Quietening_Open_Spaces_july2010_lower_res).pdf (accessed 12 January 2011)

spaces) creates a snowball or tipping effect whereby other key amenities (e.g. biodiversity, mixing of ages groups) also suffer and users start to vote with their feet. The study included some preliminary testing of questions to users of public open spaces that might illuminate this tipping point further (see Section 5.5). However, there appears to be no existing mechanism or conclusive evidence for estimating the difference between the value of a quiet open space and a similar non-quiet open space. Furthermore, the evidence that does exist appears to focus overwhelmingly on the benefits or attributes that are important to users of open spaces; there is relatively little that examines the features that are important to non-users or those who could use a quiet area or urban open space but choose not to.

5 The Economic Value of Quiet Areas

5.1 Overview

5.1.1 This chapter describes various conceptual approaches to valuing quiet and quiet areas. There is a vast and growing literature on these approaches and their relative strengths and weaknesses which is not repeated here. Rather, the review has been kept deliberately short and designed to be accessible to the general reader. It then presents the published evidence on the value of quiet and quiet areas and the results of both a field-based survey questionnaire amongst open space users in London and an online survey amongst URS/Scott Wilson employees. An interim valuation methodology that makes best use of the available evidence and that may be applied in support of government decision-making is then proposed and tested. This methodology is considered very much a provisional approach to be refined and/or replaced by a more sophisticated technique as future research in this area emerges.

5.2 Valuation Approaches[139]

5.2.1 The key approaches available for the valuation on non-marketed goods include revealed and stated preference methods and opportunity cost. Selection and application of a valuation methodology is the third step in a valuation process: firstly the change in the environment has to be measured or known; secondly the impact on humans identified and thirdly the valuation of that change established. Economists have sought to place a money value on a wide range of non-marketed good and externalities including: air quality, noise, ecological services and life. It has not been possible to identify studies that value quiet areas specifically. The vast majority of studies have focused on the noise externality rather than the quiet benefit. Here, we consider the available methods and the applicability of the methods and values to the benefits of quiet areas (and the disbenefits associated with quiet areas becoming noisier).

Revealed Preference Methods

5.2.2 There are two main approaches of relevance to this issue; the travel cost method (TCM) and the hedonic pricing method (HPM). Essentially, these methods function by identifying a market within which the attribute of interest is implicitly valued. These are briefly outlined below.

Travel Cost Method

5.2.3 This approach has been widely used for establishing a use value of outdoor leisure destinations such as parks and forests[140]. The method assumes that the cost of reaching and using a destination (including any travel costs and admission fees) provides an estimate of the benefits derived by the user from the visit. It is, therefore, dependent on the identification of a demand curve for the destination of interest which may be based on individuals or origin zones. According to Haab and McConnell[141] there are two main applications, firstly and originally to establish the value of the land in its recreational use and secondly, to assess the benefits of, for example, pollution control that might affect the recreational value of a site.

[139] This section draws upon Bristow A.L. (2010) Valuing Noise Nuisance, paper to INTER-NOISE 2010, the 39th International Congress and Exposition on Noise Control Engineering, 13th -16th June, Lisbon.and Bristow and Wardman forthcoming.
[140] Hanley N. and Spash C.L. (1993) Cost-Benefit Analysis and the Environment, Edward Elgar, Cheltenham, UK.
[141] Haab T.C. and McConnell K.E. (2002) Valuing Environmental and Natural Resources: The Econometrics of non-market valuation. New Horizons in Environmental Economics Series. Edward Elgar, Cheltenham, UK.

5.2.4 An attraction of this approach is that it is based on revealed preference – what people actually do. However, the approach is limited in scope to the estimation of a use value of any location and cannot capture non-user benefits. The TCM might be expected to give a lower bound estimate of use value as it is based on actual costs incurred and not the maximum that individuals might be willing to pay. There are difficulties in allocating the travel cost attributable to the site visited where trips are multipurpose. The application of conventional values of the disutility of travel time may not be appropriate in the case of leisure journeys, where estimates have been found to be sensitive to the adopted values of time[142]. The attractiveness of alternative sites should be considered and a failure to do so will inflate values[143] though individuals will differ in their perceptions of what is a substitute. The approach assumes that sites are separable from their surroundings.

5.2.5 This method may be applicable to obtain a value for the use of quiet areas. However, as such destinations are multi-attribute an additional method would be needed to segment any such value in order to capture the contribution of quietness to the whole.

Hedonic Pricing Method

5.2.6 The hedonic pricing method (HPM) essentially decomposes house prices into the constituent attributes or characteristics. In accordance with Lancaster[144] "it is these characteristics, not good themselves, on which customers' preferences are exercised". The technique has been widely applied in the environmental economics literature with sufficient studies on air pollution and air transport noise to support meta-analysis[145]. To date no formal meta-analysis has been conducted on studies of road traffic noise though Bateman *et al.*[146] provide a review. However, ten years on, the increased number of studies available may well support such an analysis. The approach establishes the impact on house prices of specific characteristics and/or changes in those characteristics. Table 4 presents results from recent studies of road traffic noise in Europe.

Table 4: Recent HPM studies of road traffic noise in Europe

Authors	Location	Threshold dB(A)	NSDI % change
Wilhelmsson (2000)	Stockholm, Sweden	56 (implicit)	0.60
Lake *et al.,* (1998, 2000)	Glasgow, Scotland	54 68	0.20 1.07
Rich and Nielson (2004)	Copenhagen, Denmark Houses Apartments	50	 0.54 0.47
Bjørner *et al*., (2003)	Copenhagen, Denmark	55	0.47
Bateman *et al.,* (2004)	Birmingham, England	55	0.21-0.53
Theebe (2004)	Western Netherlands	65	0.3 to 0.5

[142] Smith V.K. and Kaoru Y. (1990) Signals or Noise? Explaining the variation in Recreation Benefit Estimates, American Journal of Agricultural Economics, 72(2) 149-433

[143] Smith V.K. and Kaoru Y. (1990) Signals or Noise? Explaining the variation in Recreation Benefit Estimates, American Journal of Agricultural Economics, 72(2) 149-433

[144] Lancaster K.J. (1966) A New Approach to Consumer Theory, The Journal of Political Economy, 74(2) 132-157

[145] Smith V.K. and Huang J-C. (1995) Can Markets Value Air Quality? A Meta-Analysis of Hedonic Property Values. The Journal of Political Economy 103(1) 209-227; Schipper Y., Nijkamp P. and Rietveld P. (1998) Why do aircraft noise value estimates differ? A meta-analysis. Journal of Air Transport Management 4(2), 117-124; Nelson J.P. (2004) Meta-analysis of Airport Noise and Hedonic Property Values: Problems and Prospects. Journal of Transport Economics and Policy 38(1), 1-28; and Wadud Z. (2010) Meta-Regression of NDIs around Airports: Effect of Income/Wealth, paper to the 12th World Conference on Transport Research, 11th to 15th July 2010, Lisbon, Portugal.

[146] Bateman I., Day B., Lake I. and Lovett A. (2001) The effect of road traffic on residential property values: a literature review and hedonic pricing study. Report to the Scottish Executive.

Authors	Location	Threshold dB(A)	NSDI % change
Baranzini and Ramirez (2005)	Geneva, Switzerland, rental sector	50	0.25
Andersson *et al.,* (2010)	Lerum, Sweden	50 55	1.15-1.17 1.68-1.69
Brandt and Maenig (2011)	Hamburg, Germany	None	0.23

Source: Bristow and Wardman, forthcoming.

5.2.7 As can be seen from Table 4, even in a sample from a small number of Northern European countries there is considerable variation in the estimated impact of noise on house prices. Comparison of studies is difficult due to differences: in functional form, the quality and scope of data, definitions of variables and the level of discrimination of the impact being valued.

5.2.8 The quantity of hedonic studies on aircraft noise is such that a number of meta-analyses have been carried out the most recent by Wadud (2010)[147] included 53 estimates of house price depreciation from aircraft noise concluding that a 1 dB(A) change in aircraft noise levels leads to a fall in house prices of between 0.45% and 0.64%. This estimate is broadly consistent with earlier analysis by Nelson (2004)[148] and the early review by Nelson (1980)[149] though somewhat lower than the estimates of Schipper *et al.,* (1998)[150] of 0.9% to 1.3%. Studies of road traffic noise are less numerous and no formal analyses have been conducted. Bateman *et al.,* (2001)[151] reviewed 18 studies of road traffic noise mostly from North America finding an average Noise Sensitive Depreciation Index (NSDI) of 0.55%. This value is somewhat higher than the 0.40% identified by Nelson (1982)[152] from nine studies and 14 values all from Canada and the USA. Although the average values seem broadly consistent the range of original values is very large.

5.2.9 The HPM is attractive because it has a basis in real decisions in the market place and may make use of measured or modelled noise levels. However, the approach may be criticised in that purchasers may not have perfect knowledge of all the attributes of the different houses they choose between; the housing market is susceptible to other imperfections, most notably transaction costs; explanatory variables suffer from correlation and it is difficult to measure some intangible influences and perceptions of them. HPM is also limited in that it can only give a value of disturbance as experienced at home. Additionally, the measures of noise used are often quite crude contours. Meta-analysis suggests that this cost may be capitalised through a house price discount of about 0.5% to 0.6% per dB(A). In order to convert this to a value per dB(A) per year assumptions must be made about house purchasers' discount rates and the time period over which the values should be discounted. Even then the method cannot tell us what people might be willing to pay now for changes in the noise level experienced or how this might vary by time of day, day of week or season. These are interesting policy questions and for answers we must find another approach. If noise has a value and this is observed to influence house prices then noise values should be discernable in disaggregate choice analysis[153].

[147] Wadud Z. (2010) Meta-Regression of NDIs around Airports: Effect of Income/Wealth, paper presented at the 12th World Conference on Transport Research, 11th to 15th July 2010, Lisbon, Portugal.
[148] Nelson J.P. (2004) Meta-analysis of Airport Noise and Hedonic Property Values: Problems and Prospects. Journal of Transport Economics and Policy 38(1), 1-28.
[149] Nelson J.P. (1980) Airports and Property Values, Journal of Transport Economics and Policy 14(1) 37-52.
[150] Schipper Y., Nijkamp P. and Rietveld P. (1998) Why do aircraft noise value estimates differ? A meta-analysis. Journal of Air Transport Management 4(2), 117-124.
[151] Bateman I., Day B., Lake I. and Lovett A. (2001) The effect of road traffic on residential property values: a literature review and hedonic pricing study. Report to the Scottish Executive.
[152] Nelson J.P. (1982) Highway Noise and Property Values: A Survey of Recent Evidence. Journal of Transport Economics and Policy 16(2) 117-138
[153] Bristow A.L. (2010) Valuing Noise Nuisance, paper to Inter-Noise 2010, the 39th International Congress and Exposition on Noise Control Engineering, 13th -16th June, Lisbon.

5.2.10 This is the dominant paradigm in the valuation of noise nuisance experienced in the home from air and road transport in particular, with a very much smaller number of studies of rail transport noise. The Department for Transport values for road and rail noise are derived from an hedonic study of Birmingham[154]. The value per unit change in decibels increases as the level of noise experienced increases.

Stated Preference Methods

5.2.11 These are essentially hypothetical questioning techniques. There are two main forms: Contingent Valuation Method (CVM) and Stated Choice (SC). Their main advantages over HPM are as follows. Firstly, control over the experimental conditions which can ensure: avoidance of correlation between independent variables; sufficient variation in attribute levels; better trade-offs than might exist in the real world; investigation of levels of noise or quiet outside current experience; design can ensure that secondary variables are not dominated; avoidance of measurement error in the independent variables; the ability to "design out" variables by specifying them to be the same for each choice. Secondly, it enables disaggregate analysis relating to individual characteristics but also variation by, for example, time period. Thirdly, in the case of stated choice, multiple observations are obtained for each person allowing more precise estimation[155].

Contingent Valuation Method (CVM)

5.2.12 In CVM the respondent is asked a direct question on willingness to pay for a beneficial change (or to avoid an adverse change) or willingness to accept compensation for an adverse change (or to forgo a beneficial change). Essentially, respondents are asked for a value that is contingent upon a hypothetical change[156]. Interestingly some of the earliest UK studies to apply this technique addressed noise from aircraft and road traffic[157].

5.2.13 An open-ended CVM question would simply ask, for example, "What increase in your monthly rent would you agree to pay in order to halve your housing noise level?"[158]. However, people find it difficult to provide a specific amount expressing a precise strength of preference. Therefore respondents might be offered an amount and asked if they would pay it or not and if they answer yes asked again to respond to a higher value. Such an iterative bidding process can lead to a final valuation that is dependent on the starting point[159] and higher valuations[160]. This has led to more examples of dichotomous choice (or referendum) CVM where respondents are given a single amount and asked whether they are willing to pay it or not (and double and one and a half bound versions of such an approach). This approach has again been found to yield higher values than open ended questions, which may be the result of "yea saying" (respondents simply

[154] Nellthorp J., Bristow A.L. and Day B. (2007) Introducing willingness-to-pay for noise changes into transport appraisal – an application of benefit transfer. *Transport Reviews* 27(3) 327-353.
[155] Bristow A.L. and Wardman M. (forthcoming) What can we learn from the application of Contingent Valuation and Stated Choice methods to noise valuation? A meta-analysis, abstract accepted, to the 2nd International Choice Modelling Conference 4th to 6th July 2011, Leeds.
[156] Garrod G. and Willis K.G. (1999) Economic Valuation of the Environment: Methods and Case Studies. Edward Elgar, Cheltenham, UK.
[157] Bristow A.L. (2010) Valuing Noise Nuisance, paper to INTER-NOISE 2010, the 39th International Congress and Exposition on Noise Control Engineering, 13th -16th June, Lisbon.
[158] Soguel N. (1994) Measuring benefits from traffic noise reduction using a contingent market. CSERGE Working Paper GEC 94-03, University of East Anglia.
[159] Mitchell R. and Carson R. (1989) Using Surveys to Value Public Goods: the Contingent Valuation Method, Resources for the Future, Washington, USA.
[160] Bateman I., Langford R.K., Turner K., Willis K. and Garrod G. (1995) Elicitation and truncation effects in contingent valuation studies. Ecological Economics 12, 161-179.

agreeing for simplicity or thinking it is the norm) rather than because the values are genuinely higher[161].

5.2.14 CVM has a number of problems and limitations. Problems include the prevalence of zero bids (which can be more than half the sample) and the difficulty in distinguishing between genuine zero values where respondents do not value the scenario presented and protest bids where respondents have a non-zero value but do not reveal it. Clearly any assumptions made as to the validity of zero bids affect the value derived. Apart from protest bids other forms of bias may be present, for example strategic bias where respondents tailor their bid to signal what they want to happen rather than a genuine value. CVM studies require large samples as only one piece of information is gathered from each respondent and cannot therefore examine individual attributes of a scenario in a systematic way[162].

5.2.15 This approach has been applied to transport noise. The recommendation of a value of noise nuisance in the home of €25 per household per decibel per year by The Working Group in Health and Socio-economic Aspects (2003)[163] was based on results from eleven CVM and Stated Choice (SC) studies reviewed by Navrud (2002)[164] where the median value was €23. As with hedonic studies, the range of values was wide although the number of studies reviewed was too small for any formal analysis of the sources of variation.

Stated Choice

5.2.16 Stated choice experiments are similar to CVM in that they offer hypothetical scenarios, but in this case the choice is between two or more scenarios that differ with respect to a number of attributes. In a typical experiment respondents are asked to express a preference for one of two scenarios A and B which each have a number of common attributes any or all of which may vary in terms of their level between scenarios. The choice could be between three or even more scenarios. This is a common approach in marketing and transport studies and, more recently, has established a strong foothold in environmental valuation.

5.2.17 Wardman and Bristow[165] rehearse arguments on the relative strengths of CVM and SC approaches and these are briefly summarised here.

- SC examines several attributes simultaneously whilst CVM tends to look at attributes in isolation, therefore SC can:
  - Reduce any incentive to strategic bias;
  - Reduce protest responses; and
  - Examine interaction and package effects.
- SC examines different levels of attributes supporting detailed analysis of the functional relationship between the value of an attribute and its level as well as size and sign effects.
- SC asks for the order of preference whilst CVM asks for strength of preference – the former is both easier and more prevalent in everyday decision making. Bateman *et al.* (2006)166

[161] Hanley N., Mourato S. and Wright R.E. (2001) Choice modeling approaches: a superior alternative for environmental valuation? Journal of Economic Surveys 15(3), 435-462.
[162] Bristow A.L. and Wardman M. (forthcoming) What can we learn from the application of Contingent Valuation and Stated Choice methods to noise valuation? A meta-analysis, abstract accepted, to the 2nd International Choice Modelling Conference 4th to 6th July 2011, Leeds.
[163] Working Group on Health and Socio-economic Aspects, (2003) Valuation of Noise Position Paper.
[164] Navrud S. (2002) The State-of-the-Art on Economic Valuation of Noise. Final Report to European Commission DG Environment.
[165] Wardman M. and Bristow A.L (2004) Traffic Related Noise and Air Quality Valuations: Evidence from stated preference residential choice models, Transportation Research D, 9(1) 1-27.

find some evidence to support this when comparing open ended CVM with contingent ranking.

- SC is a behavioural model from which values are derived, CVM is a direct valuation model and easier to analyse.
- CVM is easier to design and analyse.

5.2.18 The approach is clearly applicable to the valuation of noise or quiet and would permit disaggregation of a quiet area into its constituent attributes for valuation. To date the approach has had relatively limited use in the context of noise with perhaps ten studies in the public domain. Transport noise, particularly that from aircraft can be contentious and recent studies have sought to further reduce the scope for strategic and protest response[167].

Opportunity Cost

5.2.19 In cost-benefit analysis this approach may be applied with respect to factors or inputs where markets are distorted. "The opportunity cost of land used in the construction of infrastructures is the net benefit lost in the best alternative use of that land"[168]. In most examples the land is undeveloped and next best use is agriculture or leisure.

5.2.20 This approach could be applied by examining the cost of land with planning permission for development in the areas concerned if the market is deemed to be competitive. Otherwise, some assessment of an alternative use, which would presumably be housing or commercial development, should be estimated as a benefit stream. This approach has recently been applied by Vejre *et al.* (2010)[169] to explore the intangible benefits of open spaces on the fringes of Copenhagen.

5.2.21 Any of the techniques reviewed above could be applied in the context of quiet areas. However, quiet areas clearly consist of a number of component characteristics apart from quietness any or all of which could have a value. The opportunity cost approach is the least desirable approach since it merely measures the supply price of quiet – what is foregone in order to produce more quiet in an urban area – and has no link with the preferences of those who benefit. Methods that examine different levels of characteristics and which account for beneficiary preferences are therefore the most attractive in this context. Stated Choice is best able to cope with precisely this challenge.

5.3 The Economic Value of Quiet and Quiet Areas: Evidence to Support Quantification

5.3.1 As a result of the limited research on quiet to date, the scope of the review on quantitative evidence was necessarily extended from an initial focus on identifying studies relating to the value of quiet and quiet areas, to a much broader focus on the value of urban open spaces. A particular challenge here is that some urban open areas may not meet the definition of quiet areas proposed in Section 3.4.6. However, it is assumed that these are nevertheless relatively quiet areas and therefore that at least part of the definition still applies.

[166] Bateman I.J., Cole M.A., Georgiou S. and Hadley D.J. (2006) Comparing contingent valuation and contingent ranking: A case study considering the benefits of urban river quality improvements. Journal of Environmental Management 79, 221-231
[167] Wardman M. and Bristow A.L., (2008) Valuations of Aircraft Noise: Experiments in Stated Preference, Environmental and Resource Economics. 39(4), 459-480.
[168] De Rus G. (2010) Introduction to Cost-Benefit Analysis: Looking for Reasonable Shortcuts. Edward Elgar, Cheltenham, UK, p69.
[169] Vejre H., Jensen F.S. and Thorsen B.J. (2010) Demonstrating the importance of intangible ecosystem services from peri-urban landscapes. *Ecological Complexity*, 7, 338-348

5.3.2 This section sets out the evidence that exists for quantifying the benefits of public access to quiet areas. To ensure that the present study remains focused, only those studies valuing benefits associated with "quiet areas" or areas for which "quiet" is a key attribute were selected. So, for example, studies valuing the disamenity of noise associated with living next to roads or airports are not considered as proxies for the value of quiet that would be provided by, say, public open spaces (although some 'noise' studies are included for illustrative purposes). The evidence is reported using the same typology of benefits used in Chapter 4.

Health Benefits

5.3.3 There is a substantial and growing evidence base which looks to quantify the adverse impacts of prolonged exposure to noise on health[170]. Many of these take 'quiet' or 'relative quiet' as the starting point and use dose-response functions to describe the relationship between increases in noise levels and health.

5.3.4 Dose-response functions define a direct quantitative link between exposure (i.e. the dose) and the effect that is has on a particular receptor (i.e. the response). These have been developed in robust studies for several of the health outcomes that have been attributed to prolonged exposure to high noise levels. Depending on the relationship between the exposure and the effect, dose-response functions can take any functional form or threshold above which there is an effect. For example, certain impacts may only occur above a given threshold or may not increase linearly across volumes. A dose-response relationship usually takes the form of a mathematical or graphical relationship between sound levels and some measure of response to noise (such as percentage of respondents highly annoyed), from which it is possible to estimate the likely response of a population to a particular sound level, or the level at which a certain reaction is likely to occur.

5.3.5 Any dose-response relationship relating an effect of noise to a particular sound level is a statistical relationship, representing a general trend; and therefore there is likely to be a wide degree of variation around the trend. Thus for a given source some people will be affected at sound levels considerably below the 'norm', while others will not be affected at all at much higher levels. Indeed, however stringent a noise criterion might be it is highly likely that someone will still be adversely affected by the noise at or below the criterion level[171].

5.3.6 The evidence supporting the valuation of health benefits of quiet areas, or that may be useful in developing monetary estimates, is presented in Table 5 below.

Table 5: Evidence supporting quantification of health benefits of quiet and quiet areas

Health effect measured	Approach	References	Comments
Cardiovascular effects, hypertension	Dose-response	Babisch (2006, 2010); van Kempen *et al.* (2005); Berry and Flindell; HPA (2010); IGCB (2010)	Already used by the IGCB (N) as offering the most robust assessments to date of the increased prevalence of cardiovascular effects in populations resident in areas with higher

[170] See for example WHO (1999) Guidelines for Community Noise. Geneva [online] available at: http://www.who.int/docstore/peh/noise/guidelines2.html (accessed on 8 December 2010); Berry B.F. and Flindell, I.H. (2009) Estimating Dose-Response Relationships Between Noise Exposure and Human Health Impacts in the UK, Final Project Report, BEL 2009-01, report to Defra [online] http://www.defra.gov.uk/environment/quality/noise/igcb/documents/project-report.pdf (accessed 13 January 2011); HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Protection Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).

[171] HPA (2010) Environmental Noise and Health in the UK. A report published by the Health Prote17.56ction Agency on behalf of an ad hoc Expert Group on the Effects of Environmental Noise on Health [online] available at http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1279888026747 (accessed 28 January 2011).

Health effect measured	Approach	References	Comments
			environmental noise sound levels.
Sleep disturbance	Dose-response	Basner *et al.* (2009), EC (2004)	Recommended by the IGCB (N) and covers the range of 55-81 dB(A)
Cognitive development		Van Kempen *et al.* (2006)	Relates only to exposure to chronic aircraft noise

Acute myocardial infarction and hypertension

5.3.7 The IGCB (N) guidance may be used for estimating the monetary value of reduced exposure to noise levels on acute myocardial infarction (AMI) or the incidence of heart attacks. This methodology is based on the 2006 Babisch dose-response function. The additional risk of AMI is estimated to be zero below a 57 dB(A) level and then to increase with each incremental dB (see Table 6). This relationship may therefore be applied when assessing marginal reductions in environmental noise levels from 81 dB(A) to below 57 dB(A).

5.3.8 The IGCB (N)[172] nevertheless notes a number of uncertainties in the use of the Babisch curve. These include:

- The large statistical uncertainties associated with the increasing relative risk of AMI observed as road traffic sound levels rise. These uncertainties might reflect underlying variability, such as differences in individual susceptibility, or uncertainties in measuring the dose and effect variables.
- The Babisch curve was derived from a meta-analysis comprising only road traffic noise studies, meaning the curve has limited applicability against other noise sources. To make use of the curve for aircraft noise, for example, one would have to assume the same dose-response relationship. This is unlikely to be the case, for several reasons. Babisch noted that aircraft noise acts on all sides of a building, unlike road traffic noise, suggesting that the AMI risk induced by aircraft noise could be greater.
- None of the research which has been published to date has been able to resolve the confounding effect of correlated levels of air pollution, which has similar negative health impacts.
- There are other potential confounding factors that were not possible to take into account. For example, the possibility of self-selection bias, when individuals of differing susceptibilities might have chosen (or conversely were unable to choose) quieter or noisier areas as places to live, cannot be ruled out.
- Though the Babisch curve highlights a statistical relationship between environment noise levels and risk of AMI, there is no accepted biological or physiological explanation of how they are linked.
- No research to date has been able to identify which particular features of environmental noise (if any) are the most damaging to health. There has not yet been any scientific justification for the assumption that long-term average outdoor sound level metrics such as

[172] IGCB (2010) Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure. The second report of the IGCB (N) [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcn-noise-health-response100707.pdf (accessed on 15 March 2011).

L_{Aeq} and L_{den} provide an adequate description of the most important features of environmental noise assumed to be responsible for these impacts.

5.3.9 The IGCB (N) guidance also presents a function for estimating the non-monetised benefits of a reduction in noise levels on the incidence of hypertension. It may be possible to value these using evidence of the medical costs associated with the treatment of hypertension.

Table 6: Valuing acute myocardial infarction (heart attack) impacts of noise and hypertension (from Defra, 2010[173])

Volume ($L_{Aeq, 18hr}$ dB) Low	Volume ($L_{Aeq, 18hr}$ dB) High	Additional risk of AMI	£ per household per dB(A) change	Additional risk of hypertension (%)
55	56	0.00000%	£0.00	1.16
56	57	0.00000%	£0.48	1.16
57	58	0.00010%	£2.70	1.16
58	59	0.00048%	£4.16	1.16
59	60	0.00072%	£5.67	1.16
60	61	0.00096%	£7.22	1.16
61	62	0.00144%	£8.82	1.16
62	63	0.00168%	£10.47	1.16
63	64	0.00192%	£12.17	1.16
64	65	0.00216%	£13.92	1.16
65	66	0.00264%	£15.71	1.16
66	67	0.00288%	£17.56	1.16
67	68	0.00336%	£19.45	1.16
68	69	0.00360%	£21.39	1.16
69	70	0.00384%	£23.37	1.16
70	71	0.00432%	£25.41	1.16
71	72	0.00480%	£27.49	1.16
72	73	0.00504%	£29.62	1.16
73	74	0.00552%	£31.81	1.16
74	75	0.00576%	£34.03	1.16
75	76	0.00624%	£36.31	1.16

[173] Defra (2010) Valuing the Human Health Impacts of Environmental Noise Exposure [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcn-noise-health-response-tables100721.pdf (accessed 15 March 2011)

Volume ($L_{Aeq, 18hr}$ dB) Low	Volume ($L_{Aeq, 18hr}$ dB) High	Additional risk of AMI	£ per household per dB(A) change	Additional risk of hypertension (%)
76	77	0.00672%	£38.64	1.16
77	78	0.00720%	£41.01	1.16
78	79	0.00768%	£43.43	1.16
79	80	0.00792%	£45.90	1.16
80	81	0.00840%	£48.42	1.16

Sleep disturbance

5.3.10 The IGCB (N) also provides guidance for valuing the sleep disturbance impacts from different sources of transport noise. Again, these may be applied in the present study to estimate the benefits of a reduction in noise from levels above 55 dB(A) to levels below 55 dB(A). Table 7 shows the additional % households suffering sleep disturbance from a single increase in decibel (dB) of noise levels across three different transport sources. These sleep disturbance impacts are split across “levels” of sleep disturbance (i.e. Low, Moderate and High) to reflect varying impacts among individuals of different sensitivity to noise. There is no readily available evidence on sleep disturbance impacts below the 55 dB(A) level.

5.3.11 No studies were identified that report a measurable health benefit for quiet areas.

Table 7: Valuing sleep disturbance impacts from noise (from Defra, 2010)[174]

Change in Noise Levels (dB)		Road Traffic Noise			Railway Noise			Aircraft Noise		
Low	High	% Low Sleep-Disturbed Households	% Moderate Sleep-Disturbed Households	% High Sleep-Disturbed Households	% Low Sleep-Disturbed Households	% Moderate Sleep-Disturbed Households	% High Sleep-Disturbed Households	% Low Sleep-Disturbed Households	% Moderate Sleep-Disturbed Households	% High Sleep-Disturbed Households
55	56	3.26	2.41	1.44	2.25	1.40	0.70	2.73	2.21	1.65
56	57	3.32	2.49	1.51	2.31	1.46	0.74	2.80	2.28	1.72
57	58	3.37	2.57	1.58	2.36	1.51	0.77	2.86	2.36	1.80
58	59	3.42	2.65	1.65	2.41	1.56	0.81	2.93	2.43	1.87
59	60	3.47	2.73	1.72	2.47	1.62	0.85	3.00	2.50	1.94
60	61	3.52	2.81	1.80	2.52	1.67	0.88	3.06	2.58	2.01
61	62	3.58	2.89	1.87	2.58	1.73	0.92	3.13	2.65	2.08
62	63	3.63	2.97	1.94	2.63	1.78	0.96	3.20	2.73	2.15
63	64	3.68	3.05	2.01	2.69	1.83	0.99	3.27	2.80	2.22
64	65	3.73	3.13	2.08	2.74	1.89	1.03	3.33	2.88	2.29
65	66	3.78	3.21	2.15	2.79	1.94	1.07	3.40	2.95	2.37
66	67	3.83	3.29	2.22	2.85	1.99	1.10	3.47	3.03	2.44
67	68	3.89	3.37	2.29	2.90	2.05	1.14	3.53	3.10	2.51
68	69	3.94	3.45	2.37	2.96	2.10	1.18	3.60	3.18	2.58
69	70	3.99	3.53	2.44	3.01	2.16	1.21	3.67	3.25	2.65
70	71	4.04	3.61	2.51	3.06	2.21	1.25	3.73	3.33	2.72
71	72	4.09	3.69	2.58	3.12	2.26	1.28	3.80	3.40	2.79
72	73	4.15	3.77	2.65	3.17	2.32	1.32	3.87	3.47	2.86
73	74	4.20	3.85	2.72	3.23	2.37	1.36	3.94	3.55	2.93
74	75	4.25	3.93	2.79	3.28	2.42	1.39	4.00	3.62	3.01
75	76	4.30	4.01	2.87	3.33	2.48	1.43	4.07	3.70	3.08
76	77	4.35	4.09	2.94	3.39	2.53	1.47	4.14	3.77	3.15
77	78	4.41	4.17	3.01	3.44	2.59	1.50	4.20	3.85	3.22
78	79	4.46	4.25	3.08	3.50	2.64	1.54	4.27	3.92	3.29
79	80	4.51	4.33	3.15	3.55	2.69	1.58	4.34	4.00	3.36
80	81	4.56	4.41	3.22	3.60	2.75	1.61	4.40	4.07	3.43

Amenity Benefits (including Annoyance)

5.3.12 There are numerous studies dealing with the annoyance or nuisance value of transportation (primarily road traffic and aircraft) noise. These are reviewed in detail in Bristow (2010)[175] and referred to in section 5.2 above.

5.3.13 Studies on the value of nuisance from transport noise invariably show an inverse relationship between noise levels and annoyance:

[174] Defra (2010) Valuing the Human Health Impacts of Environmental Noise Exposure [online] available at http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcn-noise-health-response-tables100721.pdf (accessed 15 March 2011)

[175] Bristow A.L. (2010) Valuing Noise Nuisance, paper to INTER-NOISE 2010, the 39th International Congress and Exposition on Noise Control Engineering, 13th -16th June, Lisbon.

- Day *et al.* (2006)[176] used HPM to estimate welfare values for the avoidance of transport-related noise in urban areas in Birmingham. Their research clearly demonstrated that ambient noise – from aircraft, roads or railways – is negatively capitalised into house prices and that people pay a premium to live in more tranquil surroundings, all else being equal, and in this context 'all else' includes access to jobs. Furthermore, their findings suggest that peace and quiet is a 'normal good', one for which willingness to pay increases with income, and that a given reduction in noise levels has higher welfare effects in a noisier context. In 1997 prices (for a model calibrated on house price data for Birmingham) a 1 dB reduction from a level of 56 dB was worth £31.49 as an annualised sum while the same reduction from an ambient level of 80 dB was worth £88.76. The Birmingham study is distinctive in that it goes beyond simply deriving 'implicit prices' for environmental attributes in the property market (the first stage of HPM) by deriving a demand function for peace and quiet (the second stage of HPM). The second stage removes the influence of supply conditions in the local market and represents – as far as possible – residents' underlying preferences for peace and quiet. It also made use of a very large GIS-referenced dataset.
- A meta-analysis of HP studies by Nelson (2004)[177] concludes that house prices in North America fall by approximately 0.5 to 0.6% in response to an increase in aircraft noise of 1 dB.
- Bateman *et al.* (2001)[178] reviewed 18 studies largely from North America yielding a mean decline in property values of 0.55% for a 1dB increase in road traffic noise.
- A meta-analysis by Miedema and Oudshoorn (2001)[179] of the relationship between transport noise and annoyance suggests the following threshold points: 32 dB(A) to move from zero annoyed to having some people who are 'a little annoyed'; 37 dB(A) as the threshold where some become 'annoyed' and 42 dB(A) as the threshold where some will become 'highly annoyed'. These thresholds apply to L_{dn} and L_{den}, measures which – by definition – produce higher levels of dB(A) than a 24 hour L_{Aeq} measure[180]. The meta-analysis does not, however, go so far as to estimate marginal values in monetary terms and is therefore of limited use to the present study.
- Schipper *et al.* (1999)[181] conducted a meta-analysis to examine the relationship between aircraft noise and property prices. They established that there is significant variation in the rate of depreciation of property values resulting from aircraft noise and the variation in rates may be explained by timing, wealth and specification of the original studies.
- A recent report by CE Delft (2011)[182] analyses the social, environmental and economic effects of a ban on night flights at Heathrow Airport. Using the relationship between night noise and annoyance, where annoyance is measured by sleep disturbance, the study estimates that the yearly net benefit of avoidance of noise exposure during the night amounts to £ 476.40 per person. Note, however, that this study takes as its baseline a night-

[176] Day, B., Bateman, I. and Lake, L. (2006) Estimating the demand for peace and quiet using property market data. CSERGE Working Paper EDM 06-03 [online] available at http://www.cserge.ac.uk/sites/default/files/edm_2006_03.pdf (accessed January 2011).
[177] Nelson J.P. (2004) Meta-analysis of Airport Noise and Hedonic Property Values: Problems and Prospects. Journal of Transport Economics and Policy 38(1), 1-28.
[178] Bateman, I. J., Day, B. H., Lake, I. and Lovett, A. A. (2001) The effect of road traffic on residential property value: a literature review and hedonic pricing study (Edinburgh: Scottish Executive and The Stationery Office).
[179] Miedema, H.M.E. and Oudshoorn, C.G.M. (2001) Annoyance from transportation noise: relationships with noise exposure metrics DNL and DENL and their confidence intervals. *Environmental Health Perspectives*, 109(4), 409-416.
[180] Nellthorp J., Bristow A.L. and Day B. (2007) Introducing willingness-to-pay for noise changes into transport appraisal – an application of benefit transfer. *Transport Reviews* 27(3) 327-353.
[181] Schipper, Y., Nijkamp, P. and Rietveld, P. (1999) Why do aircraft noise value estimates differ? A meta-analysis. Journal of Air Transport Management 4, 117-124
[182] CE Delft (2011) Ban on night flights at Heathrow Airport: A quick scan Social Cost Benefit Analysis. Delft, CE Delft, January 2011 [online] available at http://www.hacan.org.uk/resources/reports/night.flight.final.report.pdf (accessed 15 March 2011)

time noise level of 50 dB(A) and does not investigate the health effects of changes in noise levels below the 50 dB(A) threshold. Furthermore, the estimates are derived using benefits transfer methodology and applied using several questionable assumptions and are therefore treated with caution in the present study.

- Barreiro *et al.* (2005)[183] estimate the value of a noise reduction program in a Spanish city using contingent valuation. They found that urban residents generally place a positive value on a reduction in noise levels and, specifically, that a Spanish household is willing to pay approximately 4 Euros (2005 prices) per year per dB reduced.
- Garrod *et al*. (2002)[184] and Scarpa *et al.* (2001)[185] report an estimated mean WTP for traffic calming measures in three English towns of about 2 to 4 Euros per dB, per household, per year.

5.3.14 Clearly, the discrepancies in the findings of these studies can be explained, not only by the different methodologies used, but also by factors relating to different income levels, institutional settings, cultures and preferences.

5.3.15 Contrary to the overwhelming consensus that WTP decreases with noise levels, one study in Hong Kong found a positive correlation between noise level and property prices[186]. This may be explained by the uniquely dense living environment in Hong Kong where households are willing to sacrifice serenity for convenience. The marginal WTP for quietness was found to be comparatively lower for lower income groups than that of higher income groups. An apartment located in a noisy area would end up with a higher sale price than an identical one located in a quiet area.

5.3.16 Some of the potentially useful sources of information regarding the relationship between noise and amenity from the 'noise' literature are summarised in Table 8 overleaf.

[183] Barreiro, J., Sanchez, M. and Viladrich-Grau, M. (2005) How much are people willing to pay for silence? Applied Economics, 37(11).
[184] Garrod G.D., Scarpa R. and Willis K.G., (2002) Estimating the benefits of traffic calming on through routes: a choice experiment approach, Journal of Transport Economics and Policy 36(2), 211-231.
[185] Scarpa R., Garrod G.D. and Willis K.G. (2001) Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England. December 2001, Fondazione Eni Enrico Mattei.
[186] Hui, E.C.M., Chau, C.K., Pun, L., Law, M.Y. (2007) Measuring the neighbourhood and environmental effects on residential property value: using spatial weighting matrix 42, 2333-2343.

Table 8: Evidence relating to amenity value of quiet

Study	Summary	Valuation Approach	Reported values	Comments
Baranzini and Ramirez (2005)[187]	Applies the hedonic approach to assess the economic impact of noise from all sources (including aircraft noise) in the Geneva rental market. The study found that: i) The impact of all sources of noise on rents at the level of a whole neighbourhood is about 0.7 per cent per dB(A) and about 1 per cent when considering exclusively airplane noise, in the airport area. ii) This impact does not change fundamentally depending on the different measures of noise used in the estimations. iii) The impact of noise does not depend on the institutional structure of the market—i.e. it is relatively similar in the private rental sector and in apartments directly under government control, although in the former the dynamic of noise has a greater impact. iv) Noise also has a higher economic impact, when the background noise level is lower. v) Air pollution has a distinct impact on rents, in addition to noise.	Hedonic pricing	Decrease in rental value of 0.7% per dB(A) from all noise sources; decrease in rental value of 1% per dB(A) from aircraft noise alone.	Only considers one source of noise (aircraft) but may be useful as a proxy for valuing how people respond to changes in levels of loud, intermittent noise. Less applicable than similar UK-based studies.
Wadud (2010)[188]	Through meta-analysis, identified 53 estimates of house price depreciation from aircraft noise to conclude that a 1 dB(A) change in aircraft noise levels leads to a fall in house prices of between 0.45% and 0.64%.	Hedonic pricing	1 dB(A) change in aircraft noise levels leads to a fall in house prices of between 0.45% and 0.64%.	Possibly more reliable than Baranzini and Ramirez study as more recent and covers a range of empirical studies

[187] Baranzini, A., and Ramirez, J. V. (2005) "Paying for Quietness: the Impact of Noise on Geneva Rents." *Urban Studies*, 42(4): 633-646.
[188] Wadud Z. (2010) Meta-Regression of NDIs around Airports: Effect of Income/Wealth, paper to be presented at the 12th World Conference on Transport Research, 11th to 15th July 2010, Lisbon, Portugal

Study	Summary	Valuation Approach	Reported values	Comments
Schipper *et al.* (1998)[189]	Through meta-analysis of hedonic pricing studies, the authors established a Noise Depreciation Index to assess the social cost inflicted by aviation.	Hedonic pricing	House prices fell by 0.9% to 1.3% with every 1dB(A) increase in noise levels.	Only considers one source of noise (aircraft) but may be useful as a proxy for valuing how people respond to changes in levels of loud, intermittent noise
Luttik (2000)[190]	Two externality factors were shown to have an impact on house price in Leiden: traffic noise and a nice view. Traffic noise was shown to exercise a negative influence (-5%). Compared to the least favourable location characterised by traffic noise, the most favourable location attracts a premium of 29%	Hedonic pricing	The most significant increases in house prices could be attributed to environmental factors (up to 28%) for houses with a garden facing water, which is connected to a sizeable lake. A pleasant view can lead to a considerable increase in house price, particularly if the house overlooks water (8±10%) or open space (6±12%). Attractive landscape types were shown to attract a premium of 5±12% over less attractive environmental settings	Does not explicitly value quiet but value of 'open space' may be used as a proxy value.

[189] Schipper Y., Nijkamp P. and Rietveld P. (1998) Why do aircraft noise value estimates differ? A meta-analysis. *Journal of Air Transport Management* 4(2), 117-124
[190] Luttik, J. (2000) 'The value of trees, water and open spaces as reflected by house prices in the Netherlands', *Landscape and Urban Planning*, Vol. 48, s.161-167

Study	Summary	Valuation Approach	Reported values	Comments
Bateman *et al.* (2001)[191]	The aim of this research was to quantify how the physical factors associated with a new road affect the price of property in the UK. Using hedonic pricing studies, and considering a number of variables that may affect property values, the authors derived a function for estimating the appropriate level of payment to compensate residential property owners for the adverse impacts of road traffic on property values.	Hedonic property pricing	A 1 dB(A) increase in traffic noise decreases property prices by 0.2%	May be combined with webTAG values to provide a reasonable estimate of the impact of road traffic noise on property values in relatively quiet areas.
Soguel (1996)[192]	The contingent valuation method is used to estimate the willingness to pay of the inhabitants of the town of Neuchatel in Switzerland to halve their perceived noise exposure level. The results are compared to previous hedonic and contingent studies conducted previously in Switzerland, and suggest that the results are externally valid.	Contingent valuation open-ended and iterative bidding to infer WTP	It is estimated that the 15,769 households living in the town of Neuchatel are prepared to pay CHF10.5 million per year (in 1992 prices) to halve the perceived noise level they are presently exposed to. This is equivalent to a 10dB decrease in noise level. Mean monthly WTP amongst all respondents is CHF70.	Possibly less reliable than studies that have estimated values using revealed preference approaches because of the hypothetical nature of the survey. It is also not known what the ambient level of noise was (i.e. whether respondents are already affected by relatively high levels of traffic noise).

[191] Bateman I., Day B., Lake I. and Lovett A. (2001) The effect of road traffic on residential property values: a literature review and hedonic pricing study. Report to the Scottish Executive.
[192] Soguel, N. (1996) Contingent Valuation of Traffic Noise Reduction Benefits. Swiss Journal of Economics and Statistics, 132(1), 109-123 [online] available at http://www.sjes.ch/papers/1996-I-5.pdf (accessed 9 March 2011)

Study	Summary	Valuation Approach	Reported values	Comments
Wienberger, Thomassen and Willeke (1991)[193]	A mail survey was undertaken in which 6,491 questionnaires were sent out in April 1989 to various communities around Germany. Three follow-up letters were also sent out over a period of nine weeks. Respondents were asked whether they would be willing to pay more to live either in an area with no noise, or with occasional levels of noise. If so, their maximum WTP was requested. The payment vehicle used was an increase in rent and the payments presented to the respondents ranged from 10 DM to 'more than 500' DM per month.	Contingent Valuation	Individuals were asked their WTP to reduce existing noise levels to no noise or occasional noise. The total annual WTP for the Republic of Germany to achieve low levels of noise from traffic, railway, and industry is 12700, 5300, and 5211 million DM respectively.	Dated study; not considered further.
Weinberger, M. (1992)[194]	Used CVM to estimate the social costs of noise from road, rail and air traffic by asking people for their WTP to “live in a quiet area”. The monthly WTP (euro) was estimated at 0.85 L_{Aeq} – 36.6 , i.e. 10 Euros per dB(A) per person above 43 dB(A)	WTP	The monthly WTP (euro) was estimated at 0.85 L_{Aeq} – 36.6 , i.e. 10 Euros per dB(A) per person above 43 dB(A)	Dated study; not considered further
Barreiro, J., Sanchez, M., Viladrich-Grau, M. (2005)[195]	Estimates the value of a noise reduction program in a medium-sized Spanish city (Pamplona) using CVM. Changes in noise reduction levels are described by referring to the noise levels endured by respondents at different times of day and on different days of the week. The results indicate that households display a positive willingness to pay for a reduction in	Contingent Valuation	A Spanish household is willing to pay approximately 4 Euros per year per dB reduced. The study estimates a mean WTP for a reduction in noise that varies between approximately 26 and 29 € per household, per year to reduce noise	Study focuses on changes in noise from relatively high levels of noise. Not clear what the marginal changes are at lower levels of environmental noise which would be more useful for the purposes of the present study.

[193] Weinberger, Marius, Günter Thomassen, Rainer Willeke (1991): Kosten des Lärms in der Bundesrepublik Deutschland. Berichte 9/91 des Umweltbundesamtes. Berlin
[194] Weinberger, M. (1992). Gesamtwirtschaftliche Kosten des Lärms in der Bundesrepublik. Deutschland. Zeitschrift für Lärmbekämpfung 39, 91-99
[195] Barreiro, J., Sanchez, M. and Viladrich-Grau, M. (2005) How much are people willing to pay for silence? *Applied Economics*, 37(11).

Study	Summary	Valuation Approach	Reported values	Comments
	noise, which in turn shows that such a reduction will improve the well-being of the inhabitants of Pamplona. A further finding is that there is no scope sensitivity effect; which means that households display a willingness to pay different amounts for two different degrees of noise reduction.		levels from the working day level to that of a Sunday morning. Average decibel levels in Pamplona at the time of the study were 67dB(A).	
Navrud, S. (2002)[196]	Provides an updated overview and evaluation of valuation techniques, empirical noise valuation studies worldwide and the potential for transfer of noise values across countries. An analysis of Stated Preference (SP) studies on road traffic noise suggests an interim EU-wide economic value of 23.5 Euro /dB(A) / household / year. Concludes that it is not possible to establish interim values per annoyed person per year for noise from aircraft and railways due to a very small number of studies. Recommends the use of the Damage Function Approach to refine and improve the transferability of the estimate of welfare loss from noise annoyance. Highlights areas where further research is required including: i) annoyance from low noise levels and multiple noise sources, ii) health impacts from noise; and iii) the effect of being exposed to multiple environmental impacts including noise.	Stated Preference	An analysis of Stated Preference (SP) studies on road traffic noise suggests an interim EU-wide economic value of 23.5 Euro/dB(A)/household/year	A thorough review of SP approaches to valuing changes in road traffic noise. Acknowledges that most work to date focuses on the 55-65 dB(A) range and that further research is needed to understand annoyance at relatively low levels of noise (i.e. below 55dB(A)).

[196] Navrud S. (2002) The State-of-the-Art on Economic Valuation of Noise. Final Report to European Commission DG Environment.

Study	Summary	Valuation Approach	Reported values	Comments
Galilea, P., Ortuzar, J. (2005)[197]	Used a choice experiment approach to estimate WTP for reduced noise levels in a group-based residential location context in Santiago, Chile. The experiment considers variations in travel time to work, monthly house rent, sun orientation of the dwelling and subjective noise level inside it; objective noise levels were also measured after the experiment.	Stated Choice	In relation to the estimated values for reducing noise levels and given the caveats, a value of US$2.12 per decibel per month emerges. This value is considered conservative by the study authors as they do not, for example, encompass the human health benefits of reductions in noise.	The values presented in this study may provide a useful benchmark but are not directly applicable to the UK context.
Bjorner, T. (2004)[198]	Annualised property price differentials are somewhat higher (13 to 22 Euro) than the willingness to pay (2 Euro per dB at 55dB(A) to 11 Euro per dB at 75 dB(A)) calculated from the contingent valuation study. The relative difference is most pronounced for low levels of noise, but for higher noise levels the WTP from the CV is about half the size of the property size differentials. It is argued that the value of noise reduction obtained from both the hedonic pricing and the contingent valuation methods potentially maybe be upward biased. Therefore it is recommended that the more conservative values of the contingent valuation study should be used in social-cost benefit analyses for noise reduction projects.	WTP and HPM	WTP per dB reduction increases from 2 Euros at 55 dB(A) to 11 Euros at 75 dB(A) per household. According to the results of the HP model, a one dB reduction in noise level yields a 0.53% decrease in dwelling price. It appears that the average price of apartments increases when reducing noise level, from 13 to 22 Euros per dB at 55 dB(A) and 75 dB(A), respectively	The estimates are only valid for estimating changes in noise levels above 55dB(A) and are therefore considered to be of limited use in understanding the amenity value of quiet.

[197] Galilea, P. and Ortuzar, J de D. (2005), "Valuing noise level reductions in a residential location context," *Transportation Research Part D*, 10, 305–322
[198] Bjorner, T.B. (2004) "Combining Socio-Acoustic and Contingent Valuation Surveys to Value Noise. Reduction", *Transportation Research D*, 9, 341-356

Study	Summary	Valuation Approach	Reported values	Comments
CE Delft (2011)[199]	Report endeavours to quantify the costs and benefits to the UK of a ban on night flights at Heathrow before 6.00am. It uses social cost benefit analysis (SCBA) to do so. SCBA systematically identifies all the direct, indirect and external effects of a night flight ban and expresses them in monetary terms so that the net costs or benefits can be calculated. It uses the broad definition of welfare, in which all items that add to the well-being of the society are benefits, and all items that decrease well-being are costs. The boundaries of SCBA presented here are UK welfare effects.	Benefits transfer methodology	Noise effects are valued at £476.40 per person over an exposed population of 207,400 people.	The authors apply several contestable assumptions in estimating reductions in noise levels. The use of benefits transfer methodology for estimating the monetary values also reduces the reliability of the values derived.
Nelson (2004)[200]	Meta-analysis of Airport Noise and Hedonic Property Values: Problems and Prospects	Meta-analysis	House prices in North America fall by approximately 0.5 to 0.6% in response to an increase in aircraft noise of 1 dB(A).	The estimated values are considered to be of limited use to the present study as they are derived in the North American context.

[199] CE Delft (2011) Ban on night flights at Heathrow Airport: A quick scan Social Cost Benefit Analysis. Delft, CE Delft, January 2011
[200] Nelson J.P. (2004) Meta-analysis of Airport Noise and Hedonic Property Values: Problems and Prospects. *Journal of Transport Economics and Policy* 38(1), 1-28

5.3.17 The DfT webTAG values[201] are considered the most robust for the UK context when considering the impacts of changes in noise levels on amenity. The webTAG values are derived from hedonic pricing analyses that examine the impact on property prices of households' exposure to road and rail noise. The zero value placed on the impact of noise below 45dB L_{Aeq} reflects the finding of DfT research which showed that below this level the monetary values people placed on noise could not be shown to be different from zero at a 95% confidence level. Similarly the research did not provide evidence on values of the impact of noise above 81dB L_{Aeq}, and it is therefore assumed that the monetary value placed on a decibel change in noise remains constant above this.

5.3.18 The values per household per dB(A) change in noise levels are shown in Table 9 below. These are the standard appraisal values based on the UK average household income, for general use. They are expressed at 2002 prices which are assumed to grow in line with real GDP per household.

Table 9: Marginal values for amenity impacts of noise (from DfT webTAG[202])

Volume ($L_{Aeq, 18hr}$ dB) Low	Volume ($L_{Aeq, 18hr}$ dB) High	£ per household per dB(A) change (2002 prices)
	<45	£0.00
45	46	£8.40
46	47	£11.10
47	48	£13.70
48	49	£16.30
49	50	£19.00
50	51	£21.60
51	52	£24.20
52	53	£26.90
53	54	£29.50
54	55	£32.10
55	56	£34.80
56	57	£37.40
57	58	£40.00
58	59	£42.70
59	60	£45.30
60	61	£48.00

[201] See http://www.dft.gov.uk/webtag/documents/expert/unit3.3.2.php for the webTAG values
[202] See http://www.dft.gov.uk/webtag/documents/expert/unit3.3.2.php

Volume ($L_{Aeq, 18hr}$ dB) Low	Volume ($L_{Aeq, 18hr}$ dB) High	£ per household per dB(A) change (2002 prices)
61	62	£50.60
62	63	£53.20
63	64	£55.90
64	65	£58.50
65	66	£61.10
66	67	£63.80
67	68	£66.40
68	69	£69.00
69	70	£71.70
70	71	£74.30
71	72	£76.90
72	73	£79.60
73	74	£82.20
74	75	£84.90
75	76	£87.50
76	77	£90.10
77	78	£92.80
78	79	£95.40
79	80	£98.00
80	81	£98.00

Productivity

5.3.19 There is little information in the academic domain to guide the valuation of productivity effects of quiet areas. The IGCB (N) reports some studies that may be suitable for assessing the effects of noise on productivity which may be useful. An alternative approach would be to obtain information on how much companies do, or are prepared to, spend on providing 'quiet' rooms for employees.

Ecosystems

5.3.20 There is some work emerging on the noise reducing benefits provided by green infrastructure in urban areas but no reliable or transferable relationships between low levels of noise and ecosystem productivity.

5.4 The Economic Value of Open Spaces

5.4.1 Given the paucity of published evidence on the value of health, amenity and productivity benefits at low levels of noise, the search strategy was modified to examine the evidence relating to the economic value of open spaces more generally and more specifically, to see whether it is possible to determine the value of quiet using information on the value of benefits that people derive from public open spaces.

5.4.2 In recent years, substantial efforts have gone into understanding the total economic value (see Box 5) of urban open spaces. These typically focus on the indirect use benefits obtained from premiums on property values, ecosystem services such as climate regulation, air quality control, stormwater attenuation and the direct use benefits in the form of physical and other recreational activities. 'Quiet' seldom features as an explicit benefit although the value of quiet may be inferred from the values placed on activities such as meditation, relaxation or escape from 'hustle and bustle'.

Box 5: Total Economic Value

The value of environmental goods and services is typically considered within the framework of Total Economic Value (TEV) which has become one of the most widely used frameworks for identifying and categorising the benefits derived from ecosystems. In the context of TEV, economic value is generally measured in terms of the amount of money an individual is willing to pay for an environmental good or service or the amount of money an individual is willing to accept as a compensation for forgoing the good or service. In addition to direct commercial values, TEV encompasses the full range of use and non-use values provided by a resource.

Typically, TEV is divided into use and non-use values[203]. **Use values** can be further divided into direct and indirect use values. In the case of urban open space, **direct use values** are the benefits which accrue to visitors who use an area's facilities and enjoy its amenities. **Indirect use values** refer to the benefits derived from ecosystem functions such as the role of urban green spaces in reducing urban 'heat island' effects or providing a noise screen. Generally speaking, direct use values are most likely to be reflected in market prices. Indirect use values may be reflected in the prices of certain goods and services which depend heavily on the underlying environmental benefit (e.g. the premium on prices of properties surrounding an attractive urban park).

Urban open spaces may also be valued for their potential availability in the future. These potential future benefits constitute an **option value**. An option value represents the value today of potential future direct and indirect uses of an environmental asset (e.g. people may be willing

[203] Many environmental goods and services are valued for reasons not related to a direct use. However, no consensus exists in the academic community as to what set of categories is truly exclusive and exhaustive in capturing the remaining elements of the total value. The discussion that follows presents these components of value and their relationship to each other in a manner that represents the interpretation most commonly agreed upon by environmental economists.

to pay for preserving urban open spaces to ensure the option of having these spaces available in the future)[204].

Non-use value refers to willingness to pay to maintain some good in existence even though there is no current, planned or possible use. Non-use values are usually classified in terms of existence value and bequest value. **Existence value** is the benefit received by those who derive satisfaction from knowing that a site is preserved in a certain condition, irrespective of use or potential use by the individual or others. Motivations here could vary and might include having a feeling of concern for the asset itself (a threatened area of parkland, for example) or a 'stewardship' motive whereby the person ascribing the value feels some responsibility for the asset. **Bequest value** relates to the preservation of environmental assets for generations to come where the value today is derived from knowing that an environmental asset exists and can be bequeathed to future generations. Non-use values are, however, relatively abstract and hypothetical and measuring these values in monetary ways is not straightforward, and in some cases (almost) impossible.

Differentiating between use and non-use values is important because the latter can be large relative to the former, especially when the good in question has few substitutes and is widely valued.

5.4.3 There have been several recent attempts to collate evidence relating to the economic value of open space (McConnell and Walls, 2005[205]), city parks and green spaces (CABE, 2005[206]; Green Space, 2010[207]; greenspace scotland, 2008[208]; The Trust for Public Land, 2009[209]; Gensler and ULI, 2011[210]), undeveloped land (CLG, 2006)[211] and/or to develop approaches to valuing the ecosystem services provided by green infrastructure (NWDA, 2008[212]; NENW, 2009[213]).

- Green Space (2010) outlines the range of benefits provided by different types of green space in the UK and how they contribute to local priority outcomes. The review does not report monetary estimates but does try to quantify the relationship between green spaces and human-well being in biophysical terms.

[204] Some analysts add quasi-option value: the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values we are not currently aware of (reflects the precautionary principle).
[205] McConnell, V. and Walls, M. (2005) The Value of Open Space: Evidence from Studies of Non-Market Benefits. Resources for the Future, January 2005 [online] available at http://www.rff.org/Documents/RFF-REPORT-Open%20Spaces.pdf (accessed 15 March 2011)
[206] CABE (2005) Does Money Grow on Trees? CABE Space, London [online] available at http://www.cabe.org.uk/files/does-money-grow-on-trees.pdf (accessed 31 January 2011)
[207] Green Space (2010) Understanding the Contribution Parks and Green Spaces can make to Improving People's Lives. Full Report [online] available at http://www.green-space.org.uk/resources/GreenLINK/index.php (accessed 15 March 2011)
[208] Bell, S., Hamilton, V., Montarzino, A., Rothnie, H, Travlou, P. and Alves, S. (2008) Greenspace and quality of life: a critical literature review. Greenspace Scotland research report [online] available at http://www.greenspacescotland.org.uk/upload/File/greenspace%20and%20quality%20of%20life%20literature%20review%20aug2008.pdf (accessed 15 March 2011).
[209] The Trust for Public Land (2001) Economic Benefits of Open Space Index. New York, The Trust for Public Land [online] available at http://www.tpl.org/tier3_print.cfm?folder_id=727&content_item_id=1147&mod_type=1
[210] Gensler and the Urban Land Institute (2011) Open Space: An asset without a champion? [online] available at http://www.gensler.com/uploads/documents/Open_Space_03_08_2011.pdf (accessed 9 March 2011)
[211] CLG (2006) Valuing the Benefits of Undeveloped Land [online] available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/158136.pdf (accessed 31 January 2011)
[212] North West Development Agency (2009) The Economic Value of Green Infrastructure [online] available at http://www.nwda.co.uk/PDF/EconomicValueofGreenInfrastructure.pdf (accessed 3 March 2011)
[213] Natural Economy Northwest (2009) The economic benefits of Green Infrastructure: Developing key tests for evaluating the benefits of Green Infrastructure. Commissioned from ECOTEC by The Mersey Forest on behalf of Natural Economy Northwest [online] available at http://www.naturaleconomynorthwest.co.uk/download.php?The%20Economic%20Benefits%20of%20Green%20Infrastructure%20-%20Developing%20Key%20Tests.pdf (accessed 3 March 2011)

- The Trust for Public Land (2009) attempts to measure the economic value of a city park system through a series of case studies that illustrate the contribution (in monetary terms) of city parks to property values, tourism, health, community cohesion, environmental management and direct use value.
- Greenspace Scotland (2008) presents the findings of a major literature review relating to the benefits of greenspace. The range of benefits examined included health & well-being, social and community value, economic value, environmental value and planning & design. The key findings are presented under each of these themes but only a limited number of monetary values are reported and these relate to amenity impacts measured through property prices.
- CLG (2006) reviewed the evidence relating to the external benefits of undeveloped land to propose an approach and values suitable for the purpose of benefits transfer in order to estimate the values of different types of undeveloped land.
- CabeSPACE (2005) investigates the economic benefits (as revealed through house prices) of urban green spaces. Through a series of case studies, the report examines the impact on property values of improvement programmes in green open spaces in urban areas in the UK. While the report does not explicitly mention 'quiet' or 'tranquillity' it may be possible to infer 'quiet' or 'tranquillity' benefits based on the types of improvements that were made (e.g. "…lawns and benches invite office workers to relax in a setting that is removed, if not physically then conceptually, from their place of employment". Based on the information provided, it is not, however possible to disaggregate the level of benefit derived from each of the activities making up the total improvement programme. The analysis used is an appraisal approach where identical hypothetical properties were appraised at three different locations within the vicinity of the park – adjacent to the park, two blocks away from the park and several blocks away from the park. The results show that there is a positive relationship in value associated with residential properties overlooking or being close to a high quality park. However the range is wide with properties "on" the park achieving an average premium of 11.3% (standard deviation of 9.4%) and properties within close proximity achieving an average premium of 7.3% (standard deviation of 9.4%).
- McConnell and Walls (2005)[214] undertook a comprehensive review of hedonic pricing and contingent valuation studies to examine the value of different types of open space in the USA.

5.4.4 There is a substantial body of evidence on the relationship between open space and residential property values, dating back to the 1960s. Some examples of more recent studies that make use of property data include:

- In a study from Maryland in the USA, Irwin (2002)[215] looked at the effects of open space on residential property values. She found that **surrounding open space significantly influences the residential sales price of houses**. Different types of open space had differing effects. Spillover effects from preserved open space were significantly greater than those associated with developable farmland and forest. She concluded from this that the public's demand for open space preservation is motivated more by the fact that open space implies no development rather than being driven by particular features of open space landscapes. Specifically, significant additional benefits were estimated to accrue to neighbouring residential properties given a marginal change in the landscape from any of the developable open spaces to preserved open space uses. The benefits of preserving any

[214] McConnell, V. and Walls, M. (2005) The Value of Open Space: Evidence from Studies of Non-Market Benefits. Resources for the Future, January 2005 [online] available at http://www.rff.org/Documents/RFF-REPORT-Open%20Spaces.pdf (accessed 15 March 2011)
[215] Irwin, E (2002) The Effects of Open Space on Residential Property Values, *Land Economics*, 78(4), pp 465-480

particular piece of open space were a function of the number of residents within the neighbouring area, their preferences, and the relative scarcity of open space in the region.

- Tyrväinen and Antti (2000)[216] examined property prices and urban forest amenities in Finland. They found that **a 1 kilometre increase in the distance to the nearest forested area lead to an average 5.9 % decrease in the market price** of the dwelling. Dwellings with a **view on to forests were on average 4.9 % more expensive** than dwellings with otherwise similar characteristics but no view.

5.4.5 Other studies have focused on estimating people's WTP to maintain open spaces, For example:

- Breffle, Morey and Lodder (1998)[217] carried out a study using contingent valuation to estimate a neighbourhood's willingness to pay to preserve undeveloped urban land in Boulder, Colorado. They found that WTP increased with income, decreased at a decreasing rate with distance, and increased with perceived importance of preserving land. Passive use values are a small but significant portion of the total WTP for preservation of the property under investigation. The best estimate of neighbourhood WTP was greater than what it might have cost to purchase the property from the developer in order to protect it.
- Lockwood and Tracy (1995)[218] use the travel cost method and CVM to elicit WTP to maintain access to Centennial Park in Sydney. Modal choice analysis was used to estimate the value of travel time and revealed that annual non-market value of the Park is equivalent to an average value per visit of AUS$10.56. A contingent valuation survey was conducted off-site and elicited WTP values from both users (82% of the sample) and non-users of the Park. The CV survey found an average WTP bid per household of AUS$25.81.

5.4.6 The Trust for Public Land in the US compiled a casebook of evidence[219] on the relationship between good quality public space and its social and/or economic benefits. A selection of findings is presented below:

- In Salem, Oregon, land adjacent to a greenbelt was found to be worth about $1,200 an acre more than land only 1,000 feet away[220]
- In Seattle, Washington, homes bordering the 12 mile Burke-Gilman trail sold for 6% more than other houses of comparable size[221]
- In Denver, Colorado, between 1980 and 1990, the percentage of Denver residents who said they would pay more to live near a greenbelt rose from 16% to 48% percent[222]
- In Dayton, Ohio, 5% of the selling price of homes near the Cox Arboretum and park was attributable to the proximity to that open space[223]

[216] Tyrväinen, L. and Antti, M. (2000) Property Prices and Urban Forest Amenities. *Journal of Environmental Economics and Management*, 39(2): 205–23.
[217] Breffle, W., Morey, E and Lodder, T. (1998) Using Contingent Valuation to Estimate a Neighborhood's Willingness to Pay to Preserve Undeveloped Urban Land. *Urban Studies*, 35 (4) p. 715-27.
[218] Lockwood, M. & Tracy, K. (1995), Nonmarket Economic Evaluation of an Urban Recreation Park, *Journal of Leisure Research*, 27(2), pp. 155-167.
[219] Lerner, S. & Poole, W (1999) The Economic Benefits of Parks and Open Space: How Conservation helps Communities Grow Smart and Protect the Bottom Line. Trust for Public Land.. Washington USA.
[220] Brabec, E. (1992) "On the Value of Open Spaces," *Scenic America*, Technical Information Series, Vol. 1, No. 2 (Washington, DC)
[221] Brabec, E. (1992) "On the Value of Open Spaces," *Scenic America*, Technical Information Series, Vol. 1, No. 2 (Washington, DC)
[222] 1991 Survey by Economic Research Associates cited in Lerner, S. & Poole, W (1999) The Economic Benefits of Parks and Open Space: How Conservation helps Communities Grow Smart and Protect the Bottom Line. Trust for Public Land.. Washington USA
[223] 1995 Survey by the U.S. National Park Survey; cited in Lerner, S. & Poole, W (1999) The Economic Benefits of Parks and Open Space: How Conservation helps Communities Grow Smart and Protect the Bottom Line. Trust for Public Land.. Washington USA

- Corporate Chief Executives say that quality of life for employees is the third most important factor in locating a business, behind only access to domestic markets and availability of skilled labour[224] (1995 Survey by the U.S. National Parks Service).

5.4.7 Key findings from a selection of urban open space studies are summarised in Table 10 below. Using information from these and other similar studies, it is possible to derive an economic value for different types of open spaces in urban areas.

[224] 1995 Survey by the U.S. National Park Survey; cited in Lerner, S. & Poole, W (1999) The Economic Benefits of Parks and Open Space: How Conservation helps Communities Grow Smart and Protect the Bottom Line. Trust for Public Land.. Washington USA

Table 10: Evidence of the Economic Value of Urban Open Spaces

Author(s)	Study location	Type of open space	Scenario	Benefits / Activities	Method	Reported Values	Adjusted Values (GBP PPP, 2009 prices)
Lockwood and Tracy (1995)	Centennial Park, Sydney	Major urban recreational resource located 5km southeast of central Sydney. Comprises 220ha of parkland ranging from sculptured gardens and ornamental wetlands to sports fields and more natural areas	Willingness to contribute to a trust fund for the Park in case government was no longer providing funding for the park through taxes	Regulating services: Climate regulation; noise screening ***Cultural services:*** horse-riding, cycling, jogging, birdwatching, picnicking and walking. The park is also of great regional and historical significance.	Travel cost, Open-ended CVM	1993 prices AUS$7.42-10.56 per visit AUS$25.81 per household (use and non-use) AUS$12.10 per household (non-use only)	• £5.20-£7.40 per visit • £18.09 per household (use and non-use) • £8.48 per household (non-use only)
Hanley and Knight (1992)[225]	Chester, England	Greenbelt	WTP to preserve the Greenbelt around Chester, England	Recreation Landscape Ecosystem services	Open-ended CVM	£57 per household per year (2001 prices)	£70.24 per household per year
Tyrväinen (1997)	North Carelia, Finland	Urban forest	Investigated effects of diminishing distance to a forested recreation area, as well as the increasing relative amount of green spaces, on house prices	Environmental externality effects	Hedonic pricing	The effect of forested parks on apartment prices remained unclear owing to the abundant supply of urban forests	
The Trust for Public Land (2009)	Boston, USA	Parks and recreational areas	Market value (where entry fees are charged) or	Direct use (recreation)	Telephone survey of Boston	2006 prices	• £1.18 per visit for

[225] Hanley, N. and Knight, J. (1992), 'Valuing the Environment: Recent UK Experience and An Application to Green Belt Land', *Journal of Environmental Planning and Management*, 35:2.

Author(s)	Study location	Type of open space	Scenario	Benefits / Activities	Method	Reported Values	Adjusted Values (GBP PPP, 2009 prices)
			consumer surplus (where public access is relatively less expensive than a similar private facility)		residents	US$1.91 per visit for general park use (playgrounds, trails, dog-walking, picnicking, sitting, etc) US$3.05 per visit to make use of sports facilities (running, swimming, tennis, etc) US$9.33 per visit for special uses (e.g. golf, gardening, festivals, concerts, attractions, etc)	general park use (playgrounds, trails, dog-walking, picnicking, sitting, etc) • £1.88 per visit to make use of sports facilities (running, swimming, tennis, etc) • £5.76 per visit for special uses (e.g. golf, gardening, festivals, concerts, attractions, etc)
Breffle *et al.* (1998)	Boulder, Colorado	Undeveloped land parcel of 5.5 ha	Willingness to pay to keep the parcel of land undeveloped forever (one-time payment)	Recreation Aesthetics Non-use values	Contingent valuation	US$264 (2000 prices) per household (one-time payment)	£204.98 per household (one-time payment)
Bell *et al.* (2008)	Aberdeen, Scotland	Public parks and gardens and amenity green spaces	Estimates relative value of properties located 450m away from a park compared to those located on the park edge	Premium property values	Hedonic Pricing Method	Premiums on properties located on park edges compared to those located 450m away City park: Detached – 19.97% Flat – 7.54% Non-detached –	

Author(s)	Study location	Type of open space	Scenario	Benefits / Activities	Method	Reported Values	Adjusted Values (GBP PPP, 2009 prices)
						2.93% Local park: Detached – 9.62% Flat – 7.92% Non-detached - 9.44% Open space: Detached – 2.71% Flat – 4.70% Non-detached - 0.44%	

Summary

5.4.8 Most of the available valuation evidence relates to noise, rather than quiet, possibly reflecting the difficulties in separating the contribution that "quiet" makes to amenity value relative to other attributes.

5.4.9 There is a large number of papers that have studied the impacts of an increase or decrease in noise levels on amenity values. These typically use the housing market (i.e. HPM) to estimate implicit prices for quiet. These studies fail, however, to capture the value of quiet areas to those who (i) may not be able to afford to live in 'quiet' neighbourhoods and arguably, for whom, a quiet space in a noisy neighbourhood would be more highly valued and/or (ii) those who may work in a noisy environment and seek refuge from the 'hustle and bustle' during the day.

5.4.10 The open space literature provides an indication of the direct and indirect use values of public parks, greenbelt and undeveloped land but no studies specifically identified 'quiet' as a valued benefit. Some studies (e.g. CLG, 2006[226]) infer a value for tranquillity from existing studies, where tranquillity is defined as the effect that undeveloped land may have in buffering nearby residential properties from noise, vibration and light pollution.

5.4.11 The values identified across the various studies differ with respect to:

- **The type of benefit being valued**: Studies vary in their coverage of the components of the total economic value. Estimates that cover all components of total economic value are likely to be higher than estimates that cover a smaller subset. Also, some studies have bundled different types of benefits together in one estimate. For example, 'health' benefits are in fact likely to have (indirectly) covered other related benefits such as landscape and amenity.
- **The type of "quiet area" or urban open space**: Part of the variation in the value estimates is due to the site-specific nature of the studies and it is not possible to separate this cause of variation from others.
- **The change in the provision of urban open space and/or external benefit**: Whether the WTP was elicited for avoiding a threat, maintaining the current scenario or gaining an improvement will influence the magnitude of results. For the former scenario, the particular 'threat' to the provision of "quiet areas" or urban open spaces will also influence the results.
- **The study methodology**: Different valuation techniques cover different aspects of total economic value and hence produce different valuation estimates even when implemented in the same location and policy context covering the same population. These differences are expected.
- **Socio-economic characteristics**: Most studies show that socio-economic characteristics are significant determinants of people's preferences and their WTP for a given environmental resource. Therefore, when comparing the results of studies covering different populations, the differences in socio-economic characteristics (and especially income levels) of populations should be kept in mind.

5.4.12 The studies reviewed demonstrate a number of important points. First, not all forms of open space are valued equally by households. Rather, values are determined on the basis of environmental quality (including security) and the available facilities. In the context of US studies for example, parks designed for natural habitat preservation and light recreation contribute significant amenity effects and outperformed golf courses with respect to neighbouring property

[226] CLG (2006) Valuing the Benefits of Undeveloped Land [online] available at http://www.communities.gov.uk/documents/planningandbuilding/pdf/158136.pdf (accessed 31 January 2011)

value enhancement. Second, developable open space such as farmland and forested land (and sometimes vacant sites) provide amenity effects although at lower levels than permanently protected open space. Third, there is a limit to how far the externalities from parks extend. Again, the results from US studies suggest that the externalities do not extend much beyond 450m suggesting that a larger number of smaller open spaces may be more valuable than a single, large open space.

5.5 The Value of Open Spaces: Survey Findings

5.5.1 To complement the literature review, two surveys were undertaken: one amongst users of open space in central London and another amongst UK-based employees of URS/Scott Wilson.

Field-Based Survey

5.5.2 The field survey was conducted amongst users of different types of urban spaces in the City of Westminster[227] (see Appendix 7 for the sample questionnaire). The purpose of this survey was to try and establish the relative value of quiet within different types of urban open spaces and to identify the types of noise (or noise thresholds) that would discourage people from using these open spaces. Ultimately, the survey was designed to inform the derivation of a noise-sensitive demand curve for urban open spaces.

5.5.3 A total sample of 98 was obtained, 85 of which were valid[228]. The surveys were conducted in three sites as described in Table 11 below.

Table 11: Location of survey sites

Location	Description	No. of responses
St. James's Park	A large park surrounded by busy roads and with a notably quieter central zone. The park attracts a large number of office workers (particularly civil servants) during the lunch-hour. Its proximity to Buckingham Palace, Trafalgar Square and The Mall means that it also attracts large numbers of tourists.	49
Westbourne Green	A medium-sized park situated in a residential area on the western edge of the City of Westminster. Its southern boundary is the busy A40 (Westway) while to the north it is bounded by the Grand Union Canal. Three distinct zones were identified within the park – the noisier southern edge, a quiet central zone (which includes a play area and borders a school), and the quieter canal edge.	18
Golden Square	A paved urban space in Soho within the City of Westminster and one of the historic squares of Central London. The square is just east of Regent Street and north of Piccadilly Circus. The Square is surrounded by offices. Although there is no formal seating provided in the Square, people do use the steps surrounding the statue in the centre and the low-rise walls containing the flower beds.	18

[227] The report authors gratefully acknowledge the support of Westminster City Council in the design and elicitation of the survey.
[228] The questionnaire was designed to deliberately screen out tourists and/or visitors that used the park fewer than 2-3 times per month.

5.5.4 The specific survey locations within each of the sites are shown on the maps provided in Appendix 5.

5.5.5 The survey findings are summarised below:

- Over 60% of all respondents lie in the 25-50 year age range and 37% of all respondents use the open space 3-5 times per week on average. 80% of all respondents use the open space at least once a week. Golden Square has the highest number of repeat users, with 56% of respondents saying that they visit the space on a daily basis, compared to only 8% in St. James's Park.
- **'Escape from hustle/bustle' was most frequently ranked as the most important benefit** that respondents obtain from urban open spaces (25% ranked it as being of highest importance) whilst 'creativity' was seen as one of the least important benefits of open spaces (see Figure 1). Note that respondents were asked to rank their five most important benefits (from a list of 8) starting from 1 (most important) to 5 (least important).
- Fewer than 4% of all respondents listed quiet as the highest ranking feature of urban open spaces**,** yet **quiet ranked more highly than both social/visual contact with people and creativity.** However, the value of 'quiet' or 'relatively quiet' is implicit in 'escape from hustle/bustle' and 'rest/relaxation' which both score highly.

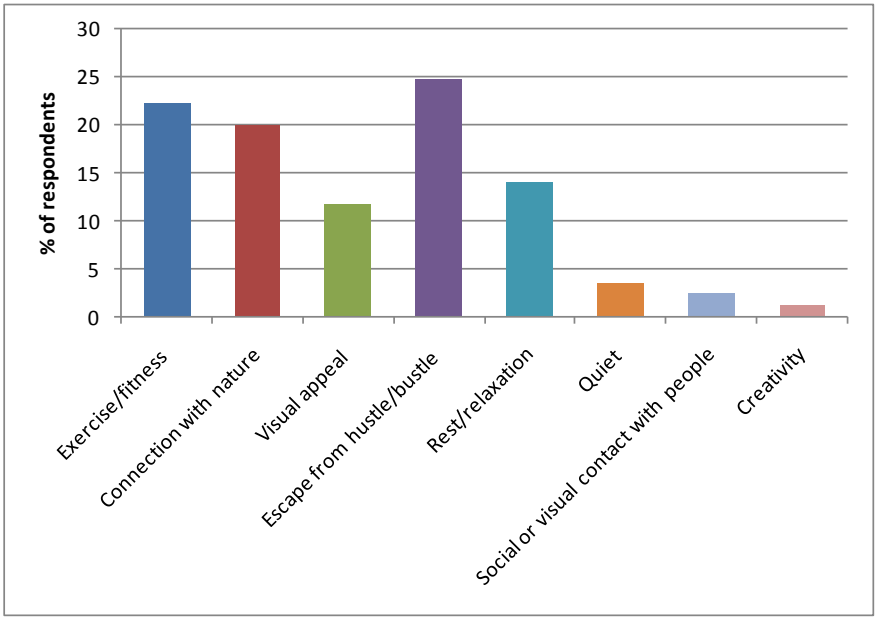


Figure 1: Ranking of benefits (% of respondents who ranked each benefit as being the most important)

- **Creativity is consistently ranked as one of the lowest ranking benefits** across age groups (see Figure 2). 'Connection with nature', 'escape from hustle/bustle', 'visual appeal' and 'exercise/fitness' are all considered more important than 'quiet' for respondents aged 25 and over. The findings also suggest that **younger respondents value 'quiet' more highly than older respondents**.

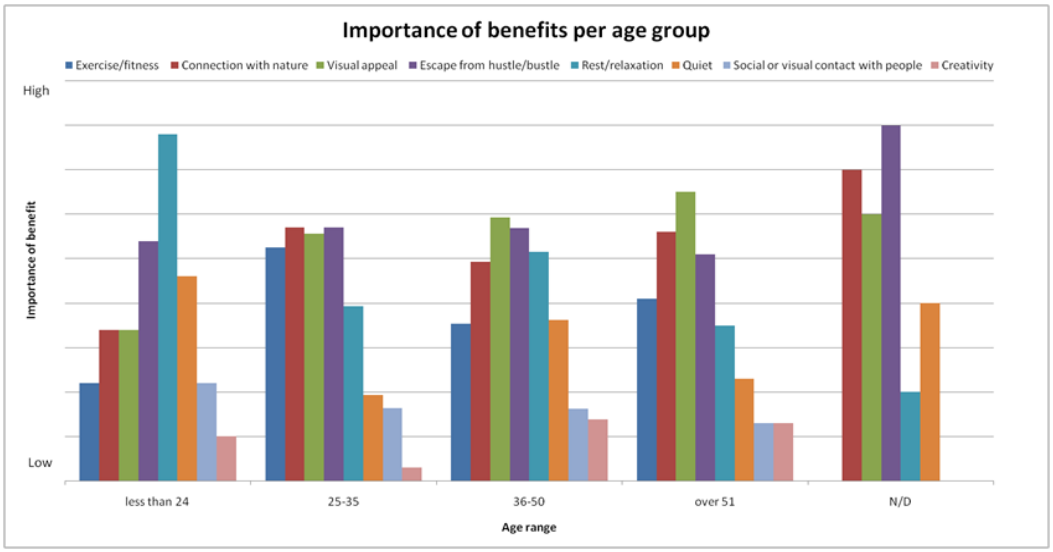


Figure 2: Ranking of benefits by age group

- When asked to rank the factors that detract from their enjoyment of urban open spaces, over 50% of respondents ranked '**an attack or verbal abuse' as the most important annoyance factor and over 80% ranked it as one of the top 5 (out of 8) factors**. 'Litter' and 'crowds of noisy people' also featured highly in people's perceptions of annoyance factors (see **Error! Reference source not found.**).

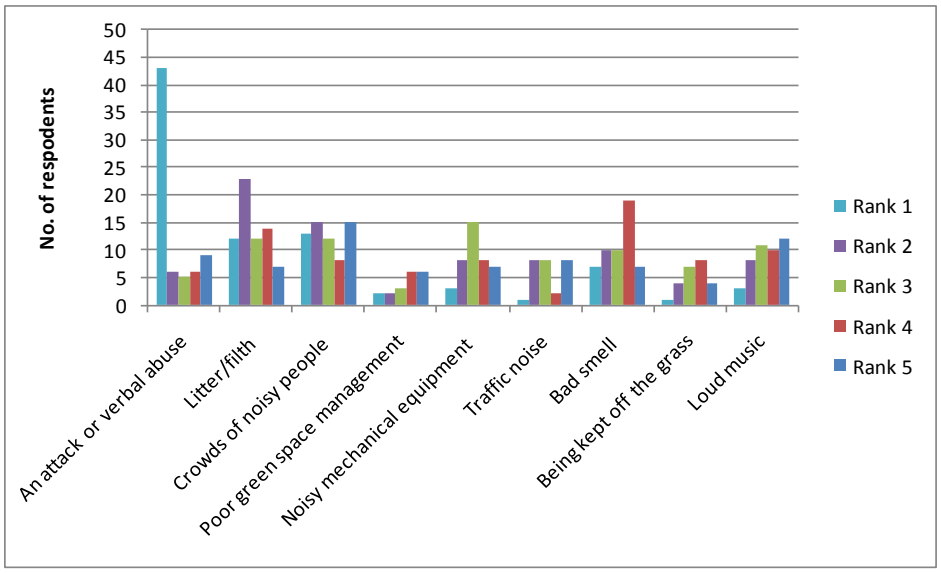


Figure 3: Ranking of annoyance factors (all respondents)

- The annoyance ranking profile is broadly the same across all age groups (see **Error! eference source not found.**). Older respondents (over 51 years of age) are more sensitive to loud music than younger groups, while younger respondents are more sensitive to bad smell than other groups. Crowds of noisy people are found more annoying than noise from mechanical equipment across all age groups (confirming that public open spaces are rival goods), and people are more sensitive to these sources of noise than they are to

background noise filtering into the open space from elsewhere (e.g. traffic noise). This was also confirmed in responses to a question on noise that would push people to move on or leave an open space altogether (Figure 5).

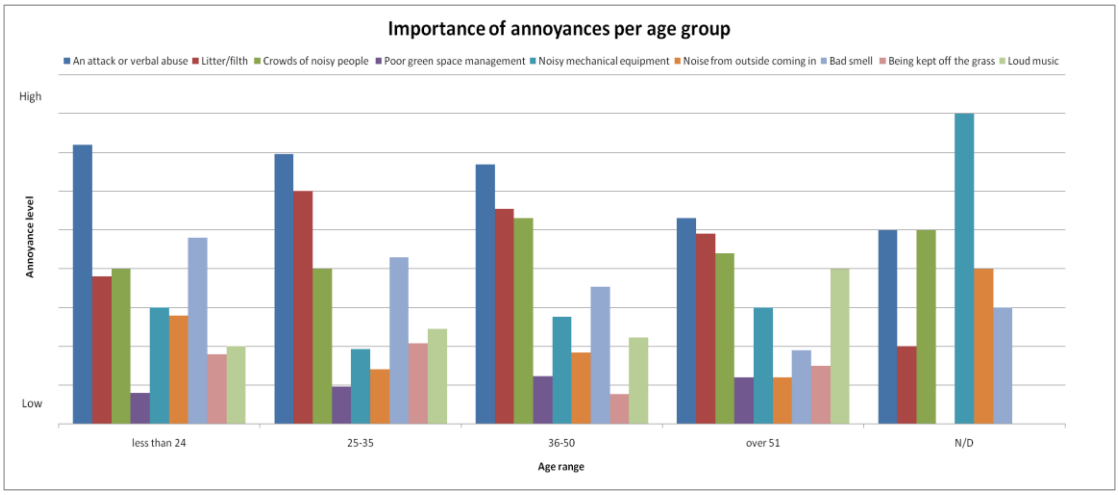


Figure 4: Ranking of annoyance factors by age group

- When asked specifically about the types of noise that would prompt the respondent to move on or leave the open space, noisy people (particularly mobile phone users) featured most prominently (see Figure 5). Construction noise and noise from mechanical equipment were also frequently cited. This is an interesting finding as these sources of noise are generally temporary. Road traffic noise which can be expected to be a relatively permanent feature, appears to be much less of a concern amongst open space users although further investigation would be required to determine whether an increase in road traffic levels would reduce the frequency with which respondents presently use the open space. There were some variations across the age groups here and the annoyance threshold in younger age groups suggests that when annoyed, younger people are more willing to move or leave.

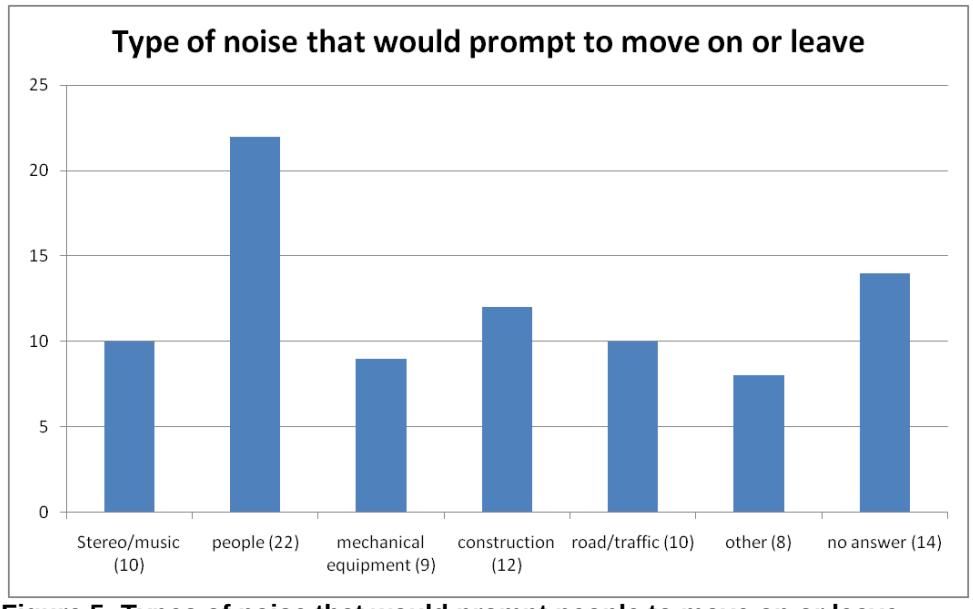


Figure 5: Types of noise that would prompt people to move on or leave

- There would be no significant change in frequency of use amongst respondents if the open space were to become significantly quieter than at present.
- As may be reasonably expected, people are more sensitive to louder sounds, particularly where these are intrusive and un-natural or man-made (see Figure 6).

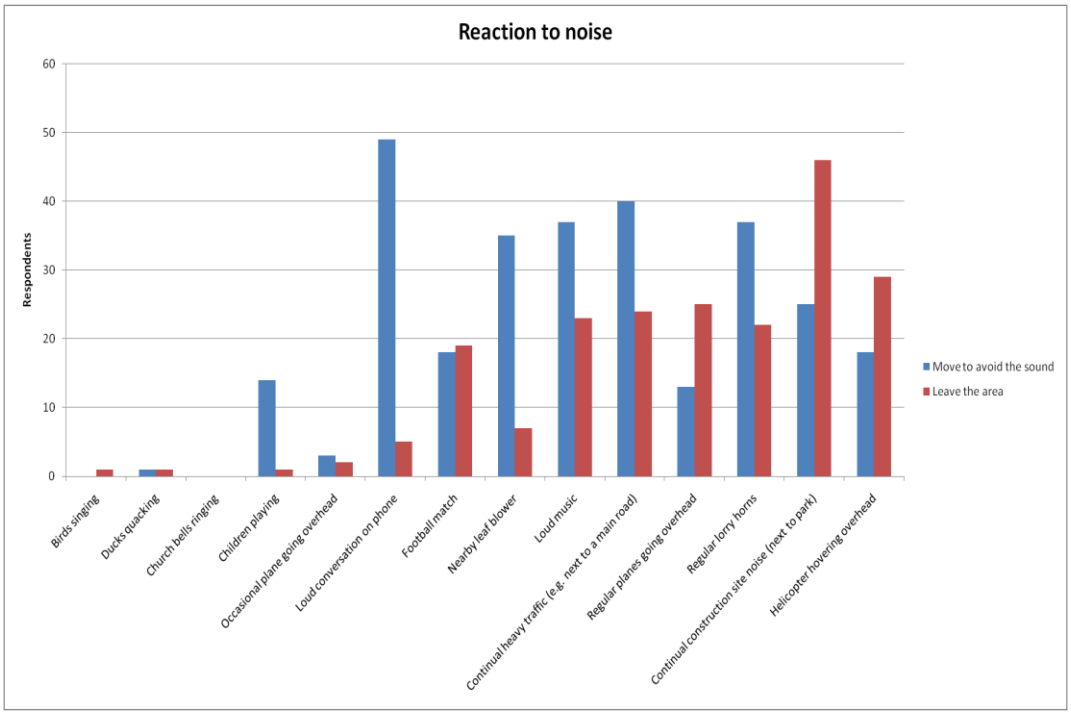


Figure 6: Reaction to noise

Caveats

5.5.6 While the field survey revealed some interesting results, the findings do need to be interpreted with care for the following reasons:

- The survey was conducted in central London where the demand for open space in urban areas is expected to be considerably higher than say the demand for urban space in a smaller city where people may have more extensive properties (with larger gardens) and easier access to the countryside.
- Given limited time and budget available, the survey was conducted on a single day over a 3 hour period on a weekday. The respondent profile is therefore skewed towards workers who use the open spaces during their lunch break. A more reliable sample may have been obtained if the survey had been conducted over a period of days including at least one weekend day and at different times of day. It is possible that seasonality may also have affected the range of responses provided as a warmer summer day may have presented a slightly different user profile to that obtained on a cold (but dry) day.
- Most of the questions were closed-ended which limited the range of answers that respondents were able to give and may not have offered the respondents the choices that more closely reflect their feelings. While respondents were provided the opportunity to give alternative answers in the open-ended questions, open-ended questions typically received less attention, particularly when the respondent had limited time to complete the survey and is already relatively biased by the closed-ended options they were given previously.

- Several respondents had difficulties in 'visualising' the range of sounds presented to them and would require more information about the location and volume of the sound in order to decide whether the noise was considered an annoyance and how they would choose to respond to this. The use of recorded sounds played to respondents through headphones was considered but was not feasible given the need to do such testing in a studio situation together with the time window for the survey and the necessity to keep it short to encourage responses.
- At the end of each questionnaire, a note was made of the respondent's occupation, age group and first four digits of the residential postcode. The postcode and occupational data was not specific enough to yield any useful results. In future, a checklist of occupations and grades may provide a more useful indicator of income.

5.5.7 Despite the above caveats, it was felt that the questionnaire was a useful device to gauge the views of a large number of regular open space users, and the responses seemed to give evidence of the relative value of quiet in different urban open spaces and the types of noise that affect people's enjoyment of these spaces.

Employee Survey

5.5.8 An online survey was conducted amongst UK-based employees of URS/Scott Wilson. In total, 753 responses were received (a 21.5% response rate). The survey asked respondents to select and rank (from most to least important) the top five benefits (from a list of eight) that they derive from an urban open space that they regularly use.

5.5.9 Interestingly, **'visual appeal' ranked as the most important attribute** of urban open spaces (32% ranked this as most important). This was closely followed by 'escape from hustle/bustle' (29%) and 'rest and relaxation' (21%) (see Figure 7).

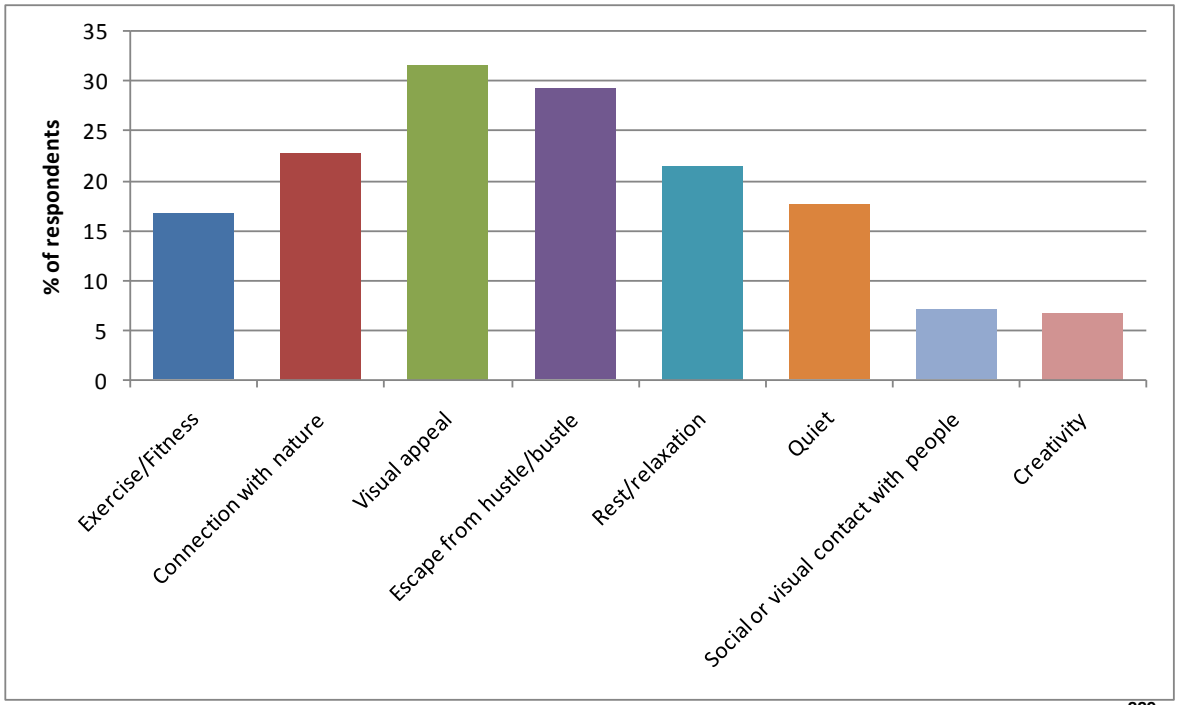


Figure 7: Ranking of benefits (% of respondents that ranked each benefit as most important)[229]

[229] Note that the percentages do not sum to 100 as respondents were allowed to joint rank benefits.

5.5.10 An optional open question was included in the survey to provide respondents with the opportunity to describe any additional benefits or attributes of urban open spaces that are important to them. The following attributes (roughly ordered to reflect the number of mentions) were repeatedly mentioned amongst the 219 responses received:

- Facilities (e.g. play areas, toilets and cafés)
- Feeling of safety and security
- Clean and well-maintained
- Connection with nature
- A less stressful/quieter way of walking into town/to work
- Relief from urban life, escapism, relief from monotony of the urban environment
- Space for community events such as sports matches, concerts and festivals
- Air quality
- Accessibility
- Quality of design features and presence of features of historical/cultural significance
- Contemplation

5.5.11 The open responses demonstrate that access to 'quiet' or 'relatively quiet' areas is important to people. Respondents were not given any information to suggest that the survey was essentially about the value of quiet and quiet areas and were therefore not prompted to mention 'quiet' or activities requiring 'quiet'.

5.5.12 On the whole it was felt that the online survey was a more effective approach than the field survey as it allowed for a rapid accumulation of responses within a short period of time and also provided respondents with an opportunity to reflect upon their answers. The benefit of this 'time to think' was evident in the considered responses provided to the open question about the attributes of urban open spaces that make them attractive to users.

5.6 Conceptual Approaches to Estimating an Economic Value of Quiet Areas

5.6.1 Using the evidence collated in sections 5.3 to 5.5 above, three possible approaches to valuing quiet areas have been identified.

1. Using a range of urban green spaces as a proxy for "quiet areas" to identify an upper range estimate of the value of quiet areas. This would draw on several recent initiatives (e.g. by CLG, CABE, etc) and other HPM and CVM studies on green open space to estimate the economic value of urban green spaces. It would also rely on studies to assess the impacts or opportunity costs of proposed (or actual) developments on greenfield sites and how these may impact on 'quiet' and/or the types of activities (e.g. recreation, reading, meditation, etc) that take place in these spaces
2. Estimating the opportunity costs associated with the loss of urban open space to make way for development (e.g. housing provision).

3. To make use of existing values for noise disturbance in the home (i.e. based on the webTAG values). This would, however, only be applicable to a change in the level of noise/quiet and would not therefore reflect the value of those 'quiet spaces' that are actively sought. While such an approach could at least provide a starting point, it is important to note that it would be open to criticism.

Approach 1: Benefits transfer from open spaces

5.6.2 This approach is predicated on the assumption that urban open spaces are relatively quiet and therefore hold value for those who actively seek quiet to escape from hustle and bustle, engage in activities that require quiet, e.g. meditation, reading, birdwatching and those who enjoy premium property values because of their location near to attractive urban open spaces. Relative quiet may also enhance some ecosystem services (e.g. habitat provision) and therefore estimating the total economic value of urban open spaces is likely to capture both use and non-use values. It may then be further assumed that the number (or profile) of open space beneficiaries (who may hold either or both direct and indirect use value) will change as a result of changes in the source, intensity and duration of certain types of sound. So for example, if an urban park was valued for birdwatching, then it could reasonably be expected that an increase in noise levels would reduce the value of the park to birdwatchers who may decide to no longer visit the park.

5.6.3 Using information on critical noise thresholds and visitor profiles, it is possible to predict the change in visitor numbers and hence the value (demonstrated by the effective demand) for quiet areas. It does not, however, consider the potential trade-offs between different types of users. It is conceivable, for example, that a reduction in the number of birdwatching enthusiasts as a result of the installation of a playground may be more than offset by an increase in the number of visitors to the park who are attracted by the new play facilities. In this case, the change in total economic value will depend largely upon the WTP for the various benefits amongst different users.

5.6.4 In economic terms, the approach is equivalent to summing the private demand curves of individual beneficiaries to estimate a social demand curve. The area under the social demand curve therefore represents the total economic value of the open space. As noise levels from certain sources increase, the effective demand for the open space amongst certain types of beneficiaries (e.g. those sensitive to that particular types of noise) may be expected to fall and will be represented by a drop off in the number of open space users or a decline in the number of households benefiting from property price premiums attributable to the presence of the open space. The area under the social demand curve therefore contracts and the difference between the baseline value and the noise scenario represents the change in the total value of quiet as a result of an increase in noise.

5.6.5 Using this approach, it is possible to specify a valuation framework as depicted in Table 12 and described in more detail below.

Table 12: Conceptual framework for valuing quiet areas using the value of urban open spaces as an upper bound estimate

Type of 'quiet' open space	Example	Benefits	WTP for quiet or activities / benefits associated with quiet	No. of park beneficiaries (users and nearby properties)	Total value of quiet
Areas that are absolutely quiet	Quiet zones within large	Reflection		Estimate number of	Calculated as the difference

Type of 'quiet' open space	Example	Benefits	WTP for quiet or activities / benefits associated with quiet	No. of park beneficiaries (users and nearby properties)	Total value of quiet
in terms of dB(A) levels (i.e. below a certain threshold)	urban parks	Creativity Escape from hustle and bustle / stress relief Convalescence Air quality regulation Carbon sequestration Stormwater attenuation		beneficiaries(users and non-users) under baseline scenario Estimate number of beneficiaries (users and non-users) under change scenario	between the products of number of beneficiaries and WTP under each of the baseline and change scenarios.
Areas that are relatively quiet i.e. they are significantly less noisy than surrounding areas	An urban park or other urban spaces with plenty of trees	Reflection Creativity Cognitive development Escape from hustle and bustle / stress relief Physical activity Premiums on neighbouring property values Air quality regulation Carbon sequestration Stormwater attenuation	See for example values derived by Lockwood and Tracy (2005) and Bell *et al.* (2008)	Estimate number of beneficiaries(users and non-users) under baseline scenario Estimate number of beneficiaries (users and non-users) under change scenario	Calculated as the difference between the products of number of beneficiaries and WTP under each of the baseline and change scenarios.
Areas that are quiet but not necessarily considered tranquil	An urban waste land	Habitat provision / wildlife breeding grounds		Estimate number of beneficiaries(users and non-users) under baseline scenario Estimate number of beneficiaries (users and non-users) under change scenario	Calculated as the difference between the products of number of beneficiaries and WTP under each of the baseline and change scenarios.
Areas that are sensitive to noise but may or may not be quiet	Churchyards and cemeteries; hospital grounds; schools etc	Reflection Convalescence Cognitive development		Estimate number of beneficiaries(users and non-users) under baseline scenario Estimate number of beneficiaries (users and non-	Calculated as the difference between the products of number of beneficiaries and WTP under each of the baseline

Type of 'quiet' open space	Example	Benefits	WTP for quiet or activities / benefits associated with quiet	No. of park beneficiaries (users and nearby properties)	Total value of quiet
				users) under change scenario	and change scenarios.

Define the type of open space in question and the benefits it confers

5.6.6 The starting point is the typology of quiet open spaces described in Section 2.2.3. Based on the findings of the literature review, it is possible to identify the range of benefits that one might expect people to derive from each of these open spaces. Where possible, this should be supplemented by local knowledge of the open space in question to identify benefits that may relate to specific features of the space (e.g. playground and seating provision, presence of a wetland, landscaping, etc).

Select the most appropriate transfer value

5.6.7 Once the characteristics and benefits that the open space confers have been assessed, the most appropriate values (i.e. those derived from published studies that correspond most closely with the open space in question) should be selected and may need to be adjusted for purchasing power parity (if from another country) and to current or at least constant prices (using a GDP deflator). They would also need to be adjusted for differences in the characteristics of beneficiaries, the site and possibly also for the nature of the change in quiet between the study site and the policy site (see para 5.6.10).

Determine the size and profile of the beneficiary population

5.6.8 The next step will be to determine the size (and ideally profile) of the beneficiary population. This should include both users of the open space and those who benefit from property price premiums that can be attributed to the presence of the open space. Where possible, the distinction should be made between users and non-users to avoid (or at least identify) the risk of double-counting.

5.6.9 The size of the population who experiences external benefits of a particular land-type or site will have significant bearing on the relative importance of these benefits. This particularly becomes an issue when aggregating individual WTP estimates. Overall, within the relevant population, there are likely to be both 'users' and 'non-users' with different preferences, which set them apart from each other. The 'user population' is relatively easy to identify. For example, for recreation benefits, households living in and/or around a site can be said to be users as would be visitors to the site. Some sites may provide services to populations other than those who live nearby or visit the site. For example, some sites may support migratory bird populations and the 'user' of such sites should include those birdwatchers at other sites visited by migratory birds. Thereby the nature of the benefits provided will also influence the size of the population affected, and in turn the magnitude of the value of land.

5.6.10 Any demand analysis based on individual preferences should also take into account socio-economic characteristics. In general, estimates of WTP for environmental amenities are found to be influenced by population characteristics such as income, education, age, occupation, etc.

5.6.11 These characteristics influence people's preferences for land-use and benefits and thereby influence the monetary values that they would place on the resource. Out of these, income is

usually found to be among the most influential and is sometimes used as an adjustment factor for the 'benefits transfer' procedure, in order to ensure that the income level of the relevant population is reflected in the total economic value. Income is also the influencing factor for which it is easiest to find data and for which it is easiest to generalise about (generally, the higher people's income, the higher is their willingness to pay - all else remaining the same)

5.6.12 Consideration should also be given to other influencing factors such as the availability of substitutes and the relative scarcity of open space types in different places.

5.6.13 Another issue of consideration is how monetary values change over time with changing attitudes, incomes and availability of publicly accessible open space. Willingness to pay for certain benefits or land types could increase in the future as land becomes scarcer or as education and income increase, thereby changing people's preferences. Conversely, WTP could decrease in the future if alternatives become available or as tastes change (e.g. changing fashions for recreational pursuits).

Estimate total economic value under the baseline

5.6.14 The value of the open space is then simply the product of the number of beneficiaries and the value per visit (in the case of direct use values) or value per household (in the case of indirect use values). The value of quiet or relative quiet is embedded within this total value and therefore the total value may be considered as an upper bound estimate for the value of quiet areas. However, this would still not encompass any non-use values.

Estimate marginal values for quiet

5.6.15 Using information on the sensitivity of people and property values to noise levels, it may be possible to determine how changes in noise levels will affect the effective demand (or total economic value) of open spaces. Findings from the questionnaire surveys presented in Section 5.5 suggest that, on aggregate, annoyance levels increase in response to incrementally higher levels of noise. So, for example, over half of all people would leave an area as a result of construction noise. If it is assumed that there are substitute open spaces available and/or that people would pay to visit a private park, for example, (rather than making use of an open space with no entry fee) then the marginal value of quiet (i.e. the change from the baseline at x dB(A) to the new noise level) is simply the change in total value as a result of the change in demand, assuming that WTP remains constant. In essence, this approach aggregates the different potential benefits from quiet areas.

Approach 2: The opportunity cost of public open spaces

5.6.16 Public open spaces are usually situated in areas where the most people can have access to them. These areas are often prime real estate. Parks, for example, are most often located near large residential developments, popular downtown shopping districts, or near developing business districts.

5.6.17 There is evidence to suggest that businesses and real estate developers would pay a premium for the land that large parks in urban areas occupy. In London, the opportunity cost of urban parkland may represent the upper bound value of quiet given the relative scarcity of undeveloped land in London. However, this would probably yield an extremely high value that would significantly limit the usefulness of the approach and is therefore not considered further in this report.

Approach 3: Calculating amenity value from existing webTAG values

5.6.18 The third potential approach is to investigate the change in amenity value (as measured by changes in property values) using the existing webTAG values. These can be applied for incremental changes in noise above 40 dB(A) using the values shown in Table 9. This approach would necessarily ignore direct use values (i.e. the value of benefits obtained by those who actively seek quiet or relatively quiet areas), and only accounts for traffic noise. As such, it would significantly underestimate the value of quiet. The transfer values are, however, widely applied and accepted to understand the impact of traffic noise on amenity.

5.6.19 More specifically, webTAG gives a value per household for households lying within a certain radius (600m) of the transport intervention. Using noise contour maps, it would be possible to identify the incremental changes in amenity value above the 40 dB(A) threshold (or a change from above to below the 40dB(A) threshold). The webTAG methodology does, however, assume that households all react uniformly to the noise and that none of them already have measures (e.g. double glazing) that might limit the level of annoyance experienced.

5.6.20 In light of the above, it is recommended that the first approach (i.e. using the value of open spaces as an upper bound estimate) is used in the interim for valuing quiet areas. The case study presented in the following section demonstrates the application of the methodology to Westbourne Green in London.

5.7 Illustrative case study

5.7.1 The case study draws together information from noise mapping, the literature review and primary research to illustrate how the proposed methodology may be applied to assess the economic value of a quiet area.

5.7.2 Westbourne Green in Westminster City Council has been selected as the case study location as there were clearly discernible changes in noise level from the centre of the open space to the surrounding area and we are able to make use of primary data collected during the field survey.

5.7.3 Westbourne Green is a medium-sized park situated in a residential area on the western edge of the City of Westminster. Its southern boundary is the busy A40 (Westway) while to the north it is bounded by the Grand Union Canal. Three distinct zones were identified within the park – the noisier southern edge, a quiet central zone (which includes a play area and borders a school), and the quieter canal edge.

Beneficiary population under the baseline scenario

5.7.4 There were no available data on the number of users of Westbourne Green. Therefore a short observational survey was conducted for one hour on 7th April 2011 moving between the main entrances and noting the number of people entering the site. From these data, it is estimated that approximately 2,000 people visit the site each day although this estimate does not allow for seasonality. Many of these visitors use Westbourne Green as a walking or cycling route. In addition to the users, there are also a number of non-users who may nevertheless value the space. These include people who live in the vicinity of the space and may therefore benefit from increased property values as a result of having a nice outlook or a quieter environment, as well as people who simply value the existence of the open space.

5.7.5 Again, it was not possible within the study timeframe to obtain information on property types and values within the vicinity of Westbourne Green so the case study is limited to use values only.

Total economic value under the baseline scenario

5.7.6 Applying the values reported by Lockwood and Tracy[230] and the Trust for Public Land[231], and adjusting these for purchasing power parity and inflation only, the use value of Westbourne Green is estimated to lie between £1.18 and £7.40 per visit, or, assuming 2,000 visitors a day, between £2,360 and £14,800 per day or between £861,400 and £5,402,000 per year. This could reasonably be considered as an upper bound for the use value of the park. As we might expect those simply passing through to have lower values for quiet than those who stop and use the space, the value of quiet will then be a component of this total value.

Change scenario

5.7.7 Measured noise levels within Westbourne Green ranged between 51 and 63 dB $L_{Aeq,5min}$. The quietest area (M3 on the map in Appendix 5) lies at the northern edge of the space, close to the canal, while the noisiest area is, as expected, at the edge bounded by the A40 (corresponding to M1 on the map in Appendix 5). Noise mapping data show that noise levels rise steeply immediately outside the Green, with L_{den} measurements of up to 75 dB(A) alongside the A40.

5.7.8 Westbourne Green therefore corresponds with the definition of quiet areas proposed in Chapter 3 in that the park is relatively quiet in relation to its surroundings and there are areas within it that are below 55 dB(A).

5.7.9 Consider a hypothetical scenario where a new road scheme is to be developed to the south of the Green which will result in a substantial increase in traffic flows along the A40 and an associated increase in noise levels within Westbourne Green.

Scenario analysis

5.7.10 One third of all survey respondents in Westbourne Green said that they would move out of the open space altogether if subjected to continual loud traffic noise. Assuming a complete loss of utility to these users, the resulting welfare loss is estimated to lie between £284,130 and £1,782,660 per year. This estimate does not, however, account for those users who simply relocate to alternative quiet spaces nearby (with little or no change in utility) and those who continue to use Westbourne Green (perhaps because there are no convenient alternatives or choose instead to spent time in quieter parts of the space) but whose use values have been reduced as a result of the increase in noise.

Caveats

5.7.11 The case study presented above is a necessarily crude illustration of one approach to valuing quiet using available information on the value of urban open spaces, where quiet or relative quiet may represent only one component within a package of benefits that society as a whole derives from these spaces. The key limitations of the case study are as follows:

1. It ignores non-use values which may be significant. For example, the Lockwood and Tracy study (1995) estimates that non-use values for Centennial Park could be around 40% of the total economic value.
2. It does not account for the fact that those users who choose not to leave the space may have diminished use values as a result of the increase in traffic noise; while some of

[230] Lockwood, M. and Tracy, K. (1995) Nonmarket Economic Valuation of an Urban Recreation Park. Journal of Leisure Research. 27(2), pp155-167.
[231] The Trust for Public Land (2001) Economic Benefits of Open Space Index. New York, The Trust for Public Land

those who do leave Westbourne Green are able to make use of alternative open spaces thereby suffering little or no loss in utility. Yet others may simply choose to spend their time in the quieter parts of Westbourne Green near the northern edge.

3. It contains a number of uncertainties around visitor numbers (i.e. it does not account for seasonality) and people's WTP to use the space.
4. It does not consider the difference in characteristics or preferences between the beneficiaries cited in the Lockwood and Tracy and Trust for Public Land studies and users of Westbourne Green.
5. It does not take account of differences between the sites being valued.

Estimating the national value of quiet areas

5.7.12 Here we provide an aggregate estimate of value for England, based only on those who expressly stated that they regularly visit quiet areas. The current population of England is around 52 million[232]. If 31% of the population (refer to the findings of the ICM poll in Table 1) regularly visits quiet areas and this is interpreted very conservatively as one visit per person per year, that gives a total of 16.12 million visits per year. Under a less conservative interpretation of regular – say one visit per person per month – there may be up to 193.44 million visits to quiet areas per year. Note, however, that there is a high degree of uncertainty around the number of visits specifically motivated by a desire for quiet, not excluding of course those trips made for other reasons but where quiet is a critical component of the package of experiences. If we employ the use values of £1.18 to £7.40 (which are themselves highly caveated and reflect the use value of green space in its entirety) we can produce illustrative values for the use value of quiet areas as shown in Table 13 below.

Table 13: Illustrative values for user visits to quiet areas (motivated by access to quiet). £ millions per year.

	Total use value (£ millions) assuming 1 visit per person per year	Total use value (£ millions) assuming 12 visits per person per year
Low value (£1.18 per visit)	19.02	228.26
High value (£7.40 per visit)	119.29	1,431.46

5.7.13 Clearly, these estimates cover a wide range and include only those who travel expressly for the purpose of experiencing quiet. These estimates do not include:

- Users who visit open spaces for other reasons but gain added utility from the quiet
- Non-use values (e.g. benefits derived from knowing that quiet areas exist or from a premium on the value of properties located in, or near to, quiet areas).

[232] Office for National Statistics (2009) Population Estimates for United Kingdom, England and Wales, Scotland and Northern Ireland, current data sets, online edition, 2009. http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15106

6 Conclusions and Recommendations

6.1.1 This study has taken forward our understanding of quiet areas and their value in our complex urban ecology. It provides perhaps the most conclusive evidence so far that there is a rich and important seam to tap here that adds social, economic and health value to the many physical characteristics that we already know open spaces in built-up areas offer individual communities and their neighbourhoods.

6.1.2 In many ways trying to put an absolute price on accessible quiet or relative quiet undermines the very richness of the characteristic. To some people quiet is priceless, to others as stated in responses to the open space survey, 'noise is to be expected'. Whilst the physiological as well as economic aspects of quiet are complex, the study has been able to come up with a framework or tool that can be used by policy makers to protect, enhance and put into perspective the particular contribution of quiet areas to both individuals and neighbourhoods at large.

6.1.3 The study concludes there is neither a single definition of quiet nor one single value to be derived from them. Rather, it suggests a combination of legitimate approaches to identify such areas in the first place and then to estimate their Total Economic Value. For the purposes of this study, 'quiet areas' are subject to three tests and defined as areas where:

- natural sounds are audible and not masked by man-made sounds– **the 'Sound Quality' test** and/or
- the area is noticeably less noisy than its immediate surroundings; **the 'Relatively Quiet' test** and/or
- the space is urban and publicly accessible; **the 'Potential Use' test**

6.1.4 Further criteria may be applied for a more objective definition of quiet and 'quiet areas':

- The area meeting the noise criteria must meet a minimum area constraint (i.e. at least 1ha) to prevent the inclusion of large numbers of very small areas;
- Maximum noise level of 55 dB L_{day}. This level would apply at the perimeters of the space, and ideally levels within the space would be well below this level. Areas that are quiet for parts of the time (when they are likely to be used) should also be considered.
- For relatively quiet areas, the noise level across the majority of the area must be at least 10 dB(A) below the noise levels of the surrounding areas (e.g. possibly defined as the noise levels associated with all dwellings within a 200m radius).

6.1.5 The study also increases our evidence base and understanding of quiet areas in the following ways:

- By showing the general importance placed by the public on quiet areas. A 2009 ICM survey (Table 1) shows that across the UK 91% of people think quiet areas need protecting, 31% regularly visit quiet areas and 40% visit a park to find quiet.
- A small survey commissioned as part of the study identified that park usage in London would reduce by a third if users were exposed to continual loud road noise. Both surveys reinforce the fact that a substantial number of people use parks to find quiet.
- A review of green space literature found that there was no commonly used value in appraisal and identified a range of values for visiting a green space of between £1.18 and £7.40 per visitor.

- The tangible benefits of quiet areas can be broken down into health, amenity, productivity and ecosystem categories (Table 2, page 30). This provides a useful framework for understanding and building up a picture of the total value of quiet areas and a basis for further investigation in terms of how the benefits inter-relate and the relative value of each of the characteristics.

6.1.6 The review covered the benefits relating to both 'quiet' and 'quiet areas' using a broad search strategy encompassing terms synonymous with, or implying 'quiet' or 'quietness'.

Benefits of quiet

6.1.7 A comprehensive review of over 80 studies was undertaken to collate evidence on the nature and significance of the benefits that people derive from quiet and relatively quiet areas. The literature suggests that quiet confers benefits over and above the positive impacts gained through a reduction in loud noise. It has a number of important and often co-related benefits to human well-being, including restorative effects, space for reflection and creativity, and an escape from hustle and bustle. Improved creativity, problem solving, mental health, concentration and undisturbed sleep. In addition to the direct economic benefits that human well-being confers (in terms of, for example, savings on health costs and increased worker productivity), access to "quiet areas" also offer other services of economic and social value including impacts on property values (people generally prefer to live in "quiet" neighbourhoods) and impacts on the wider community, including children and the elderly. The body of evidence relating to the benefits of quiet and quiet areas is summarised in Table 14 below.

Table 14: Evidence relating to the benefits of quiet and quiet areas

Broad Category	Benefits	Evidence
Health	Mental well-being	Berry and Flindell (2009); Defra (2010); New Economics Foundation (2005); Chu *et al.* (2004)
	Psychological restoration / recovery	Clark *et al.* (2007)
	Psychological well-being, including stress release / relief	Öhrström *et al.* (2006); Gidloff-Gunnarsson and Öhrström (2007)
	Physiological well-being (reduced risk of cardiovascular disease and hypertension)	Berry and Flindell (2009); Defra (2010); Health Protection Agency (2010); Babisch (2006); Sørensen *et al.* (2011)
Amenity	Reduced annoyance reflected in property price premiums	Bateman *et al.* (2001), Navrud (2002); Wardman and Bristow (2008); Nelson (2004)
	An escape from the 'hustle and bustle' of surrounding (relatively noisier) areas	Van den Berg *et al.* (2006)
	Relaxation / Recreation	Berglund *et al.* (2004); Gidloff-Gunnarsson and Öhrström (2007); Klaeboe (2005)
	Spiritual	Prochnik (2010)
	Quality of life	Lawton *et al.* (1980)
Productivity	Creativity and problem-solving	Stansfeld *et al.* (2000); Clark and Stansfeld (2007)

Broad Category	Benefits	Evidence
	Aid to concentration	Berglund and Lindvall (1995)
	Cognitive development	Berglund and Lindvall (1995); Stansfeld *et al.* (2000); Berry and Flindell (2009); Evans and Maxwell (1997); Boman *et al*. (2005)
Ecosystems	Biodiversity (habitats for breeding, foraging, etc)	EPUK (2010)
	Air quality (induced)	EPUK (2010)

6.1.8 It is difficult to separate the specific benefits of quiet from both the wider benefits of quiet areas with all their multiple features and the disbenefits of noise. The vast majority of evidence published to date appears to focus on the impacts of noise on health and amenity at, or for a transition to, relatively high levels of environmental noise. The benefits of 'quiet' are therefore cast as the costs avoided from high noise levels. There is far less information regarding the amenity benefits of quiet and quiet areas, and much of the evidence that does exist is anecdotal, reflecting people's perceptions or expectations of urban open spaces.

6.1.9 The evidence shows that quiet contributes to the overall quality of urban spaces. However, the challenge lies in trying to separate out the benefits derived specifically from 'quiet' and the benefits derived from other attributes of these spaces. Studies that try to rank the contributions that various attributes make to overall enjoyment of a space, consistently rank quiet as one of the most important factors. However, it is not clear to what extent study framing (i.e. where the study is designed to specifically evaluate the contribution of quiet) has influenced the outcome.

Approaches to valuing quiet

6.1.10 Most of the valuation evidence relates to noise, rather than quiet, possibly reflecting the difficulties in separating the contribution that "quiet" makes to amenity value relative to other attributes.

6.1.11 There are a large number of papers that have studied the impacts of an increase or decrease in noise levels on amenity values. These typically use the housing market (i.e. HPM) to estimate implicit prices for quiet. These studies fail, however, to capture the value of quiet areas to those who (i) may not be able to afford to live in 'quiet' neighbourhoods and arguably, for whom, a quiet space in a noisy neighbourhood would be more highly valued and/or (ii) those who may work in a noisy environment and seek refuge from the 'hustle and bustle' during the day.

Towards a methodology for valuing quiet areas

6.1.12 In light of the findings, three possible approaches to valuing quiet and quiet areas were identified:

- Using a range of urban green spaces as a proxy for "quiet areas" to identify an upper range estimate of the value of quiet areas. This would draw on several recent initiatives (e.g. by CLG, CABE, etc) and other HPM and CVM studies on green open space to estimate the economic value of urban green spaces, studies to assess the impacts or opportunity costs of proposed (or actual) developments on greenfield sites and how these may impact on 'quiet' and/or the types of activities (e.g. recreation, reading, meditation, etc) that take place in these spaces;
- Estimating the opportunity costs of maintaining undeveloped sites; and

- Making use of existing values for noise disturbance in the home (i.e. based on the webTAG values). This would, however, only be applicable to a change in the level of noise/quiet and would not therefore reflect the value of those 'quiet spaces' that are actively sought. While such an approach could at least provide a starting point, it is important to note that it would be open to a lot of criticism.

6.1.13 None of these approaches is perfect but they are believed to make best use of the available evidence to provide an indicative measure of the economic value of quiet areas. The results derived from any of these approaches would need to be heavily caveated and the extent to which they over- or under-value quiet clearly highlighted. The first approach (using open space values as a proxy for quiet or relatively quiet areas) is conceptually preferred and once the method is established, values and classifications could be further refined as more evidence becomes available.

The Value of Open Spaces

6.1.14 To complement the literature review, two surveys were undertaken: one amongst users of open space in central London and another amongst UK-based employees of URS/Scott Wilson.

6.1.15 The field survey was conducted amongst users of different types of three urban spaces in the City of Westminster: St. James's Park, Golden Square and Westbourne Green. The purpose of this survey was to try and establish the relative value of quiet within different types of urban open spaces and to identify the types of noise (or noise thresholds) that would discourage people from using these open spaces. Ultimately, the survey was designed to inform the derivation of a noise-sensitive demand curve for urban open spaces.

6.1.16 Key findings from the field survey were that:

- 'Escape from hustle/bustle' was most frequently ranked as the most important benefit that respondents obtain from urban open spaces (25% ranked it as being of highest importance) whilst 'creativity' was seen as one of the least important benefits of open spaces
- Fewer than 4% of all respondents listed quiet as the highest ranking feature of urban open spaces, yet quiet ranked more highly than both social/visual contact with people and creativity. However, the value of 'quiet' or 'relatively quiet' is implicit in 'escape from hustle/bustle' and 'rest/relaxation' which both score highly.
- When asked to rank the factors that detract from their enjoyment of urban open spaces, over 50% of respondents ranked 'an attack or verbal abuse' as the most important annoyance factor. Over 80% of respondents listed 'an attack or verbal abuse' as one of the top five (out of 8) annoyance factors while litter and noisy people (80% and 74% respectively) also ranked highly. More people are disturbed by crowds of noisy people than by noise from mechanical equipment (confirming that public open spaces are rival goods), and people are more sensitive to these sources of noise than they are to background noise filtering into the open space from elsewhere (e.g. traffic noise).
- When asked specifically about the types of noise that would prompt the respondent to move on or leave the open space, noisy people (particularly mobile phone users) featured most prominently. Construction noise and noise from mechanical equipment were also frequently cited. Road traffic noise, which can be expected to be a relatively permanent feature, appears to be much less of a concern amongst open space users.
- There would be no significant change in frequency of use amongst respondents if the open space were to become significantly quieter than at present.

- As may be reasonably expected, people are more sensitive to louder sounds, particularly where these are intrusive and un-natural or man-made

6.1.17 The online employee survey revealed 'visual appeal' as the most important attribute of urban open spaces (32% ranked this as most important). This was closely followed by 'escape from hustle/bustle' (29%) and 'rest and relaxation' (21%). Answers to an open question about other important benefits that respondents derive from urban open spaces clearly demonstrated that access to 'quiet' or 'relatively quiet' areas is important to people. A significant number of respondents alluded to the importance of urban open spaces as offering a less stressful/quieter way of walking into town/to work and providing relief from urban life and the monotony of the urban environment.

Application of an Approach to Estimating the Economic Value of Quiet Areas

6.1.18 Using information from noise mapping, the literature review and primary research, the benefits transfer approach was applied to estimate an economic value for Westbourne Green, an open space in west London that exhibits clearly discernible changes in noise level from the centre of the open space to the surrounding area.

6.1.19 It is estimated that around 2,000 people visit Westbourne Green each day. This includes both those for whom the Green is a destination in itself and those who use it as a thoroughfare. In addition to the users, there are also a number of non-users who may nevertheless value the space. These include people who live in the vicinity of the space and may therefore benefit from increased property values as a result of having a nice outlook or a quieter environment, as well as people who simply value the existence of the open space. The case study accounts for use values only.

6.1.20 Under a baseline scenario, the use value of Westbourne Green is estimated to lie between £1.18 and £7.40 per visit, or between £861,400 and £5,402,000 per year. This could reasonably be considered as an upper bound for the use value of the park.

6.1.21 A hypothetical change scenario is then introduced to examine the impact of the development of a new road scheme to the south of the Green which will result in a substantial increase in traffic flows along the A40 and an associated increase in noise levels within Westbourne Green. One third of all survey respondents in Westbourne Green said that they would move out of the open space altogether if subjected to continual loud traffic noise. Assuming a complete loss of utility to these users, the resulting welfare loss is estimated to lie between £284,130 and £1,782,660 per year. This estimate does not, however, account for those users who simply relocate to alternative quiet spaces nearby (with little or no change in utility) and those who continue to use Westbourne Green (perhaps because there are no convenient alternatives or choose instead to spent time in quieter parts of the space) but whose use values have been reduced as a result of the increase in noise.

6.1.22 The case study is a necessarily crude illustration of one approach to valuing quiet using available information on the value of urban open spaces. It ignores non-use values and does not account for those users who may continue to use the space but whose WTP to use the space is diminished by the increase in traffic noise, or those who are able to make use of alternative open spaces.

6.1.23 Using a similar approach, it is possible to derive an aggregate estimate for the value of quiet in England as a whole. An ICM poll conducted in 2009 found that 31% of the population regularly visits quiet areas. Without a definition of 'regular' two scenarios are assessed: the first assumes one visit per person per year giving a total of 16.12 million visits per year nationally. The second

assumes one visit per person per month giving up to 193.44 million visits per year. There is, however, a high degree of uncertainty around the number of visits specifically motivated by a desire for quiet, not excluding of course those trips made for other reasons but where quiet is a critical component of the package of experiences. Once again employing the use values of £1.18 to £7.40 per visit (which are themselves highly caveated and reflect the use value of green space in its entirety), the total use value for visits to quiet areas for England as a whole is estimated to lie somewhere between £19.02 million and £1.4 billion per year.

6.1.24 This estimate covers a wide range and includes only those who visit open spaces expressly for the purpose of experiencing quiet. These estimates do not include the value held by those users who visit open spaces for other reasons but gain added utility from the quiet and the non-use values held by those who may not necessarily visit quiet areas but derive benefit from knowing that quiet areas exist and/or who can take advantage of a premium on the value of properties located in, or near to, quiet areas.

6.2 Uncertainties and Sensitivities

6.2.1 There are several uncertainties in using any of the approaches described in Chapter 5. Broadly, these cover:

- uncertainties surrounding the quantification and valuation of benefits provided by quiet and relatively quiet areas, largely due to a lack of suitable valuation evidence;
- uncertainties around the definition of the beneficiary populations for estimating changes in the total social value of open spaces and the implicit value of quiet or relative quiet within this;
- a lack of reliable evidence pertaining to the value of quiet or relative quiet in relation to the wider range of benefits deriving from public open spaces; and
- issues relating to non-linearities, including the sensitivity of the unit value of a change of, noise level to:
    - The direction of the change (gains v losses)
    - The size of the change (scope sensitivity, satiation)
    - The baseline (which might also encompass any threshold effects)

6.2.2 There is a limited amount of evidence in the noise valuation literature on these issues.

6.3 Recommendations for Further Research

6.3.1 As is evident from the review findings, very little research has sought to evaluate the benefits of quiet, taking ‘quiet’ or ‘relative quiet’ as the starting point. Rather, studies have typically focused on the effects of noise or the impacts of changes in environmental noise levels above a quantitative threshold (often 55 dBA).

6.3.2 Further research is therefore needed to:

- Identify the criteria or attributes that define different types of ‘quiet areas’, or spaces that people value specifically because they are perceived as ‘quiet’.

- Develop the concept of tranquillity where quiet or a high quality soundscape is one of the pillars of determining the tranquillity of a space.
- Assess the value or ranking of quiet relative to the other properties that characterise 'quiet areas', or those perceived as 'quiet'. A more detailed survey may be able to reveal this ranking.
- Identify and quantify the determinants of value (i.e. is it possible to develop a typology of quiet areas, where each category of 'quiet area' is characterised by different types of properties and/or benefits?).
- Better define the relationships between the different types of 'quiet' areas and the value of benefits obtained (i.e. are there thresholds above or below which the benefits of 'quiet areas' are no longer realised?). In other words is there a 'tipping point' where people stop using or valuing quiet areas which in turn leads to a marked increase in annoyance which in turn has effects on the wider neighbourhood. For example, the amenity value of a quiet island within a quiet area could be compared with the popularity of a quiet coach in an inter-city train. Even though the overall noise level is still quite high, social noise is reduced significantly and this offers a benefit to passengers. Similarly a quiet island designation may confer benefits and behavioural prompts to users of the open space generally and would certainly both promote and remind users of the significance of quiet as a characteristic of the space and the contribution the user themselves can make to this characteristic. This was reinforced by our survey and is relevant to this study in that it reinforces the amenity value of the whole space, by offering users a particular experience in the quiet island, a choice of whether to experience it (i.e. depending on mood) and a reminder of the level of care and aspiration being taken by, for example, a local authority in the experience users have.
- Determine the WTP for quiet and quiet areas and how this changes in response to changing noise levels. A meta-analysis of the literature for urban green or open space could potentially provide a useful starting point from which a benefits transfer model could be derived and which would include some way of measuring the contribution of quiet to overall green / open space values. The model predictions would then need to be tested across a sample of study sites in English cities to examine the nature of transfer errors and what is driving them. However, given the complexity of the relationship between quiet (and perceptions of quiet) and people's enjoyment of open spaces, it is likely that primary valuation studies using deliberative approaches (e.g. choice experiments) would ultimately be required.
- Test the effectiveness of the proposed definition for quiet areas and/or develop a new indicator of quiet that is fit-for-purpose.
- Conduct trial studies using (a) noise mapping and long-term noise measurements together with data on user numbers and information collected through various participatory approaches and (b) examining the role of quiet spaces within large multi-use open spaces.

6.3.3 More broadly, it is clear from both the review and study findings that much more effort is needed to ensure that acoustic factors (including noise, soundscape, quiet and tranquillity issues) are included on the agenda when considering open space. While 'quiet' does not explicitly feature as one of the most highly ranked attributes of urban open spaces amongst users, it is an implicit feature of other benefits that are considered very important including 'an escape from hustle/bustle' and a place for 'rest and relaxation'. This suggests too that quiet areas are valuable and need to be protected and enhanced.

6.3.4 In undertaking future research it is important to engage with the relevant experts in the various fields which should include (but not be limited) to acousticians, planners, cultural heritage experts, architects and landscape architects, health experts and socio-economists.

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Appendix 1: Summary Review Findings

Table A1-1: Benefits of Quiet and Quiet Areas

Category	Benefits Identified	Context	Citations	Quantified links?
Health	Health effects of noise exposure	• Reviews of the available evidence to support the development of robust dose-response relationships between noise exposure and health.	Ad Hoc Expert Group on Noise and Health, 2010; Berry and Findell, 2009; Health Council of the Netherlands, 2006;	• Dose-response relationship
		• Gidlof-Gunnarsson and Ohrstrom examined whether perceived availability to nearby green areas affects various aspects of well-being in two noise-condition groups: one with access to a quiet side and one with no access to a quiet side. For both those with and without access to a quiet side, the results show that "better" availability to nearby green areas is important for their well-being and daily behaviour by reducing long-term noise annoyances and prevalence of stress-related psychosocial symptoms, and by increasing the use of spaces outdoors. However, the results also indicate that access to "quietness" or nearby green areas alone or in combination is not completely effective in minimizing the noise problem in our sample of highly traffic noise exposed residents. To achieve a long-term sustainable and health-promoting urban residential environment it is essential t o strive for lower sound levels at the residencies but also in the close neighbourhood (Klaeboe *et al.*., 2005), to assure access to "noise-free" places or a quiet side, as well as to protect, preserve and increase the supply of nearby green areas. Concluded that in the process of planning health-promoting urban environments, it is essential to provide easy access to nearby	Gidlöf-Gunnarsson and Ohrström, 2007	• Show significant correlations between three psychosocial symptoms (very tired, irritated and angry and stressed) and noise annoyance "at home" and "outdoors": (r = 0.19–0.28). The symptoms are also closely correlated with one another (r = 0.39–0.55). Do not give WTP values.

Category	Benefits Identified	Context	Citations	Quantified links?
		green areas that can offer relief from environmental stress and opportunities for rest and relaxation, to strive for lower sound levels from road traffic, as well as to design "noise-free" sections indoors and outdoors.		
		• Access to quiet indoor and outdoor sections of one's dwelling supports health, produces a lower degree of annoyance and disturbed daytime relaxation, improves sleep and contributes to physiological and psychological well-being.	• Ohrström, Skanberg, Svensson and Gidlöf-Gunnarsson, 2006.	
		• Access to a quiet façade of a dwelling reduces noise by 10-20% depending on sound level from road traffic at most exposed side.	• Berglund *et al.*, 2004	
	Mental health	• "*Within our communities, the design of buildings, the lack of diversity in structure and form, the lack of access to green space, and high noise levels can have an adverse effect on mental health. They contribute to feelings of insecurity (i.e. fear for safety), social isolation and stress…"*	• Canadian Review Committee	No
	Stress relief	• "*Exposure to tranquil areas of nature is thought to be stress reducing and have positive impacts on physical and mental health"* But not clear whether these benefits are attributed to quality of tranquillity itself or because tranquil areas provide a preferred space for exercise.	• Health Protection Agency, 2009	No
		• Opportunities to easily escape a heavily trafficked and noisy surrounding and to perceive a more positive tranquil sound	• Gidlöf-Gunnarsson and Ohrström, 2007	

Category	Benefits Identified	Context	Citations	Quantified links?
		environment might help to reduce noise-induced stress and other adverse effects of traffic noise exposure		
	Sleep and recovery from illness, including therapeutic benefit	• Quiet time interventions in an acute care hospital ward can affect noise levels and patient sleep/wake patterns during the intervention period.	• Gardner *et al.*, 2010	
		• The time required to fall asleep is considered as an important aspect of noise-induced sleep disturbances. A longer time to fall asleep was found in sensitive as well as nonsensitive adults at sound pressure levels of 50 and 60 dB L_{Amax} road traffic noise (Öhrström & Rylander, 1990). A reduction in the time needed to fall asleep was found among children who slept in a more quiet room (Eberhardt, 1987) and among adults who slept with closed windows as compared to sleeping with open windows (Griefahn & Gros, 1983). The number of noise events per time unit rather than the absolute noise level seems to be important for the time needed to fall asleep since the effects were similar at 45, 50, and 60 dB(A) of road traffic noise (Öhrström & Rylander, 1990, Öhrström, 1991).	• Berglund and Lindvall, 1995	
	Psychological		Ohrström *et al.*, 2006; Gidlöf-Gunnarsson and Ohrström, 2007	
	Hearing	Certain people who live in remote and generally quiet areas of the world have been found to have unusually acute hearing in comparison with members of urban populations in corresponding age groups (S. Rosen, Bergman, Plester, El-Mofty, & Satti, 1962). However, it is not clear	• Berglund and Lindvall, 1995	

Category	Benefits Identified	Context	Citations	Quantified links?
		whether such audiometric differences are due to the lack of noise exposure alone. Differences in the patterns of hearing found between communities that are widely separated geographically and culturally may result from cultural, dietary, and genetic factors and differences in general environment (S. Rosen *et al.*., 1962; S. Rosen & H.V. Rosen, 1971).		
Productivity	Concentration	Concentration and mental work of all kinds are often assumed to require a quiet environment. However, in spite of some experimental laboratory data, there are no reliable field data to confirm this. No generalized criteria relating task efficiency and noise level or duration in the workplace can be stated.	Berglund and Lindvall, 1995	
	Creativity and problem-solving	"The brain needs time to assimilate and allow the creative process to happen – the time and space to bring together raw material and make the surprising connections and leaps of faith that lead to creativity"	Alzheimer Society website	No
		Quiet time interventions in an acute care hospital ward were found to affect noise levels and patient sleep/wake patterns during the intervention period. This also resulted in improved satisfaction of patients, visitors and health professionals and better organisational functioning.	Gardner *et al.*, 2010	
Amenity	Higher property prices	• Study in Hong Kong found that households were willing to sacrifice serenity for convenience. Neighborhood quality is a crucial determinant for property prices. The authors summarise the relevant literature specifically on four typical categories of environmental and neighborhood attributes and their relationships with property price. Of them, air quality and noise level are negatively related to property price, whilst view (sea, etc.) and structural and	• Hui *et al.*, 2007	Yes – uses a hedonic model with spatial adjustments

Category	Benefits Identified	Context	Citations	Quantified links?
		neighbourhood variables are positively associated. Marginal WTP for quietness was comparatively lower for lower income groups than that of higher income groups. Furthermore, it was found that an apartment located in a noisy area closer to the CBD would typically fetch a higher price than an identical one located in a quiet area further away from the CBD. This is at odds with similar studies in other countries but the authors explain that densely populated areas in Hong Kong are usually provided with more shopping and dining facilities as the premise owners used to make money by transaction volumes. Thus, people in Hong Kong tended to sacrifice serenity for convenience.		
		• Bjorner found that average price of apartments increases when reducing noise levels and that WTP for reductions in noise levels is significantly higher at higher ambient noise levels.	• Bjorner, 2004	
		• Freeman lists the environmental attributes among other variables when conducting a statistical test to measure people's willingness to pay for housing with different attributes. There are many aspects that contribute to environmental attributes, for instance, noise, air quality, and the accessibility of green areas.	• Freeman, 1979	
	Quiet as a starting point for hearing positive soundscapes	Good urban outdoor soundscape is dominated by positive sounds from nature and has an overall equivalent sound level below 50 dB(A) during the daytime.	Nilsson and Berglund, 2006	
	Spiritual		Quiet Garden Movement and No Trust	

Category	Benefits Identified	Context	Citations	Quantified links?
	Freedom from annoyance	• Access to a high-quality "quiet courtyard" provides an attractive restorative environment providing residents with a positive soundscape, opportunities for rest, relaxation and play, as well as social relations that potentially reduce the adverse effects of noise.	• Gidlöf-Gunnarsson and Ohrström, 2007	
		• Opportunities to experience quietness, or to experience freedom from unwanted sounds and a natural soundscape has been shown to play an important role in recreation experiences.	• Gidlöf-Gunnarsson and Ohrström, 2007	
		• The possibilities of using powered machines in leisure activities are increasing all the time. For example, motor-racing, off-road vehicles, motorboats, water skiing, snowmobiles, etc., can all contribute significantly to loud sound pressure levels in previously quiet areas. Shooting activities not only have considerable potential for disturbing nearby residents, but can also damage the hearing of those taking part. Even tennis play and church bell ringing can lead to noise complaints.	• Berglund and Lindvall, 1995	
		• Brouwer examines the effects of motor boats in providing access to the Norfolk Broads, an internationally recognised wetland. Found that large numbers of motor boats have a negative effect on the natural environment and disturb the peace and quiet many people come to experience. A majority of people are believed to visit the Broads to experience the area's tranquility and unspoiledness, words which run like a thread through several hundred survey forms filled in by holiday visitors to Norfolk in 1997 (Day, 1998).	• Brouwer, 1999	Yes – uses CVM to examine visitors' preferences for the Broads as a visitor attraction. Specifically examined WTP to reduce overcrowding in the Broads in order to enhance their own quiet enjoyment of the area. Almost 80 percent of the people interviewed considered being out on a motor boat fairly to very important to their overall enjoyment of the Broads. Of these
		• Homel and Burns interviewed a random	• Homel and Burns, 1986	

Category	Benefits Identified	Context	Citations	Quantified links?
		sample of 9-11-year-old children living in 18 suburbs of Sydney, Australia, regarding their likes and dislikes about their neighbourhood, and their overall evaluation of their area as a "'place for children to grow up in". The I8 suburbs were selected to represent a range of scores on the Vinson-Home risk scale, a composite index of neighbourhood quality derived from health, income, employment, education and welfare statistics that are available on an area basis. Children's evaluations were strongly related to area risk scores, with the two highest-risk (inner city) neighbourhoods particularly disfavoured, The major reasons advanced for liking or disliking a neighbourhood were plotted against risk scores, showing a complex pattern of associations, with parks particularly valued by children in the highest risk areas. A canonical correlation analysis of likes, dislikes and overall ratings showed two canonical variables to be statistically significant. The first was a good-bad dimension, which was strongly associated with risk score. The second contrasted open playspace with private peace and quiet, bringing together the six highest- and lowest-risk areas in comparison to the twelve middling-risk areas. No variables other than risk were found to be predictive of children's evaluations of their neighbourhoods. When asked (open response) what the good things were about their neighbourhood, 48% of children said "quiet streets". The most frequently given response was "friendly people" (61.7%), followed by "parks" (50.2%). When asked what was not so good, 24.1% of children interviewed said "too noisy, dirty, polluted".		164 respondents, about 90 percent considered the area's peace and quiet equally important. Half of the respondents (53%) who were asked how a 10 percent reduction of the number of motor boats would affect their own enjoyment of the area's peace and quiet said that this reduction would only result in a small or very small improvement. Only 7 percent of the respondents thought that a 10 percent reduction would be a large improvement. One respondent indicated that a 10 percent reduction would make him feel worse off, even though he had previously indicated that he considered the number of motor boats in the Broads a fairly serious problem. Sixteen respondents (14%) felt that a 10 percent reduction would have no effect at all.
Contribution to quality of urban	• Quietude • Peace and quiet (and screening)	• In a study of amenity use and contingent valuation of urban greenspaces in	• Jim and Chen, 2006	Look at WTP to value greenspaces but not

Category	Benefits Identified	Context	Citations	Quantified links?
spaces	• Amenity value • Experienced social quality	Guangzhou, China, Jim and Chen explore the pattern of use and role of urban greenspaces.The monetary value of the non-priced benefits was gauged by the contingent valuation method using willingness-to-pay and open-ended payment card approaches. Respondents stated the purposes of using greenspaces, in order of importance, to be relaxation, quietude, physical exercise, nature appreciation, and aesthetic pleasure.		specifically linked to "quiet". Quietude given as one important attribute – among many - of green spaces.
		• Tyrväinen examines the amenity value of an urban forest in a town in North Carelia, Finland using a hedonic pricing model. The majority of urban forest benefits represent non-consumptive use values, which include benefits derived from pleasant landscape, clean air, peace and quiet and screening, as well as recreational activities. The hedonic pricing method examines external benefits and costs of urban forests associated with housing. This investigation studied whether and how urban forest benefits are capitalized in property prices. It also searches for suitable variables for describing the green space benefits in hedonic pricing studies.	• Tyrväinen, 1997 • Tyrväinen and Miettinen, 2000	
		• 'Peace and quiet', alongside a pleasant landscape, clean air, screening and recreational activities is recognised as a distinct benefit of urban forests.	• Tyrväinen, Makinen and Schipperijn, 2007 • Tyrväinen, Makinen and Schipperijn, 2007	
		• For urban open public spaces, an important element of urban areas, it is vital to study the users' perception of sounds. A recent study based on the semantic differential analysis showed that relaxation, including comfort–discomfort, quiet–noisy, pleasant–unpleasant, natural–artificial, like-dislike and gentle–harsh, is a main factor for people's	• Yang and Kang, 2004	

Category	Benefits Identified	Context	Citations	Quantified links?
		soundscape evaluation in urban open public spaces		
Disbenefits of Noise				
Annoyance		• Navrud reviews existing noise value studies covering noise from road traffic, aircraft, rail and industry in European countries. Concludes that in order to refine and improve the transferability of this estimate, the Damage Function Approach should be applied to value welfare loss from noise annoyance; implying a great need for new SP studies. These studies should be constructed to provide values for endpoints of exposure-response functions for different annoyance levels, defined according to the current international standard. We also need to establish values for: i) annoyance from low noise levels and multiple noise sources, ii) health impacts from noise; and iii) the effect of being exposed to multiple environmental impacts including noise.	• Navrud, 2004	• An analysis of Stated Preference (SP) studies on road traffic noise suggests an interim EU-wide economic value of 23.5 euro / dB(A) / household / year. • Weinberger (1992) conducted a CV study of a random sample of 7000 persons in Germany in 1989 asking for their WTP to "live in a quiet area". The monthly WTP (euro) was estimated at 0.85 L_{Aeq} – 36.6 , i.e. 10 euors per dB(A) per person above 43 dB(A) (J. Lambert pers. comm.. 2002). • Assuming that the annual "average" initial noise level is in the area of 60-65 dB, exposure response
		• Barreiro, Sanchez and Viladrich-Gau estimate the value of a noise reduction program in a Spanish city. The chosen technique is contingent valuation with a one and one-half bound question format. They found that urban residents generally value noise negatively and, specifically, that a Spanish household is willing to pay approximately 4 euros per year per dB reduced. A further finding is that there is no scope sensitivity effect; which means that households display a willingness to pay different amounts for two different degrees of noise reduction.	• Barreiro, Sanchez and Viladrich-Gau, 2005	

Category	Benefits Identified	Context	Citations	Quantified links?
				functions give the following approximate reductions in dB-level, which have then been used to produce the results shown in table 1. (a) ”getting a 50 % reduction in noise level” is equivalent to about 8 dB (b) ”getting a 100 % reduction in noise annoyance” is equivalent to about 10 dB (c) ”avoiding a 100 % increase in noise levels” is equivalent to about 10-15 dB • A Spanish household is willing to pay approximately 4 euros per year per dB reduced
Health	Socio-pscyhological disturbance – annoyance, sleep disturbance, disturbance of daily activities and performance Physical responses such as hypertension and ischemic heart disease.	• In their study, Nijland *et al.* seek to contribute to an ongoing discussion on the desirability of implementing a set of noise control measures for road and rail traffic in the Netherlands. The paper describes a cost-benefit analysis of a number of (possible) noise abatement measures in the Netherlands. Benefits are calculated according to consumer’s preferences for dwellings, and values applied	• Nijland *et al.*, 2003	Provides unit value cost estimates for dB reductions in noise as a result of various measures to reduce noise emissions.

Category	Benefits Identified	Context	Citations	Quantified links?
		are derived from two different methodologies (hedonic pricing and contingent valuation). Costs are shown to be surpassed by benefits. The results show that implementing these measures will considerably improve the noise situation in the residential, recreational and nature areas. As a consequence human health and well-being will be improved too.		
		• Noise exposure is associated with a number of health effects (Berglund *et al.*., 1999). First, we can distinguish socio-psychological responses, such as annoyance, sleep disturbance, disturbance of daily activities and performance, and secondly, physical responses, such as hypertension (i.e. high blood pressure) and ischemic heart disease. At low noise levels of 40 dB(A), for example, people may already be affected by noise exposure. This is especially the case in susceptible subgroups (children, elderly).		
		• Noise is something to which we are exposed throughout life. It is exposure to levels above 40 dB(A) that begins to influence our well being, while levels above 60 dB(A) are considered detrimental to our health. Excessive levels of noise have both physiological, and psychological consequences. The physiological effects include, for example, hearing impairment, disturbed sleep, high blood pressure, stomach ulcers and other digestive disorders. Among the psychological effects we can also mention greater levels of anxiety, irritability and nervousness; it also influences social behaviour and cognitive development (Bolaños and Ochoa, 1990; Guski, 1989). High noise levels have a negative impact not only on health but also on other areas of life, and therefore give rise to economic	• Barreiro, Sanchez and Viladrich-Gau, 2005	

Category	Benefits Identified	Context	Citations	Quantified links?
		consequences. • Exposure to high levels of noise decreases the ability to concentrate, increases the likelihood of errors of perception, interferes with communication, and causes difficulties in the learning process among children (Grandjean and Gilgen, 1976).2 Other economic consequences are losses in property value and increased health expenditure. Noise affects not only urban areas and human health, but also the natural environment.		
		• Galilea and Ortuzar estimate the willingness-to-pay for reducing noise levels in a group-based residential location context in Chile. The experiment considers variations in travel time to work, monthly house rent, sun orientation of the dwelling and subjective noise level inside it; objective noise levels are also measured after the experiment. Multinomial and mixed logit models are estimated based on a consistent microeconomic framework, including non-linear utility functions and allowing for various stratifications of the data.	• Galilea and Ortuzar, 2005	• A conservative value of US$2.12 per decibel per month emerges as corresponding to the lower bound of the confidence interval associated to the best ML model (and also to the point estimate of the various MNL functions). This value (and most values estimated) appears to be reasonable when compared (although the comparison is per force not strict) with the real costs associated with reducing noise by physical means (i.e. double

Category	Benefits Identified	Context	Citations	Quantified links?
				glazing).

Table A1-2: Summary of findings relating to definitions of quiet and quiet areas

Study Title	Authors	Date	Summary	Commentary (i.e. how useful is this study and how may it contribute to our work?)
Mapping Tranquillity	CPRE	March 2005	Used public perception of tranquillity to define tranquillity, building on previous work where 'Tranquil Areas' were defined as: 'places which are sufficiently far away from the visual or noise intrusion of development or traffic to be considered unspoilt by urban influences' and identified such places through specific criteria, with Tranquil Areas being found certain distances away from features such as roads, towns, airports and power stations.	Relates to tranquillity rather than quiet. Specific focus on the rural setting is not directly applicable to a more urban context.
A proposal for identifying quiet areas in accordance with the Environmental Noise Directive	Watts GR, Morgan PA, Abbott PG, TRL	2006	Proposals were developed for the identification of quiet areas as required by the END. These included filtering by geography, land type and noise level.	Definitions of quiet including both noise level and space factors. No account is taken for relative quiet by comparing with noise levels in surrounding areas.
Definition, Identification and Preservation of Urban & Rural Quiet Areas	Symonds Group	July 2003	Proposals for the identification of quiet areas for the END. Provided criteria based on noise level only, but also extended noise levels beyond those immediately available from the END noise maps, by including $L_{Aeq,24hour}$ indicator.	Totally quantitative acoustic approach. No direct reference to relative noise levels.
The Need for Quiet in Amsterdam: A Survey,	Van den Berg F, Booi H	2009	Survey of residents regarding quiet areas. Provides a list of typical areas identified as quiet areas, although figures relating to access to quiet are specific to Amsterdam	Identifies the types of areas typically considered as local quiet areas by residents.
Recommendations for public quiet places in Amsterdam	Van den Berg F, Brand A	2009	Used "low noise maps" showing quieter areas on noise maps, but extending below the 55 dB L_{den} cut off used for the END noise maps, and calculated at 1.5m height rather than the 4m height used for the END mapping exercise. Identifies the following types of quiet spaces: - natural reserves, where natural sounds should dominate; - green spaces in the countryside, with natural sounds and sounds from agricultural or forestry activities; - green spaces in cities (such as parks and cemeteries) where unwanted sounds should not dominate;	Both these changes are beneficial for the identification of quiet areas as they allow maps to be produced which correspond more closely to the noise levels which would be experienced by people on the ground in these locations. It should be noted that equivalent figures for the UK are not available from END maps.

Study Title	Authors	Date	Summary	Commentary (i.e. how useful is this study and how may it contribute to our work?)
			- quiet built-up areas in cities (such as court yards, squares or resting areas with little traffic) where again the unwanted sounds should not dominate.	
Working group of authorities concerned with noise, "Acoustic quality in natural and cultural environments – Proposal for metrics, indicators and auditing methods"	Sweden (cited by Ven den Berg *et al.* 2009)	2002	Suggests limit values of 45-50 dB(A) or a relative quiet area being 10-20 dB(A) below the level of surrounding streets.	Useful quantitative limits on quiet and relative quiet.
The Urban Soundscape A Different Perspective	Botteldooren D, Coensel BDE, Van Renterghem T, Dekoninck L, Gillis D	2009	Gives a subjective definition of quiet as "Generally, a quiet area is defined as an area that is more quiet than the surrounding region, and which has a psychological restoring effect on people visiting it."	Alternative quantitative and subjective definition of quiet.
Noise Mapping Bristol – The SILENCE Project – Tranquil Spaces Poject	Steve Crawshaw, Bristol City Council	2009	People were asked to plot their chosen quiet places on a web based streetmap "Bristolstreets". The data from "Bristolstreets" was used alongside other GIS data including strategic noise maps and qualitative information on open space quality to identify those places in the city where "quietness" is an important characteristic of the area.	Quite useful, need to follow up to meeting with key players.
Birmingham	Birmingham City Council Environmental Protection Team	2011	Brief telephone conversation to discuss what had been done regarding public consultation asking people to identify areas they felt wee quiet and comparing with the noise maps, plus some long term noise monitoring around the city. Further information to be obtained once skey staff return from sick leave.	Could be very relevant and form bais of further study
Quieteing Open Spaces	Ruth Calderwood, City of London Claire Shepherd, Bureau Veritas Mary Stevens, Environmental Protection	2010	Report sets out policy context and practical ways in which existing open spaces in the City of London can be transformed into "havens of calm"	Very relevant as contains useful and recent body of references from previous work Approach used in City of London may be applicable to other areas.

Study Title	Authors	Date	Summary	Commentary (i.e. how useful is this study and how may it contribute to our work?)
	UKand then GLA noise team			

Appendix 2: Review Protocol

See file called “Appendix 2 – Review Protocol”

Appendix 3: Noise and Vibration

Acoustic Terminology

Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure (measured in Pascals, Pa). Because of this wide range, a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB. The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A), dBA, or L_A dB. Table A3-1 lists the sound pressure level in dB(A) for common situations.

Table A3-1: Noise Levels for Common Situations

Approximate Sound Pressure Level (dB(A))	Example
0	Threshold of hearing
30	Rural area at night
50	Quiet office, no machinery
80	General factory noise level
100	Pneumatic drill
140	Threshold of pain

The noise level at a measurement point is rarely steady, even in rural areas, and varies over a range dependent upon the effects of local noise sources. Close to a busy motorway, the noise level may vary over a range of 5 dB(A), whereas in a suburban area this variation may be up to 40 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night-time noise levels will often be smaller and the levels significantly reduced compared to daytime levels. When considering environmental noise, it is necessary to consider how to quantify the existing noise (the ambient noise) to account for these second to second variations.

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background noise level, L_{A90}. This is the noise level exceeded for 90 % of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the L_{A90} will be the noise level exceeded for 54 minutes.

The equivalent continuous A-weighted sound pressure level, L_{Aeq} is the single number that represents the total sound energy measured over that period. L_{Aeq} is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. It is commonly used to express the energy level from individual sources that vary in level over their operational cycle.

Human subjects, under laboratory conditions, are generally only capable of noticing changes in steady levels of no less than 3 dB(A). It is generally accepted that a change of 10 dB(A) in an overall, steady noise level is perceived to the human ear as a doubling (or halving) of the noise level. (These findings do not necessarily apply to transient or non-steady noise sources such as changes in noise due to changes in road traffic flow, or intermittent noise sources).

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background noise level, L_{A90}. This is the noise level exceeded for 90 % of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the L_{A90} will be the noise level exceeded for 54 minutes.

L_{den} is defined in terms of the "average" levels during daytime, evening, and night-time, and applies a 5 dB penalty to noise in the evening and a 10 dB penalty to noise in the night. The definition is as follows:
$L_{den} = 10 \lg [(12/24).10^{LD/10} + (4/24).10^{(LE+5)/10} + (8/24).10^{(LN+10)/10}]$

Appendix 4: Acoustic Measurement Methodology

The three sites were visited for a period of approximately two hours during Wednesday 2nd March 2011. The noise instruments were set up at a point considered typical of the site as a whole. Where possible this was chosen to be central to the open space. Care was taken not to cause an obstruction to the users of the site or to be too close to an obvious local noise source, such as building service equipment in nearby buildings. Additional measurements were undertaken along the boundaries to gain a comparison between the centre and the edge of each site.

Noise measurements were undertaken with a 5-minute logging period, and recorded noise indicators included: L_{Aeq}, L_{AF10}, L_{AF90}, and L_{AFmax} sound pressure levels for each 5-minute period.

In addition to the noise measurements and social surveys, a site pro-forma was completed at each site to capture the following information:

- Instrumentation used for noise measurements, including calibration records;
- Weather conditions during measurements;
- Audible noise sources noted during the site survey (categorised, with spaces for additional noise sources and comments);
- A subjective assessment of noise climate at the site (the opinion of acoustic consultant undertaking noise measurement, and separate from the questionnaire responses).

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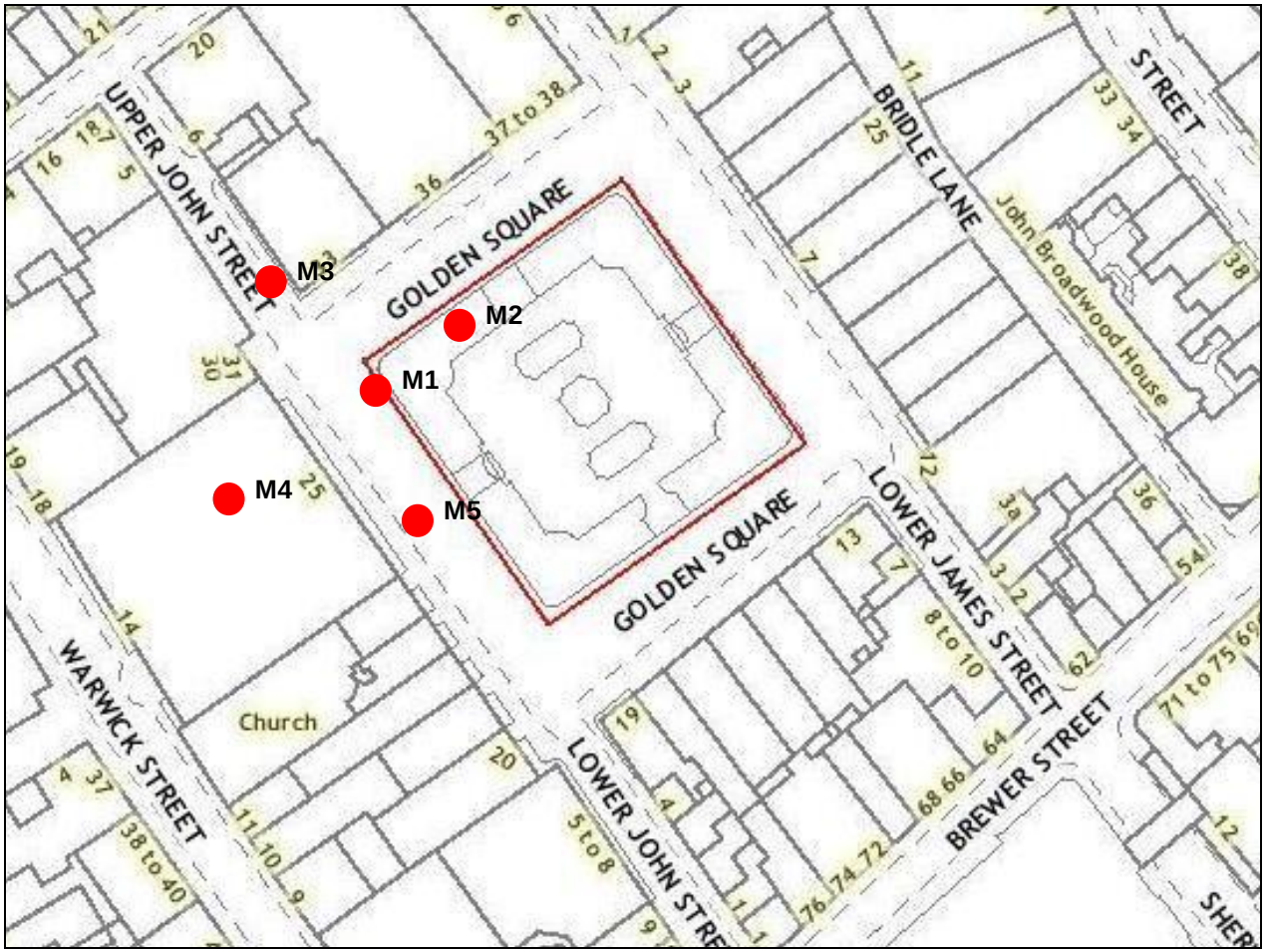
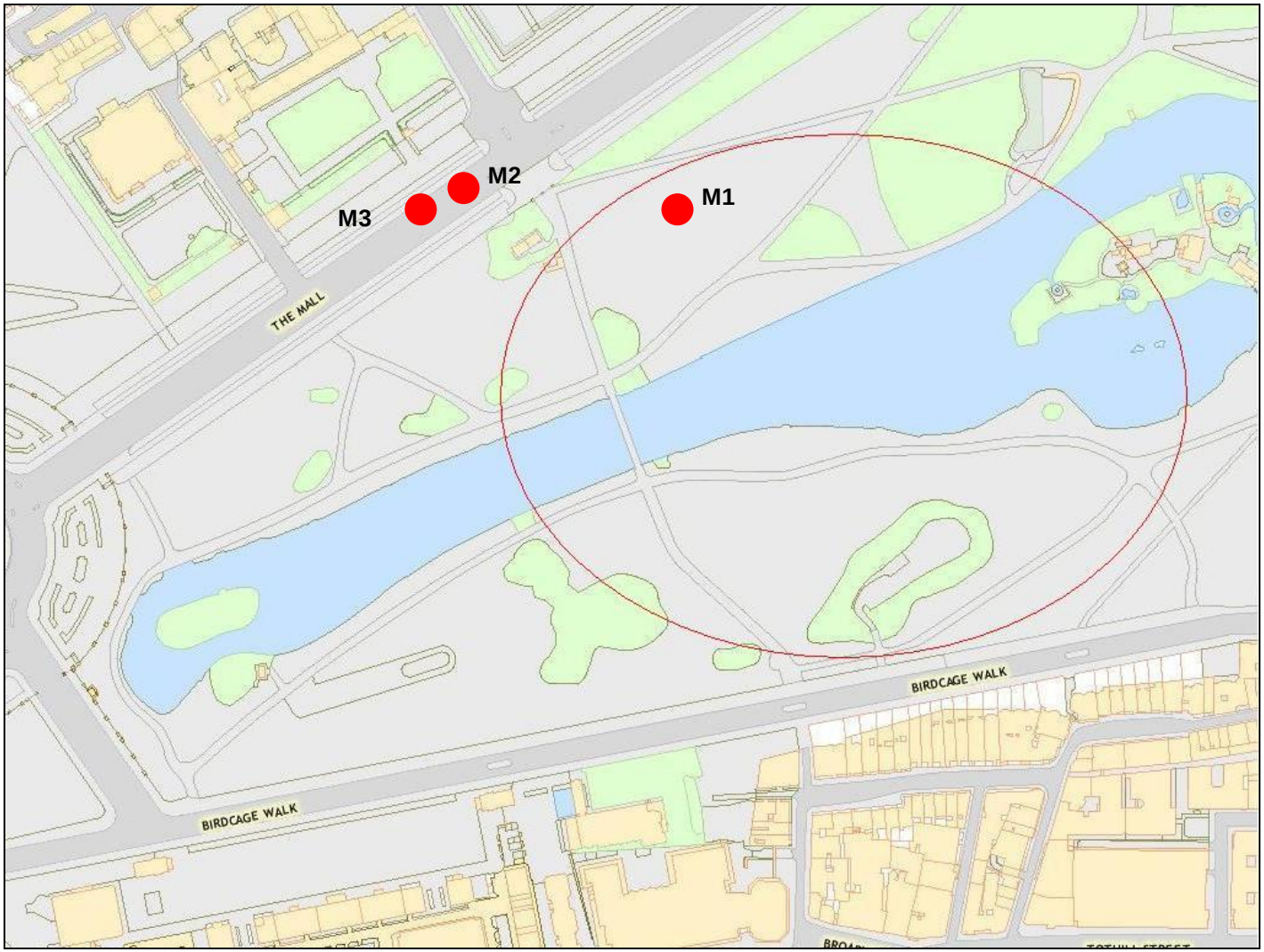
Appendix 5: Noise Measurement Locations

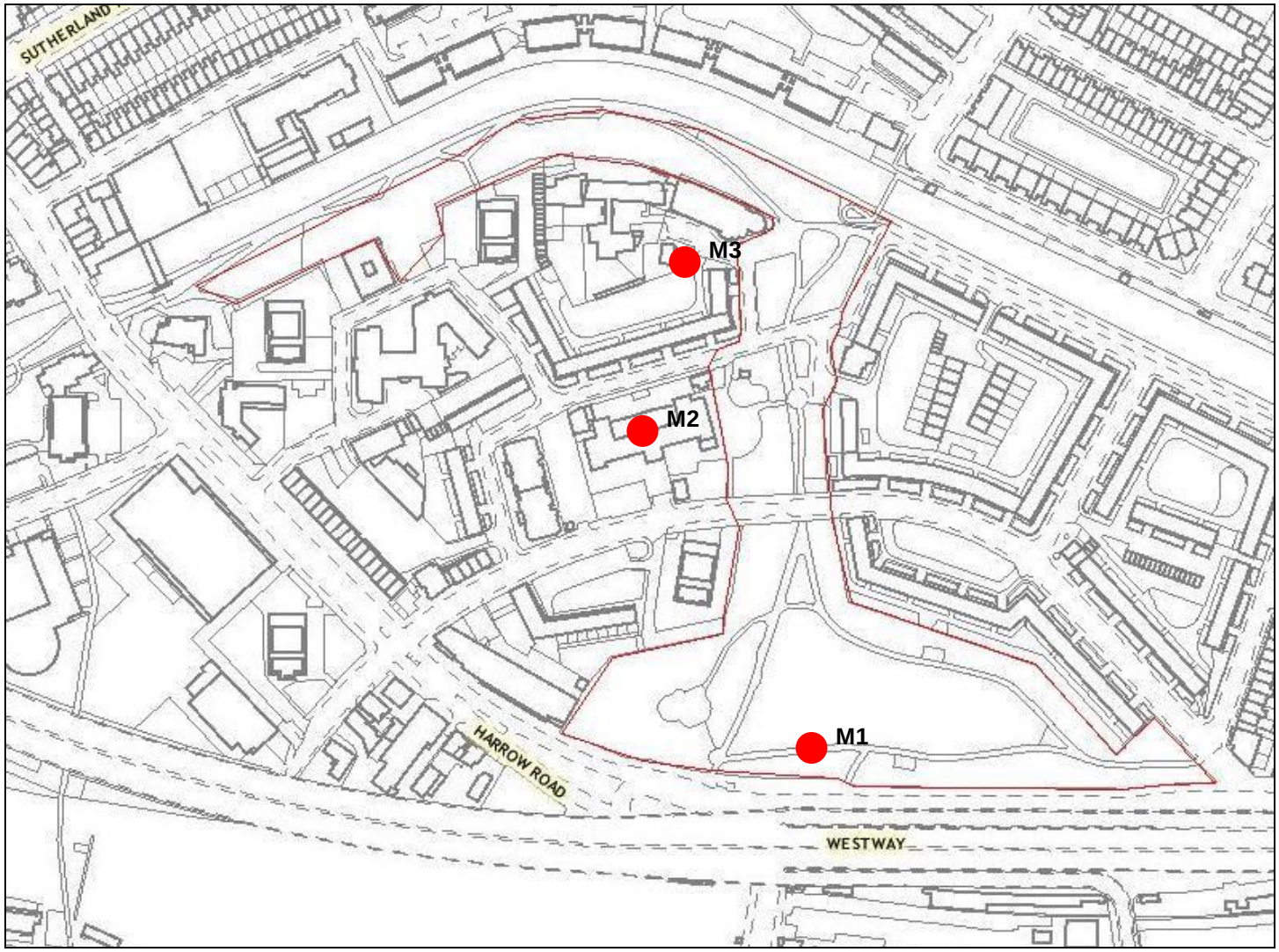
Golden Square



St James's Park



Westbourne Green

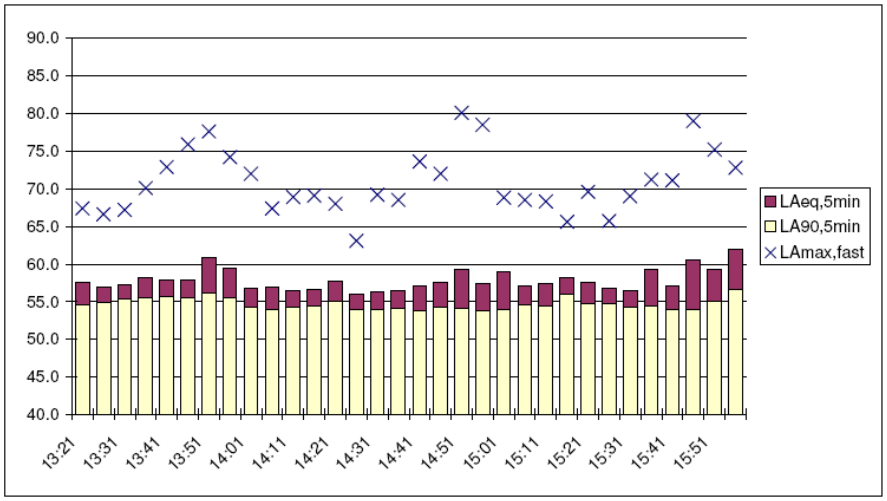


Appendix 6: Noise Measurements Recorded at each Site

Golden Square - Center - Position M1

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
13:21	57.6	59.6	54.6	67.4
13:26	57.0	58.8	54.9	66.6
13:31	57.3	59.1	55.4	67.2
13:36	58.2	59.8	55.5	70.1
13:41	57.8	59.4	55.7	72.9
13:46	57.8	59.1	55.5	75.9
13:51	60.9	62.2	56.2	77.6
13:56	59.5	62.6	55.5	74.2
14:01	56.7	58.6	54.3	72.0
14:06	56.9	59.2	54.0	67.4
14:11	56.4	57.8	54.3	68.9
14:16	56.6	57.9	54.5	69.1
14:21	57.7	59.7	55.0	68.0
14:26	56.0	57.7	53.9	63.1
14:31	56.3	58.0	53.9	69.2
14:36	56.5	57.9	54.1	68.5
14:41	57.1	59.0	53.7	73.6
14:46	57.6	60.0	54.2	72.0
14:51	59.3	60.1	54.1	80.1
14:56	57.4	58.0	53.7	78.5
15:01	59.0	62.4	53.9	68.8
15:06	57.1	59.0	54.6	68.5
15:11	57.4	59.6	54.4	68.3
15:16	58.2	60.3	55.9	65.6
15:21	57.6	59.7	54.7	69.6
15:26	56.7	58.4	54.7	65.7
15:31	56.5	58.3	54.3	69.0
15:36	59.2	62.0	54.5	71.2
15:41	57.1	59.5	54.0	71.1
15:46	60.6	60.6	53.9	79.0
15:51	59.2	61.2	55.1	75.2
15:56	62.0	65.5	56.6	72.8
Average	***58***	***60***	***55***	***Max = 80***



Noise Sources

Road noise	
Constant, nearby	
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	●
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

Other

Site specific noise

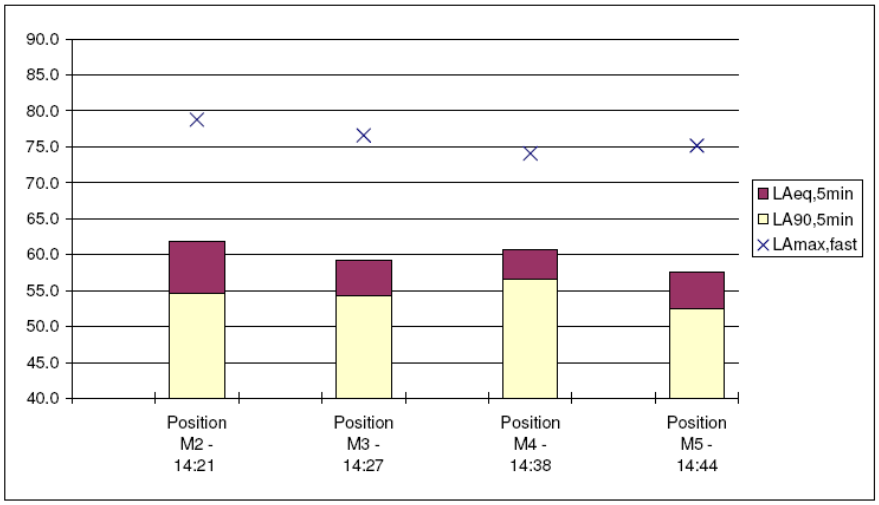
Subjective Comments

Construction noise was the dominant noise source. Traffic noise was predominantly distant but the occasional vehicle drove by on the roads around to the square.

Golden Square - Edges - Positions M2, M3, M4, M5

Measurement date: Wednesday 2nd March 2011

Pos / Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
Position M2 - 14:21	61.8	63.2	54.6	78.8
Position M3 - 14:27	59.2	60.6	54.2	76.6
Position M4 - 14:38	60.7	64.1	56.5	74.1
Position M5 - 14:44	57.5	59.2	52.5	75.2
Average	***60***	***62***	***55***	***Max = 79***



Noise Sources

Road noise	
Constant, nearby	
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	●
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

Other

Measurements were undertaken at each entrance to the park. The measurments were undertaken at the east, north, west and south entrance respectively to time.

Site specific noise

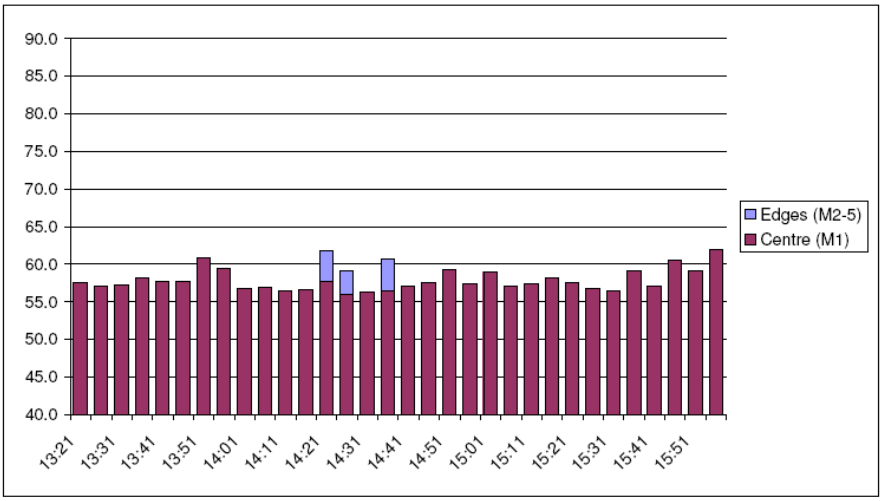
Subjective Comments

Construction noise was the dominant noise source. Traffic noise was predominantly distant but the occasional vehicle drove by on the roads around to the square.

Golden Square - $L_{Aeq,5min}$ Comparison

Comparison between the contigious $L_{Aeq,5min}$ measurments undetaken at the centre and the corresponding $L_{Aeq,5min}$ measurements at the edge.

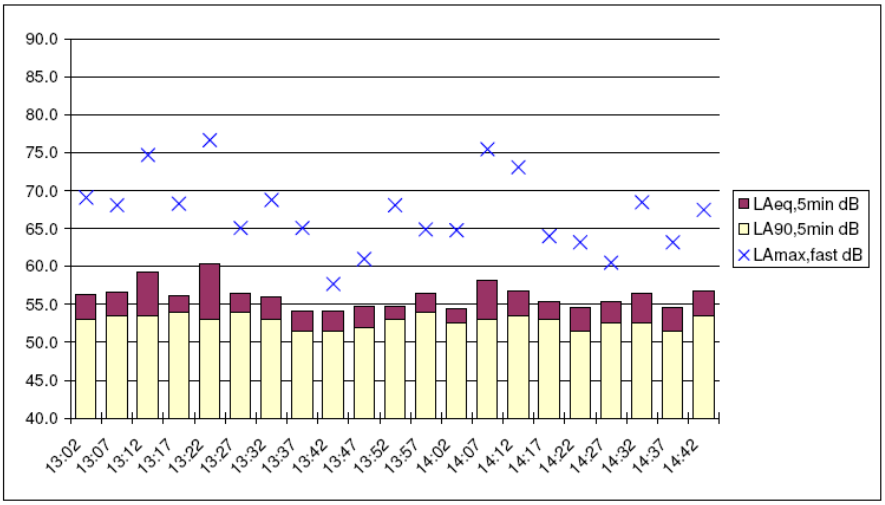
Start Time	Monitoring Position	
	Centre (M1)	Edges (M2-5)
13:21	57.6	
13:26	57.0	
13:31	57.3	
13:36	58.2	
13:41	57.8	
13:46	57.8	
13:51	60.9	
13:56	59.5	
14:01	56.7	
14:06	56.9	
14:11	56.4	
14:16	56.6	
14:21	57.7	61.8
14:26	56.0	59.2
14:31	56.3	
14:36	56.5	60.7
14:41	57.1	
14:46	57.6	57.5
14:51	59.3	
14:56	57.4	
15:01	59.0	
15:06	57.1	
15:11	57.4	
15:16	58.2	
15:21	57.6	
15:26	56.7	
15:31	56.5	
15:36	59.2	
15:41	57.1	
15:46	60.6	
15:51	59.2	
15:56	62.0	
Average	***58***	***60***



St James' Park - Inside the park - Position M1

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A90,5min}$ dB	LAmax,fast dB
13:02	56.3	53.0	69.1
13:07	56.6	53.5	68.1
13:12	59.2	53.5	74.7
13:17	56.1	54.0	68.3
13:22	60.4	53.0	76.7
13:27	56.5	54.0	65.1
13:32	56.0	53.0	68.8
13:37	54.1	51.5	65.1
13:42	54.1	51.5	57.7
13:47	54.7	52.0	61.0
13:52	54.8	53.0	68.1
13:57	56.5	54.0	64.9
14:02	54.5	52.5	64.8
14:07	58.2	53.0	75.5
14:12	56.8	53.5	73.1
14:17	55.4	53.0	64.0
14:22	54.6	51.5	63.2
14:27	55.4	52.5	60.5
14:32	56.4	52.5	68.5
14:37	54.6	51.5	63.2
14:42	56.8	53.5	67.5
Average	***56***	***53***	***Max = 77***



Noise Sources

Road noise	
Constant, nearby	
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	●
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	●
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	●
Water flow	
Wind	

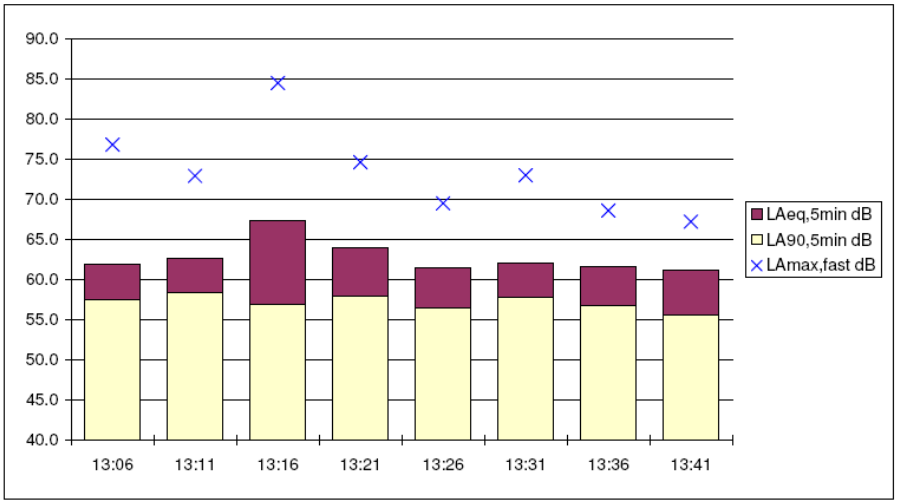
Subjective Comments

Traffic noise was the dominant noise source. Traffic noise was predominantly local but distant traffic maintained a constant background noise level.

St James' Park - Perimeter - Position M2

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
13:06	61.9	64.5	57.4	76.8
13:11	62.6	65.7	58.4	72.9
13:16	67.3	66.8	56.9	84.5
13:21	64.0	68.2	57.9	74.6
13:26	61.5	64.8	56.4	69.5
13:31	62.1	65.2	57.8	73.0
13:36	61.6	64.8	56.8	68.6
13:41	61.2	65.3	55.6	67.2
Average	***63***	***66***	***57***	***Max = 85***



Noise Sources

Road noise	
Constant, nearby	●
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

Other
Noise from emergency vehicle siren at 13:19

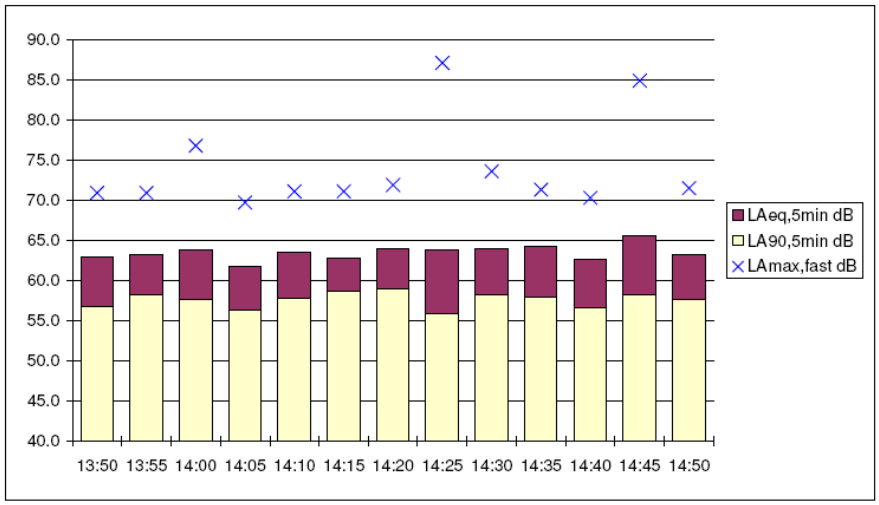
Subjective Comments

Traffic noise was the dominant noise source. Traffic noise was predominantly local but distant traffic maintained a constant background noise level.

St James' Park - Perimeter - Position M3

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
13:50	62.9	66.3	56.8	70.9
13:55	63.3	66.0	58.3	70.9
14:00	63.8	67.7	57.7	76.8
14:05	61.8	65.8	56.3	69.7
14:10	63.5	67.0	57.8	71.1
14:15	62.8	66.5	58.6	71.1
14:20	63.9	66.9	59.0	71.9
14:25	63.8	66.2	55.9	87.1
14:30	64.0	66.9	58.2	73.6
14:35	64.2	67.5	58.0	71.3
14:40	62.6	66.2	56.6	70.3
14:45	65.6	67.4	58.2	84.9
14:50	63.3	66.8	57.7	71.5
Average	***64***	***67***	***58***	***Max = 87***



Noise Sources

Road noise	
Constant, nearby	●
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	
Overhead	
Helicopter	●
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

Other
Distant church bells

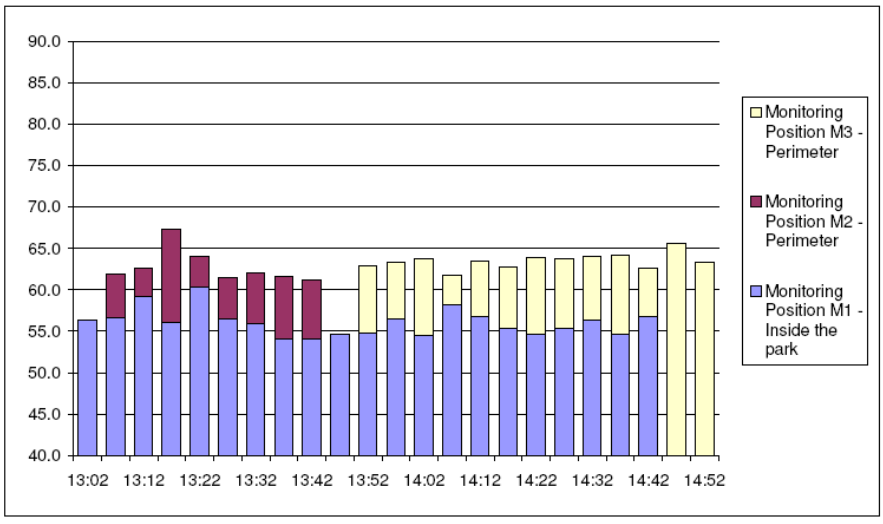
Subjective Comments

Traffic noise was the dominant noise source. Traffic noise was predominantly local but distant traffic maintained a constant background noise level.

St James' Park - $L_{Aeq,5min}$ Comparison

Comparison between the contigious $L_{Aeq,5min}$ measurments undetaken at the centre and the corresponding $L_{Aeq,5min}$ measurements at the edge.

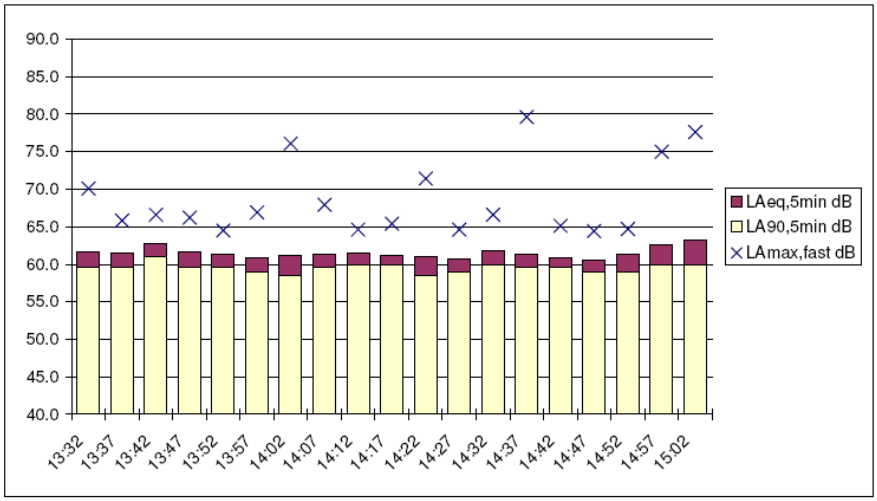
Start Time	Monitoring Position		
	M1 - Inside the park	M2 - Perimeter	M3 - Perimeter
13:02	56.3		
13:07	56.6	61.9	
13:12	59.2	62.6	
13:17	56.1	67.3	
13:22	60.4	64.0	
13:27	56.5	61.5	
13:32	56.0	62.1	
13:37	54.1	61.6	
13:42	54.1	61.2	
13:47	54.7		
13:52	54.8		62.9
13:57	56.5		63.3
14:02	54.5		63.8
14:07	58.2		61.8
14:12	56.8		63.5
14:17	55.4		62.8
14:22	54.6		63.9
14:27	55.4		63.8
14:32	56.4		64.0
14:37	54.6		64.2
14:42	56.8		62.6
14:47			65.6
14:52			63.3
Average	***56***	***63***	***64***



Westborne Grove - Edge - Position M1

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
13:32	61.6	59.5	70.1
13:37	61.5	59.5	65.8
13:42	62.8	61.0	66.6
13:47	61.6	59.5	66.2
13:52	61.4	59.5	64.5
13:57	60.8	59.0	66.9
14:02	61.1	58.5	76.1
14:07	61.4	59.5	67.9
14:12	61.5	60.0	64.6
14:17	61.2	60.0	65.4
14:22	61.0	58.5	71.4
14:27	60.7	59.0	64.6
14:32	61.8	60.0	66.6
14:37	61.4	59.5	79.6
14:42	60.9	59.5	65.1
14:47	60.6	59.0	64.4
14:52	61.3	59.0	64.7
14:57	62.6	60.0	75.0
15:02	63.3	60.0	77.6
Average	***62***	***60***	***Max = 80***



Noise Sources

Road noise	
Constant, nearby	●
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

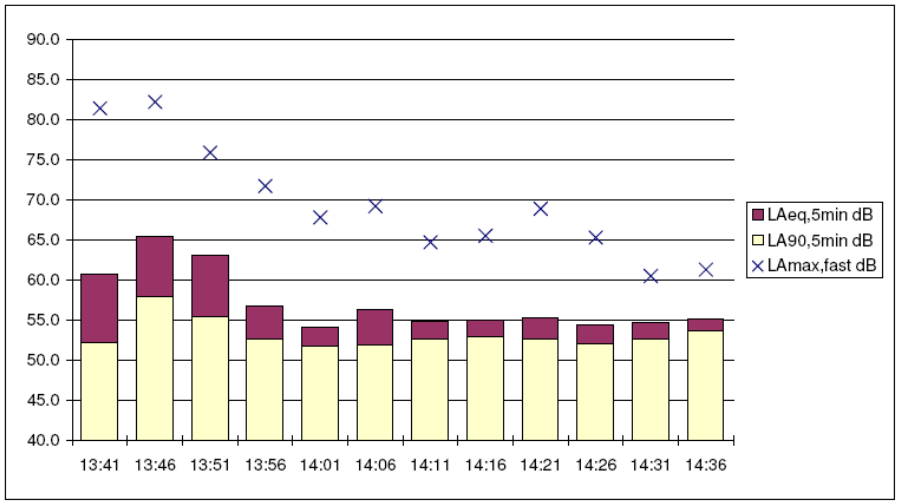
Subjective Comments

Traffic noise along the A40 Westway was the dominant noise source and maintained a constant background noise level. Individual vehicles gave rise to the maximum measured noise levels.

Westborne Grove - Centre - Position M2

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
13:41	60.8	61.3	52.2	81.4
13:46	65.4	68.6	57.9	82.2
13:51	63.1	66.4	55.4	75.9
13:56	56.7	59.3	52.7	71.7
14:01	54.1	55.4	51.8	67.8
14:06	56.3	58.3	51.9	69.2
14:11	54.9	56.6	52.6	64.7
14:16	55.0	56.4	52.9	65.5
14:21	55.3	57.4	52.7	68.9
14:26	54.4	56.2	52.1	65.3
14:31	54.7	56.3	52.7	60.5
14:36	55.2	56.6	53.6	61.3
Average	*59*	*59*	*53*	*Max = 82*



Noise Sources

Road noise	
Constant, nearby	●
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	●
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	●
Other man made	
Construction	
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

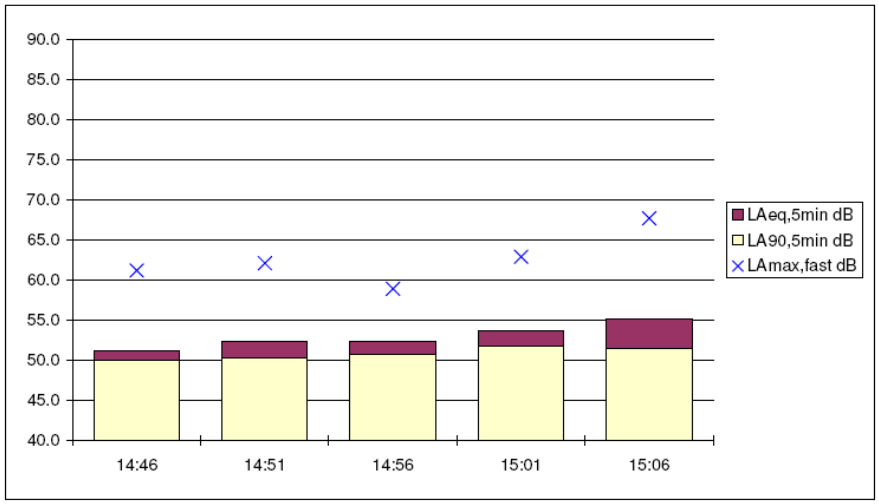
Subjective Comments

Traffic noise was the dominant noise source. Traffic noise was predominantly local but distant traffic along the A40 Westway maintained a constant background noise level.

Westborne Grove - Edge - Position M3

Measurement date: Wednesday 2nd March 2011

Start Time	$L_{Aeq,5min}$ dB	$L_{A10,5min}$ dB	$L_{A90,5min}$ dB	$L_{Amax,fast}$ dB
14:46	51.2	52.2	50.0	61.2
14:51	52.4	54.3	50.3	62.1
14:56	52.4	53.7	50.7	58.9
15:01	53.7	54.9	51.8	62.9
15:06	55.1	57.0	51.4	67.7
Average	*53*	*54*	*51*	*Max = 68*



Noise Sources

Road noise	
Constant, nearby	
Constant traffic hum	●
Individual vehicles	●
Emergency sirens	
Other	
Aircraft noise	
Distant	●
Overhead	
Helicopter	
Railway noise	
Distant	
Nearby	

Leisure	
Sport activities	
Conversation	●
Children playing	
Other man made	
Construction	
Alarms	
Fountains	
Building services	
Natural	
Birds	
Animals	
Trees rustling	
Water flow	
Wind	

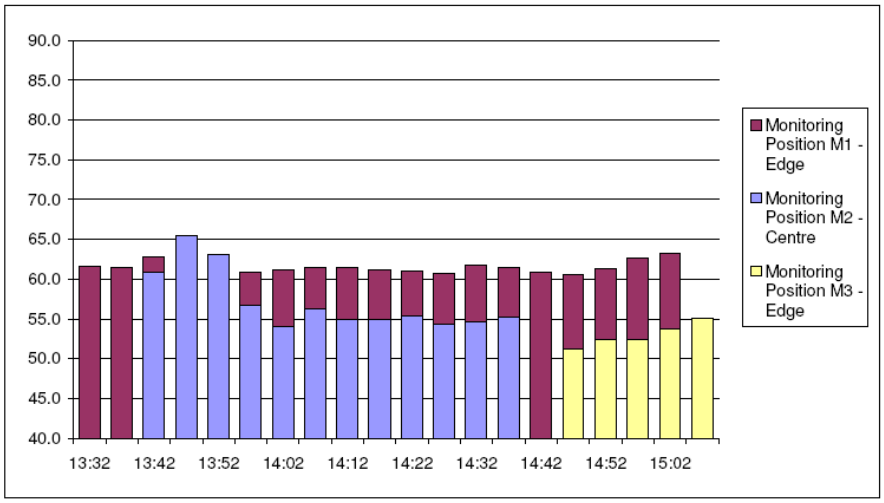
Subjective Comments

Traffic noise was the dominant noise source. Traffic noise was predominantly local but distant traffic along the A40 Westway maintained a constant background noise level.

Westborne Grove - $L_{Aeq,5min}$ Comparison

Comparison between the contigious $L_{Aeq,5min}$ measurments undetaken at the centre and the corresponding $L_{Aeq,5min}$ measurements at the edge.

Start Time	Monitoring Position		
	M1 - Edge	M2 - Centre	M3 - Edge
13:32	61.6		
13:37	61.5		
13:42	62.8	60.8	
13:47	61.6	65.4	
13:52	61.4	63.1	
13:57	60.8	56.7	
14:02	61.1	54.1	
14:07	61.4	56.3	
14:12	61.5	54.9	
14:17	61.2	55.0	
14:22	61.0	55.3	
14:27	60.7	54.4	
14:32	61.8	54.7	
14:37	61.4	55.2	
14:42	60.9		
14:47	60.6		51.2
14:52	61.3		52.4
14:57	62.6		52.4
15:02	63.3		53.7
15:07			55.1
Average	***62***	***59***	***53***



Golden Square

This site is a predominantly paved area, surrounded by high rise offices on all sides.

The noise climate is typically dominated by traffic noise from the roads surrounding the area. Distant traffic noise provided a constant background noise level. The noise levels between the centre and the edges of the area are not likely to have significant variance, as the distances between the centre and the edges are relatively small.

A comparison of the measured L_{Aeq} noise levels at the edges and the centre show a relative difference of approximately 2 dB. A comparison of the Defra Environmental Noise Directive (END) noise maps[233] show that the L_{den} noise levels are at least 3 dB below the measured $L_{Aeq,T}$ noise levels at each position. It must be noted that the noise maps do not taken into account traffic noise on the local roads around Golden Square, or noise from non-traffic sources.

St James' Park

This site is a predominantly green area, surrounded by major on all sides.

The noise climate is typically dominated by traffic noise from the roads surrounding the area. The noise levels between the centre and the edges of the area are likely to have significant variance, as the distances between the centre and the edges of the park are considerable.

A comparison of the measured L_{Aeq} noise levels at the edges and the centre show a relative difference of approximately 7 to 10 dB. A comparison of the Defra END noise maps show that the L_{den} noise levels approximately corresponds to the measured L_{Aeq} noise levels at each position. It must be noted that the noise maps do not taken into account additional noise sources.

Westbourne Green

The site does not match the 'typical' park shape and lacks an obvious central area; instead the site is a conglomeration of a north and south parkland area, joined by a series of walkways. The northern parkland area is surrounded by housing to the east and west, with a canal to the north. The southern parkland area is surrounded by housing to the east and west, with the A40 and A404 to the south of the site.

The noise climate is typically dominated by traffic noise from the A40 Westway to the south of the parks. It is likely that a comparison of noise levels the park edges and the centre will produce less notable differences, than a comparison between the south and the north, with distance from the A40.

A comparison of the measured L_{Aeq} noise levels at the south of the park and the centre show a relative difference of 3 to 6 dB, depending on the time of day and interference from local noise sources. A comparison of the measured L_{Aeq} noise levels at the south of the park and the north show a relative difference of approximately 9 dB. A comparison of the END noise maps show that the L_{den} noise levels are approximately between 2 to 5 dB above the measured L_{Aeq} noise levels at each positions. It must be noted that the noise maps do not taken into account traffic noise from the local roads, or noise from additional noise sources.

[233] Defra Noise Mapping England Website: http://noisemapping.defra.gov.uk/cara/

Appendix 7: Survey Questionnaire

Appendix 8: Study Database

See separate Excel spreadsheet “Appendix 8 - Study Database”. The database records all studies that were identified through the search strategy.