

LASALLE INVESTMENT MANAGEMENT

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		Mr
First Name		Robert
Last Name		Davies
Job Title <i>(if applicable)</i>		Partner
Organisation <i>(if applicable)</i>	LaSalle Investment Management	Gerald Eve LLP
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Address 2		
Address 3		
Town		London
Post Code		W1G 0AY
Telephone		020 7333 6207
E-mail		rdavies@geraldeve.com

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Draft Local Plan Policy CR16

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Our client controls the site at 15-18 Friar Street, 2-16 Station Road and Harris Arcade. As such our client's previous representations, submitted on 13 June 2017, in response to the Reading Borough Council's (RBC) Draft Local Plan in respect of 15-18 Friar Street, 2-16 Station Road and Harris Arcade ('the site') still stand.

Draft Local Plan Section 5 - Strategy for Central Reading / Station/River Major Opportunity Area / Draft Local Plan Policy CR11(a) and (b)

We continue to support RBC's wider strategy for Central Reading as set out in the Draft Policy CR11(a) and (b) and in particular support the objectives to significantly improve the wider station area as a gateway into a vibrant and successful town centre.

LaSalle welcome the acknowledgement that large parts of the area are currently low density and that there is some inefficient uses of one of the most accessible locations in the South East (paragraph 5.4.1). At paragraph 5.2.15 it is stated that there is "undoubted physical capacity within the centre to incorporate a significant level of new development, by efficient use of underused land through carefully developing at higher densities". This statement is fully supported along with the conclusion at paragraph 5.4.4 that "in order for the station area to become a destination in its own right, it should contain a wide mix of uses across the area".

The Policy Approach to Draft Policy CR16

Our client's site is approximately 0.34ha and is comprises the majority of the draft designated 'Area to the north of Friar Street and east of Station Road', referenced within Draft Policy CR16. The extent of the landholdings is shown on the attached

plan.

Not Positively Prepared

The Pre-Submission Draft of the Local Plan does not properly address the identified local development requirements at the site. According to the NPPF, in order to be thought of as ‘positively prepared’ the plan should seek to **“meet objectively assessed development and infrastructure requirements...”**

The Local Plan as currently prepared would fail to deliver the significant level of development for which there is an acknowledged capacity and requirement, in Central Reading. This is because Draft Policy CR16 as drafted precludes ‘wholesale redevelopment’ within the ‘Area to the north of Friar Street and east of Station Road’, a key central development site.

The site as existing comprises a mix of retail and main town centre uses (including leisure and drinking establishments) and is located immediately adjacent to the Station/River Major Opportunity Area boundary. The western side of Station Road, opposite the site, is included within Policy CR11a and is identified as a Site for redevelopment as set out above. The western side of Station Road is also the boundary of the Station Road Tall Buildings Cluster area where buildings of 10 storeys and above would be considered. It is recognised that the landholdings within Draft Policy CR16 are unlikely to accommodate tall buildings, although the policy ought to recognise that in accordance with good design principles there may be opportunities to make better use of parts of the site. Station Road is identified as an essential north-south link where a high quality public realm is vital to integrating the Station Area with the existing shipping core. In recognition of this, we support the cluster of small local businesses within the Harris Arcade and seek to enhance the fine-grain retail offer through comprehensive consideration of development opportunities.

In addition, Friar Street is included within the Friar Street Business Improvement District which includes the main retail, financial and night time economy uses.

Massing

It is considered that the existing Site represents an opportunity for a phased redevelopment. A redevelopment scheme would have the potential to increase the efficiency of the site through careful and well considered increase in density as part of comprehensive proposals that consider the individual components, but also the site as a whole. Additional development across very low density parts of the site could be explored subject to good design and appropriate consideration of the townscape. It is recognised that County House provides a very strong element of the overall massing at the crossroads. It is considered that there is potential for at least, an extension into the service yard off Winston Terrace and for additional height, and massing to the predominantly single storey western part of the site.

Uses

The Site is located within the RCAAP which will be “promoted and maintained as a

top-class location for business, retail, leisure, culture and learning... the focus for continued high class mixed use development”. It is therefore considered that the Site represents an opportunity for redevelopment for a range of uses with active frontages on the ground floor and a mix of uses on the higher floors. In our view, a broad range of uses could be explored for the site, as follows:-

- a. Retail and main town centre uses (including leisure and drinking establishments) as the Site is in the Primary Shopping Area, Central Core and an Active Frontage location;
- b. Hotel uses - as the Site is in the Central Core with the Central Area identified as the prime focus for major leisure, cultural and non-regionally significant tourism development;
- c. Office use - as the Site is in the Office Core;
- d. Student Accommodation given the accessibility to higher education and further education institutions in terms of walking, cycling and accessibility of all town centre bus services;
- e. Residential use in accordance with town centre aspirations.

Therefore the document is unsound as it fails to maximise the development potential of the ‘Area to the north of Friar Street and east of Station Road’.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

RBC should reconsider its Local Plan. There is a clear opportunity for positive and significant development at the site to deliver vital town centre uses to Central Reading, a need and capacity for which RBC acknowledge at paragraph 5.2.15. The Local Plan as drafted would preclude such levels of development and is overly restrictive.

The following wording is suggested for Draft Local Plan Policy CR16:

“The function of the area east of Station Road and north of Friar Street, as shown on the Proposals Map, makes a positive contribution to the character of the town centre. Where possible, development proposals should seek to enhance and sustain the character of the retail units within the Harris Arcade and the buildings fronting the streets will be conserved and, where possible, enhanced. ~~Whilst~~ Tthere ~~will be~~ is potential for ~~some~~ the conversion of buildings and ~~, potentially, some~~ development within the site that does not detrimentally affect its overall character. Pproposals for ~~wholesale~~ comprehensively considered redevelopment and enhancement of the area will ~~not~~ be supported as a positive opportunity to contribute to the mix of uses

within this part of the town centre, in the context of wider town centre policies and other material considerations.”

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

To enable the Planning Inspector to fully understand the key reasons why our requested amendment to the Local Plan is required to make the plan ‘sound’ and to facilitate a thorough examination of the issues.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Friar Street, Station Road and Harris Arcade Reading RG1



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J7827



LAUNCHBURY, AMANDA

From: Amanda
Sent: 24 January 2018 10:02
To: Planning Policy
Cc: Amanda Launchbury
Subject: Draft Local Plan

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Thank you very much for inviting me to comment on the Draft Local Plan for Reading.

My only concern is the lack of emphasis on our (very limited) parks and public spaces. I've lived in Reading for 44 years and in that time it's grown from a large market town to , for want of a better word, a city : busy & bustling . However, I do feel that other cities have far more acceptable ratios between developed land and open ,green public spaces.

Reading is essentially office building, shops, warehouses and housing. In my local area alone, RBC have closed a council run , old peoples home and replaced it with... As many small luxury flats as they could fit on the site. Obviously this increases the strain on the immediate environment and all local amenities. I would like to see in place a ratio that is addressed, when the population is increased in the area because of housing development , that the relevant amenities, school places, shops, transport and green open space have been carefully considered first. I believe careful planning and finance needs to be injected in to any area where housing is increased to rebalance the community and its environment- this should be included within all future building/ development plans.

This brings me on to my main concern. Compared to other cities, I feel Reading is massively lacking in open green recreational spaces. If we exclude land within Readings floodplain (because we can assume the council would have built on this land, if it were possible) our environment is shockingly concrete.

I'd like to know what plans/ powers/ laws will be in place to insist RBC comply with residence wishes to not just encourage existing open green spaces but also create more parks and spaces, especially as our population expands. What is in place to prevent RBC over riding any suggestions you have made in this report? Or ignoring any policies agreed by government or bulldozing through 'legal trusts' on open spaces and recreation grounds? How do we prevent them from developing and building schools or housing on these spaces regardless?

If all your draft can accomplish are preferred guidelines that the planning and development of Reading can hope to achieve; it will all sadly be pointless if at any point RBC can override your guidelines just to achieve and fore-fill their housing/schooling/ development quotas.

I wish you the very best of luck with this project.

Kind regards

Mrs Amanda Launchbury

LAURIA, DR S.

From: stasha lauria
Sent: 24 January 2018 09:15
To: Planning Policy
Subject: Local Plan Section EN7N Item EN7Nn

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

To whom it may concern.

Could you please address/consider the following points:

1. Why is the current Local Plan being ignored in favour of RBC supporting the ESFA's proposals to build a school on Mapledurham Playing Fields, which is designated green open space and held in trust exclusively for recreation?

2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?

3. In particular how will it safeguard against the following factors, which cannot be mitigated and will significantly impact Mapledurham Playing Fields, if the EFSA proposal is implemented:
 - a. Traffic movements
 - b. Air pollution
 - c. Noise pollution
 - d. Visual dominance and overbearing on the area of the site where they propose to build
 - e. Privacy and overlooking
 - f. Out of character with local residential properties
 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment

4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?

Regards,
Dr. S. Lauria

LAWSON, IAN

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Section 8 Caversham and Emmer Green

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

CA1b describes the change of use of the Reading Golf Course which has been an important asset of not only the locality but the whole of Reading for over 100 years. It has been the subject of successive overtures from developers over the years which to an extent blighted the club and the properties boarding the land. This important green asset should be left alone.
To build 90 plus homes on the land would overload the roads in the locality and cause further significant traffic jams which already can reach from the Henley Road to Buckingham Drive

CA2 discusses the development of Caversham Park . The site was once the location of a private school before the BBC took the site over.
It is well known that the Chiltern College at 18 Peppard Road are looking to redevelop their nursery facility. It might be possible to relocate the college to Caversham park in order to allow development of college site. There is also the school (870/6009) which is now operating at capacity which could benefit from a larger site if it were offered. Such a move over time would benefit the community an offer a positive use for the site.

In both cases the need for third river crossing would have to be completed before any new housing were to be approved for Caversham and Emmer Green

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Allow use of the Caversham Park as a private school

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

LAWSON-MUDGE, JANE

From: Jane Lawson-Mudge
Sent: 22 January 2018 23:58
To: Planning Policy
Subject: Development of land at Reading Golf Club Kidmore End Rd
Attachments: Pre-Submission_Local_Plan_November_2017.pdf; ATT00001.txt

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Planning Office,

It has been brought to my attention via a leaked correspondence among Reading Golf Club members, that suggests a submission has been reissued to develop part of the course to make way for 130 houses and a leisure centre.

If this is the case, how can it be possible that local neighbours have been given no notification of these proposals- with a 26th Jan deadline to voice any oppositions?

Please confirm if this is the case, or please provide us with some peace of mind, that this is merely anxious speculation without any factual basis.

If this is based in fact however- I would have to strongly place my objection on record: to further develop a green space- a haven to wildlife- in an area whose public resources are already under massive strain to meet the demands of primary school places and available doctors' appointments (to name but two objections), would be devastating to the local community.

Where would any site entrance be positioned during proposed construction and how would the additional noise and airborne pollution from 130-260 vehicles be compensated for?

The kidmore end road is predominantly, a country road that leads on to a narrow and highly restricted winding lane. Gravel lane has already been partially cut off to prevent traffic cutting across from Kidmore Rd Caversham Heights to minimise accident and dangerous through traffic.

Are Reading Borough Council and the Highways Department honestly considering turning this quiet residential area into a noisy and polluted thoroughfare?

Please advise me of the facts so I can either calm the gossip, or embark on an appropriate defence.

Sincerely
Jane Lawson-Mudge

From: Jane Lawson-Mudge
Sent: 08 February 2018 12:53
To: Burr, Sarah
Subject: Reading Golf Club

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Sarah,

Thank you for replying to my previous email so promptly. I have hesitated in contacting you too prematurely, but have now received confirmation that the Club has made a proposal to shareholders to approve the sale of the land for development.

I understand that this land borders both Berkshire and South Oxfordshire, so I would appreciate clarification as to how individual council's approach and authorise such decisions (in areas of shared boundaries). Do I need to address my letters of opposition, to two planning authorities?

Please could you also provide clarification on the following concerns I have:

As stated on the Reading Golf Club website, this is 'an area of park and woodland' a Green site, which is now, being put forward for development (bordering existing developments).

I believe that a Site of Alternative Green space would need to be identified before any planning were approved.

Where, would this S.A.N.G fall, if under a shared authority - would it be in Reading Borough or South Oxfordshire- or both?

Additional concerns I have, are the contribution to the continuance of existing pathways and cycle lanes and what would be done regarding the widening of highways to provide safe passage of traffic along narrow country lanes (single track with 'passing' in some areas).

The proposal that is being put forward is for the development of 480 homes. This would be devastating on both the environment and on an infrastructure under existing pressure. Any large development would cause irreversible and significant environmental damage.

My understanding is, that all new developments must make provision for at least 30% affordable housing; Older citizen housing; plus environmental conditions including bike and public transport allowances before planning is approved- am I correct in this belief?

As this land was developed 100 yrs ago and is a long established recreational facility (open to members of the general public); would I therefore be correct in my understanding that these alternative facilities would have to be returned to the community, by way of relocation- if so- would that facility be located within Reading Berks or South Oxon?

My concerns regarding all of these questions are steeped in the long held anticipation of previously unfulfilled planning 'promises' that now make the community less trusting of such assurances.

The most publicly debated of these, continues to be an agreement over the location of a new school in Caversham & the continuing crisis over school places. Having attended the meeting at the Bugs Bottom development- where assurances were given that a school would be built and money paid to the council solely for this purpose- 20 years ago, and still no school being built, what assurances can our community now trust.

Would S.A.N.G areas for the preservation or relocation of park; woodland and public, recreational facilities need to be appointed before planning were approved?

I appreciate that many of my questions might be hypothetical at this juncture and the decisions I make reference to, occurred 20yrs ago, before many current councillors took office, but someone must be held accountable to both current and future generations.

If you can please provide me with as many answers to my many questions as is possible & re-direct me to any departments regarding those you are unsure of- it would be hugely appreciated.

I just need to know the legal stand point on that which is black and white: and which areas, fall under the 'grey' so I can act accordingly.

My sincere thanks for your time and continued attention, in this matter.

Mrs Jane Lawson-Mudge

Sent from my iPhone

LEEKE, VERONICA

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	Mrs	
First Name	Veronica	
Last Name	Leeke	
Job Title <i>(if applicable)</i>		
Organisation <i>(if applicable)</i>		
Address 1		
Address 2		
Address 3		
Town		
Post Code		
Telephone		
E-mail		

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

8.2 Strategy for Caversham and Emmer Green

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

I would like to endorse the following 2 paragraphs of section 8, which emphasises the importance of the surrounding Chilterns AONB in the character of the area of Emmer Green:

8.2.4 The relationship of the landscape with the Chiltern Hills and River Thames, described in paragraph 8.1.6, and of the townscape with the former separate settlements of Caversham and surrounding hamlets, will be preserved.

8.2.5 The adequacy of infrastructure to support additional development remains one of the most significant concerns in the area. In particular, transport, education and healthcare are issues that would need to be addressed in any development.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

LOCHAILORT READING LIMITED

LOCHAILORT READING LIMITED

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108-110 JERMYN STREET
LONDON
SW1Y 6EE

TEL: 020 3468 4933

Planning Policy
Reading Borough Council
Civic Offices
Bridge Street
Reading **RG1 2LU**

Friday 12th January 2018

Dear Sirs

Representations in respect of the Reading Pre-Submission Draft Local Plan:

Please find attached a duly completed representation form in respect of the above.

Lochailort Reading Ltd has been working closely with the Local Planning Authority over the past two years on what is the first – and currently the only – purpose-designed Build-to-Rent development in the Borough.

We have an excellent understanding of this emerging tenure, having sought extensive advice from leaders in the sector such as Paul Belson (author of the *PRS Market Report* submitted with application and former member of the Government's Build-to-Rent Task Force), CBRE (international property consultants with a dedicated Build-to-Rent in-house team) and CallisonRTKL (award-winning architects who specialise in designing bespoke Build-to-Rent schemes).

Our recently-approved *Thames Quarter* development, specifically referred to in the *Pre-Submission Draft Local Plan*, sets a new benchmark for Build to Rent developments in Reading. The quality of the scheme is a reflection of the detailed research that informed its design, which has been confirmed to us as being fit for purpose and an exemplar of its kind.

Consequently, we are particularly well placed to make comment on the draft Build to Rent policy in the *Pre-Submission Draft Local Plan*, which we are concerned sets requirements that will not only deter Build to Rent investment in the town but may well render further future schemes unfundable and unviable.

For the reasons that we set out in our attached submission, the draft plan cannot be found sound without a number of modifications to the proposed Build to Rent policy. We have set out our recommended modifications and ask that the Local Planning Authority adopts these before submitting the draft Plan to the Secretary of State for examination.

We would be happy to meet to discuss our concerns and recommended amendments if this would assist.

Yours sincerely



James Croucher MTP MRTPI
Planning Director

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
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Last Name	Croucher MTP MRTPI	
Job Title <i>(if applicable)</i>	Planning Director	
Organisation <i>(if applicable)</i>	Lochailort Reading Ltd	
Address 1	Eagle House	
Address 2	108-110 Jermyn Street	
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Town	London	
Post Code	SW1Y 6EE	
Telephone	020 3468 4933	
E-mail	james.croucher@lochailort-investments.com	

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Policy H4: Build to Rent Schemes

“Planning permission will be granted for developments of self-contained, private rented homes which:

- 1. Are secured in single ownership providing solely for the rental market for a minimum 30 year term with provision for clawback of affordable housing contributions should the covenant not be met; and*
- 2. Provide tenancies for private renters for a minimum of three years with a six month break clause in the tenant’s favour and structured and limited in-tenancy rent increases agreed in advance; and*
- 3. Provide a high standard of professional on-site management and control of the accommodation; and*
- 4. Meet Reading Borough Council’s Rent with Confidence Standards; and*
- 5. Provide for a mix of unit sizes in accordance with Policy H2; and*
- 6. Meet the standards of design set out in Policy H4; and*
- 7. Provide 30% on-site affordable housing, either in accordance with Policy H2 and any relevant Supplementary Planning Document; or in the form of Affordable Private Rent Housing as defined and set out in a relevant Supplementary Planning Document.”*

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?

Yes

No

No

Is sound?

Yes

No

No

Fulfils the duty to co-operate?

Yes

Yes

No

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Whilst the Local Planning Authority's support in principle for Build to Rent developments is welcomed, the requirements in draft Policy H4 render the policy unsound for reasons of viability and the absence of an evidential basis. The draft Policy is a late addition to the draft Local Plan. It did not appear in any of the previous consultation versions of the Plan and has not been subject to any public consultation other than at this very late pre-submission stage. Consequently, the evidential basis for some of the draft Policy's requirements is absent and the lack of proper prior consultation with interested parties further undermines the vague or generalised assertions in both the draft Policy and its supporting text. Specifically:

1. The proposed minimum 30-year term for which a Build to Rent development must be retained in a single ownership and provide solely rented accommodation is excessive and without any evidential justification. This extended minimum term (in excess of an entire generation and almost 40% of the average life expectancy in Reading) may fetter the ability of institutional investors to incorporate Build to Rent investments into their wider investment strategies, thus stifling the investment capital essential to such schemes. Whilst the Local Planning Authority may seek the reassurance that Build to Rent schemes will not be broken up and sold on the open market for quick or elevated returns, a more reasonable and appropriate minimum term should be set. A 20-year term was agreed by the Local Planning Authority when it granted planning permission 162166 (Thames Quarter) and there has been no subsequent new evidence or change in national policy to demonstrate that a longer term is necessary. Indeed, by way of comparison, the *Homes for Londoners Supplementary Planning Guidance* document published by the Mayor of London (August 2017) looks for a minimum 15-year period as a matter of *guidance*, not *adopted policy*. For all these reasons, draft Policy H4 is **unsound**.

2. The draft policy requirement of a minimum tenancy term of 3 years with a six month break clause in the tenant's favour and structured/limited in-tenancy rent increases agreed in advance is wholly unjustified and has no evidential basis. There is no evidence whatsoever in the *Berkshire (including South Bucks) Strategic Housing Market Assessment* or in the *Housing Implementation Strategy* to substantiate such an onerous requirement, with the draft Local Plan's evidence base containing no evidence whatsoever that short tenancy periods are a social or economic issue in Reading. Whilst it is in the institutional investor's interests to maximise a Build to Rent development's occupancy rates, site-specific tenancy policies must remain a matter for commercial consideration and control by the operator. Equally, as with all forms of market housing, pricing is not a matter within which the Local Planning Authority has any legal authority to intervene. Whilst rental controls are appropriate in respect of affordable housing, it is not for the Local Planning Authority to seek to extend those controls to market housing. For all these reasons, draft Policy H4 is both **unsound** and **not legally compliant**.

3. We have no comment to make on the draft policy requirement that a high standard of professional on-site management and control of the accommodation should be provided.

4. The requirement for Build to Rent developments to meet Reading Borough Council's *Rent with Confidence Standards* is wholly inappropriate. Those standards are not contained within an adopted Supplementary Planning Guidance document but rather, simply provide a voluntary framework which has no legal basis. They have not been subject to the necessary minimum level of documented public consultation and have not been subject to any independent examination. The draft policy requirement for compliance with such an evidently non-statutory document renders draft Policy H4 **unsound**.

5. We have no comment to make on the draft policy requirement to provide for a mix of unit sizes in accordance with Policy H2.

6. We have no comment to make on the draft policy requirement to meet the standards of design set out in Policy H4.

7. The draft policy requirement to provide 30% on-site affordable housing (either in accordance with Policy H2 and any relevant Supplementary Planning Document, or in the form of Affordable Private Rent Housing as defined and set out in a relevant Supplementary Planning Document) does not make any reference to scheme viability testing. It is therefore not compliant with *National Planning Policy Framework* paragraph 173. The financial viability model that underpins commercial investment appraisal of a Build to Rent scheme is entirely different to traditional build-to-sell housing or apartments. The draft policy's expectations must be adjusted accordingly in order to provide the necessary certainty to investors, requiring a recalibration of the approach to financial viability and assessing Build to Rent proposals based on the longer term operational net income stream generated by the asset combined with a reversionary value based on the valuation of net receipts from the asset via investment sale or a unit disposal programme. This distinction is recognised in both the *National Planning Practice Guidance* and the RICS Information Paper *Valuing Residential Property Purpose Built for Renting* (1st edition, September 2014). The absence of reference to viability testing in the draft policy text, and the lack of flexibility within the policy in terms of acceptable solutions, renders draft Policy H4 **unsound**.

Furthermore, in light of the accepted need for flexibility with Build to Rent schemes compared to traditional "for sale" developments, the lack of reference in the draft Policy to offsite provision on surrogate sites or the potential ability for an applicant to agreed a financial contribution in lieu of onsite provision may render any future such development unviable. Consequently, the lack of flexibility in the draft policy in respect of allowable affordable housing solutions renders Policy H4 **unsound**.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

In order to remedy the soundness and legal non-conformity issues identified above, Policy H4 should be amended to read as follows:

“Planning permission will be granted for developments of self-contained, private rented homes which:

*1. Are secured in single ownership providing solely for the rental market for a minimum ~~30~~ **20** year term **from the date of first occupation** with provision for clawback of affordable housing contributions should the covenant not be met; and*

~~2. Provide tenancies for private renters for a minimum of three years with a six-month break clause in the tenant's favour and structured and limited in-tenancy rent increases agreed in advance; and~~

*~~3.~~ **2. Provide a high standard of professional on-site management and control of the accommodation; and***

~~4. Meet Reading Borough Council's Rent with Confidence Standards; and~~

*~~5.~~ **3. Provide for a mix of unit sizes in accordance with Policy H2; and***

*~~6.~~ **4. Meet the standards of design set out in Policy H4; and***

7. 5. Subject to viability, provide 30% on-site affordable housing, either in accordance with Policy H2 and any relevant Supplementary Planning Document; or in the form of Affordable Private Rent Housing as defined and set out in a relevant Supplementary Planning Document, which may be provided onsite in the form of Affordable Private Rent Housing, offsite at a surrogate site elsewhere within the Borough, or by way of a commuted sum.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

Not applicable

B7. Do you wish to be kept informed of planning policy matters?
(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

 Yes

Please keep me informed of all planning policy matters:

 Yes

LUNN, SUSAN

From: Sue Lunn
Sent: 25 January 2018 22:54
To: Planning Policy
Subject: Planning

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

I object very strongly to proposals by Reading Golf Club to development of all or part of their land in Emmer Green.

The volume of traffic north of the river grinds to a halt very easily, with just a minor accident or small road works. So far we have been very lucky, but it is inevitable that some accident will happen and the emergency services will not be able to get through. To build even 150 houses and each with at least 2 cars, would cause yet more pollution and danger on roads that are already very busy at all times.

It is important for health and safety to think very carefully about pollution levels, road safety, losing more green space and the danger to the environment.

The schools in particular, primary schools, local doctors surgeries and hospitals are all over subscribed and the situation is dire, without any more houses. It is very important to have the right infrastructure before even considering development.

Development north of the river in Reading/South Oxfordshire is impossible without the building of a third bridge.

Susan Lunn

Click [here](#) to report this email as spam.

MAPLETREE INVESTMENTS PTE

24 January 2018

Planning Policy Team
Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

Dear Sir/Madam,

Response to the Regulation 19 Consultation- Representation on Behalf of Mapletree Investments Pte Ltd in relation to the Pre-Submission Draft Reading Borough Local Plan Document

We write on behalf of our client Green Park Reading No.1 LLP, the owner of Green Park Business Park, Reading. Green Park Reading No.1 LLP (GPR) is ultimately wholly owned by Mapletree Investments Pte Ltd (Mapletree). This response relates to the Regulation 19 Consultation Draft Reading Local Plan document (dated November 2017).

In writing this letter, we do so under the statutory provisions of a Regulation 19 consultation under the Town and Country Planning (Local Planning) (England) Regulations 2012.

Introduction and Overview

Since acquiring GPR in 2016, Mapletree has been reviewing the Park's potential, undertaking some asset management and considering future opportunities. GPR is keen to support the Council in making Reading a sustainable place to live for both for now and the future.

Having reviewed the draft Local Plan, GPR is generally supportive of the Council's wider strategic policies (especially in relation to the promotion of sustainable development). There are a number of policies GPR wishes to comment on which it believes better reflects its aspirations for Green Park and south Reading area.

Pre-Submission Draft Local Plan Consultation Response

GPR's responses can be divided in to three areas i) Strategic Policy Amendments-Cross Cutting Policies and Other Generic Policies ii) Other Local Plan Policy Amendments and iii) Site Specific Policy Amendments.

Strategic Policy Amendments

Policy CC9: Securing Infrastructure

GPR are pleased to see revised policy supporting text relating to the securement of new infrastructure, now acknowledging the contribution existing levels of development already play, as well as their associated transport mitigation measures already agreed or implemented (paragraph 4.1.44). Development at Green Park has a long history of contributing significant amounts to transport infrastructure to mitigate future development impact. GPR maintains therefore, that the approach should continue to be on capturing

transport contributions from uplifts in floorspace only, from those developments which have already made significant investments.

Reference is still made in the draft policy to new employment development needing to mitigate its potential demand for affordable housing. Whilst GPR recognise that proper infrastructure and housing is in place to support further economic growth in Reading (Infrastructure Delivery Plan, 2017), they maintain it is not the role of employment development to fund affordable housing. GPR, therefore, remains concerned about linking employment development mitigation with the provision of affordable housing without up to date evidence that the historic affordability issue in Reading relates to employment development. Housing developments should be the focus for provision of affordable housing contributions.

Employment development is a land use priority at Green Park, which means contributions towards housing, in addition to the other mitigation measures, creates an unacceptable burden on development. This was demonstrated in the determination of the scheme at 400 Longwater Avenue, Green Park, office development on the Park is at the margins of viability. The policy risks jeopardising future employment development at the Park. GPR, therefore, requests that Reading Borough Council revisit this policy. If it is to be retained, GPR request that in the last sentence of paragraph 4.1.50 that "should" be replaced with "could" and the following words inserted at the end: "and subject to viability to reflect the Supplementary Planning Guidance and the NPPF".

Other Local Plan Policy Amendments

EM1: Provision of Employment Development

Whilst GPR supports the principles of this policy, they maintain their position that consideration be given to the role that supporting employment uses, such as hotel, serviced apartment, retail and leisure uses can play in adding to the diversity, sustainability and vitality of office environments. Hotel, retail and leisure uses should also be acknowledged for their job creation benefits.

EM2: Location of New Employment Development

In relation to the location of new employment development, GPR maintains the view that specific reference is made to the role new office development plays in Core Employment Areas. GPR request that the first sentence of the policy be reworded as follows (new words listed in red below):

"Major office development will take place in the centre of Reading and *in Core Employment Areas* along the A33 corridor."

GPR are pleased to see the revised acknowledgement of the role non-employment uses play in supporting the area's economic function in Core Employment Areas (paragraph 4.3.11). They would prefer, however, that the employment benefit of some non-employment uses, as well as their ability to expand on job generation, is better acknowledged and noted in this policy.

TR1: Achieving the Transport Strategy

GPR are pleased to see an alteration in the policy supporting text (paragraph 4.5.4) relating to transport impact in that the Council will look to take into account levels of development already been accepted, and will acknowledge mitigation measures that have already been agreed or implemented.

TR2: Major Transport Projects

GPR maintains, as far as possible, that the MRT should not use the existing road network which will exacerbate the traffic situation.

TR3: Access Traffic and Highways Related Matters

Policy TR3 remains unchanged from the previous Regulation 18 consultation, listing criteria i) to v) that need to be addressed. The policy and supporting text seems to reflect current transport planning rationale, and GPR assumes the wording has been drafted to give some flexibility to enable a 'monitor and manage' approach.

In overall terms, GPR maintains the view that draft policy is, therefore, logical in stating that where there are currently safe and free-flowing transport links, then such conditions should not be compromised by intensifying traffic levels from accesses on to the corridor, and/or facilitating localised car trips that could otherwise be made by other alternative modes. GPR, therefore, supports this approach.

Paragraph 4.5.14 outlines that where congestion occurs and additional trips are likely to worsen conditions, then the policy suggests transport mitigation should come forward, but not just highway mitigation, which GPR would encourage. GPR also agrees this should be added to the list in TR3 to offer a way forward for potential development to mitigate additional trips on the transport network.

CR10: Tall Buildings

GPR maintains their position (as per the previous representation) that the evidence base to support the tall building strategy is out of date.

Paragraph 3.12 of the Infrastructure Development Plan references the Plan's approach to focus additional employment development in the town centre and along the A33. In order to achieve this ambition, higher density development should be focused in locations such as Green Park, in order to meet employment requirements over the Plan period. There should be some flexibility in the policy to allow for a tall building in this important employment location. As Green Park becomes more accessible with the introduction of the train station, and its back drop will soon be much more urban in nature as a result of the Royal Elm Park development, there is an opportunity to create more of a statement or landmark on the Park. GPR's agents would also support this approach in order to increase the Park's visibility on the M4 which would help with marketing.

Retail, Leisure and Culture Chapter- "Centre" and "Non-Centre Uses"

GPR maintains the need to differentiate between in centre and non-centre uses, reflective of the NPPF definitions, in relation to protect uses in district and local centres. GPR maintains that it would be better if paragraph 4.6.16 could recognise that some in centre uses may be appropriate as ancillary or 'community' uses to support business and employment development, subject to the sequential test. This would reflect the text change to Policy EM2 supporting text.

Site Specific Policy Amendments

EM2a: Location of New Development, the Role of Core Employment Areas

Reflective of the comments above, we welcome the change to Core Employment Areas policy and that it now includes recognition for ancillary uses to support business and employment areas. The benefits of having ancillary facilities, such as retail, hotel and restaurants on site, encourage a community feel and make these areas an attractive place to work as well as increasing sustainability by reducing trips off-site.

SR1: Island Road Opportunity Area

GPR still maintains that Opportunity Area SR1, Island Road should focus on B2 and B8, uses where B1 use would be wholly ancillary. While the policy loosely has regard to this by stating that: "new business space

comprising mainly industrial and warehouse uses, with some supporting office uses”, we would prefer more overt wording to reflect GPR’s intent.

GPR previously resisted proposals in paragraph 6.3.3 which directed the Mass Rapid Transit to be directed through this site, rather requesting it to be directed towards Green Park Station. This paragraph remains unchanged. GPR therefore maintains its position in that the MRT should be directed to where it would capture most passengers. This would be Green Park and office users rather than the Island Road area which will have much lower employee/passenger movements.

Next Steps

In summary, GPR welcomes the publication of the Pre-Submission Draft Plan which sets a direction of travel in policy terms for Reading until 2036.

We look forward to receiving confirmation of receipt of these representations and request to be kept informed on progress of the next stage of the plan process.

Yours sincerely

Caroline McDade
For Deloitte LLP

MCCARTHY AND STONE RETIREMENT LIFESTYLES LTD



26th January 2018

Planning LDF Team
Planning Section
Reading Borough Council
Civic Centre
RG1 7AE

Dear Sir/Madam,

**McCARTHY & STONE RETIREMENT LIFESTYLES LTD.
RESPONSE TO CONSULTATION ON THE READING PRE-SUBMISSION DRAFT LOCAL PLAN**

Thank you for the opportunity to comment on the consultation papers for the aforementioned document.

As the market leader in the provision of sheltered housing for sale to the elderly, McCarthy and Stone Retirement Lifestyles Ltd considers that with its extensive experience in providing development of this nature it is well placed to provide informed comments on the Pre-Submission Draft Local Plan Consultation, insofar as it affects or relates to housing for the elderly

The National Planning Policy Framework stipulates that the planning system should be '*supporting strong, vibrant and healthy communities*' and highlights the need to '*deliver a wide choice of high quality homes, widen opportunities for home ownership and create sustainable, inclusive mixed communities. Local Planning Authorities should plan for a mix of housing based on current and future demographic trends, market trends and the needs of different groups in the community... such as... older people*' (emphasis added).

The National Planning Practice Guidance reaffirms this in the guidance for assessing housing need in the plan making process entitled "**How should the needs for all types of housing be addressed?**" (Paragraph: 021 Reference ID: 2a-021-20140306) and a separate subsection is provided for "**Housing for older people**". This stipulates that "*the need to provide housing for older people is critical given the projected increase in the number of households aged 65 and over accounts for over half of the new households (Department for Communities and Local Government Household Projections 2013). Plan makers will need to consider the size, location and quality of dwellings needed in the future for older people in order to allow them to move. This could free up houses that are under-occupied. The age profile of the population can be drawn from Census data. Projections of population and households by age group should also be used. The future need for older persons housing broken down by tenure and type (e.g. Sheltered, enhanced sheltered, extra care, registered care) should be assessed and can be obtained from a number of online tool kits provided by the sector. The assessment should set out the level of need for residential institutions (use class C2). But identifying the need for particular types of general housing, such as bungalows, is equally important*" (My emphasis).

The '*Housing White Paper: Fixing our broken housing market*' clearly signals that greater consideration must be given to meeting the needs of older persons' in Local Plans stipulating that



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*‘Offering older people a better choice of accommodation can help them to live independently for longer and help reduce costs to the social care and health systems. We have already put in place a framework linking planning policy and building regulations to improve delivery of accessible housing. To ensure that there is more consistent delivery of accessible housing, **the Government is introducing a new statutory duty through the Neighbourhood Planning Bill on the Secretary of State to produce guidance for local planning authorities on how their local development documents should meet the housing needs of older and disabled people.** Guidance produced under this duty will place clearer expectations about planning to meet the needs of older people, including supporting the development of such homes near local services⁸². It will also set a clear expectation that all planning authorities should set policies using the Optional Building Regulations to bring forward an adequate supply of accessible housing to meet local need. **In addition, we will explore ways to stimulate the market to deliver new homes for older people.**’ (Para 4.42) (My emphasis).*

The Pre-submission Local Plan confirms that the Borough has an ageing population. We strongly suggest that the Council for taking a proactive approach in assessing the housing needs of its ageing population.

In line with the rest of the country, the document identifies an acceptance that the demographic profile of the Borough is projected to age. The largest proportional increases in the older population are expected to be of the ‘frail’ elderly, those aged 85 and over, who are more likely to require specialist care and accommodation provided by Extra Care accommodation. It is therefore clear that the provision of adequate support and accommodation for the increasingly ageing demographic profile of the Reading area is a significant challenge.

Unless properly planned for, there is likely to be a serious shortfall in specialist accommodation for the older population in the district, which will have a knock on effect in meeting the housing needs of the whole area and wider policy objectives. Specialist accommodation for the elderly, such as that provided by McCarthy and Stone, will therefore have a vital role in meeting the areas housing needs.

We would advocate that the Council continues in taking a positive approach in seeking to provide appropriate accommodation to meet the needs of its ageing population within the Local Plan. We consider that the best approach towards meeting the diverse housing needs of older people is one that encourages both the delivery of specialist forms of accommodation such as sheltered / retirement housing and Extra Care accommodation. We believe that a standalone policy to address the needs of older people in the authority.

We would like to highlight the advice provide in the *Housing in Later Life: Planning Ahead for Specialist Housing for Older People toolkit*. This toolkit was developed by a consortium of private and public organisations with an interest in housing for the elderly and encourages a joined up approach to planning, housing and social care policy both in the collection of evidence and the development of specialist accommodation for the elderly. A copy of this document has been appended for your convenience. Whilst we appreciate that no one planning approach will be appropriate for all areas, an example policy is provided that, we hope, will provide a useful reference for the Council:

“The Council will encourage the provision of specialist housing for older people across all tenures



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in sustainable locations.

The Council aims to ensure that older people are able to secure and sustain independence in a home appropriate to their circumstances and to actively encourage developers to build new homes to the 'Lifetime Homes' standard so that they can be readily adapted to meet the needs of those with disabilities and the elderly as well as assisting independent living at home.

The Council will, through the identification of sites, allowing for windfall developments, and / or granting of planning consents in sustainable locations, provide for the development of retirement accommodation, residential care homes, close care, Extra Care and assisted care housing and Continuing Care Retirement Communities."

Policy H3 refers to an "open book" approach. This is misleading as it suggests that a viability assessment should be based on the individual's own costs and revenues, effectively a tax on the individual builder's performance. It is well established that viability modelling of this nature is based on generic inputs particularly relating to revenues and build costs. Reference to "open book" should therefore be deleted with sole reference to "transparent process" being entirely adequate and presumably what is really being sought here.

Well located and designed specialist housing for older home owners is a highly sustainable form of housing. Given the critical need for older persons accommodation in the Borough there should be a presumption in favour of sustainable housing and in particular specialist housing which is being proposed on suitable sites. This accommodation will come from a number of sources both public and private and with varying levels of care and shelter provision enabling individual people to remain in their own home with independence and security.

I trust that the above comments will be considered in the evolution of any emerging consultation document and that we will continue to be invited to comment as the document progresses.

Yours faithfully

Carla Fulgoni
Senior Planning Associate
Tel: 01202 508 206
Email: Carla.fulgoni@theplanningbureau.ltd.uk

MOLNER, MARIA TERESA

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	Mrs	
First Name	Maria Teresa	
Last Name	Molner	
Job Title <i>(if applicable)</i>	Branch Lead	
Organisation <i>(if applicable)</i>	Federation of Small Business FSB	
Address 1		
Address 2		
Address 3		
Town		
Post Code		
Telephone		
E-mail		

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

4.General Policies/ 4.3.1

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Because it does not consider the small business part of the the grand plan.

Multinational companies are much more prolific in future in your plan.(4.3.2)

Central Reading is only reserved for large corporate businesses which can afford high Business Rates and big rents.

Pushing the small businesses to the South and West is not the answer.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

The modifications should be to accommodate individuals with their businesses and local enterprises which are already established in Reading centre. The Council have the moral obligation to consider the issues of the small businesses of Reading and to help it's own population first.

The local JobCentre is working with lots of people to help them to have a better existence from the town where most of them live.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

Because by lobbying with the Council perhaps we can all find a mutual solution to the problem of small businesses in the Town Centre.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

MONKS, PAULINE

From: Pauline Monks
Sent: 23 January 2018 18:42
To: Planning Policy
Subject: Mapledurham playing fields .. No heights school

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

When a child or parent is involved in an accident on woodcote rd, I hope you will see the error of your ways.

Nothing has ever been done to slow traffic down or stop lorries on that road, and you expect dozens and dozens of extra cars trying to get in out out of that small entrance and children walking . Maybe. To school. I would not want your conscience.

Find a safer location for all our sakes, and surrounding houses that will have to put up with all the disruption.

As will I with my dogs.

Ps. Why not use the allotments, good bit of land there.

Pauline monks

Sent from my iPad

MOORGARTH GROUP LTD

CPB/AJH/DP4003

26 January 2018

Planning Policy Team
Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU



DP9 Ltd
100 Pall Mall
London SW1Y 5NQ

Registered No. 05092507

telephone 020 7004 1700
facsimile 020 7004 1790

www.dp9.co.uk

Dear Sir / Madam,

READING BOROUGH LOCAL PLAN – CONSULTATION ON THE PRE-SUBMISSION DRAFT, NOVEMBER 2017

REPRESENTATIONS ON BEHALF OF MOORGARTH GROUP LIMITED

We write on behalf of our client, Inception Reading Sarl which is a subsidiary of Moorgarth Group Limited (“Moorgarth”), the owners of Broad Street Mall and Fountain House in central Reading. We welcome this opportunity to respond to the Pre-Submission Draft Local Plan document. The Broad Street Mall and Fountain House site is referred to as Site CR12d in the document.

The Council will be aware that Moorgarth has already embarked upon a series of investment management initiatives at the site, including internal refurbishment of the Mall comprising replacement ceilings, lighting and shopfront replacement, together with external improvements in the form of a coherent signage strategy. Fountain House has been subject to refurbishment of the existing office floorspace together with the installation of a new entrance and lobby which will improve appearance and visibility on Queens Walk. More recently, planning permission has been granted for a temporary urban market at South Court.

Moorgarth continue to investigate a number of other short term initiatives aimed at enhancing the retail experience, as well as longer term development aspirations for the site to cement its place as a vibrant shopping environment, together with the introduction of alternative uses aimed at creating a new mixed-use area forming part of the West Side Major Opportunity Area.

Area Strategy for Central Reading

As per our response to the last consultation, Figure 5.1 should be amended so that the areas defined for concentration of retail, offices and leisure uses fully encompass the whole of the Broad Street Mall and Fountain House site. The site is an important retail, office and leisure hub



within central Reading and this should be reflected in the Area Strategy plan. As drafted, the boundaries of these concentration areas cut across the site and therefore should be amended.

CR6: Living in Central Reading

The suggested approach for a specific residential mix in the Central Reading area is supported. However, in seeking to further distinguish Central Reading's locational context and residential market requirements, it should be noted that the town centre is not generally suitable for family housing, and therefore the suggested residential mix is flexible.

CR12: West Side Major Opportunity Area

Moorgarth generally supports the Council's aspirations for the West Side Major Opportunity Area. In particular, Moorgarth supports the policy direction toward a mix of uses including residential in this location.

Moorgarth generally supports Policy CR12d, Broad Street Mall, however, the indicative development potential for both residential and retail/leisure uses should not be regarded as an upper limit. The policy text should acknowledge that high density development is appropriate in the town centre, and that sustainably located sites such as Broad Street Mall should optimise the quantum of housing delivery, with due regard to all other relevant planning policies, without any artificial policy cap on density or overall housing numbers. This will assist the Borough to meet or exceed its housing targets in the most sustainable locations.

Concluding Remarks

We trust that the above comments will be considered as part of the ongoing evolution of the Reading Local Plan. If you require any further information, then please contact Chris Beard or Alan Hughes of this office.

Yours faithfully,


DP9 Ltd

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		MR
First Name		CHRIS
Last Name		BEARD
Job Title <i>(if applicable)</i>		DIRECTOR
Organisation <i>(if applicable)</i>		DP9 LTD
Address 1		100 PALL MALL
Address 2		
Address 3		
Town		LONDON
Post Code		SW1Y 5NQ
Telephone		020 7004 1700
E-mail		chris.beard@dp9.co.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Figure 5.1; CR6 and CR12d

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

See enclosed letter dated 26th January 2018

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

See enclosed letter dated 26th January 2018

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

MORLEY, DAVID

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	MR	
First Name	David	
Last Name	Morley	
Job Title <i>(if applicable)</i>		
Organisation <i>(if applicable)</i>		
Address 1		
Address 2		
Address 3		
Town		
Post Code		
Telephone		
E-mail		

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Development on Reading Golf Course

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

I think the plan to develop on the golf course is ill considered for a number of reasons, the most serious in my mind is the impact on the already over populated road infrastructure in the area. The traffic getting into Reading in rush hour is even now ridiculous and I cannot see how an increase in traffic can be accommodated. In addition the schools and doctor surgery services are also I believe running at capacity.

We are fortunate to live on the course and we see deer, rabbits and other wildlife as well as the wide variety of trees and shrubs, all of which would be lost if this development were to go forward.

Finally the course at Reading should be considered as a great asset to the entire area and one that should be treasured. It has been in existence for over 100 years.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Not applicable

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

yes

Please keep me informed of all planning policy matters:

yes

MORLEY, KIM

From: Kim morley
Sent: 24 January 2018 13:21
To: Planning Policy
Subject: Reading Borough Local Plan – chance to comment on Pre-Submission Draft Local Plan

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Sirs

I would like to register my concerns regarding the possible development of Reading Golf Club. I hope I am not being a nimby but a development of the size being talked about of 400-500 houses would impact the local area. It would add to the congestion on already busy roads in the area in particular through Caversham which is already a bottle neck. Would the ever talked about extra bridge over the Thames actually happen?

There is also a lot of pressure on local community services such as schools and doctors surgeries. How will this be addressed?

I understand there is a need for more housing but the infrastructure does need to be in place.

Yours faithfully

Kim Morley

Click [here](#) to report this email as spam.

MYERSCOUGH, PAUL

From: Paul Myerscough
Sent: 23 January 2018 18:57
To: Planning Policy
Subject: Local Plan Section EN7N Item EN7Nn

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

1. Why is the current Local Plan being ignored in favour the ESFA's proposals to build a school on Mapledurham Playing Fields, which is designated green open space and held in trust exclusively for recreation?
2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?
3. In particular how will it safeguard against the following factors, which cannot be mitigated and will significantly impact Mapledurham Playing Fields, if the EFSA proposal is implemented:
 - a. Traffic movements
 - b. Air pollution
 - c. Noise pollution
 - d. Visual dominance and overbearing on the area of the site where they propose to build
 - e. Privacy and overlooking
 - f. Out of character with local residential properties
 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment
4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?

Your faithfully

Paul Myerscough

Click [here](#) to report this email as spam.

NATURAL ENGLAND

Date: 26 January 2018
Our ref: 233109



Reading Council

BY EMAIL ONLY

Customer Services
Hornbeam House
Crewe Business Park
Electra Way
Crewe
Cheshire
CW1 6GJ

T 0300 060 3900

Dear Planning Policy Team

Planning Consultation: Reading Local Plan, Regulation 19.

Thank you for your consultation on the above dated 30th November 2017.

Natural England is a non-departmental public body. Our statutory purpose is to ensure that the natural environment is conserved, enhanced, and managed for the benefit of present and future generations, thereby contributing to sustainable development.

Natural England is of the opinion that as it stands this Local Plan **does not** meet all of the tests of soundness or deliverability, namely, whether it is effective and whether it is consistent with national policy. However, Natural England's concerns mainly centre around the clarification of the wording of policies. Once this is addressed we would be happy to review our advice with regards to soundness of the plan.

In our review of the Reading Local Plan we would like to thank Reading Council for taking on board our previous comments. We would like to comment further on some aspects of the Plan. Please find our main comments tabulated for your convenience.

Yours sincerely,

Chris Baines
Sustainable Development Adviser
Thames Team

Plan Section/Policy	Legislation/ Plan reference	Issue type	Issues	Possible solutions
H4	Paragraph 110 of the NPPF states that ' <i>Plans should allocate land with the least environmental or amenity value</i> '	Compliance with NPPF	Development should be directed to sites of least biodiversity value. We do not consider that the policies within the plan, particularly the housing and area-specific policies makes provisions to ensure that development is directed away from areas of high biodiversity value.	We advise that additional policy is incorporated into this policy, or elsewhere in the Housing chapter, in order to ensure that use of previously development land is prioritised for development and use of greenfield land of high biodiversity value is not proposed for development wherever possible. We would then advise that the sites allocated for development within this plan are reviewed in order to ascertain whether they conform to such a revised policy, and modifications proposed to account for any inconsistencies.
H13	Paragraph 109 of the NPPF states that ' <i>the planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible</i> '	Compliance with NPPF	Ambiguity around compensation for the loss of open space through development and how this relates to the principle of biodiversity net gain.	Where this policy states that 'any loss of undeveloped land would be outweighed by a qualitative improvement in open and green space', it should be clarified that a biodiversity net gain would be required for development, as per the measure outlined in policy EN12.

EN9, EN11, EN12, and associated text of the Plan.	Paragraph 114 of the NPPF states; <i>Local planning authorities should: set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure;</i>	Compliance with NPPF	The Plan uses the term 'landscaping' where it needs to use the word green infrastructure. There is no reference to 'landscaping' in the NPPF.	Do a search and replace 'green infrastructure' for 'landscaping'
EN9: Provision of open space	Paragraph 114 of the NPPF	Effectiveness	The NPPF requires that local plans positively plan for connected green infrastructure. It is essential that green infrastructure is considered appropriately at the beginning of the development planning process (along with the grey infrastructure) to ensure the GI on site is connected to the neighbouring sites. "where possible" allows for argument of location.	Remove "where possible"
EN12 – Biodiversity and the Green Network	Paragraph 109 of the NPPF states; “ <i>The planning system should contribute to and enhance the natural and local environment by: ...minimising impacts on biodiversity and providing net gains in biodiversity where possible</i> ”.	Compliance with NPPF	Development must demonstrate a net gain in biodiversity in line with the NPPF. This should be demonstrated through a recognised metric such as the DEFRA metric.	Change the wording; All development will provide a measure of biodiversity loss/gain and it shall be calculated in accordance with nationally or locally recognised guidance and metrics.

<p>EN13 – Major landscape features and Areas of Outstanding Natural Beauty</p>	<p>Paragraph 115 of the NPPF states, <i>'Great weight should be given to conserving landscape and scenic beauty in National Parks, the Broads and Areas of Outstanding Natural Beauty, which have the highest status of protection in relation to landscape and scenic beauty'</i>.</p>	<p>Effectiveness</p>	<p>We support NE13 but would like to add a reference to the best practice methodology to ensure its effectiveness at delivering the supported outcomes through the development planning process.</p>	<p>A requirement for an LVIA in line with the Guidelines for Landscape and Visual Impact Assessment (V3) May 2013 (or as replaced).</p> <p>Thoroughly consider any comments made by the AONB boards.</p>
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<p>EN14: Trees, hedges and woodlands</p>	<p>Paragraph 118 states; <i>When determining planning applications, local planning authorities should refused for development resulting in the loss or deterioration of irreplaceable habitats, including ancient woodland and the loss of aged or veteran trees found outside ancient woodland, unless the need for, and benefits of, the development in that location clearly outweigh the loss:</i></p> <p>And</p> <p>Paragraph 109 of the NPPF,</p> <p>And</p> <p>Paragraph 117 states 'To <i>minimise impacts on biodiversity and geodiversity, planning policies should: promote the preservation, restoration and re-creation of priority habitats</i>'.</p>	<p>Compliance with NPPF</p> <p>Effectiveness</p>	<p>There is no policy for Ancient Woodland. It would appear to fit here.</p>	<p>Policy wording recommendation;</p> <p>Development proposals that would lead to an individual or cumulative significant adverse impact on irreplaceable habitats such as ancient woodland or ancient trees the Council will refuse unless exceptional circumstances can be demonstrated and that the impacts to the site are clearly outweighed by the benefits of the development.</p> <p>Sufficient information must be provided for the Council to assess the significance of the impact against the importance of the irreplaceable habitat and the species which depend upon it. This will include the buffer area around the tree or woodland. Natural England advise 15m for ground works (root disturbance) and 50m for pollution and ground compaction. Planning permission will be granted only where:</p> <ol style="list-style-type: none"> a. the benefits of the development at this site clearly outweigh any adverse impacts on the irreplaceable habitat and the ecosystem services it provides b. development has followed a mitigation hierarchy of avoid, then mitigate if avoidance cannot be achieved - then
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				compensate/offset if mitigation cannot be achieved. Avoidance will require the applicant to demonstrate that the development could not be located in an alternative, less harmful location
EN15 – Air quality	Paragraph 117 states – ‘ <i>To minimise impacts on biodiversity and geodiversity, planning policies should: promote the preservation, restoration and re-creation of priority habitats</i> ’.	Compliance with NPPF Effectiveness	Lack of reference to potential impacts of air pollution on priority habitats.	This policy may be considered more closely in line with Paragraph 117 of the NPPF by including an additional consideration relating to the potential air pollution-related impacts of development within 200m of priority habitat such as deciduous woodland.

<p>EN16: Pollution and water resources</p>	<p>Paragraph 109 of the NPPF</p> <p>And</p> <p>Paragraph 114 of the NPPF states; <i>Local planning authorities should: set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure;</i></p>	<p>Compliance with NPPF</p> <p>Effectiveness</p>	<p>This policy omits some key issues and its requirements should be clarified. It omits detail on development next to sensitive habitat. It would also be advisable to sub heading this policy to make the content clearer or make separate policies for water resources, and pollution, with subheadings for land, light, noise, other. We recommend you consult the Aylesbury Vale Reg 19 version of their Plan. The plan includes good examples of all environmental and green infrastructure policies (although this is yet to be approved by the inspector).</p>	<p>Consider rewording;</p> <p>Development will only be permitted where it would not be damaging to the environment and sensitive receptors through land, noise or light pollution, including no deterioration in, or ideally enhancement of, ground and surface water quality.</p> <p>Water resources</p> <p>* highlight areas of known pollution, provide some words from the text to explain what the requirements for developers is exactly*</p> <p>Adequate water resources, sewerage and wastewater treatment infrastructure will be in place to support any proposed development prior to occupation.</p> <p>Land</p> <p>Development will need to provide an assessment to determine the existence or otherwise of contamination, its nature and extent, the risks it may pose and to whom/what (the 'receptors') so that these risks can be assessed and satisfactorily reduced to an acceptable level through mitigation. Assessment should also identify the potential sources, pathways and receptors</p>
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				<p>(‘pollutant linkages’) and evaluate the risks.</p> <p>Noise and light Proposals for development that are sensitive to the effects of noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution.</p> <p>Developments where external lighting is required, planning permission will only be granted where all of the following criteria are met:</p> <ul style="list-style-type: none">a. The lighting scheme proposed is the minimum required for the security and to achieve working activities which are safeb. Light spill and potential glare and the impact on the night sky is minimised through the control of light direction and levels , particularly in residential and commercial areas, areas of wildlife interest or the visual character of historic buildings and rural landscape characterc. The choice and positioning of the light fittings, columns and cables minimise their daytime appearance and impact on the streetscape, andd. In considering development involving potentially adverse
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				<p>lighting impacts to wildlife, the Council will expect surveys to identify wildlife corridors and ensure that these corridors are protected, and enhanced where possible.</p> <p>Development that will result in noise pollution should consider both human and wildlife sensitive receptors and provide an impact assessment as part of the development application.</p>
NE?	<p>Paragraph 112 of the NPPF states that; <i>Local planning authorities should take into account the economic and other benefits of the best and most versatile (BMV) agricultural land. Where significant development of agricultural land is demonstrated to be necessary, local planning authorities should seek to use areas of poorer quality land in preference to that of a higher quality.</i></p>	Compliance with NPPF	<p>There is no policy or mention of Best and Most Versatile (BMV) agricultural land. In order to preserve as much BMV land as possible and use areas of poorer quality agricultural land, areas of BMV should be the focus of strategic green infrastructure on development sites.</p>	<p>Suggested Policy wording;</p> <p>Council will seek to protect the best and most versatile agricultural land for the longer term. Where development involving best and more versatile agricultural land is proposed, those high value areas on site should be preferentially used as green open space and built structures avoided. Where development would result in the loss of best and more versatile agricultural land, planning consent will not be granted unless there are no other suitable sites of poorer agricultural quality that can accommodate the development.</p>
Glossary	<p>Paragraph 109, 117 and 114 of the NPPF</p>	Effectiveness	<p>There is no definition of open space or green infrastructure.</p>	<p>Provide definition/examples</p>

N.H.S PROPERTY SERVICES

26th January 2018

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Planning Policy
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Civic Offices
Bridge Street
Reading
RG1 2LU

Lambert Smith Hampton
United Kingdom House
180 Oxford Street
London
W1D 1NN

By email: planningpolicy@reading.gov.uk

Dear Sir/Madam

**Reading Borough Council, Pre-Submission Draft Local Plan
Representations made on behalf of the NHS Property Services with regard to the Former
Battle Hospital, Oxford Road, Reading, RG30 1AG**

This consultation response has been prepared by Lambert Smith Hampton on behalf of the NHS Property Services (NHSPS) to make representations with respect to the Pre-Submission Draft of Reading Borough Council's Local Plan. As one of the largest property owners in the UK, the NHSPS are keen to ensure that surplus and vacant land within their portfolio are not strategically constrained by local planning policies. This response makes detailed comments to specific sections of the emerging Local Plan, particularly to Policy WR3j.

Background

The above site was transferred to the NHSPS following the NHS reforms in April 2013. The NHSPS maintain and improve around 3,500 properties nationwide, working with NHS organisations to create safe, efficient, sustainable and modern healthcare and working environments. A major part of NHSPS's role is the efficient management and disposal of properties which are no longer required by the NHS for the delivery of services. It is important to recognise that capital receipts from disposals and any saving will be reinvested in the NHS to provide funding for new improved services and facilities.

The site currently comprises of a vacant parcel of land extending to approximately 0.16 ha. The former Battle Hospital which previously occupied the site closed in 2005 and was subsequently demolished, leaving the site vacant. It is bounded by residential in the form of modern terraced houses to the east and a block of flats set over four storeys to the north. To the south of the site (the rear) is the Curzon Club, which fronts onto Oxford Road, whilst a Tesco superstore lies to the west of the site.

It is the NHSPS's aspiration to bring forward their land for disposal and it has been in pre-application discussions with the Council (Ref: 171091) to secure the delivery of the site.

Policy WR3j - Land and Moulford Mews

The NHSPS fully support the Local Plan's allocation of their land at Moulford Mews by virtue of WR3j. However, the policy is considered **unsound** as it is currently drafted and does not meet the tests of soundness as set out in paragraph 182 of the National Planning Policy Framework (NPPF). The NHSPS objects to the proposed arbitrary cap on the quantum of development which makes the **unjustified** assumption that the site can only accommodate 10-16 dwellings without any robust evidence. The site can deliver more dwellings than indicated and this density cannot be reasonably reached without a detailed planning and design exercise.

This policy is also **inconsistent with national policy**, particularly the NPPF where the intention is to "*significantly boost the supply of housing*" (paragraph 47), "*encourage the effective use of land by reusing land that has been previously developed*" (paragraph 17) and "*to optimise the potential of the site to accommodate development*" (paragraph 58). It also advises Local Plans to "*allocate sites to promote the development and flexible use of land*" (paragraph 157). Government guidance, set out most recently in the Housing White Paper (February 2017) is also committed to significantly deliver more homes on public sector land. It sees the NHSPS as a key stakeholder in the process and the NHSPS is now being pushed by the DCLG to deliver more housing and at an accelerated timescale.

Furthermore, the policy is also at odds with emerging Policy H2 which provides guidance on the appropriate density and mix within residential schemes. The wording of Policy H2 is welcomed as it advocates the need to "*maximise the efficiency of land use*".

Modifications

Local Plans by nature should be non-prescriptive, allowing policies to be "*sufficiently flexible to take account of changing market conditions*" (paragraph 50). By imposing an arbitrary ceiling on the number of dwellings that could be delivered eliminates a key element of plan flexibility. We strongly urge that the policy is amended to reflect a higher range of **16-26 dwellings** based on the work the NHSPS has already done which will enable a higher rate of delivery for this sustainable urban brownfield site.

Summary

For the reasons identified above, Policy WR3j is **unsound** as it is not justified or consistent with national policy. We therefore strongly urge that the suggested amendments to the policy are taken forward before the examination stage. It is imperative that the site is not subject to overly onerous policies, particularly when the NHSPS is pressured by the White Paper and DCLG to deliver more housing. It also has a statutory duty to help finance improved healthcare services and facilities nationally through the disposal of their sites.

We trust that this covering letter and the enclosed pro forma provide you with sufficient information. Should you require further information, please do not hesitate to contact me

Yours sincerely

Renzo Yau
Planner

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Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

Personal Details

Agent's Details *(if applicable)*

Title		Mr
First Name		Renzo
Last Name		Yau
Job Title <i>(if applicable)</i>		Planner
Organisation <i>(if applicable)</i>		Lambert Smith Hampton
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Address 3		
Town		London
Post Code		W1D 1NN
Telephone		
E-mail		ryau@lsh.co.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

WR3j

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

See covering letter

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

See covering letter

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

Put forth case at the examination and participate in overall discussion.

B7. Do you wish to be kept informed of planning policy matters?
(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

OXFORDSHIRE COUNTY COUNCIL

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	Mr	
First Name	John	
Last Name	Disley	
Job Title <i>(if applicable)</i>	Policy & Strategy Manager	
Organisation <i>(if applicable)</i>	Oxfordshire County Council	
Address 1	County Hall	
Address 2	New Road	
Address 3		
Town	Oxford	
Post Code	OX1 1ND	
Telephone	07767 006742	
E-mail	John.disley@oxfordshire.gov.uk	

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

1. Paras 4.5.8 bullet 6; 4.5.9; 8.2.1d; 8.2.5; and the IDP
2. Paragraphs 4.5.8 bullets 1 and 2; 8.2.1c; Figs 4.8 and 8.1; and the IDP.
3. Para 4.7.6

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

1. a) The draft Local Plan is not positively prepared in that it does not provide for measures within South Oxfordshire to mitigate the impact of the proposed new River Thames crossing.
b) The costs of the proposed new river crossing scheme quoted in the IDP are a significant underestimate.
c) The costs of the scheme do not include mitigation measures within South Oxfordshire.
2. a) The approach to Park & Ride sites and Rapid Transit which suggests that Park and Ride sites potentially being within South Oxfordshire is not justified or effective.
b) The cost figure for all of the Park & Ride proposals quoted in the IDP is not broken down by scheme and appears to be an underestimate.
3. a) The Plan is not effective in that it does not provide sufficient detail to demonstrate that sufficient schools capacity will be provided to meet the demands for places generated by growth, including the extent to which Reading Borough is relying on schools outside the borough
b) The Plan is ineffective in that the plan text does not rule out the possibility of a new secondary school being located in north Reading.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

1. a) Para 4.5.9 and/or para. 8.2.5 should include a requirement for relevant mitigation measures within South Oxfordshire
b) The River Crossing section of the IDP needs to be updated to reflect recent work undertaken for the financial case for the scheme options which range from £109m for option 1 to £165m for option 3
c) A reference to relevant mitigation measures within South Oxfordshire being additional must be included in the River Crossing section of the IDP and when available, the level and cost of measures should be built into the costs and delivery of the bridge.
2. a) The last two sentences of para 4.5.8 bullet 2 should be deleted.
b) A reference should be included in the Plan to an alternative strategy of pump-priming interurban bus services to 'Premium Route' standards (doubling of service to four buses per hour) being investigated through partnership working.
c) The IDP should be amended to deduct the cost of Park & Ride sites from the total Park and Rides sites figure and replaced with the cost of pump-priming interurban bus services to 'Premium Route' standards. However, if

references to potential Park and Ride sites within South Oxfordshire remain in the Plan, the IDP should be amended to reflect the full costs of providing sites within South Oxfordshire and how they are to be funded.

3. a) The Plan should be supported by a paper on existing school capacity and forecasts and clarify in para 4.7.6 the extent to which Reading Borough is relying on schools outside the borough to meet the growth in pupil numbers as well as more detail on the planned additional capacity required.
- b) Para 4.7.6 should be strengthened to clarify that the site of the proposed new 6FE secondary school will not be in North Reading - delete the word 'Ideally'

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

To explain to the Inspector the Council's case and to assist in answering questions on cross-boundary issues.

B7. Do you wish to be kept informed of planning policy matters?
(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Oxfordshire County Council's Response to Consultation on the Pre-submission Draft Reading Borough Local Plan

Overall Comments

1. Oxfordshire County Council (OCC) wishes to support Reading Borough Council (RBC) in its aim of putting an up to date Local Plan in place but we do have some concerns that the Plan policies and proposals as currently worded and the level of detail in the Infrastructure Delivery Plan (IDP) are unsound in relation to the supporting strategic infrastructure put forward to deal with the cumulative impacts of growth.
2. The soundness issues we are raising on the draft plan relate to the following infrastructure proposals:
 - New River Thames crossing
 - Park and Ride sites and Mass Transit
 - Secondary education infrastructure

Scale and Distribution of growth

3. OCC supports joint strategic planning in principle and notes that the four LPAs in the Western Berkshire Housing Market Area (HMA) – Reading, West Berkshire, Wokingham and Bracknell Forest Councils - have been undertaking joint work, including production of the non-statutory West Berkshire Spatial Planning Framework (WBSPF) to 2036.
4. The WBSPF identifies key development opportunities within Central and South Reading and a large opportunity (15,000 homes) to the south of Reading at Grazeley on the boundary between West Berkshire and Wokingham. The framework also identifies at a high level the major infrastructure items needed in the HMA to support growth; these include a new River Thames crossing, enhanced park and ride provision and a new secondary school.
5. The draft Reading Borough Local Plan reflects the guidance in the WBSPF; it provides for an additional 15,433 homes within Reading between 2013-2036, including 7,600 homes in Central Reading and 3,700 homes in South Reading. Growth elsewhere would be limited: 2,400 homes in West Reading, 700 in North Reading and 1,100 in East Reading. It also provides more detail around the provision of supporting infrastructure.
6. OCC has no objection in principle to the scale and distribution of the housing growth proposed in the draft Plan. However we raise the following concerns about the strategic infrastructure proposals in the draft plan:

New River Thames Crossing

7. Policy TR2 includes a new crossing of the River Thames as a major transport project and Fig 4.8 shows its likely location within South Oxfordshire and Wokingham. The IDP states a cost figure of c. £100m and identifies the Local Growth Fund as a funding source.
8. OCC's current position is that it has no objection in principle to the bridge and will continue to engage in joint work with RBC, Wokingham Council and South

Oxfordshire District Council. However, the strategic outline business case for the bridge is weak in terms of defining the nature of the problem and why there is a need for action.

9. If the bridge is seen as a solution to problems in Reading, OCC will need to be satisfied that any scheme does not have any adverse effects on South Oxfordshire. In any further business case work on the bridge and indeed if a bridge is delivered, the potential impacts must be fully explored and relevant mitigation measures (which are not currently included in the bridge proposals) need to be built in to the costs and delivery of a Bridge. The level and cost of mitigation could be very significant if major upgrades of the highway network in South Oxfordshire are required and any measures needed to complement the bridge will need funding as part of the overall bridge package.
10. OCC **objects** to the draft Local Plan as it is not positively prepared in that it does not provide for necessary mitigation measures within South Oxfordshire. In addition, the costs of the scheme quoted in the IDP are a significant underestimate and need to be updated to reflect recent work undertaken for the financial case for the scheme options which range from £109m for option 1 to £165m for option 3. The costs must also include mitigation measures within South Oxfordshire.

Park and Ride and Mass Transit

11. Policy TR2 lists Park and Ride (P&R) sites and Mass Rapid Transit (MRT) as major transport projects to support growth.
12. The draft Plan states that there is continued need for new P&R provision and opportunities for new sites will be sought. Opportunities are identified on Fig 4.8 and include corridors radiating out of Reading into South Oxfordshire. Para 4.5.8 says that the constraints within Reading mean that P&R sites are likely to be in adjoining authorities, and RBC will continue to work with its neighbours to bring new facilities forward. Para 8.2.1 specifically states that new P&R capacity will be sought on the A4155, A4074 and B481 corridors.
13. Currently there is no policy in place to support this approach within Oxfordshire. Oxfordshire's LTP4 proposes a network of remote P&R sites supported by Rapid Transit services on key growth corridors into Oxford, primarily focused on the "knowledge spine" corridor linking Harwell/Didcot – Oxford – Bicester. It does not propose development of P&R sites to support travel to Reading and it would not be Oxfordshire's priority to acquire land for, fund, develop or maintain new P&R facilities or dedicated bus-based Mass Transit services to Reading. Likewise, the Oxfordshire Infrastructure Strategy (OxIS) to 2040 (approved by the Oxfordshire Growth Board) does not identify P&R for Reading as a priority for infrastructure investment.
14. Reading's main employment areas and the bulk of the proposed housing growth are to be located within the central area and to the south of Reading. Growth in neighbouring areas is also focused to the south of Reading and there is no significant growth planned within Oxfordshire closed to the Reading boundary. Therefore, in the absence of technical information demonstrating that P&R sites on the identified corridors into Oxfordshire are the most effective, viable and deliverable solution to the town's congestion issues arising from planned growth, OCC **objects** to references in the plan to P&R sites potentially being located within Oxfordshire – they are not justified.

15. The draft Plan sees P&R sites as complementing existing bus services, including inter-urban buses, by supporting their use. New P&R sites within South Oxfordshire on corridors to Reading are likely to generate significant additional traffic on the network. We would prefer to see an alternative strategy of pump-priming bus services to 'Premium Route' standards (doubling of service to four buses per hour) e.g. services from Wallingford along the A4074, Peppard/Sonning Common along the B481 and Henley along the A4155. This would be a potentially more sustainable solution than promoting car travel along already congested 'A' roads to P&R sites and cost far less as it would not require land acquisition or investment in new transport interchanges which in turn require planning permission, potentially difficult if located in the AONB.
16. OCC is willing to work with RBC to identify the most appropriate strategy for dealing with congestion on routes from Oxfordshire into Reading, including how the frequency of bus services can be increased and whether bus priority measures could be developed to support the attractiveness of alternative to the car for accessing the town.
17. The IDP identifies the capital cost of the six P&R sites as £19m, to be funded from s106, LTP and LGF; this appears to be an underestimate. Work undertaken for the Oxfordshire P&R sites suggests costs around £5m per site rather than Reading's figure of £3.2m. If P&R sites within Oxfordshire are shown to be the most appropriate transport strategy then further work would be needed to show how the full costs are broken down, including for land acquisition and how they are to be funded to demonstrate that the sites would be deliverable.
18. OCC **objects** to the approach to P&R sites and Rapid Transit outlined in the draft Plan on the grounds that it is not justified or effective.

Secondary Education infrastructure

19. The draft Plan provides for significant housing growth, over 15,400 homes, of which some 13,000 remain to be built. Para 4.7.6 identifies a need for a 1 form entry primary school expansion and a new 6 form entry secondary school; in addition, the IDP specifies a need for expansion of existing secondary schools to provide three forms of entry. On the surface this provision would not appear to be sufficient to meet the demand for places that will be generated by new housing growth.
20. There are currently significant numbers of Reading pupils attending Oxfordshire schools, and in particular Chiltern Edge School is sustained by Reading pupils with nearly 70% of pupils on roll coming from the Caversham area. To confirm the plan will be effective and to demonstrate duty to cooperate RBC should provide information on existing school capacity and forecasts and set out the extent to which Reading is relying on schools outside the borough to meet the growth as well as more detail on planned additional capacity required.
21. Para 4.7.6 states that the proposed new secondary school would "ideally" be centrally located. The requirement for the new school to be in central Reading, or at least outside of north Reading, needs to be strengthened. If the new school was in north Reading not only would there be negative impacts on Oxfordshire schools, but the new school could fail to meet the needs of Reading as intended.
22. The draft Local Plan allocates the vast majority of Reading's planned housing to south of the river. If a new school were to be located in north Reading, in order to meet the needs of population growth large numbers of pupils would need to travel

from other areas of Reading, increasing pressure on the river crossing which is already a constraint.

23. A new school in north Reading could also result in pupils being diverted from the existing Oxfordshire schools, leaving one or more of them unviable. If the new school filled up in this way from pupils who would otherwise have attended Oxfordshire schools, it would then have insufficient capacity to meet the population growth in the rest of Reading. The result would therefore be insufficient places in Reading and unviable schools in Oxfordshire.
24. OCC **objects** to the local plan as currently presented in respect to new secondary school provision and where it is to be located as it is not effective. Further work is needed to justify how RBC proposes to accommodate growth in pupil numbers and the plan should be amended to confirm the location of the proposed secondary school should be south of the river.
25. The completed Representations Form is attached.

PANG VALLEY GROUP OF THE RAMBLERS' ASSOCIATION

Reading Borough Council

Pre-Submission Local Plan November 2017

Policy WR4

1 Introduction

- 1.1 My Name is Henry Colin Hatcher. I retired in 2005 as a Chartered Surveyor with 48 years' experience in the Public and Private sector. I am Footpath Officer for the Pang Valley Group of the Ramblers Association.
- 1.1 The aim of that Association is to protect dedicated Rights of Way to the benefit of pedestrians.
- 1.2 In November 2017 Reading Borough Council consulted on a proposal to establish a Gypsy and Traveller site at Cow Lane via access from a gravelled track doubling as Public Footpath Reading 17.
- 1.3 I made representations on that proposal and attach a copy of that document dated 23 October 2017.

2 The Basis of objection

- 2.1 Public Footpath Reading 17 is a designated public footpath and as such access is limited by Section 34 of the Roads Traffic Act 1988 to pedestrian use only.
- 2.2 **Policy WR4: Potential Traveller Transit Site at Cow Lane** says:

This site has been identified as having potential for transit accommodation for travellers. This will continue to be explored by the Council. Any proposed development for transit accommodation should:

- *At a minimum, provide five transit pitches, with each pitch capable of accommodating two caravans;*
- *Ensure that pitches are available to rent on a temporary basis only;*
- *Include access to the highway network that does not detrimentally affect the use of existing vehicular routes or public rights of way;*
- *Not have significant adverse effects on existing operations, in particular the Reading Festival;*
- *Not cause adverse effects on the local area in terms of public amenity and safety;*
- *Take account of the potential for flooding; and*
- *Be provided with a strong landscaped buffer to open spaces, commercial sites and the Richfield Avenue frontage.*

- 2.3 *The Justification paragraphs to the policy say:*

7.3.19 The need for transit accommodation for gypsies and travellers in Reading is highlighted in relation to policy H13 of this plan. A rise in the number of illegal encampments in Reading and the Thames Valley area over recent years has brought the issue of traveller accommodation into sharper focus. The provision of a transit site within Reading would enable the police to make use of powers under Section 62a of the Criminal Justice and Public Order Act 1994.

7.3.20 *The Cow Lane site emerged from a thorough assessment of the potential for provision for gypsies and travellers in the Borough. The site is in Council ownership, and is considered to be the only location in Reading where transit needs could potentially be met. More detailed consideration of the potential of the site, including the likely costs, will be needed before any detailed proposal can be made.*

7.3.21 *It should be noted that there are existing commercial operations that could be affected. In particular, the site is currently used as part of the Reading Festival site, which takes place annually in August. The Festival is a major asset to the town, and any proposal will need to ensure that the ability of the Festival to operate will not be threatened.*

- 2.4 In my submission to the consultation exercise in October 2017 I pointed out that the designation of Cow Lane as a dedicated footpath meant that access to this site cannot be obtained legally by motor vehicle. I suggested that an alternative access should be used either from Richfield Avenue itself or along the back of the former Leaderboard Golf Driving Range.
- 2.5 I am pleased to see that any existing Rights of Way are to be protected by the wording highlighted above in the sub-paragraphs to Policy WR4 but nevertheless register an objection because the heading of the Policy suggests that access will be from Cow Lane.

3 Conclusion

- 3.1 The identification of Cow Lane as a Gypsy and Traveller site is premature given there are many difficulties to be overcome with access and that it clashes with the pop festival use.
- 3.2 Accordingly the heading of Policy WR4 and the wording of the justification paragraphs should be amended to reflect that the Borough Council have identified a potential site but difficulties with access and use have to be resolved. Any reference to access from Cow Lane should be removed from the Policy heading since that is aspirational.

Reading Borough Council

Pre-Submission Local Plan November 2017

Policy H12

1 Introduction

- 1.1 My Name is Henry Colin Hatcher. I retired as a Chartered Surveyor in 2005 with 48 years' experience in the Public and Private sector. I am Footpath Officer for the Pang Valley Group of the Ramblers Association.
- 1.1 The aim of that Association is to protect dedicated Rights of Way.
- 1.2 In November 2017 Reading Borough Council consulted on a proposal to establish a Gypsy and Traveller site at Cow Lane via access from a gravelled track doubling as Public Footpath Reading 17.
- 1.3 I made representations on that proposal and attach a copy of that document dated 23 October 2017 as Appendix 1.

2 The Basis of Objection

- 2.1 Within Policy WR4, reference is made to Policy H13. That is incorrect and reference should have been to Policy H12 as set out below:
- 2.2 *Policy H12: Provision for Gypsies and Travellers*

Proposals for new sites or extensions to existing sites for gypsies, travellers and travelling showpeople will be judged against the following criteria. Proposals should:

- i) Meet an identified need for gypsy, traveller or travelling showpeople accommodation within Reading;*
- ii) Have safe and convenient access onto the highway network;*
- iii) Have good access to a range of facilities including education and healthcare by a choice of means of travel, including walking;*
- iv) Not have an unacceptable impact on the physical and visual character and quality of the area;*
- v) Not have an unacceptable impact on the amenity of existing residents in surrounding areas, or on future residents of the proposal; and*
- vi) Not result in the loss of important trees or wildlife.*

4.4.86 National planning policy requires that the local authority assess the need for accommodation for gypsies, travellers and travelling showpeople in its area. As it stands, the only existing site is a site for travelling showpeople at Scours Lane. The Council is currently undertaking a Gypsy and Traveller Accommodation Assessment (GTAA) that assesses the need for accommodation for these groups, which is expected to be published shortly. It is anticipated that it will identify a need for pitches arising from the high recent numbers of unauthorised encampments.

4.4.87 The expectation in national policy is that, where a need is identified, a local authority should plan to meet that need

unless there are exceptional reasons why it should not. As the GTAA is now being finalised, the Council has not had an opportunity to identify whether a site can be found within Reading Borough, and if so, where that site should be. If a site cannot be found within Reading, the Council will seek to resolve this issue with neighbouring authorities through the duty to co-operate. This issue will need to be resolved by the time of the Pre-Submission Draft of the Local Plan, later in 2017. The Council therefore remains open to suggestions for a site to meet this need.

4.4.88 In addition to an identified site, there is also a need to include a general policy to judge any applications for sites for gypsies, travellers and travelling showpeople. The requirements do not differ markedly from the requirements for housing for any other groups, but the need to have good access by foot to education and healthcare (ideally within 400m, but 800m at the furthest) is particularly vital, as is the need for good access to the highway network.

3 Comment

- 3.1 Subsection (ii) of the Policy requires that proposals should "have safe and convenient access onto the highway network." I support that contention because that should mean both to users of the site and to other users be they vehicular or pedestrian. The site that the Council has selected is outlined in Policy WR4 and I have registered an objection to that Policy because it is proposed that access is provided by that part of Cow Lane that is Public Footpath Reading 17.
- 3.2 Justification Paragraph 4.4.86 should be amended to exclude the wording highlighted because the Council has now concluded its Gypsy and Traveller Accommodation Assessment.
- 3.3 Similarly the wording highlighted in justification paragraph 4.4.88 should be removed because it has been overtaken by the publication of this Pre-Submission Draft

4 Conclusion

- 4.1 I submit that the wording of Paragraphs 4.4.86 and 4.4.87 should be amended to reflect that events have now rendered that wording obsolete.
- 4.2 This submission should be read in the context of my other submission in respect of Policy WR4.

H C Hatcher
Footpath Officer of Pang Valley Group of Ramblers' Association
25 January 2018

Comments on

Gypsy and Traveller Provision Consultation Document

Reading Borough Council September 2017

- 1 My name is Colin Hatcher. I write as Footpath Officer for the Pang Valley Group of the Ramblers' Association. The concern of that organisation is the protection of Rights of Way.
- 2 The proposal is to designate 0.73 ha of land in the ownership of Reading Borough Council to accommodate 5 transit pitches at the junction of Cow Lane and Richfield Avenue.
- 3 Highway access is to be by way of Cow Lane which is a gravelled track doubling as Reading FP17 from Richfield Avenue north to the Thames Towpath.
- 4 We have concerns that by providing access to the designated site from Cow Lane, the use of Reading FP17 by members of the public could be compromised.
- 5 Since we do not know of the provisions under which Reading Borough Council has allowed access along Cow Lane by motor vehicles, we cannot be specific. We can point out that Reading FP17 is a designated Footpath and as such should only be used by pedestrians. Under section 34 of the Road Traffic Act 1988 "it is an offence to drive a mechanically-propelled vehicle without lawful authority on any road which is over any footpath, bridleway or restricted byway". There is a defence if the vehicle does not have to travel more than 15 yards but that is exceeded in this case.
- 6 Our other concern is that there is already fly tipping along Cow Lane and we would not want pedestrians to be faced with a major increase in the accumulation of such waste with the resultant increase in public health issues. That concern can be obviated by the proposed site being security fenced without access to Cow Lane.
- 7 Alternative access could be provided from Richfield Avenue itself or from the access road to Rivermead Leisure Centre and along the back of the former Leaderboard Golf Driving Range. Either of those accesses together with adequate fencing between the site and Cow Lane would overcome our concerns.

H C Hatcher
23 October 2017

Reading Borough Council

Pre-Submission Local Plan November 2017

Policy TR4 and Proposals Map

1 Introduction

- 1.1 My Name is Henry Colin Hatcher. I retired in 2005 as a Chartered Surveyor with 48 years' experience in the Public and Private sector. I am Footpath Officer for the Pang Valley Group of the Ramblers Association.
- 1.1 The aim of that Association is to protect dedicated Rights of Way to the benefit of pedestrians.
- 1.2 In May 2017 Reading Borough Council has launched a Public Consultation by Notice Dated 27 April 2017 on their proposal to convert half the width of public footpaths covering the length of the Thames Path from the Roebuck Hotel through to Kennet Mouth.
- 1.3 I, together with many others, objected to that proposal and attach a copy of that submission. Reading Borough Council was thus obliged to submit their proposal to the Secretary of State for approval. I attach a copy of that submission dated 23 May 2017 as Appendix 1 together with Appendices A, B and C that were attached to that submission.

2 The Basis of objection

- 2.1 The Thames Path is shown on the proposals map as a cycle track (admitted by the Council to be a designation that it does not control) and is covered by Policy TR4. I maintain that designation is premature and incorrect.

2.2 Policy TR4: Cycle Routes and Facilities says:

Developments will be expected to make full use of opportunities to improve access for cyclists to, from and within the development and to integrate cycling through the provision of new facilities. Development of new facilities for cycling, such as cycle hire points and cycle parking, will be acceptable. The cycle routes identified in the most up-to-date Cycling Strategy will be maintained, enhanced and added to or extended. Development will not detrimentally affect an identified cycle route. Where opportunities exist, improvements to that route, including the provision of connecting routes, and/or cycling facilities will be sought within developments or through planning contributions.

- 2.3 The justification paragraphs to the policy say:

4.5.17 Cycling is one of the most sustainable forms of transport, and forms an important part of Reading's transport strategy. Opportunities to continue to promote cycling, and enhance important routes, should be seized.

4.5.18 The Local Transport Plan 2011-2026 is supported by a full Cycling Strategy, published in 2014. This seeks to enhance cycling in Reading through:

- "new and improved cycle infrastructure that will aim to bridge gaps between existing barriers, including the railway and River Thames
- cycle hire will give people that do not currently have access to a bicycle the opportunity to cycle to key destinations
- increased cycle parking facilities to enable to people to park closer to more key destinations
- positively promoting the benefits of cycling in a compact urban area such as Reading."81

4.5.19 The Cycling Strategy 2014 continues and builds upon the cycle routes developed as part of the 2008 strategy by identifying detailed policies for delivering infrastructure and route improvements for cyclists on the public highway to enhance the routes. The relevant routes are shown on the Proposals Map, and the Policy therefore applies to these routes. If an updated Cycling Strategy or supporting cycle map shows a different network of cycle routes, these will become the routes to which this policy applies.

4.5.20 The measures which the strategy identifies in different areas include minor improvements, new links, maintenance, branding and signing. The Cycling Strategy and the development of a Local Cycling and Walking Infrastructure Plan will be useful to help identify which improvements are required.

4.5.21 In addition, a cycle hire scheme was initially introduced in central, north, south and east Reading in 2014. There is the potential for this scheme to be expanded to key destinations in west Reading during the plan period, and this should be supported, subject to compliance with other policies in this Plan.

4.5.22 Reading is working with the Thames Valley Berkshire LEP and neighbouring authorities to provide additional strategic cycle routes as part of the NCN (National Cycle Network) and to provide enhanced linkages between the NCN and local cycle routes within the borough.

- 2.4 In particular I take issue with the highlighted words of justification paragraph 4.5.19: "The relevant routes are shown on the Proposals Map, and the Policy therefore applies to these routes" and in the first sub-paragraph of Justification Paragraph 4.5.18 "and River Thames".
- 2.5 The first sub-paragraph 4.5.18 should be amended by deleting the word "and River Thames"
- 2.6 Justification paragraph 4.5.19 should be amended by deleting the wording "The relevant routes are shown on the Proposals Map, and the policy therefore applies to those routes" and the designation of the Thames Path as a cycle track should be removed from the proposals map.
- 2.7 My reasoning is that The Secretary of State has yet to give his decision on the application by Reading Borough Council on their proposal to alter the status of the Thames Path. The Council could be seen to be pre-empting that decision and possibly attempting to circumvent the procedure of having to seek the Secretary of State's ruling. Government Advice is

that development should be in accordance with the Adopted Local Plan unless there are extenuating circumstances so it is important that the Borough Plan is clear and unambiguous.

3 Conclusion

- 3.1 The designation of the Thames Path is premature. All of the objections raised in May 2017 have to be considered by the Secretary of State, possibly following a public inquiry, before any change in designation from a footpath to a footpath and Cycle Track.
- 3.2 The reasoning for my objection is fully set out in the submission and Appendices that I made in May 2017 and which are attached to this submission.
- 3.3 The wording of Justification Paragraphs 4.5.18 and 4.5.19 should be amended as suggested above and the designation of the Thames Path as a cycle track should be removed from the Proposals Map.

H C Hatcher
Footpath Officer
Pang Valley Group of the Ramblers' Association

23 January 2017

Representation on Proposal by Reading Borough Council to
alter the Status of half the width of the Thames Path
between the Former Roebuck Inn and Kennet Mouth from
Public Footpath to Footpath and Cycle Track

1 Introduction

- 1.1 My name is Henry Colin Hatcher and I am Footpath Officer to the Pang Valley Group of the Ramblers' Association.
- 1.2 Reading Borough Council has launched a Public Consultation by Notice Dated 27 April 2017 on their proposal to convert half the width of public footpaths covering the length of the Thames Path from the Roebuck Hotel through to Kennet Mouth.

2 Legislation

- 2.1 The conversion of a footpath to a cycle track is covered under Section 3 of the Cycle Tracks Act 1984. The Department of Transport supplemented the Act with the Cycle Tracks Regulations 1984 deals with this specifically in Sections 12 and 13 which is reproduced in full immediately below.

*CONVERSION OF A FOOTPATH TO A CYCLE TRACK
General*

12. Section 3 of the 1984 Act provides a new procedure under which a local highway authority can convert all, or part, of a footpath to a cycle track. The effect of an order made and confirmed under this section is to convert the footpath, or part thereof, to a cycle track with a right of way on foot. On conversion the cycle track becomes a highway maintainable at public expense (section 36 of the Highways Act 1980) even if the footpath had not previously had that status.

*13. A local highway authority can make and confirm an order under section 3 if there are no unwithdrawn objections. **If the order is opposed it has to be submitted to the Secretary of State for confirmation.** (my emphasis) The necessary procedures for the making and confirmation of an order are set down in section 3 and in the 1984 Regulations. For convenience the advice in this Circular follows the general sequence followed when an order is made and confirmed. The advice is cross referenced to the 1984 Act and 1984 Regulations which should be read together with it.*

3 Reading Borough Strategy

- 3.1 Reproduced below is an extract from Item 19 of the Reading Borough Council Traffic Management Sub-Committee 15 June 2016 Agenda Item 19

CYCLING STRATEGY IMPLEMENTATION PLAN 2016/17

4.4 The Cycling Strategy delivery programme for 2016/17, as set out at Appendix C, has been developed by assessing the level of available funding alongside an assessment methodology to prioritise projects which meet strategic objectives and deliver value for money.

4.5 The opening of the pedestrian and cycle bridge has led to an increase in cycle use in the vicinity of the River Thames and Thames Path, which is legally classified as a footpath over which the public has a right of way by foot only. Increased cycle use has been highlighted through site visits along the Thames Path and ongoing dialogue with the Cycle Forum that led to the decision to carry out informal consultation seeking the views of key stakeholders regarding the possibility of permitting cycling along the Thames Path between Reading and Caversham Bridge. **It should be noted that the Council initiated the process to convert the section of the Thames Path between Reading and Caversham Bridge to a cycle track in 2007, which resulted in over 150 objections and 29 letters of support. Objections related to concerns regarding the width of the footpath, the perceived threat to wildlife and conflicts between different user groups. The consultation resulted in the Council seeking independent legal advice and taking the decision to not pursue the Order further.** (my emphasis)

4.6 Respondents were generally in support of opening up more traffic-free routes in order to avoid alternative busy roads and to encourage cycling amongst vulnerable groups or less confident cyclists, including the Thames Path Management Group that is reviewing cycle access across the whole Thames Path route. Half of the respondents also suggested the need to consider improved signing promoting considerate use, such as the slogan adopted by The Canals & Rivers Trust - 'share the space, drop your pace'. However a number of respondents raised concerns regarding the width of the towpath being appropriate for a shared facility, in particular the section of footpath between De Montfont Road and Reading Bridge was highlighted to be of insufficient width to accommodate dual-use. The majority of the Thames Path between Reading and Caversham Bridge has a width of between 2 and 2.6 metres. However, one short section of the Thames Path near Thameside measured 1.7 metres wide. **National guidance recommends that unsegregated share-use facilities should ideally be 3 metres wide as reflected in our Cycling Strategy that also states that shared-use facilities will be a minimum of 2 metres wide. The Environment Agency requested that sections of failing river banks be taken into consideration should improvements be made to the path.** (my emphasis)

4.7 It is now recommended that a statutory consultation is carried out to seek the views of landowners to further identify options for cycle use along the full section of the Thames Path (Footpath 1) in Reading. The results from the consultation will be reported back to the Committee along with our recommendation taking into account feedback from the informal and statutory consultation.

4. Current Situation

- 4.1 A major change since Reading Bough Council carried out the Consultation Process in 2007 has been the construction and opening of the new footbridge across the Thames on the stretch between Caversham and Reading Bridges. That Consultation process in 2007 resulted from the proposal to convert the Public Footpath to a Cycle Track. The proposal was dropped for reasons well highlighted in The Cycling Strategy Implementation Plan 2016-17 set out in Paragraphs 4.5 to 4.7 above. The length of path between Caversham and Reading Bridges is 0.5 miles (0.8 Km).

- 4.3 The current proposal is to convert 4.25 miles (6.80 Km) of the Thames Path from the status of a public footpath to a cycle track.
- 4.4 There are stretches of the path that do not comply with Reading Borough Council's own criteria because they are less than 2.0 metres wide. None of the section of path is admitted by Reading Borough Council to comply with National Guidelines for a shared user path of 3.0 metres wide.

5 The Evidence

- 5.1 Photographic evidence is contained within **Appendix A** together with the measured width of the footpath at the point where the photographs were taken.
- 5.2 The measurements physically taken do not agree with the Statement Accompanying the Definitive Map:
1. Number 1(PV) states that the minimum width for the section from "Reading Bridge E past Caversham Lock and over Kings Meadow and the River Kennet, following Thames Towpath" has a width varying from 5.0 metres to 3.0 metres. My measurement for the Path at the Eastern end of Kings Meadow is 1.5 metres wide and 1.7 metres wide opposite the "Better Boating Company".
 2. Number 1B(PV) gives a minimum width of 2.0 metres from "Roebuck Ferry Cottage...along Thames Towpath to E side of Caversham Road". My measurements show that at the bottom of the steps leading to Roebuck Bridge over the Railway Line, the towpath is only 1.2 metres wide widening to 1.5 metres wide further along the Towpath where it is constrained both by metal fencing and by the River bank.
 3. Reading Borough's own Cycling Strategy delivery programme for 2016/17 said that "The majority of the Thames Path between Reading and Caversham Bridge has a width of between 2 and 2.6 metres. However, one short section of the Thames Path near Thameside measured 1.7 metres wide" and yet the definitive map reference 1(PV) claims widths of up to 4.0 metres but accepting in one area that it is only 2.0 metres wide.
- 5.3 Additionally there is a perfectly good alternative for cyclists between Tilehurst Railway Station (a short distance from the Roebuck) and I make no apology for repeating an submission by Ray Clayton, The Pang Valley Rambler's Walks Co-ordinator
- "There is already a metalled cycle track which avoids cyclists using the busy roads. This goes alongside the A329(Oxford Road) from Tilehurst Railway Station to Norcot Road Junction, from Norcot Road Junction to Cow Lane alongside Portman Road, and from Cow Lane alongside Richfield Avenue to Caversham Bridge. The section under Cow Lane Bridges is currently controlled by traffic lights, but will be regularised for cyclists when the bridges under the railway are finally constructed."
- 5.4 During this exercise two cyclists overtook at speed without sounding their bells. Since dog and solo walkers were using the footpath at the same time, those cyclists were thoughtless and dangerous and did not comply with Reading Borough Councils own standards for cycling reproduced as **Appendix B**. A further cyclist dismounted on the Oxford Road to the west of the Roebuck Inn and entered a footpath which is clearly signed to prohibit cyclists (**Appendix C**) demonstrating that cyclists disregard notices where they are posted. It is unlikely therefore that they will abide by any code relating to shared footpaths.

6. Conclusion

- 6.1 Whilst the concept of a cycle track along the Thames Path might seem attractive, the path is not wide enough to accommodate both walkers and cyclists. In many places it is below the width deemed appropriate by Reading Borough Council and falls well below the National Guideline of 3.0 metres minimum width admitted in Reading Borough Council's Cycling strategy.
- 6.2 Problems will arise because cyclist do not give warning of their approach by use of their bell, cycle too fast and often do not consider the mobility of walkers. Widening the path is not an option in stretches of the path because of the close proximity of the river bank. Any proposals that Reading Borough Council might have to widen the path should have been included in the strategy document and stated in the notice and the conversion of the footpath should not have been proposed until those works had been undertaken.

H C Hatcher

23 May 2017

APPENDIX A



Footbridge over railway to rear of former Roebuck Inn showing 11 steps down onto bridge. Bridge width 2.2 metres.



70 steps down from footbridge over railway to Thames. Cyclists would have to carry bicycles up or down these steps.



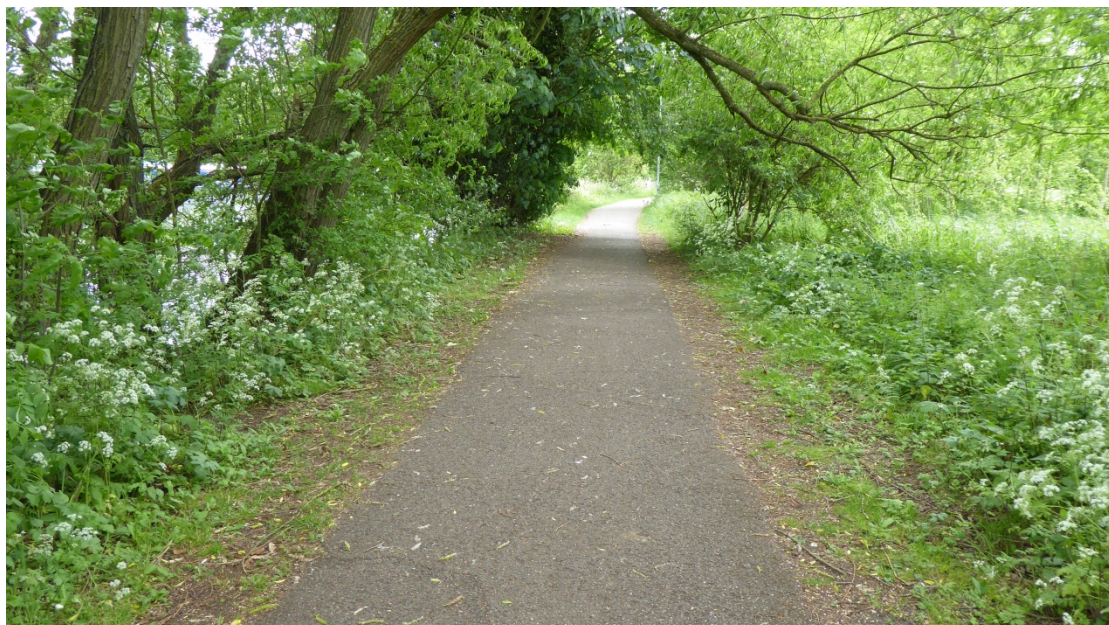
At bottom of steps path is initially 1.2 metres wide and possible widening constrained by river bank falling away.



Further along Thames Path width is 1.5 metres constrained by metal fencing and river bank.



Across Kings Meadow the footpath is 1.5 metres wide. Widening is possible here but no mention of widening is mentioned in official notice.



Opposite Better Boating Company it widens to 1.7 metres and eventually to 2 metres at the back of Tesco Superstore

Appendix B is the Borough Council's leaflets of Cycling Routes routes within the Borough and requirements for safe cycling

APPENDIX C



Gateway just West of former Roebuck Inn displaying clear notice of status of path where cyclist observed cycling

PARRY, RICHARD

From: Richard Parry
Sent: 17 February 2018 21:06
To: Bell, Alison
Cc: Page, Tony (Councillor); Grashoff, Clare (Councillor); Stanford-Beale, Jane (Councillor); Robinson, Simon (Councillor)
Subject: Reading Golf Course

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Ms Bell,

I live in Eric Avenue and back on to the second fairway of Reading Golf Course. I have lived in this house since 1987 when I came to Reading with a work promotion. It is a lovely location and I and my family have been very lucky to live here.

Recently I have become aware of the possibility that the Course may be given over to housing under the terms of the Local Plan and I am deeply concerned about this prospect and its implications for the whole environment in Emmer Green. In short I would like the Council to withdraw the Course from the Local Plan before it is submitted to the Secretary of State at the end of March.

My objections and concerns can be summarised as follows:

-the increase in road traffic around Emmer Green and the roads into Reading. From personal experience it can take over 30 minutes to get as far as Prospect Street of a weekday morning and with perhaps another 500+ cars on these roads each day it may become intolerable.

- the lack of sufficient healthcare and school places for an expanding population. I well remember the promises made when permission was given for the development of Bugs Bottom. Non of which came to pass.

-I understand that levels of pollution are already high across Reading and the increase in cars and car journeys together with the loss of green space would combine to make things much worse.

-the Council and the Government have made it clear that they will prioritise the development of brownfield sites before considering green field sites such as Reading Golf Course. I have recently learned that the Homebase site in the centre of town is due to be converted into as large number of flats and it seems to me that this is in keeping with this strategy and far more sensible.

-if the Course were to be developed I would expect the whole road network around Emmer Green to be reconfigured. A new junction at the at the end of Kidmore End Road plus the loss of part of the recreation ground to widen access to the roads into Reading.

I do hope that you and your team can be persuaded that the whole idea is impractical and, probably, unnecessary given the availability of brownfield sites that may better provide the number and affordability of homes the Council needs.

Regards
Richard Parry

Sent from [Mail](#) for Windows 10

Click [here](#) to report this email as spam.

PHELAN, MARY

From: Mary Phelan
Sent: 26 January 2018 09:03
To: Planning Policy
Subject: Draft Local Plan Section EN7N

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Sirs/ Madams,

I have the following questions related to the draft Local Plan Section EN7N Item EN7Nn:

1. Why is the current Local Plan being ignored in favour of RBC supporting the ESFA's proposals to build a school on Mapledurham Playing Fields, which is designated green open space and held in trust exclusively for recreation?
2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?
3. In particular how will it safeguard against the following factors, which cannot be mitigated and will significantly impact Mapledurham Playing Fields, if the EFSA proposal is implemented:
 - a. Traffic movements
 - b. Air pollution
 - c. Noise pollution
 - d. Visual dominance and overbearing on the area of the site where they propose to build
 - e. Privacy and overlooking
 - f. Out of character with local residential properties
 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment
4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?

Kind Regards,

Mary Phelan

Click [here](#) to report this email as spam.

PHILLIMORE SUCCESSOR'S SETTLEMENT TRUSTEES

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		Mr
First Name		Phil
Last Name		Brown
Job Title <i>(if applicable)</i>		Director
Organisation <i>(if applicable)</i>	Trustees of the Phillimore Successor's Settlement	Savills
Address 1		Hawker House
Address 2		Napier Court
Address 3		Napier Road
Town		Reading
Post Code		RG1 8BW
Telephone		0118 952 0506
E-mail		pbrown@savills.com

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Spatial Strategy Policy TR2: Major Transport Projects Sustainability Appraisal
--

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

See attached letter.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

See attached letter.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
---	-----------------------------

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

To enable a full and proper discussion of the issues raised.
--

B7. Do you wish to be kept informed of planning policy matters?
(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

22nd January 2018



Planning Policy
Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

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T: +44 (0) 118 952 0500
savills.com

Dear Sir

**Reading Borough Pre-Submission Draft Local Plan Consultation:
Response of Behalf of the Phillimore Estate**

We write on behalf of the Trustees of the Phillimore Successor's Settlement ("The Trustees"), who own part of the Coppid Hall Estate, in response to consultation by Reading Borough Council on the Pre-Submission Draft Local Plan ("the Plan"). Land owned by the Trustees at Playhatch lies within South Oxfordshire District but adjoins the urban area of Reading.

Representations to the Pre-Submission Draft Local Plan

The Pre-Submission Draft Local Plan recognises that the Berkshire Strategic Housing Market Assessment (SHMA) identifies the Objectively Assessed Housing Need (OAN) for Reading as being 699 homes per year in the period 2013 to 2036. In accordance with the requirements of the National Planning Policy Framework (NPPF), the Reading Borough Council Local Plan must therefore plan to meet this need **in full**, by identifying land for 699 homes per annum as a minimum.

The Council contends that it is unable to meet this requirement in full as it is a tightly constrained, urban Borough. As such the level of housing proposed within the Pre-Submission Draft Plan is only 671 dpa, leaving a shortfall over the Plan period of 644 dwellings. The Council proposes to work with neighbouring Authorities in the Western Housing Market Area (HMA) to provide for this need. However, the Berkshire SHMA recognises that parts of South Oxfordshire also fall within the Western HMA and that the influence of Reading, economically and in terms of local housing demand, extends into South Oxfordshire.

It is encouraging that the Pre-Submission draft Plan acknowledges, at footnote 15, that "*notably areas of South Oxfordshire around Henley-on-Thames and Sonning Common... functionally form part of the Western Berkshire HMA*". However, despite acknowledging this, the Plan then neglects any discussion of how this need might met "for practical planning purposes". This is a significant omission. Rather, in recognition of the functional relationship with South Oxfordshire and in seeking to meet Reading's unmet housing need, the Plan should express support for development proposals on the edge of the urban area, but within South Oxfordshire District (this would mirror the approach that the Plan takes towards supporting significant levels of development at Grazeley, which lies within Wokingham Borough and West Berkshire Councils). Indeed, this approach would result in more sustainable patterns of development in accordance with national policy,

and so the Plan should support land adjoining the urban area of Reading at Playhatch for the following reasons:

- The site adjoins the urban area of Reading and is within close proximity of the services and facilities (including employment, leisure, retail, educational) within the town. The edge of urban location provides the opportunity to deliver family homes, a type of housing for which the Plan acknowledges a pressing need and admits that it would be difficult to deliver elsewhere within the Borough (paragraph 3.1.4).
- The Draft Plan proposes the provision of Park and Ride facilities along the A4155 corridor (Policy TR2: Major Transport Projects, paragraph 8.2.1(c), Figures 4.8 and 8.1). This reflects the sustainable location of the site, along a key transport corridor, and would further enhance the sustainability of our clients land. The proposals for a Park and Ride in this location are supported.
- The Draft Plan refers to the potential for a third Thames Crossing in the vicinity of our clients land (e.g. Policy TR2: Major Transport Projects, and Figure 4.8). In fact, the Strategic Outline Business Case for the proposed crossing has been published and concluded that that a two lane crossing would deliver a 'benefit to cost ratio' (BCR) of 2.72, which represents a very high value for money when compared to Department for Transport guidance. Further, the Strategic Outline Business Case finds that an additional crossing would enhance the connectivity of the area and support economic growth. Its provision would therefore support many of the wider objectives of the Local Plan.

Paragraph 8.2.5 of the Plan recognises that the adequacy of infrastructure to support additional development in the Caversham/Emmer Green area is a concern, with particular reference to transport infrastructure. However, the Council will be aware that the need to provide infrastructure is not a reason to plan for less than full OAN (as required by the NPPF). In fact, the proposed Park and Ride facility and the new Thames Crossing would further increase the sustainability of our clients land at Playhatch and could offer significant benefits to the Borough as a whole, which are recognised in the draft Plan:

"An additional crossing could result in measures to increase public transport capacity on existing crossings, which would improve traffic issues. A new park and ride site associated with any additional crossing on the A4155 Henley Road would also help to alleviate issues" (paragraph 8.2.5).

In summary, the Trustees wish to **support** the proposals for a Park and Ride facility on the A4155 corridor, and for a third Thames Crossing in the vicinity of our clients land. However, we **object** to the omission of reference to the role which development outside, but adjoining, the Borough boundary, at our clients land, could play in meeting the needs of Reading and of the Western HMA (of which land within South Oxfordshire is functionally part of). The omission of this means that the Plan as currently drafted is '**unsound**' because it would not be:

- Positively prepared (based on a strategy which seeks to meet objectively assessed development needs);
- Justified (the most appropriate strategy when considered against the reasonable alternatives);
- Effective (based on effective joint working on cross-boundary strategic priorities); or
- Consistent with national policy (enabling the delivery of sustainable development).

Comments on the draft Sustainability Appraisal (SA)

Appendix 3 of the Sustainability Appraisal tests the option of four strategic development locations as urban extensions to Reading. The allocation of land to the northeast of Reading for residential development is said to have adverse impacts – it “would harm landscape character... since the site is undeveloped”. However, the same conclusion is not drawn in respect of other strategic locations which are also undeveloped. In fact, our clients land at Playhatch is not, in itself, of any particular landscape value and due to reasons of topography has no inter-relationship with the AONB. It is therefore not clear why this has scored negatively (especially as other strategic locations, which are also undeveloped, have scored neutrally in this respect).

The SA also scores the northeastern development location negatively under impact on healthcare infrastructure and school places, despite acknowledging that such infrastructure could be provided. With respect to transport infrastructure (Objective 14) the site scores especially poorly, despite the draft Local Plan supporting significant transport infrastructure improvements in this location (Park and Ride and Third Thames Crossing). This is illogical in the extreme.

Lastly, the SA states that development in this location would expose residents to floods, “*as much of the area if subject to fluvial flooding*”. However, on our clients land only a narrow strip of land along the A4155 frontage lies within Flood Zone 2 and the vast majority of the site lies within Flood Zone 1 i.e. at the lowest risk of flooding.

It can therefore be seen that there are inaccuracies in the assessment of land to the northeast of Reading as a strategic development location, and inconsistencies with other strategic development locations which the Council favours in the draft Plan. The draft Plan is therefore, currently not the most appropriate strategy based on the evidence and is not ‘justified’ i.e. is ‘**unsound**’.

Yours faithfully

Philip Brown BA (Hons) MRTPI
Director

PLANWARE LTD

Response to the Reading Local Plan Pre-Submission Draft November 2017

Response to Policy RL3 Part b

1. Introduction

1.1 We have considered the above policy and its supporting text with regard to the principles set out within the Framework. Local Plans should “plan” positively for development; be justified; effective; and consistent with the Framework.

1.2 We consider that limiting the concentration of hot food takeaways would be unsound.

2. Such an approach is not positive, justified, effective or consistent with the Framework.

2.1 Restricting the concentration of new A5 proposals within the borough is not a positive approach to planning. The Framework “foreword” sustainable development is about positive growth, making economic; environmental; and social progress, for this and future generations.

2.2 The suggested restrictions, take an ambiguous view of A5 uses. It would apply an over-generic approach to restrict development with little sound planning reasoning or planning justification. This is contrary to Para 14 of the Framework which advises authorities to positively seek opportunities to meet development needs of their area.

2.3 Thus it is inconsistent with Para 19 and 21 of the Framework. Para 19 states:

Planning should operate to encourage and not act as an impediment to sustainable growth. Therefore significant weight should be placed on the need to support economic growth through the planning system.

2.4 Para 21 states:

Investment in business should not be over-burdened by the combined requirements of planning policy expectations.

2.5 The Policy seeks to restrict town centre uses within designated centres. The Policy contradicts the framework and the sequential approach.

2.6 The Framework cannot be interpreted to provide generic restrictions on a particular use class. Moreover, the evidence does not support such restrictions. The need for evidence is emphasised in para 158 of the Framework which states that each local plan should be based on adequate, up-to-date and relevant evidence. Compliance with the soundness test is still required.

2.7 The proposal does not accord with the “golden thread” running through the Framework which seeks to build a strong competitive economy. Such a policy could potentially stifle economic development and is not consistent with the Framework.

3. Soundness - summary

3.1 We consider that restricting the concentration of hot food takeaways would be unsound and fails to meet the four tests of the Framework. It is not a positively approach to planning; justified; effective; or consistent with national planning policy. Such a policy should therefore not be taken forward to the next stage of the plan making process.

4. Conclusion

- 4.1 It has been highlighted above that there is no appropriate reason to restrict A5 uses by their concentration.
- 4.2 The proposed policy takes no account of the sequential approach and therefore contradicts the Framework.
- 4.3 No evidence is provided to show existing A5 locations and saturation levels within centres and key frontages.

RAEBURN-WARD, DEIGHTON PETER

From: Peter Raeburn-Ward
Sent: 24 January 2018 09:26
To: Planning Policy
Subject: FW: Reference to the Draft Local Plan Section EN7N Item EN7Nn

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

From Deighton Peter Raeburn-Ward.
Owner of my property since April 1975

To The Reading Borough Council

I understand that The Reading Borough Council is consulting on the draft Local Plan. In view of the risks to the survival of the very important amenity of the Mapledurham Playing Fields, please take note of my very deep concern about the way the changes in usage are being imposed on many local residents and ratepayers and the many organisations which use and value the Mapledurham Playing Fields and add the following questions/ comments to the debate:-

1. Why is the current Local Plan being ignored in favour of RBC supporting the ESFA's proposals to build a school on Mapledurham Playing Fields, which is a designated green open space and held in trust exclusively for recreation?
2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?
3. In particular how will it safeguard against the following factors, which cannot be mitigated and will significantly impact Mapledurham Playing Fields, if the EFSA proposal is implemented:
 - a. Traffic movements
 - b. Air pollution
 - c. Noise pollution
 - d. Visual dominance and overbearing on the area of the site where they propose to build
 - e. Privacy and overlooking
 - f. Out of character with local residential properties
 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment
4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?

I would like an acknowledgement that you have received and noted the contents of my email

Deighton Peter Raeburn-Ward

RANKIN, LYNN

From: Lynn Rankin
Sent: 26 January 2018 21:42
To: Planning Policy
Subject: draft Local Plan Section EN7N Item EN7Nn,

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Mapledurham Playing Fields

1. Why is the current Local Plan being ignored in favour of RBC supporting the ESFA's proposals to build a school on Mapledurham Playing Fields, which is designated green open space and held in trust exclusively for recreation?
2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?
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 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment
4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?
look forward to hearing from you .

Lynn Rankin

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R.B.S. PENSION TRUSTEE LTD

23 January 2018
L 180123 SAV LBR - Pre Submission Local Plan Reps



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RG1 2LU

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Dear Sir or Madam

**READING LOCAL PLAN – PRE SUBMISSION DRAFT (NOVEMBER 2017)
FORBURY RETAIL PARK PHASE 2, FORBURY ROAD, READING, RG1 3JD**

REPRESENTATIONS BY RBS PENSION TRUSTEE LTD

We write on behalf of our client, RBS Pension Trustee Ltd, the owners of the Forbury Retail Park Phase 2 (the 'Site'), to make formal representations on the Reading Local Plan – Pre Submission Draft (November 2017). These representations build on previous submissions by our client in respect of earlier drafts of the Local Plan in March 2016 and June 2017¹.

Below we detail our comments on the new Local Plan, which we trust will be taken into consideration in the finalisation of the document.

Central Reading

We support the continued designation of the Site as forming part of Central Reading.

The Site has been developed with the overt support of the Local Planning Authority to provide retail accommodation that complements the traditional commercial premises located within the Primary Shopping Area (PSA) in Reading Town Centre. It ensures that the town can accommodate and benefit from a comprehensive range of retail operations to meet the requirements of local residents.

Policy H3: Standard for New Housing

Our client supports the Council's desire to see the delivery of good quality homes in the Borough. As Reading continues to grow, it is important that residents can access an array of housing types and tenures in both central and suburban locations.

Construction standards for new housing are principally controlled through building regulations. The New Local Plan identifies a number of additional targets for new homes in Reading such as water efficiency, zero carbon, and emissions. While identification of such targets is important, the policy should allow flexibility for schemes that cannot achieve all of the optional targets due to technical or viability considerations.

¹ Our Ref: L 160307 SAV LBR - New Local Plan Reps and L 170613 SAV LBR - New Local Plan Reps

Policy RL5: Impact of Main Town Centre Use

As noted above, the Site has been developed with the overt support of the Local Planning Authority to provide retail accommodation that complements the traditional commercial premises located within the PSA of Reading Town Centre.

National and local planning policy acknowledges that due to operational and floorspace requirements, large format retail warehouses cannot be located within PSAs. The sequential test therefore seeks to direct such floorspace to accessible edge-of-centre locations in the first instance. The Site meets these policy aspirations by locating within an easy walking distance of the Reading PSA and selling principally bulky non-food goods.

Accordingly, while national policy advocates an impact assessments for retail proposals outside of the PSA, Policy RL5 should incorporate different thresholds for edge-of-centre and out-of-centre retail and leisure proposals. This will ensure that proposals which make a positive addition to the overall retail and leisure offer of defined centres are not unduly restricted. Our proposed amendment to Policy RL5 is detailed in **bold text** below:

*'Proposals that include more than 1,000 sq m (gross) of new or additional floorspace for main town centre uses in an ~~edge-of-centre or~~ out-of-centre location should demonstrate that there will be no significant adverse impact on existing centres. Ensuring that centres within areas of deprivation are not adversely affected is of particular local importance. **Retail and leisure proposals on well-connected edge-of-centre sites that propose more than 2,500 sq m should also demonstrate that there will be no significant adverse impact on existing centres.'***

Site Specific Allocations

The extent of our client's ownership is detailed on the Site Location Plan enclosed with this correspondence. Phase 2 of the Forbury Retail Park comprises of seven large format retail warehouse units providing approximately 9,100 sq m of floorspace at ground floor level. In addition, a new drive through KFC restaurant was recently constructed and is not open to the public.

Site Allocation CR13b 'Forbury Retail Park' includes our client's site in addition to other retail warehousing to the east and south. Reading Local Plan – Pre Submission Draft proposes the following allocation:

This site would be the focus of the new residential community, and, alongside residential, additional retail, leisure and community uses at a scale to serve the Kenavon Drive area would be appropriate. It should include a new area of open space and enhance the frontage to the canal, including a buffer zone to the canal bank to reflect its wildlife significance. Implementing this policy may involve complete redevelopment or using new additional development to improve the existing urban form of the area. Some parts of the site are likely to be implemented in the long term.

Site size: 6.99 ha Indicative potential: 1,230-1,840 dwellings, no net gain of retail.

Proposed Local Plan Amendment

Following the publication of the Local Plan Issues and Options stage document (January 2016) and the inclusion of the Site within the Reading Housing and Economic Land Availability Assessment, our client investigated residential led redevelopment of the Site.

Given the high existing use value of the established commercial floorspace, it is not economically viable to redevelop the Site for residential land uses in the short to medium term.

Furthermore, given the uncertainty linked to longer term forecasts of development costs and values, it is impossible to predict whether a residential led redevelopment of the Site will become viable in the longer term.

In light of the above, there can be no certainty that the Site will be available to contribute towards local housing supply over the emerging Local Plan period.

Whilst the owner does not object to the proposed identification of the Site as one that offers potential for residential land uses in the future, it is critical that such an allocation does not impact on the established commercial function of the Site.

In order for the emerging Plan to be deemed sound, it must be based on robust and credible evidence and effective. Given the commercial considerations set out above, there is an obvious risk that the Site will not be delivered which could lead to a shortfall in supply. The allocations that are progressed should be realistic in terms of phasing and overall deliverability.

To properly reflect the position above, we would request that the Site is separated from the adjoining retail warehouses to create a new, distinct allocation. The new allocation should acknowledge the Site's established commercial function and the contribution it makes to meeting the commercial requirements of residents within the Reading Central Area and wider Borough.

As set out above, the owner of the Site does not object to the Site being identified as one that has potential for housing. It follows that the allocation can support such a land use but this would not preclude any future commercial development linked to the established role and function of the Site. It is critical that any allocation does not prejudice the owner's ability to meet the operational requirements of existing or new operators as formats and consumer needs evolve and develop. Such requirements may include: the reconfiguration of and / or extension to existing floorspace; changes of use to other commercial classes or variations of conditions relating to opening hours or servicing.

Below we set out our proposed revised wording for a new site specific allocation:

Forbury Retail Park Phase 2 – Revised Allocation

Forbury Retail Park Phase 2 is located in the Central Area and makes a positive contribution to meeting the retail and commercial needs of the local population. Given its location, it is suitable for a range of main town centre uses such as retail and leisure as defined by the NPPF.

The site is also considered acceptable for residential land uses including private rented homes.

Should the Local Planning Authority consider a separate allocation is inappropriate, we would request that specific reference is made to the Site in the existing allocation.

Summary and Conclusion

We trust that these representations are helpful and will be taken in to consideration in the finalisation of the document. We would be grateful if you can keep us updated of any further stages of consultation so we can provide comments as may be required

Should you require any clarification or additional information, please do not hesitate to contact Raymond Tutty or Tim Price at these offices.

Yours faithfully

A handwritten signature in cursive script, appearing to read "Savills".

Savills (UK) Ltd
Retail Planning

READING CLIMATE CHANGE PARTNERSHIP

From: Dan Fernbank
Sent: 26 January 2018 16:40
To: Planning Policy
Subject: Local Plan - comments on behalf of Reading Climate Change Partnership

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Hi

Please find below a response to the Draft Local Plan on behalf of the Reading Climate Change Partnership (RCCP), of which I am the current Chair. RCCP oversees the Reading Climate Action Network (RCAN), which is a collaboration of local community and business delivery bodies, organisations and individuals, some of whom have also commented on this consultation separately.

- We believe policy CC2 does not go far enough in driving the required reductions in carbon emissions, including embedded carbon, and therefore is in conflict with Section 10 of the NPPF which states planning should “*secure radical reductions in greenhouse gas emissions*”. Further, we believe the proprietary BREEAM standard to be an insufficient driver alone for achieving significant carbon reductions, and the policy should be strengthened to ensure high levels of carbon reduction are mandated
- In 4.1.2 we welcome recognition of the important role of the Reading Climate Change Strategy, but as this only currently runs until 2020, feel recognition is required that deeper cuts beyond the referenced 34% will be required over the planning period to 2036, in line with the UK Climate Change Committee’s Carbon Budgets
- Policy CC3 we welcome recognition of the importance to climate change adaptation (with specific comments regarding flood risk covered further below)
- Policy CC4 – whilst CHP has a role to play in reducing carbon emissions in the medium term, overt (and multiple) reference to it appears to be at the expense over other currently viable or future low carbon technologies, and a more broad-ranging statement on low carbon technologies for decentralised energy would be more appropriate
- In policy EN11, we welcome the recognition of the importance of Reading’s waterways to its overall character and the proposed steps to protect and enhance these areas
- We support the section 4.4.34 and 4.4.42 proposals for requiring new build housing to meet the higher water efficiency standard
- We support the section 4.4.34 and 4.4.44 proposal for major new-build residential developments to designed to achieve zero carbon homes, together with the proposed contribution towards the cost of carbon offsetting. We would like to see this extended beyond major developments.
- In EN18, we support the proposal for all major developments to incorporate SuDS, but would like to see this extended to smaller schemes too where these are in proximity to flood risk areas. Further, in point 4.2.100, we would like to see consideration given to incorporation of SuDS in any redevelopment where practical
- In 4.2.77 regarding air quality, the absence of specific UK guidelines for PM2.5 exposure could be addressed by reference to current WHO guidelines

We are not seeking to appear in person at the public examination (though some of our members may under their own representation), but would be grateful to be kept informed of the progress of the plan.

Kind regards

Dan Fernbank
Chair, Reading Climate Change Partnership

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READING FOOTBALL CLUB

Reading Borough Council
Pre-Submission Draft Local Plan
November 2017
Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	Mr	Mr
First Name	Nigel	Jonathan
Last Name	Howe	Locke
Job Title <i>(if applicable)</i>		Planning Associate
Organisation <i>(if applicable)</i>	Reading Football Club	Barton Willmore
Address 1	Madjeski Stadium	The Blade
Address 2	Junction 11, M4	Abbey Square
Address 3		
Town	Reading	Reading
Post Code	RG2 0FL	RG1 3BE
Telephone		01189430064
E-mail		Jonathan.locke@bartonwillmore.co.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Paragraph 6.1.3, 7.3.18 and table to top of page 194

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

On behalf of Reading Football Club, the representations (see attached) recommend the updating of the table to the top of page 194 of the plan, and addition to paragraph 6.1.3 in order to recognise the significant contribution the Royal Elm Park development would provide the Borough and wider region with significant housing, retail and leisure development. Please refer to enclosed representations letter for more detail.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Please see attached report.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

Provided the changes recommended within the enclosed representations are made, RFC do not consider it necessary to appear in person at the public examination.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Planning Policy Team,
Reading Borough Council,
Civic Offices,
Bridge Street,
Reading,
BERKSHIRE. RG1 2LU

BY EMAIL: planningpolicy@reading.gov.uk

24116/A3/JL/slh

26th January, 2018

Dear Sir/Madam,

**PRE-SUBMISSION DRAFT READING BOROUGH LOCAL PLAN (REGULATION 19)
CONSULTATION (NOVEMBER 2017)
REPRESENTATIONS SUBMITTED ON BEHALF OF READING FOOTBALL CLUB**

We write on behalf of our client, Reading Football Club ("RFC") in response to the Council's Pre-Submission Draft Local Plan for Reading Borough.

The Council will be aware that RFC submitted representations in response to the Issues and Options Consultation (January 2016) to assist with the preparation of the Local Plan. Since then, the Council have consulted on a Draft version of the Local Plan in the summer of 2017. The situation concerning the proposals at Royal Elm Park, adjacent to the Madjeski Stadium have also developed since that time.

RFC submitted a planning application at Royal Elm Park ("REP") in February 2016 under reference 160199, for the following development:

"Outline application (all matters reserved apart from access to the site) for residential development (Blocks 1-6) to provide up to 422 residential units, comprising predominantly 1 and 2 bedroom apartments (Use Class C3) along with associated landscaping and car parking; and Detailed application for residential and mixed use development comprising:

- **196 residential units (within Block 7) (Use Class C3) including 164 dedicated parking spaces (of which 12 are accessible);**
- **Convention centre and ice rink (Use Classes D1/D2);**
- **246 bedroom hotel (Use Class C1) and up to 102 serviced apartments (Use Class C1);**
- **Decked car parking within Convention Centre;**
- **Flexible ancillary retail space (Use Class A1) (within Block 7 only);**



- **Multi storey car park including 1,972 sq.m of office space (B1a) or 1,732 sq.m of office space (B1a) and 240 sq.m of community space (D1 use);**
- **Public open space (including public square and public park) with associated street furniture and public art and directional signage to form part of wider outline public open space strategy;**
- **Associated access, landscaping, cycle parking, transport interchange and related infrastructure and engineering works;**
- **Ancillary facilities for storage, management facilities and plant;**
- **Vehicular and pedestrian access;**
- **Demolition of existing indoor training facility; and**
- **Enhancement of existing RFC Garden of Remembrance."**

The Council considered the application at Planning Committee on the 26th April, 2017, at which Planning Committee Members passed a resolution to grant permission, subject to the completion of a Section 106 legal agreement. The Section 106 Agreement is nearing completion, following which, consent will be issued by the Council.

Notwithstanding promotion of the site for inclusion within the emerging Local Plan as an allocation, the presence of a motion to grant in relation to the above-mentioned development has led the Council to consider the site to be a commitment. In accordance with other sites within Reading which exceed 10 dwellings or 1,000sq.m of employment development, which have planning permission, the Council have stated within paragraph 7.3.18 of the Pre-Submission Local Plan ("Pre-Submission Plan") that there is not considered to be a need to identify these sites within a policy, as the permission establishes the principle of development.

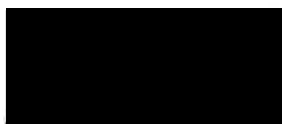
The Council continues to state, within paragraph 7.3.18 of the Pre-Submission Plan that "any future applications on these sites will be acceptable where they are substantially the same as the existing permission" and "will need to be considered against the policies in the plan, in particular whether it would adversely impact the likelihood of meeting Reading's identified development needs."

RFC agree with the principle of the Council's comments as stated above, however, wish to comment on the table which summarises major development progress, to the top of page 194 of the Pre-Submission Plan, which is stated as being correct to 31st March 2017. This referenced table is now be out of date. Prior to adoption of the Local Plan the table should be updated to include the REP scheme which currently has a resolution to grant permission and is further anticipated to receive permission prior to the adoption of the emerging Local Plan. Should this referenced table be updated to refer to the REP scheme, as is understood to be the intention of the Council, RFC would on that basis consider the Local Plan sound with reference to REP.

REP will provide significant residential, retail and leisure provision within Reading Borough, and its contribution towards the objectives of the Local Plan should be reflected by its recognition within the aforementioned table concerning development progress. To this end, RFC also consider it important that the emerging Local Plan recognises the significant contribution the REP development would provide to the Borough and wider region within the supporting text to South Reading which references Reading Football Club within paragraph 6.1.3 of the Pre-Submission Plan.

The above represent RFC's representations in relation to the Pre-Submission Plan.

Yours faithfully,



JONATHAN LOCKE
Planning Associate

READING FRIENDS OF THE EARTH

Reading Friends of the Earth – www.readingfoe.org.uk –
info@readingfoe.org.uk Contact for this issue: John Booth

Reading Friends of the Earth

Comments on Reading Pre-Submission Draft Local Plan – January 2018

Version: final – 26th January 2018

Reading Friends of the Earth would like the opportunity to appear at the Public Examination if matters on which we have made representation are chosen for detailed examination.

Reading Friends of the Earth would like to be kept informed of the progress of the plan.

PART A – YOUR DETAILS

	Personal Details	Agent's Details (if applicable)
Title	Mr	
First Name	John	
Last Name	Booth	
Job Title (if applicable)		
Organisation (if applicable)	Reading Friends of the Earth	
Address 1		
Address 2		
Address 3		
Town		
Post Code		
Telephone		
E-mail		

Notes from RBC on representations at this stage of the process:

We do ask that your representations set out the following information for each part of the plan that you wish to comment on:

- The part of the document to which your response relates (paragraph, policy or section);
 - Whether you consider that the plan, or part of the plan, is legally compliant, sound and complies with the duty to co-operate, and why;
 - What modification you think is necessary to make the plan, or part of the plan, legally compliant and/or sound.
-

Policy CC2: SUSTAINABLE DESIGN AND CONSTRUCTION

Soundness: This is not sound because it does not require new non-residential buildings to reduce their energy consumption and CO2 emissions to a sufficiently '*radical*' extent and it fails to account of 'embodied carbon'.

- Section 10 of the NPPF says planning should "*secure radical reductions in greenhouse gas emissions*".
- Objective 5 of the Plan is "*Ensure new development and existing areas are accessible and sustainable, in accordance with the sustainability appraisal objectives, including reducing its effects on, and adapting to, climate change*"

BREEAM standards do not adequately address carbon emissions.

BREEAM 'Very Good' and 'Excellent' standards require respectively no credits and 6 credits for CO2 reduction as a minimum standard.

These credits are then expressed as % of 30 credits which is the maximum number of credits for CO2 reduction. So buildings meeting BREEAM 'VG' and 'Excellent' standards could score respectively 0% and 20% for CO2 reduction.

These percentages are then weighted by the 19% which is the weighting for CO2 reduction under BREEAM assessment. So BREEAM 'VG' and 'Excellent' standards could be achieved with CO2 reduction contributing respectively 0% and 3.8% to the total BREEAM score.

BREEAM 'VG' and 'Excellent' standards require total scores respectively of 50% and 70%.

Retro-fitting energy saving technology in the future is likely to be much less cost-effective than achieving a high standard for the initial build.

Modification: The developments covered by this policy should be required to achieve high levels of energy efficiency and carbon reduction.

In addition to their proposed BREEAM standard this policy should require:

- Fabric energy efficiency to meet a high standard— perhaps under the BREEAM scoring system so that no additional assessment will be required.

- Future-proofing of the heat supply system to allow for low-temperature heat supply from district heating or heat pumps (i.e. suitably sized underfloor or ‘blown air’ heat exchangers) even if initially gas or direct electric heating is to be used.
- Lifetime carbon emissions – including both embodied and use-phase carbon - should be assessed using the RICS Whole-Life Carbon Professional Statement method to ensure that the best design choices are being made to minimise climate impacts.
- Post-occupancy Evaluation to confirm that performance is being achieved and to provide evidence that the ‘performance in use gap’ has been closed.

References:

http://www.breeam.com/BREEAM2011SchemeDocument/content/06_energy/ene01_general.htm

http://www.breeam.com/BREEAM2011SchemeDocument/content/06_energy/ene01_general.htm

Paragraphs 4.1.2 and 4.4.43

Soundness: This is a Plan to 2036 so there should be commitment to carbon reduction beyond the 2020 horizon of Reading’s Climate Change Strategy.

Modification: Reference should be made to:

- The Climate Change Act ... and ...
 - The Climate Change Committee’s Carbon Budgets – e.g. 5th Budget 57% reduction by 2030 ... and ...
 - There should be commitment that Reading’s emissions reduction targets will exceed future Carbon Budgets and Building Regulations.
-

Policy CC4: DECENTRALISED ENERGY

Soundness: This is not sound because it takes a short-term view of carbon emissions reduction based on current viability and technology and only requires developers to consider rather than implement decentralised energy provision if this is ‘suitable, feasible and viable’.

Gas-fired CHP may be currently suitable and viable compared with grid electricity and gas-fired heating but it is becoming less so as grid electricity is decarbonised, and as ever-tighter emissions targets must be achieved. It must be used as a temporary measure if at all. Future ‘energy vectors’ to distribute energy to urban developments are likely to be electricity or hydrogen so as to eliminate local carbon emissions.

The policy does not require new developments to be prepared to use low-grade heat in the future, if at present only conventional heat sources are judged viable.

Modification: Replace Paragraph 2 with “Any development of more than 20 dwellings and/ or non-residential development of over 1,000 sq m shall include all forms of decentralised energy provision, within the site, that are suitable, feasible and viable. If a low carbon heating system using decentralised energy is not currently viable developments shall future-proof their heating system to allow for low-temperature heat supply from district heating or

heat pumps (i.e. by installation of suitably sized underfloor or blown air heat exchangers) even if initially gas or direct electric heating is to be used.”

Paragraph 4.2.77: PM2.5

Soundness: This is not sound because, while it references a national goal to reduce PM2.5 exposure by a percentage, and points out that there is no safe level, it does not reference guidelines for absolute levels of exposure.

Modification: Include reference to WHO guide level for annual exposure to PM2.5

Paragraph 4.2.81: Air Quality Assessment

Soundness: This is not sound because in the context of both air quality and congestion 100 extra car parking spaces per development may well prove excessive ... especially if many of them were to be used by peak hour traffic ... because congestion has a non-linear response to traffic density, and air quality probably has a non-linear response to congestion and traffic density. Note that the proposed East Reading Park and Ride has only 277 spaces.

All development within the AQMA should be subject to an Air Quality Assessment if parking for motor vehicles is to be provided.

Modification: Modify second bullet point to read as follows: “Would include parking for motor vehicles.”

Policy H1: PROVISION OF HOUSING

Soundness: This is not sound because projected population growth in Reading and central Berkshire will make it less environmentally and economically sustainable and less attractive, so much lower figures – on a declining trend - should be adopted for housing so that this remains an attractive and prosperous area. See NPPF Paragraph 14 ‘plan-making’.

It is important that some available land remains at 2036 but the draft Plan would leave none.

Modification: Replace “Provision will be made for at least an additional 15,433 homes (averaging 671 homes per annum) in Reading Borough for the period 2013 to 2036.” with “Provision will be made for 671 homes per annum in Reading Borough for the period 2013 to 2023 after which the rate of new housebuilding will decline linearly to zero by 2036 unless this plan is revised”

Policy H5: STANDARDS FOR NEW HOUSING

Soundness: This policy is unsound because:

- It does not require new developments to be prepared to use low-grade heat in the future, if at present only conventional heat sources are judged viable.
- The reduction targets below building regulations are not sufficiently deep because it becomes increasingly difficult to save energy by post-build improvements. For long-term economic and environmental sustainability bigger savings must be designed-in as it will not be possible to make the necessary savings later on. Designed energy reduction measures must deliver those savings and not leave the well-known “performance gap” that regularly occurs with most standards including building regulations.
- It does not require developers to take account of lifetime carbon emissions including ‘embodied carbon’.
- It does not state that Reading Borough Council will commission buildings to higher standards than allowed by government regulations, delivering the best housing for Council tenants and trailblazing for future standards in accordance with Reading’s ambitions to be a ‘Green Tech’ exemplar City.
- It does not address issues around water resources and waste management for new housing

Modification:

Add:

- Developments shall future-proof their heating system to allow for low-temperature heat supply from district heating or heat pumps (i.e. by installation of suitably sized underfloor or ‘blown air’ heat exchangers) even if initially gas or direct electric heating is to be used.
- In order to achieve the targeted savings developers shall use a robust low energy standard like Passive House. It is important that the standard works in practice and that the gap between design and as built energy savings is eliminated - this is automatic with Passive House. Whatever standard is used developers must validate and verify results against the set targets.
- Lifetime carbon emissions – including both embodied and use-phase carbon - shall be assessed using the RICS Whole-Life Carbon Professional Statement method to ensure that the best design choices are being made to minimise climate impacts.
- Housing commissioned by Reading Borough Council will conform to Passive House standard or above to provide the best housing for Council tenants, and will be used to demonstrate that this is feasible and affordable.
- Developers shall perform Post-occupancy Evaluation to confirm that performance is being achieved and to provide evidence that the ‘performance in use gap’ has been closed.
- Housing development should include recycling greywater and rainwater harvesting where systems are energy and cost effective. *(Text from CC2)*
- Bin and cycle storage is of an appropriate size and standard for the units proposed and should be located at ground floor level with easy access *(Text from H8)*
- Food Waste recovery and recycling shall be addressed by provision of Macerators.

Ref: https://www.designingbuildings.co.uk/wiki/Performance_gap_between_building_design_and_operation

Ref: Passive House achieved by local Council without cost penalty ...

<https://passivehouseplus.ie/news/design-approaches/passive-house-is-affordable-for-large-scale-housing-en Craft>

Policy TR1: ACHIEVING THE TRANSPORT STRATEGY

Soundness:

Not sound because the current Transport Strategy does not include demand management measures so is unlikely to achieve Reading LTP's Objectives as set out in 4.5.1 of this document, in particular:

- To improve journey times, journey time reliability and the availability of information; and
- To reduce carbon emissions from transport, improve air quality and create a transport network which supports a mobile, affordable low-carbon future.

In view of the forecast growth of Reading (referenced in 4.5.2) measures such as Road Pricing, Clean Air Zones, and Workplace Parking Levies should be included in the Transport Plan.

While measures to support modal shift away from the private car are to be supported the current proposals are unlikely to lead to a substantial fall in congestion. For example recent analysis (Demand Modelling Report – see Ref.) for the East Reading Mass Rapid Transit concludes: “5.3 the scheme would shift some car trips to public transport, the reduction in car trips on the network would not be so large as to release substantial road capacity in the corridor.”

Modification to 4.5.2: Replace “The predicted growth in trips can only be accommodated through major investment in transport, particularly sustainable modes.” With “The predicted growth in trips can only be accommodated through major investment in transport, particularly sustainable modes, and substantial modal shift achieved through demand management measures such as Road Pricing, Clean Air Zones, and Workplace Parking Levies.”

Ref: http://www.reading.gov.uk/media/7933/East-Reading-MRT---Demand-Modelling-Report/pdf/East_Reading_MRT_-_Demand_Modelling_Report.pdf

Policy TR2: MAJOR TRANSPORT PROJECTS

Soundness:

Not sound because alternatives to the East Reading Mass Rapid Transit should be safeguarded because the ‘preferred route’ is extremely controversial and has been objected to by the Environment Agency and many others.

Safeguarding of land for East Reading MRT as depicted in Figure 4.8 is not sound as it contravenes Reading LTP's Objectives as set out in 4.5.1 of this document:

"To deliver balanced packages of value for money transport solutions and make best use of existing transport investment."

- Readings sophisticated traffic management system could be utilised to actively manage traffic via selective road user charging at minimal cost and for widespread benefit compared to East Reading MRT which carries high cost and negligible benefit.

"To align transport and land use planning to enable sustainable travel choices, improve mobility, reduce the need to travel and preserve the natural environment"

- East Reading MRT would create gratuitous destruction of the natural environment for negligible benefit to the local population.

Modification to TR2: Land should also be safeguarded to improve capacity on the A4 between Cemetery Junction and Suttons Seeds.

Modification to 4.5.8: Replace first bullet with ""Mass Rapid Transit: This is a scheme to provide high quality public transport connections between park and ride sites and major travel generators. To the maximum extent possible this will make use of existing transport infrastructure to avoid loss of natural environment. The project involves a number of corridors across the Borough (see figure 4.8), but the route to the south is at an advanced stage, and can be safeguarded on the Proposals Map. Much of the land shown on the route to the South has been secured by Section 106 agreement on major development schemes, and this will continue to be sought on key sites where they come forward."

Modification to figure 4.8: The map in Figure 4.8 must be modified to remove East Reading MRT.

Policy TR5: CAR AND CYCLE PARKING AND ELECTRIC VEHICLE CHARGING

Soundness: This does not go far enough to encourage and facilitate electric vehicle use. New communal parking space provision should be future-proofed by provision of sufficient charging capacity to cope with much higher up-take than 10%. Provision should be made for residents with on-street parking.

Modification:

Change second bullet point to: "Within communal car parks for residential or non-residential developments of at least 10 spaces, 25% of spaces should provide an active charging point and cabling should have capacity to supply charge to 100% of vehicles."
Add new third bullet point: "Where on-street parking is to be permitted in residential areas residents should have defined spaces and cabling and layout should provide for easy installation of electric vehicle charging points."

READING URBAN WILDLIFE GROUP

Comments on Reading Pre-Submission Draft Local Plan – January 2018

Reading Urban Wildlife Group does not thin that any of the issues raised is likely to require attendance at the Public Examination, but is happy to appear.

RUWG would like to be kept informed of the progress of the plan.

PART A – YOUR DETAILS

Personal Details

Title	Ms
First Name	Ann
Last Name	Briers
Job Title (if applicable)	Secretary
Organisation (if applicable)	
Address 1	
Address 2	
Address 3	
Town	
Post Code	
Telephone	
E-mail	

General

RUWG supports most of the elements of this Local Plan. Given that Reading must accept extensive development over the plan period, we appreciate the efforts made to minimise the environmental impact and improve the environment where possible.

However, we feel that a commitment to supplementary planning documents in some areas will make it easier for developers, planners and NGOs alike to interpret the local plan and to clarify issues when different policies are in conflict for particular development proposals

Policy EN14, para 4.2.71

Soundness: Whilst in full support for the objectives of this policy, RUWG does not think that it protects existing trees sufficiently during the development period. The town is highly developed and new construction/refurbishments will take place in restricted areas, making it far more difficult to retain trees and hedges on the site without the actions of construction creating damage. The policy and supporting text should reference *BS 5837: 2012 : Trees in Relation to Design, Demolition and Construction* as the minimum require standard for all developments.

This should be added to para 4.2.71

We also think that there should be a commitment to a supplementary planning document covering the protection of trees and hedges during construction. This would translate the sections of BS 5837 referring to the construction phase into easily accessible language that all parties can understand easily.

Paragraph 4.2.77

Soundness: the document acknowledges that there is no safe level for PM_{2.5} and refers to a national goal to reduce PM_{2.5} exposure by 15%, but it does not give a absolute target.

Modification: Refer to WHO guidance levels for annual exposure to PM_{2.5}

Paragraph 4.2.84

Soundness: It is reasonable to expect some reduction in air quality in areas of Reading due to new development with mitigation elsewhere, but the Plan should make it *clear* that mitigation elsewhere cannot be used for reductions in air quality that take an area below Air Quality Objective levels.

Modification: add this proviso to the first sentence.

Policy H5/CC2

Soundness: We agree with Policy H5 requiring higher water efficiency standards under Regulation 36(3) of the building regulations for all new build dwellings, and the requirements for improved emission rates. It is not clear why these standards are not applied to conversions of commercial property to residential.

Suggested Modification: either modify Policy H5 parts b and d to include conversions from commercial to residential or change Policy CC2 to state that conversions must reach the standards of new build.

Policy TR2

Soundness: the 'preferred route' for the East Reading Mass Rapid Transit is controversial; alternative routes should be safeguarded in the local plan

Policy TR5

Soundness: The government has announced elimination of diesel and petrol vehicles well within the lifespan of these new developments; we can expect a faster take-up of electric vehicles in the near future. A large proportion of proposed development in Reading is high density apartments where there is no dedicated parking. Owners of these units should not be prevented from choosing electric vehicles either as individual or car share ownership. Charging points for electric vehicles need to be far more numerous or, at a minimum, the electrical supply system laid during construction phase so that additional charging points can be installed easily and cheaply in the future without disturbance of paving/planting etc.

Suggested Modification: increase provision to a minimum 20% of spaces with charging points and add to second paragraph: "and electrical supply cables laid to enable additional charging points to be installed easily in the future".

RENTPLUS U.K. LTD



Planning Policy
Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

Date: 16 January 2017

Our Ref: MR M15/0715-174

By email only:
planningpolicy@reading.gov.uk

Dear Sir or Madam

RE: READING BOROUGH LOCAL PLAN: PRE-SUBMISSION DRAFT CONSULTATION

We represent **Rentplus UK Ltd**, an innovative company providing affordable rent to buy housing for working people aspiring to home ownership with an accessible route to achieve their dream through the rent - save - own model. We have previously responded to the Issues and Options and Draft consultations, submitting responses together with an Affordable Housing Statement which sets out the model's compliance with the current NPPF definition of affordable housing. That document is enclosed with this response once more so that the Inspector may have the details to hand when examining the Local Plan policies.

Policy H3: Affordable Housing

We have previously sought a wider description of affordable housing in this policy to ensure that it remains consistent with national planning policy. Through a number of national consultations, the Government has sought feedback on proposals to widen the definition of affordable housing, including last year's housing White Paper, *Fixing our Broken Housing Market* which stated:

"Rent to Buy homes ... will enable thousands of households to access home ownership through a product that fits their circumstances. Rent to Buy will help hard-working households to benefit from a discounted rent set flexibly at levels to make it locally affordable so they can save for a deposit to purchase their home." (Paragraph 4.28)

The definitions contained within Box 4 of that consultation included reference to rent to buy, albeit under the description of intermediate affordable housing – this does not reflect the practical nature of the tenure which is occupied by tenants at an affordable rent, under a 20-year full repairing lease through partner housing associations, prior to purchase.

The Communities Secretary Sajid Javid indicated in a statement to the House of Commons late last year that CLG is looking at including affordable rent to buy as a separate tenure in the update to the NPPF, while the Prime Minister Theresa May announced in a speech on 3 January 2018 that she has made it her:

"personal mission to build the homes this country needs so we can restore the dream of home ownership for people up and down the UK".

As set out in our previous responses, the Rentplus affordable rent to buy model addresses the primary barrier to home ownership – the lack of a mortgage deposit – through a combination of a secure rented period at an affordable rent, giving time to save, and a 10% gifted deposit to enable tenants to buy their own home in 5, 10, 15 or 20 years. In this way it extends the opportunity of home ownership to families who are otherwise unable to afford it and to do so within a timeframe to suit their circumstances.

The aim of the model is to help those hard working families unable to access shared ownership, starter homes or homes on the open market overcome the mortgage deposit 'gap' by enabling real savings to

be built while renting at an affordable rent - 80% of open market rent (including any service charge) or Local Housing Allowance (whichever is the lower).

Policy H3 seeks to enable the delivery of those affordable housing tenures as currently explicitly defined in the NPPF, providing planning and housing officers with no opportunity to take a flexible approach to individual applications delivering alternative models. Whilst affordable rent to buy is not yet formally recognised within national planning policy, it does provide the Borough Council with an additional route to providing affordable housing, diversifying local housing options and extending the opportunity of home ownership to a greater number of local people. Unlike shared ownership and starter homes, affordable rent to buy does not require an upfront mortgage deposit; those and other intermediate affordable housing tenures fall short of helping those people who have the ability to save while renting an affordable home to realise their aspiration of ownership.

The NPPF asks local planning authorities to seek to meet their full affordable housing needs, and to widen opportunities for home ownership - flexible planning policies encourage developers to bring forward housing developments that properly reflect local housing needs and aspirations, and work effectively to meet a diverse range of housing needs. To ensure that **Policy 3** can be found sound at examination we recommend the following amendments:

In determining residential applications, the Council will assess the site size, suitability and type of units to be delivered in relation to the ~~current best available~~ evidence of identified needs. The Council will seek an appropriate tenure mix of affordable housing to include ~~social rented, affordable rent, intermediate rented and shared ownership affordable units tenures~~. The affordable units provided should be integrated into the development.

We consider the above changes will ensure the policy is suitably flexible, enabling it to be implemented effectively by the Council in advising developers and negotiating with applicants on individual development proposals. This we consider will also future-proof the policy, helping to ensure that the planned changes to the NPPF do not require a rapid review of the Local Plan prior to or following adoption.

We would like to be notified when the Local Plan is submitted for examination, by email only to consultation@tetlow-king.co.uk. Please ensure that **Rentplus** is retained on the consultation database, with **Tetlow King Planning** listed as their agents.

Yours faithfully

MEGHAN ROSSITER BSc (Hons.) MSc MRTPI
PRINCIPAL PLANNER
For and On Behalf Of
TETLOW KING PLANNING

Cc: Sue Coulson and Anthony Eke, Rentplus

REYNOLDS, PAM

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title	Mrs	
First Name	Pamela	
Last Name	Reynolds	
Job Title <i>(if applicable)</i>		
Organisation <i>(if applicable)</i>		
Address 1		
Address 2		
Address 3		
Town		
Post Code		
Telephone		
E-mail		

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Preservation of green spaces

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input type="checkbox"/>	No	<input type="checkbox" value="N"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input type="checkbox" value="N"/>
Fulfils the duty to co-operate?	Yes	<input type="checkbox" value="Y"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

See attached

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

See attached

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No N

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

 Y

Please keep me informed of all planning policy matters:

 N

Pam Reynolds BEM

To whom it may concern

I would like to put forward my views with regard to the RBC Local Plan which affect green open spaces. I feel that it is RBC's future duty to protect green open spaces, since its stewardship of green spaces to date has already left the Borough below the level recommended.

As a biologist I feel it is essential to keep what green space we have in order to protect habitats, allow drainage of water, re-cycle oxygen into the air and provide a peaceful therapeutic space for those who enjoy being in the open air. I think it is a particularly bad idea and against the Council's own Local Plan to even consider allowing a 350 pupil school to be built on green space and charitable land (classified LGS) which is well used for sport, recreation and leisure - which was the donor's original intention. In fact the original documents of the bequest contains the words 'for ever' - a clear and unambiguous statement of his intention, which RBC intends to ignore.

Having looked carefully at RBC's Local Plan, specifically page 40 Section EN7 in which Mapledurham Playing Fields is listed as Site EN7Nn, I was shocked to read:

"The following Local Green Spaces (LGS) and Public Open Space (POS), as shown on the Proposals Map, will be protected from development development. Proposals that would result in the loss of any of these areas of open space, erode their quality through insensitive adjacent development or jeopardise their use or enjoyment by the public, will not be permitted".

It is therefore surprising that the RBC Sub-Committee presumably following the advice of RBC Head of Legal Services, has allowed the EFSA proposal to proceed when it requires land which in its own words 'will not be permitted'. What is the point of a Local Plan if the Authority which set it up totally ignores its own strictures?

In particular I would like to make the following objections

CC7 - Design & the Public Realm

The school proposed by the EFSA will

- Adversely affect the character and amenity value of the playing fields and the surrounding area
- At its maximum of 350 children, this school will only cater for a small minority of the beneficiaries which numbers 171,000. Most of the population will be greatly disadvantaged – this cannot be acceptable.
- EFSA schools are quickly and cheaply built, visually unattractive and with little to recommend them aesthetically . Thos neighbours in Hewett Avenu, Hewett Close, Blagrove Lane and Upper Woodcote Road unfortunate enough

to have a view of it will be greatly disadvantaged after previously enjoying a beautiful peaceful aspect.

- Despite the imprecise plans being put forward, and the constant quoting of inaccurate figures of actual coverage by the EFSA, it is clear that the school will dominate the playing Fields, damage its Character and diminish the amenity value of the area
- Suggestions of a school on the playing fields are already affecting the sale of property in the surrounding area. Far from increasing the value of property, as the EFSA would have the public believe, the reverse is true. I am not affected, but I would be seeking compensation if my property was devalued to satisfy a very small part of the community.

CC8 Safeguarding Amenity

Impact on neighbours will affect

- Privacy and likelihood of being overlooked
- Visual dominance of the development
- Noise and disturbance
- Artificial lighting late in the day which does not happen now.
- Activity at the school from early morning until evening
- Traffic nuisance – despite all promises to the contrary this is inevitable
- Reduction of the quality of the environment

CC9 Securing Infrastructure

This development is ignoring the high priority which should be given to

- Loss of open space
- Green infrastructure and its importance for health and wellbeing
- Protection of the biodiversity of the environment – which is the duty of all of us to protect

EN7N Local Green Space & Public Open Space

Mapledurham Playing Fields (EN7Nn) is classified as LGS (Local Green Space) for the entire 10.86 hectares. Since item 4.2.2.5 states that *'The National Planning Policy Framework states that local communities, through local plans, are able to identify Local Green Space for specific protection which is of particular importance to them. The aim of this policy is therefore to define the boundaries of Local Green Space based on the criteria in the NPPF Local Green Spaces can only be designated during local plan preparation or review and must be capable of enduring beyond the end of the plan period.'*

Why then has RBC and the Charity Commission ignored members of the local community in its requests to have MPF protected in perpetuity. It supports over 500 members of Caversham Trents Football Club, over 500 dog walkers, around 365 members of Mapledurham Lawn Tennis Club and many other users. Constant

requests have been made for a Deed of Dedication to be put in place immediately. The Head of Legal Services has however seen fit to decline this request on several occasions.

4.2.28 states that *'high quality open spaces , sport and recreation can make an important contribution to the health and well being of communities'* Yet RBC is prepared to ignore effects of the following on the community

- Decrease in air quality from the use of cars and service vehicles
- Noise pollution – I have taught in many school and the volume of noise produced is undeniable.
- Traffic movement on the Woodcote Road and the surrounding roads will increase and the effect on progress through Caversham will be marked. Crossing the road with one or two small children will be hazardous and accidents are sadly bound to happen. The Council's own traffic report was pretty damning about what is likely to happen.

RL6 Protection of Leisure Facilities and Public Houses

Although this section states clearly that *'Existing leisure facilities (or public houses)....will generally be retained and there is a strong presumption in favour of retaining leisure facilities.....where they are clearly the only facility of their type on a district, major local or local centre'* This does not appear to have affected RBC at all. It has, as required been demonstrated there is a need for this facility as well as all other points, stated in the guidance. RBC has carried on regardless. Thus cannot be right.

The Pavilion, which is the only community centre in the area has been allowed to fall into such a poor state of repair by RBC that many organisations have lost a meeting place for their activities. Again this cannot be right and is completely against the RL6 guidance.

Although a case was made for the development of a Free School, one must question the need for it at all. Local primary schools have had requests for extending their buildings to accommodate pupils rejected by RBC. The Office of National Statistics actually shows that births in the area between 2009 and 2015 have fallen by 84, meaning that Caversham will need less primary school places by 2020. Clearly the best option would be to increase facilities in local schools and leave an important community asset untouched. However at a recent meeting one of RBC's officials was reported to have mentioned that if the school does not go through it will cost RBC around 12 million pounds – the motive now becomes clear and is directly in conflict with RBC's own Local Plan. This must be considered carefully and lawfully,

Yours faithfully

Pamela Reynolds

ROARK, SALLY

From: Sally Roark
Sent: 23 January 2018 21:50
To: Planning Policy
Subject: Local Plan Section EN7N Item EN7Nn

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Can you please advise on the following in regards Local Plan Section EN7N Item EN7Nn:

1. Why is the current Local Plan being ignored in favour of RBC supporting the ESFA's proposals to build a school on Mapledurham Playing Fields, which is designated green open space and held in trust exclusively for recreation?
2. How will the new Local Plan be strengthened to overcome future threats to green open space, especially when it is held in trust?
3. In particular how will it safeguard against the following factors, which cannot be mitigated and will significantly impact Mapledurham Playing Fields, if the EFSA proposal is implemented:
 - a. Traffic movements
 - b. Air pollution
 - c. Noise pollution
 - d. Visual dominance and overbearing on the area of the site where they propose to build
 - e. Privacy and overlooking
 - f. Out of character with local residential properties
 - g. Light pollution
 - h. Impact to other users i.e. tennis club, dog walkers, footballers, casual visitors
 - i. Hours of operation
 - j. Reduction to the quality of the environment
4. What plans are there to demonstrate commitment to the current Local Plan and protect Mapledurham Playing Fields from the threat of the EFSA proposal?

Your earliest response would be much appreciated

With Regards

Sally Roark

Click [here](#) to report this email as spam.

ROBBINS, GARY AND JULIE

From: Gary and Julie Robbins
Sent: 26 January 2018 16:17
To: Planning Policy
Subject: Ref: Reading Golf club, proposed housing development, Emmer Green

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

We would like to object to proposed development in the above location.

We are concerned that our view onto the open area of the golf course would be completely destroyed.

Squeezing houses into this area has not been thought through and would cause immense strain on the surrounding area such as; services which are already oversubscribed, schools and GP surgeries, impact on congestion, noise and pollution would also spoil what is at present a peaceful area in which to live.

We are also concerned that such a development would have a detrimental effect on the house prices of residences currently backing onto the golf course, as is ours.

The area also provides a rich habitat for wildlife for example red kites are commonly seen flying or nesting in the trees of the golf course.

We do not want this proposal to go ahead.

Regards

Gary and Julie Robbins

Sent from [Mail](#) for Windows 10

Click [here](#) to report this email as spam.

From: Gary and Julie Robbins
Sent: 26 January 2018 17:14
To: Planning Policy
Subject: RE: Reading Golf club, proposed housing development, Emmer Green

Hello

Please note our comments were based on the redevelopment of all of Reading Golf club land. (Unable to find information for this)

We are not opposed to the small part of Reading Golf club as outlined on site A19 in principle. Dependent on the number dwellings

Kind regards
Julie and Gary Robbins

Sent from [Mail](#) for Windows 10

From: [Planning Policy](#)
Sent: 26 January 2018 16:22
To: [Gary and Julie Robbins](#)
Subject: RE: Reading Golf club, proposed housing development, Emmer Green

Hello,

Thank you for your comments on the Pre-submission Draft Local Plan. Your email has been acknowledged and your comments will be considered during the next stage of the process.

Kind regards,

Planning Policy Team
[Planning Section](#) | [Directorate of Environment and Neighbourhood Services](#)

Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

0118 937 3337
Email: planningpolicy@reading.gov.uk

[Website](#) | [Facebook](#) | [Twitter](#) | [YouTube](#)



From: Gary and Julie Robbins
Sent: 26 January 2018 16:17
To: Planning Policy
Subject: Ref: Reading Golf club, proposed housing development, Emmer Green

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

We would like to object to proposed development in the above location.

We are concerned that our view onto the open area of the golf course would be completely destroyed.

Squeezing houses into this area has not been thought through and would cause immense strain on the surrounding area such as; services which are already oversubscribed, schools and GP surgeries, impact on congestion, noise and pollution would also spoil what is at present a peaceful area in which to live.

We are also concerned that such a development would have a detrimental effect on the house prices of residences currently backing onto the golf course, as is ours.

The area also provides a rich habitat for wildlife for example red kites are commonly seen flying or nesting in the trees of the golf course.

We do not want this proposal to go ahead.

Regards

Gary and Julie Robbins

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ROBERT COLLARD LTD



BLANDY & BLANDY
solicitors

Reading Borough Council
Pre- Submission Draft Reading Borough Local Plan
Representation on behalf of R Collard Limited in respect of proposed policy WR4: Potential Traveller Transit Site at Cow Lane

This representation is made on behalf of Robert Collard Ltd.

R Collard Ltd are strongly opposed to the proposed location of land at Cow Lane for a traveller transit site. Our client has recently acquired premises in the Richfield Avenue Economic Area.

Our client notes that the previous drafts of the Local Plan made no mention of an allocation of a transit site within the Reading Borough, and Policy WR4 has only been included in the latest, pre-submission draft. This has meant that the normal process of allowing the public the opportunity to comment on draft policies of the Local Plan, when taken as a whole, has not been provided in respect of Policy WR4. Instead it has simply been summarily inserted in the pre-submission draft issued on 30 November 2017.

Our client understands that the Council did run a consultation in September 2017 regarding Gypsy and Traveller sites. However this consultation only closed on the 24 October 2017, leaving just over 4 weeks between the closure of the consultation and the insertion of the new proposed policy into the pre-submission draft.

Our client does appreciate that the Council has a duty to try and provide suitable sites where there is a need for them, and our client understands that the Council is limited to allocating a site from land within its ownership as no privately owned sites were submitted for the location of Gypsy and Traveller sites during the Call for Sites process.

However, the Council asserts that out of 80 potential sites only 1 site within its ownership has been identified which could potentially meet transit needs. The method upon which the Council has reached this conclusion is unclear. Although the September Consultation document referred to the

site assessment process as a background paper to inform the consultation, the detail of the site assessment process lacked substance.

At the end of Annex 1 of the consultation document there is the comment: “the reasons for rejections set out above are not necessarily the only reason why a particular site is considered unsuitable. Once a site had been excluded for robust reasons there was not considered to be any need to identify further issues”. However, examination of the site assessment process lacks sufficient detail to inform the public on how and why certain reasons were considered ‘robust’ and others were not.

In particular sites are rejected on the basis that the land is required for other use – e.g. continued use as a car park. There is no evidence of why these are reasons are considered “robust” whereas the fact that the proposed site is required for the use of Reading Festival, one of the major contributors to the local (and UK) economy, has resulted in allocation.

Furthermore, there are a number of parcels of land where the only apparent reason for rejection is “visual amenity” but there is nothing to demonstrate the robustness of this assertion or how this conclusion has been reached. Whilst this visual amenity is a valid concern, it is often possible to mitigate this impact. Indeed the final bullet point in draft policy WR4 requires “a strong landscape buffer”. It is clear that landscaping is anticipated and therefore why would it not be possible to make appropriate landscaping provisions in a number of alternative sites. This surely must be a more sensible approach than allocating a site that would result in an inherent conflict with a number of other draft policies within the Local Plan.

It is considered that the decision of the Council to simply consult on the proposed allocation of one site, without giving the public the opportunity to comment on the site assessment procedure or even the necessary information to understand and consider the basis of that assessment is flawed.

There are a number of legitimate and significant issues and reasons as to why the allocation of this site is unsuitable. These reasons should be weighed in the balance against the other available site options and the potential mitigation measures that would be available to turn one site that on the face of it appear unsuitable in planning terms to a site that is suitable.

In respect of the proposed site the issues cannot be easily mitigated. The allocation of this site puts at risk one of the town’s biggest economic drivers, the Reading Festival, and a number of significant businesses who contribute heavily to the economic success of the Thames Valley.

The Council themselves recognise this contribution, and they are clear that they wish to maintain Richfield Avenue as a Core Employment Area (EM2g on the Proposals Map). The proposed Employment policies clearly states that Employment development for industrial, storage and distribution should be located in highly accessible locations.

Cow Lane is an extremely busy road which suffers from a high degree of congestion, especially during the rush hours in the morning and evening. The current highway infrastructure of this area of Reading is inadequate to deal with the greater strain of increased vehicular movement that will be added through the provision of the Site and also be able to support the expansion and development of the economic area as envisioned by the other policies submitted in the draft local plan.

The allocation of the proposed site for non-Employment use therefore represents an inherent conflict with the other policies of the Local Plan, something that cannot be easily mitigated against.

Conclusion

In light of the above, our client strongly believes that the proposal for the Site to be situated in this location will be incongruous with the surrounding uses. The allocation of the Site will have a detrimental impact on the local highway network which supports one of the Readings key economic areas, not to mention the direct impact on the Reading Festival. An alternative site that where the negative planning issues can be properly mitigated against should be considered.

In light of the reasons above, our client does not consider that the Local Plan is sound in respect of Policy WR4. In particular, our client does not consider that the Policy WR4 is justified. Due to the lack of information regarding proposed Policy WR4 the Council have not demonstrated that the proposed policy has been weighed against the reasonable alternatives available to the Council nor that their conclusions are based on proportionate evidence. Policy WR4 should be amended so that the Council is not allocating a specific site to locate the transit site on. This will allow these issues to be robustly assessed in a proper manner.

Our client would like to reserve the right to appear at the public examination, and to be kept informed of the progress of this Local Plan.

Blandy & Blandy LLP

26.01.2017

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices, Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		
First Name		
Last Name		
Job Title <i>(if applicable)</i>		
Organisation <i>(if applicable)</i>	R Collard Ltd	Blandy & Blandy LLP
Address 1	128 Cardiff Road	
Address 2		
Address 3		
Town	Reading	
Post Code	RG1 8PQ	
Telephone		
E-mail		

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Policy WR4

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Please see attached representations.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Deletion/Amendment of Policy WR4 so that a specific site is not allocated.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

Due to the potential impact that this proposed policy may have on the area.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

ROBERT CORT PROPERTIES LTD

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		Mrs
First Name		Zahra
Last Name		Waters
Job Title <i>(if applicable)</i>		Planner
Organisation <i>(if applicable)</i>	Robert Cort Properties Limited	Lichfields
Address 1	c/o Agent	7 The Aquarium
Address 2		1-7 Kings Street
Address 3		
Town		Reading
Post Code		RG1 2AN
Telephone		0118 334 1920
E-mail		Zahra.waters@lichfields.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Policies EM2 and EM3

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Please see covering letter - our clients consider that the plan is not sound in relation to Policies EM2 and EM3
--

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Please see covering letter.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

To amplify our clients concerns in respect of this element of the Local Plan

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Planning Policy Team
Reading Borough Council
Bridge Street
Reading
RG1 2LU

Date: 26 January 2018
Our ref: 15818/DL/ZA/15213353V1
Your ref:

Dear Sir/Madam

Representations to the Reading Borough Council Pre-Submission Draft Local Plan in respect of Robert Cort Industrial Estate and Preston Road Industrial Estate – Draft Policies EM2 and EM3

This letter forms representations to the Reading Borough Council (RBC) Pre-Submission Draft Local Plan (DLP) Consultation (December 2017) (hereafter the emerging Local Plan) which are submitted on behalf of our client Robert Cort Properties Limited.

These representations follow those submitted on behalf of Robert Cort Properties (hereafter “*our clients*”) to the Draft Local Plan consultation in June 2017 in respect of the earlier iterations of draft policies EM2 and EM3. They focus on RBC’s response to our earlier representations (which include proposed revisions to draft Policy EM3) and further changes which our client considers are necessary to seek to ensure that this element of the emerging plan is sound.

Background

The representations relate to two neighbouring sites: (i) Robert Cort Industrial Estate, Britten Road, Reading, RG2 0AU and (ii) Preston Road Industrials Estate, Preston Road, RG2 and draft policies EM2 and EM3.

Both of these sites are located within close proximity to each other (and are also form much of the Elgar Road site in the RBC Sites and Detailed Policies Document (October 2012) (site SA12 (f)). They are allocated as a Core Employment Area (policy EM2 (f)) within the emerging . For the purposes of these representations they are together referred to as “the sites” except where it is appropriate to differentiate between them. A site plan showing both locations can be found at Appendix 1.

Our clients are long term investors in Reading who have owned the sites for over 20 years. They recognise that the emerging Local Plan (para 1.1.1) “*contains the policies for how Reading will develop up to 2036*” and the focus of their concerns, as amplified below, is that the Plan must allow sufficient flexibility over this period. Specifically the Local Plan policy framework must reflect the location and use of the current buildings, the potential for replacement or alternative uses over this timeframe and allow flexibility for the differing national and sectoral economic patterns which are inevitable over this period. Crucially the

emerging plan must reflect the requirements of the NPPF in relation to employment land (para 22) specifically that such *“land allocations should be regularly reviewed.”*

Site Location & Surrounding Area

The sites measure approximately 3.4ha in total (site (i) is around 2.5 hectares and site (ii) is around 0.85 hectares) and predominantly comprise light industrial uses along with some leisure use. The sites are framed by further employment uses and residential dwellings to the north, a tree belt with open space and residential dwellings beyond to the east; and a mixture of residential and commercial uses to the west (across Elgar Road South) with further open space beyond.

The sites fall within Flood Zone 1 as identified on the Environment Agency Flood Map for Planning (Rivers and Sea); land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). According to magic.defra.gov.uk there are no listed buildings within the vicinity of the sites.

The sites are accessible and well connected to the surrounding local area, with regular bus services to Reading Town Centre. They are situated approximately 1.8 miles from Reading West rail station which provides frequent services to Reading, Basingstoke and Newbury, and just over 2 miles from Reading rail station which has frequent services to a number of destinations.

Our clients long term experience of owning and letting the sites means that they have identified a specific commercial constraint arising from the Preston Road sites location being on a hill which means that access for commercial vehicles is very tight at best. Furthermore the access road is not straight which introduces further constraints for HGV's (including a requirement for such vehicles to reverse downhill). In addition the loading bay doors for most of the units are off the steep incline which hampers their operation. These constraints cannot be addressed within the current configuration and limit the end use of the units.

The Sites

Site History

The Robert Cort Industrial Estate was built in three phases. Phase 1 was built in circa 1985, phase 2 circa 1987 and phase 3 circa 1989. The online planning history for Robert Cort Industrial Estate shows a series of permissions for Class B uses and development associated with these. In 1998 planning permission was granted for change of use from General Industrial (B2) to Leisure and Assembly (D2). There are also some older engineering buildings on the site which were built in the 1950s and 1960s.

The exact date the Preston Road units were built is unknown but it was prior to the sites was purchased by Robert Cort Properties in 1995.

Level of Occupation

The Robert Cort Industrial Estate is close to full occupancy, though there are some vacant units. The vacant units include the older units on Robert Cort Industrial Estate, which comprise approximately 1,300 sq m of floorspace. We understand these units have been difficult to let due to accessibility issues and other constraints identified above. In addition, the roof on the older units contain asbestos, meaning future renovation works to bring the units up to modern standards are likely to be costly. The lease lengths at the site vary from between 2 -20 years, with the longest lease ending in the next decade.

The five units under our clients ownership on the Preston Road site are almost at full occupation though we understand demand for these units has historically been low. Again the longest lease at the site ends during the next decade. Whilst RBCs response to our clients earlier representations (within their Statement of Consultation on the Draft Local Plan (November 2017)) notes *“the site is almost fully occupied”* this does not

reflect our clients longer term concerns about the potential reuse of these premises and we expand upon this below.

Current Condition

The condition of the units on the Robert Cort Estate reflect their construction period of the 1980s and this, combined with their age, means they have required constant refurbishment over time. In general the majority of units on the estate are in good order - they have been modified and refurbished to a good standard. Refurbishments costs are however increasing as the units get older and the presence of asbestos may lead to subsequent refurbishments becoming unviable due to the low rents experienced.

The units on the Preston Road estate are also ageing buildings which have required frequent maintenance and refurbishment to make the units lettable. The site in general is considered to be less desirable than the Robert Cort – for the reasons outlined above. In addition the roofs on this site also include asbestos and therefore refurbishment costs are significant. With changes to EPC ratings in the future the units are unlikely to meet rising standards without significant costly investment and this could potentially prove to be unviable.

Despite the current high levels of occupancy that our clients have achieved the scope for future refurbishment forms a key concern for them – particularly in the context of an emerging Local Plan with an end date of 2036.

Existing Planning Policy Allocations

Both sites are currently application in the RBC Core Strategy (2008) and the Sites and Detailed Policies Document (2015) within the Elgar Road Core Employment Area (site ref SA12f, as designated under Policies CS10 CS11 and SA12). The eastern fringe of the site is also covered by ecological/biodiversity designations (policies CS36 and DM17) which seek to retain features of biodiversity or ecological interest.

Emerging Local Plan

Draft Local Plan (May 2017)

We submitted representations on behalf of our clients to the previous consultation on the emerging Local Plan in May 2017. Following the consultation RBC published their Statement of Consultation, which provided a summary of the comments received and RBCs response to these. In respect of the representations submitted on behalf of our client, RBC stated:

“No change proposed. . . . however it is recognised that, where it can be demonstrated that there is no realistic long term prospect of employment use within a designated CEA, then there should be scope to consider alternative commercial uses. This would be less likely to compromise the use of surrounding employment uses than residential. A change is therefore proposed to the supporting text to policy EM3 to reflect this.”

We summarise the subsequent revisions proposed within the Pre-Submission Draft Plan and why our clients consider further flexibility within the plan is required.

Pre-Submission Draft Local Plan (December 2017)

Before summarising the current allocation and policy context for the sites within the emerging Local Plan we note that it is necessary for the Local Plan to seek to balance development pressures, in particular housing and employment land, over the Local Plan period. The emerging plan contends (para 4.3.6) *“there is currently a reasonable balance between the levels of employment planned for in policy EM1 and the levels of housing set out in H1.”*

In fact this necessary balance in the emerging Local Plan is weighted in favour of employment land with the Plan stating (para 4.3.5) in respect of employment land that :

- *“there is scope to accommodate the full level of need within Reading Borough;”*

Whilst in respect of housing provision it states (para 4.4.1) *“there is a pressing need for additional housing in Reading and the surrounding area”* but (para 4.4.5)

- *“there is a shortfall of 664 dwellings when considered against Readings need”.*

This forms the context for our subsequent analysis below.

Policy EM2

The sites are identified in the emerging Local Plan within policy EM2: Location of new employment development. The sites are incorporated within the Elgar Road Core Employment Area (site ref. EM2f).

Additional text has been inserted to the explanatory text of Policy EM2 in the Pre-Submission Draft version of the Local Plan (to which these representations relates) to clarify that ancillary non-employment uses that support employment uses may be located within the Core Employment Areas (para 4.3.11). Our clients support the flexibility inherent within this approach but consider that this text ought to be placed within policy EM2 rather than the supporting text.

Policy EM3

Draft policy EM3 relates to the loss of employment land and states in relation to the Core Employment Areas:

“Within the Core Employment Areas, the overall level of employment land should be maintained. Proposals that would result in a loss of such land will not be permitted.

Where, in exceptional circumstances, it can be demonstrated that a site in a Core Employment Area has no long-term (i.e. over five years) prospect of employment use, a related alternative commercial use may be considered that would employ a similar number of people.”

The policy goes on to identify that other sites (outwith Core Employment Areas) will be assessed against a range of criteria *“when assessing proposals which would result in the loss of employment land.”*

The supporting text states (para 4.3.12) *“there is a need for a certain degree of flexibility with existing employment land to allow an appropriate balance of uses to develop in the right location.”* It continues *“for this reasons it is not appropriate to simply apply a blanket protection to all existing employment areas.”*

An additional paragraph (4.3.13) has now been added to the pre-submission version of the emerging Local Plan which recognises in exceptional cases where there may not be a no long-term prospect of employment use in Core Employment Areas, and in these cases it is preferable for a site to be used for an alternative commercial use that complements the area than for it to be vacant in the long-term (para 4.3.13). The paragraph then goes on to state *“If there is also no long-term prospect of redevelopment of these sites for employment, alternative commercial uses under this policy may be considered.”* Our clients comments on this additional text are set out below and focus on (i) the principle of retaining the sites as Core Employment Areas (when they consider that they have potential for residential use) and (ii) other concerns regarding this text.

Potential Residential Development

Housing and Economic Land Availability Assessment

The proposed retention of both sites as Core Employment Sites was assessed within the Reading Housing and Economic Land Availability Assessment (HELAA) (May 2017). This assessed both Preston Road, as part of the wider Preston Road and Nimrod Way site (site ref. KAO14) and Britten Road (Robert Cort Industrial Estate) (site ref. KAO15). Stage 1(B) of the assessment did not identify any reasons for the exclusion of the sites from further consideration. Stage 2(A) of the HELAA then undertook an assessment of the physical capacity of the site to accommodate development. Whilst the sites (refs. KAO14 and KAO15) do not directly correlate with our client’s ownership is it identified that the two assessed sites have potential capacity for a total of 466 residential dwellings (ie including land beyond our clients control).

Stage 2(B) then went on to assess the suitability of the sites for a number of types of development and whilst we do not seek to repeat the findings in detail we provide a summary of these below:

Site	General Location	Existing Use	Environmental and Open Space	Heritage	Health and Safety	Flood Risk	Design and Amenity	Utilities	Other Considerations	Overall Suitability
KAO14 Preston Road and Nimrod Way	Suitable	Unsuitable	Potentially Suitable	Suitable	Unsuitable	Suitable	Potentially Suitable	Potentially Suitable	Suitable	Unsuitable
KAO15 Britten Road	Suitable	Unsuitable	Suitable	Suitable	Unsuitable	Suitable	Suitable	Potentially Suitable	Suitable	Unsuitable

The above analysis identifies that the sites are suitable for development when assessed against many of the relevant categories.

The alleged unsuitability identified in terms of health and safety is due to potential noise issues from the surrounding industrial uses and a small amount of potential land contamination, both of which could be mitigated against as part of any development scheme. The remaining unsuitability factors relate to the loss of the existing employment use on the site – which is addressed elsewhere within these submissions.

In terms of the overall suitability of the site, both sites are identified as unsuitable due to the following *“Loss of employment uses prevents wholesale release of area, whilst noise and disturbance prevent this area coming forward in isolation.”* We have commented on both of these matters above.

Overall therefore we do not consider that the evidence base has appropriately considered the scope for residential use on the site, despite considering that it is “suitable” against a number of the relevant criteria, as it has failed to consider mitigation which would address the concerns identified.

The failure to fully assess the potential of the sites for residential development is exacerbated in a context where RBC acknowledge that (para 4.3.5) *“there is scope to accommodate the full level of need within Reading”* but *“there is a shortfall of 664 dwellings when considered against Readings need”*. The emerging plan does not therefore appropriately balance employment and housing needs and policy flexibility to

facilitate residential development on our clients site would assist in meeting such a balance – as expanded upon below.

Proposed Flexibility for Future Uses

Our clients recognise that whilst the premises have a number of constraints (summarised above) which have historically hindered their letting – even though they currently benefit from reasonably high occupation levels. Accordingly they anticipate that a number of the current industrial uses are likely to remain in the immediate future.

In the medium to longer term however the age of many of the buildings is leading to increasing requirements for expensive remediation works to maintain the necessary standards of the units as the building come to the end of their natural life. Their concern is that the low rental levels they are achieving, allied to the site specific constraints, will not warrant the substantial development costs associated with a wider redevelopment of the site for replacement uses.

Policy EM2

Should these circumstances arise, they are therefore seeking a more flexible policy context for future uses of the site, which could potentially allow for alternative uses (including residential and commercial) should the refurbishment or redevelopment of the units become unviable. Our clients support the additional supportive text added within the Pre-Submission Draft Local Plan, however it is considered further flexibility should be added to the wording of the draft Policy EM2 to potentially allow for alternative uses.

Such flexibility would be consistent with both the NPPF and the emerging Local Plan itself - with the latter recognising (para 4.3.11) both the need for “*a certain degree of flexibility with existing employment land to allow an appropriate balance of uses to develop in the right locations*” and that “*it is not appropriate to simply apply a blanket protection to all employment uses.*”

Policy EM3

Our clients consider that the lack of flexibility within emerging policy EM3, alongside the lack of clarity regarding the requirement for a lack of “*long term (i.e. over five years) prospect of employment use*” result in such a “*blanket protection*” which the emerging plan purports to resist.

Furthermore in restricting the alternative use permitted, in such (untransparent) circumstances, to “*an alternative commercial use that complements the area*” not only lacks further clarity but fails to respond to the “*pressing need*” for additional housing development over the plan period summarised above. Our analysis of the May 2017 HEELA identifies that the sites could contribute to providing a significant level of new housing for Reading.

The flexibility that our clients are seeking to draft Policy EM3 would also be consistent with guidance in the NPPF (para 22) that “*applications for alternative uses of land or buildings should be treated on their merits having regard to market signals and the relative need for different land uses to support sustainable local communities.*” Whilst the sites have been identified as unsuitable for residential development within the HELAA, this primarily relates to the loss of the existing employment use. As the buildings continue to require ongoing maintenance due to their age, there is likely to become a point where the buildings are no longer fit for purpose and become unsuitable for employment use. We therefore consider the sites may become suitable for alternative development, such as housing, in the future and the plan should incorporate sufficient flexibility to reflect this.

Concluding Comments and Changes Sought to the Draft Plan

These representations relate to Preston Road Industrial Estate and Robert Cort Industrial Estate, Britten Road. As identified above, our clients anticipate that the existing industrial use will remain on the sites in the immediate future, though as the building continue to age and maintenance cost increase, whilst rents remain low, then our clients anticipate that they will require future flexibility which may result in alternative uses (potentially including residential development) on the sites. The emerging Local Plan, whilst acknowledging the need for such flexibility, does not reflect it within the prescriptive requirements of Policy EM3.

To summarise, our clients are seeking the addition of the supporting text at 4.3.11 to be included within Policy EM2 rather than within the supporting text. Our clients welcome the flexibility proposed within Policy EM3 / para 4.3.13 however the text should all be within the policy and the proposed flexibility should not be limited to commercial uses instead residential development should also be included given the overall suitability of the site and the level of housing need within Reading.

Our clients request that future iterations of the emerging Local Plan reflect this flexibility sought. They would also welcome opportunity to meet with the Council and discuss the future for the site.

We trust that these comments will assist in the subsequent iterations of the draft Plan. Please contact Zahra Waters or myself in the meantime if you require any additional information.

Yours faithfully


Daniel Lampard
Senior Director



Key

Site Boundaries



Project Robert Cort Properties, Reading

Title **Site Location Plan**

Client Robert Cort Properties Limited

Date 14.06.17

Scale 1:1250 @ A3

Drawn by MK

Drg. No. IL15818-001



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CL15818/01

LICHFIELDS

ROBSON, ELAINE

From: Elaine Robson
Sent: 28 January 2018 23:15
To: Worringham, Mark
Cc: 'Elaine Robson'
Subject: Comments (1) re Draft Reading Borough Local Plan
Attachments: Green infrastr & air pollution 1-s2.0-S1352231017303151-main.pdf; Green infrastr review air pollutants 1-s2.0-S1352231015000758-main.pdf

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Mr Worringham,

Thank you for agreeing to late comments on the Draft Local Plan. My suggested alteration is outlined below, and submitted with pdfs of two illustrative documents published in "Atmospheric Environment" attached.

I am sending related comments in the next e-mail (Comments (2)) with another pdf : these messages are consecutive.

EN15 Air Quality

I wish to suggest an additional subheading within pp 56-58 to specify that the Council endorses the mitigation of air pollution by the use of local green infrastructure.

The term Green Infrastructure is used here to include trees, shrubs, hedges, grass, areas of cultivated or wild plants, also green walls, balconies and roofs. These contribute to a healthier environment by absorbing aerial pollutants.

The Council's strategy for control of air pollution is to reduce it at source, and to monitor readings especially of NO₂, PM₁₀ and PM_{2.5}. But it is common experience that in some circumstances the air in certain areas of Reading is still not good (eg, Caversham Road below the rail station on 20th January).

I would urge the Council's Planners and Highway specialists to evolve a practical policy to mitigate air pollution with porous green infrastructure whenever possible. Modern city buildings or blocks of flats should use flat rooftops, balconies and green walls to improve the air quality and trap particulates. A positive statement in the New Plan is needed to ensure that future Planning Applications pay attention to Green Infrastructure.

- Two supporting publications are attached, also of interest to local road developers.

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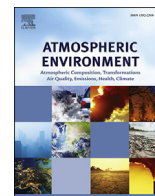
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Review article

Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review



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HIGHLIGHTS

- Green infrastructure can play a significant role in mitigating urban air pollution.
- Air quality changes in local built environments due to vegetation are assessed.
- Low-level hedges improves air quality in street canyons unlike high-level trees.
- Green green walls and roofs are effective to reduce pollution in streets/open roads.
- Prior design of green infrastructure should be performed for improving air quality.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 25 February 2017

Received in revised form

9 May 2017

Accepted 10 May 2017

Available online 10 May 2017

Keywords:

Local pollutant exposure

Street canyons

ABSTRACT

Intensifying the proportion of urban green infrastructure has been considered as one of the remedies for air pollution levels in cities, yet the impact of numerous vegetation types deployed in different built environments has to be fully synthesised and quantified. This review examined published literature on neighbourhood air quality modifications by green interventions. Studies were evaluated that discussed personal exposure to local sources of air pollution under the presence of vegetation in open road and built-up street canyon environments. Further, we critically evaluated the available literature to provide a better understanding of the interactions between vegetation and surrounding built-up environments and ascertain means of reducing local air pollution exposure using green infrastructure. The net effects of vegetation in each built-up environment are also summarised and possible recommendations for the future design of green infrastructure are proposed. In a street canyon environment, high-level vegetation

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Open roads
Urban trees and hedges
Green wall
Green roof

canopies (trees) led to a deterioration in air quality, while low-level green infrastructure (hedges) improved air quality conditions. For open road conditions, wide, low porosity and tall vegetation leads to downwind pollutant reductions while gaps and high porosity vegetation could lead to no improvement or even deteriorated air quality. The review considers that generic recommendations can be provided for vegetation barriers in open road conditions. Green walls and roofs on building envelopes can also be used as effective air pollution abatement measures. The critical evaluation of the fundamental concepts and the amalgamation of key technical features of past studies by this review could assist urban planners to design and implement green infrastructures in the built environment.

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1. Introduction

Air quality in the built environment continues to be a primary health concern as the majority (i.e., 54% in 2014) of the world's population currently lives in urban areas, and this is projected to rise to 66% by 2050 (United Nations, 2014). Traffic emissions are the main source of air pollution in cities around the globe (Kumar et al., 2016, 2015, 2013). Green infrastructure in the built environment has been considered as one potential urban planning solution for improving air quality as well as enhancing the sustainability of cities for growing urban populations (Irga et al., 2015; Salmund et al., 2016). These green solutions include street trees, vegetation barriers (including hedges), green (or living) walls, and green (or living) roofs. These types of vegetation act as porous bodies which influence local dispersion patterns, and aid the deposition and removal of airborne pollutants (Escobedo and Nowak, 2009; Fantozzi et al., 2015; Janhall, 2015; Nowak, 2006; Yin et al., 2011). Apart from possible air pollution reduction, urban green infrastructure also provides benefits such as urban heat island mitigation (Chen et al., 2014; Gago et al., 2013), potential reduction in energy consumption (Berardi et al., 2014; Pérez et al., 2014) and noise pollution (Berardi et al., 2014; Cohen et al., 2014; Salmund et al., 2016), better stormwater management (Czemiel Berndtsson, 2010; Roy et al., 2012) and climate change mitigation (Matthews et al., 2015). In addition, eco-services provided by green interventions assist in improving the health and well-being of the urban population in several ways (Dean et al., 2011; Nowak et al., 2014; Tzoulas et al., 2007).

Road traffic emits a variety of harmful pollutants in the form of particulate matter – PM₁₀ (particulate matter $\leq 10 \mu\text{m}$), PM_{2.5} ($\leq 2.5 \mu\text{m}$) and ultrafine particles (UFP; $< 100 \text{nm}$) – and gaseous pollutants such as the nitrogen oxides (NO_x), carbon monoxide (CO) and in minor part sulphur dioxide (SO₂). As for the air pollution abatement performance of various types of green infrastructure, either individually or in combination, in different urban environments (Gallagher et al., 2015), the majority of studies have focused on pollutants such as the PM₁₀ (Heal et al., 2012; Maleki et al., 2016), PM_{2.5} (Ayubi and Safiri, 2017; Heal et al., 2012), UFP (Chen et al., 2016; Kumar et al., 2014), NO_x (Beevers et al., 2012; Michiels et al., 2012), CO (Bigazzi and Figliozzi, 2015; Chen et al., 2011), and black carbon (Li et al., 2016a; Rivas et al., 2017a,b) that have implications for the adverse health effects. In future, urban green infrastructure can be implemented as a passive air pollution control measure in cities through limited alterations in the built environment (McNabola, 2010). The urban environments accounted for in the studies reviewed here were either near an open road or in an urban street canyon with high traffic volumes. For example, the impact of trees in street canyons were examined by numerous studies (Abhijith and Gokhale, 2015; Amorim et al., 2013; Buccolieri et al., 2011, 2009; Gromke et al., 2008; Gromke and Ruck, 2007; Hofman et al., 2016; Li et al., 2013; Moonen et al., 2013; Salim

et al., 2011a; Salmund et al., 2013; Vos et al., 2013; Wania et al., 2012; Jeanjean et al., 2017). These studies generally indicated that the presence of trees increases the pollution concentration in a street canyon. Other studies investigated pollutant exposure in street canyons with hedges and reported that low-level hedgerows generally reduces pollutant levels along the footpath (Gromke et al., 2016; Li et al., 2016b). Likewise, a few studies investigated the air pollution removal potential of vegetation along busy urban highways, reporting that vegetation barriers and trees along roads reduced roadside pollutant concentrations (Brantley et al., 2014; Hagler et al., 2012; Lin et al., 2016; Tong et al., 2016). A few studies also indicated that roadside vegetation can have adverse effects on air quality under certain conditions (Tong et al., 2015). Recently, Baldauf (2017) summarised the vegetation characteristics that influence the beneficial and adverse effects of roadside vegetation on near-road air quality. A number of past studies also examined the air pollution removal potential of green roofs and green walls (Joshi and Ghosh, 2014; Ottel   et al., 2010; Pugh et al., 2012) or the combinations of green infrastructure with other passive pollution control methods (Baldauf et al., 2008; Bowker et al., 2007; Tong et al., 2016; Baik et al., 2012; Tan and Sia, 2005). Overall, a general conclusion from these studies was that green infrastructure had both positive and negative impacts on air quality at street levels, depending on the urban and vegetation characteristics.

As summarised in Table 1, previous review articles on this topic have discussed particulate matter (PM) removal by vegetation (Janhall, 2015), the suitability of passive methods to reduce pollutant exposure (Gallagher et al., 2015), vegetation design characteristics for roadside applications (Baldauf, 2017, 2016; Baldauf et al., 2013) and pollutant deposition on plant canopies (Litschike and Kuttler, 2008; Petroff et al., 2008). Furthermore, previous reviews have focused on the benefits of urban infrastructure such as urban heat island mitigation from trees (Gago et al., 2013), thermal performance of green facades (Hunter et al., 2014) and energy aspects of green roofs (Saadatian et al., 2013). Recently, Berardi et al. (2014) published a state-of-the-art review on air pollution mitigation by green roofs. However, there is still a need to systematically review and summarise the individual findings of various published research studies on numerous types of green infrastructure that consider local air quality improvements in the diverse urban environment. Going beyond the scope of existing reviews on this topic, this article: (i) provides a detailed quantification of local scale aerodynamic effects and reduction potentials of urban vegetation such as trees, hedges, green wall and green roofs in both built-up (street canyon) and open road configurations, (ii) describes the individual and combined effects of the built environment, metrological and vegetation characteristics on neighbourhood air quality, (iii) identifies vegetation types and characteristics that result in the least pollutant exposure in various urban areas, and (iv) recommendations for deploying green

Table 1
Summary of review articles discussing various aspect of green infrastructure.

Review	Description
Salmond et al. (2016)	Reviewed ecosystem services provided by street trees for the improvement of human well-being and health. Urban tree benefits were analysed through an urban ecosystem services approach. Street tree modification of air quality, climate and aesthetic and cultural services were listed. Review argued to develop a bottom-up decision-making process for implementing street trees as immediate impacts are seen in local scale. The study provides detailed ecosystem services of trees which can be used by urban planners in evaluating and implementing urban trees.
Gallagher et al. (2015)	Review summarised various passive methods of controlling air pollution exposure in the built environment and discussed strength and limitations of porous as well as solid barriers. The study listed potentials of these passive methods to reduce exposure and improve air quality in urban built environment.
Janhall (2015)	Reviewed effect of vegetation on dispersion and deposition of particulate matter in urban built environments. The study provided a comprehensive description of vegetation and particulate matter deposition and dispersion. The study was able to deliver design consideration on the closeness of vegetation to the pollution source and density of vegetation for improving air quality.
Berardi et al. (2014)	An extensive review of environmental benefits of green roofs covering energy conception reduction, air pollution mitigation, noise reduction, heat island effects etc. classification and technical aspects of the green roof were explained. The study showed capabilities of green roofs for a sustainable urban environmental.
Mullaney et al. (2015)	Listed social, environmental and economic benefits of street trees and challenges associated with growing along the street.
Gago et al. (2013)	Review various heat island mitigation strategies and pointed out vegetation can reduce heat island effect
Hunter et al. (2014)	Reviewed thermal performance of green façade. This study listed thermal modulation of different types of climbing plants.
Pérez et al. (2014)	Vertical greenery systems, which include green walls and facades, were reviewed considering their potential for saving energy.
Saadatian et al. (2013)	This study reviewed energy aspects of green roofs.
Petroff et al. (2008)	Reviewed particulate matter deposition on urban vegetation
Litschke and Kuttler (2008)	Reviewed dry deposition on vegetation canopies

interventions in diverse urban environments.

This synthesis of local scale air quality impacts for each vegetation type is essential for city level implementation that uses a bottom-up decision-making process. This ensures the success of these interventions irrespective of scales (Salmond et al., 2016). Therefore, it is necessary to consolidate and synthesise previous investigations on the air pollution abatement performance of urban green infrastructure (i) for urban planners to facilitate its practical application in future urban planning strategies and (ii) for researchers to identify gaps in knowledge and to undertake further evaluation and validation of the performance of green infrastructure to improve urban air quality and ameliorate urban microclimate.

Further, this review aims to develop generic recommendations on the selection and design characteristics of suitable green infrastructure in different urban environments. These recommendations can then be deployed in the future for existing city environments to reduce pollutant exposure from nearby emission sources at the local scale. We categorised the vegetation impacts on neighbourhood air quality based on different urban forms such as street canyons (Fig. 1), open roads (Fig. 2) and building envelopes (Fig. 1d), and observed the distinct impacts of vegetation on air quality with respect to urban morphology. This revealed site-specific recommendations suitable for planting vegetation in street canyons as well as forming generic guidelines for open road configurations. In addition, the review provides insights into the least studied vegetation application (i.e. green walls and roofs) and highlights existing research gaps. A comprehensive summary of technical design inputs (e.g., leaf area density, LAD; deposition velocity; porosity) for four different types of vegetation are also compiled to assist any potential dispersion and deposition modelling activities. Altogether, the flow of the scientific knowledge consolidated in this review will aid in the practical usage of green interventions in the real-world cases for a healthier environment.

2. Common characteristics of urban vegetation (green infrastructure)

The terms 'urban vegetation' and 'green infrastructure' are used interchangeably in this review paper and refer to all types of

vegetation such as trees (Section 3.1), hedges and bushes (Section 3.2), green walls (Section 5.1) and green roofs (Section 5.2) that are the focus of this article. Before examining individual urban built environment conditions (Sections 3 and 4), it is important to understand the common vegetation characteristics that affect near-road air quality. These characteristics include: (i) pollutant removal and dispersion characteristics, (ii) density/porosity of vegetation, (iii) physical dimensions (such as height, length, thickness and spacing), and (iv) species-specific characteristics (such as leaf thickness, presence of hairs or wax on leaf surface, seasonal variations, vegetation emissions and air pollution tolerance index).

Urban vegetation removes gaseous pollutants by absorption through leaf stomata or plant surfaces (Escobedo and Nowak, 2009; Fantozzi et al., 2015; Salmond et al., 2016; Vesa Yli-Pelkonen et al., 2017). Nowak et al. (2013, 2006) investigated pollution removal for several gases (O₃, NO₂, SO₂, CO) and PM₁₀ by measuring the downward pollutant flux as the product of the deposition velocity and the pollutant concentration. They found that pollution removal values for each pollutant vary among cities based on the amount of tree cover, pollution concentration, the length of leaf season, the amount of precipitation and other meteorological variables that affect tree transpiration and deposition velocities. Furthermore, PM deposited on vegetation can be retained for some time temporarily and then re-suspend to the atmosphere by high wind speed, washed off by precipitation, or transferred to soil with falling parts of vegetation including leaves (Nowak et al., 2014). Some vegetation species act as a pollutant source by emitting pollen (D'Amato et al., 2007) and some gaseous pollutants (Benjamin and Winer, 1998; Leung et al., 2011; Wagner and Kuttler, 2014). A porous body of vegetation can influence nearby pollutant concentrations by altering the wind flow around it (Ries and Eichhorn, 2001). The aerodynamic effects of trees affect pollutant concentration in two ways depending on the built-up environment and meteorological conditions. Under neutral thermal stratification (i.e. a typical condition reproduced in laboratory studies), tree crowns act as obstacles to the wind and depending on the shape and spatial configuration, they diminish the turbulent exchange of mass and momentum between the in-canopy volume and the air above the canopy. On the other hand, tree crowns may generate wind

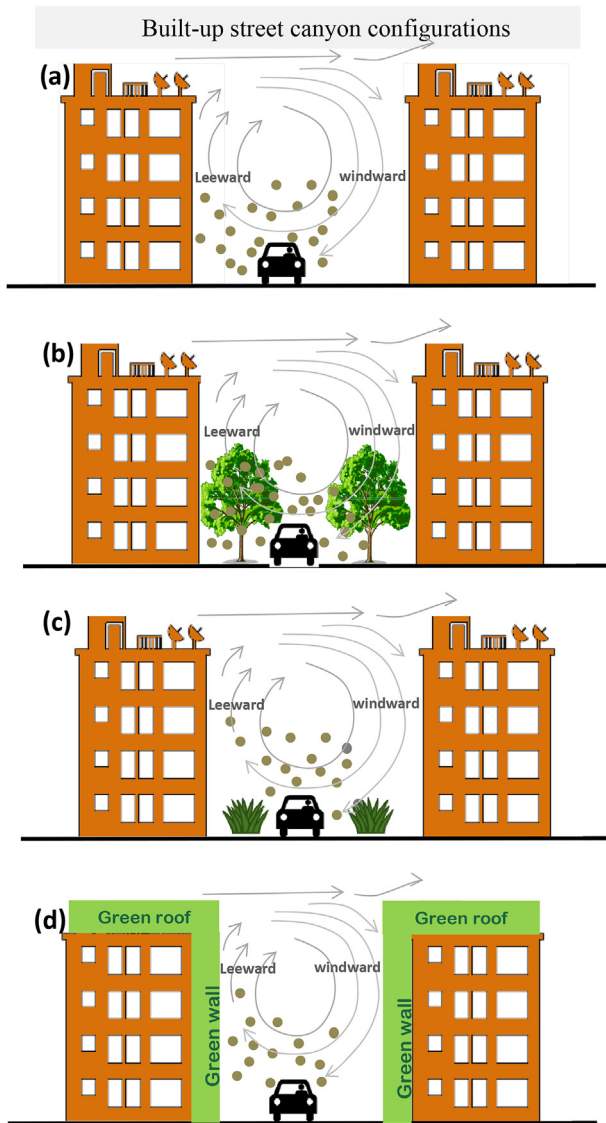


Fig. 1. Description of flow and pollutant dispersion patterns in a street canyon with and without different types of vegetation: (a) vegetation free street canyon, (b) street canyon with trees, (c) street canyon with hedges, and (d) street canyon with green roof and green wall.

direction fluctuations below the tree crown (Di Sabatino et al., 2015), and depending on foliage shape and distribution, these act as a source of turbulence and hence increase turbulent diffusion and facilitate pollutant dilution. The aerodynamics effects of trees have been addressed extensively by several authors using wind tunnel investigations complemented by detailed CFD modelling. Also, the effect of the role of non-neutral thermal stratification has been addressed in both computational and observational studies. For example, De Maerschalck et al. (2010) showed that in specific meteorological conditions or geometries of built environment, vegetation can decrease turbulent kinetic energy and act as a diffuser breaking down the turbulent eddies. Based on real-atmospheric observations in street canyons, Di Sabatino et al. (2015) showed that the presence of trees alters the thermal vertical distribution inside street canyons, especially in nocturnal hours, with the bottom layer much warmer than the top of the canyon, but with a remarkable decoupling of the flow and diminished vertical exchange. In synthesis, there is a consensus that an increase in

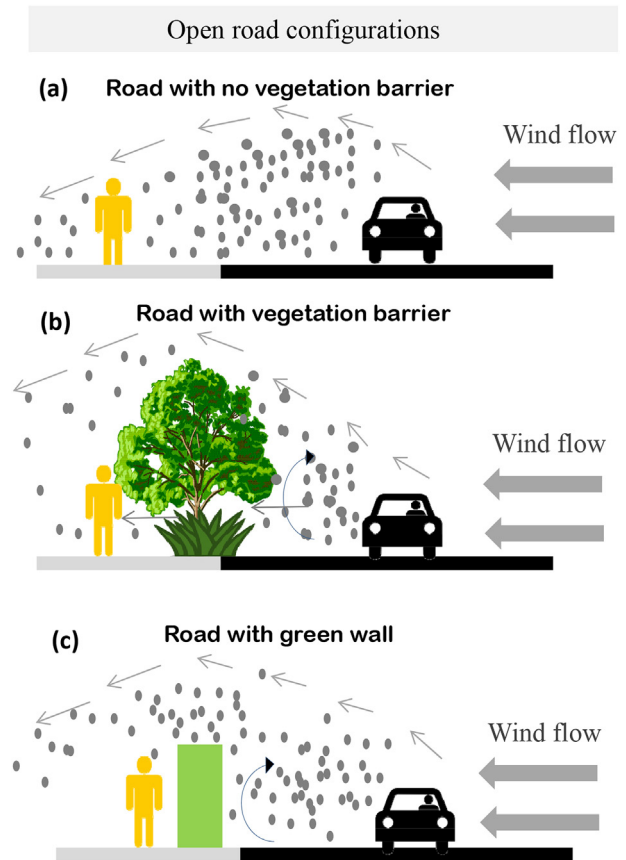


Fig. 2. Dispersion patterns of road pollutants under open road configurations (a) without vegetation barrier (b) with vegetation, and (c) with green wall.

pollutant concentrations in street canyons occur with the presence of trees (Buccolieri et al., 2009; Gromke and Ruck, 2009, 2007). However, a reduction in pollution concentrations may occur depending on micrometeorological conditions and type of foliage; this is especially true due to the presence of hedges in street canyons and dense vegetation along highways (Al-Dabbous and Kumar, 2014; Brantley et al., 2014; Gromke et al., 2016). Critical in interpreting these findings is that vegetation can both introduce extra mechanical turbulence, but also reduce turbulent kinetic energy, while the strong wind speed reduction around the vegetation causes strong shear stresses and therefore extra turbulence. Nevertheless, the combination of local meteorological conditions and vegetation has received less attention and extra research efforts may be foreseen in future years.

The nature of vegetation effects are dominated by the geometry of the built-up environment. In street canyons, trees may deteriorate air quality if their configuration is not planned adequately (Abhijith and Gokhale, 2015; Buccolieri et al., 2011; Ries and Eichhorn, 2001; Salmond et al., 2013; Vos et al., 2013; Wania et al., 2012) whereas in open road environments a mixture of trees and bushes can act as barriers to improving air quality behind them (Brantley et al., 2014; Hagler et al., 2012; Islam et al., 2012; Lin et al., 2016; Shan et al., 2007). These dispersion and deposition characteristics are affected by the density and area of the vegetation with the deposition rate due to vegetation being estimated by two methods: the leaf area index (LAI) that is defined as the amount of vegetation surface area per m^2 of ground area, or leaf area density (LAD) that is defined as the total one-sided leaf area per unit volume of canopy layer ($\text{m}^2 \text{m}^{-3}$ or $\text{m}^2 \text{m}^{-1}$). The porosity,

pressure drop or drag force can be estimated by studying pollutant dispersion around vegetation. Janhall (2015) provided a detailed explanation on PM dispersion and deposition caused by vegetation. Previous studies have employed different methods to quantify the density of vegetation. Low porosity (high-density) vegetation had a similar effect to solid barriers such as low boundary walls (Gallagher et al., 2012; Gromke et al., 2016; Janhall, 2015; McNabola et al., 2009), which forces the air to flow above and over it, while high porosity (low-density) vegetation allows air to pass through it. The porosity and drag force changes with wind velocity (Gromke and Ruck, 2008; Tiwary et al., 2005). During the high wind speed conditions, a decrease in porosity of broad-leafed trees and drag force on trees were observed by Gromke and Ruck (2008) and Tiwary et al. (2005), respectively. On the other hand, an increase in porosity was noted in conifers and no change in porosity up to a particular threshold value of wind speed (i.e. 0.8–1.7 ms⁻¹) was shown by hedges (Tiwary et al., 2005).

Vegetation parameters have contrasting impacts on local air quality with respect to the surrounding urban geometry. In general, vegetation with gaps and spacing lead to lower concentrations in street canyons as opposed to an increased concentration in open road conditions. Dense (low porosity) vegetation can usually lead to concentration reductions in street canyons. Vegetation species with thick leaves show less deposition as opposed to those with hairs and or waxes (Sæbø et al., 2012). Likewise, urban vegetation with less seasonal variations (i.e. no change in foliage) and lower pollutant (biogenic compounds) emission are preferred. A study by Pandey et al. (2015) suggests an evaluation of air pollution tolerance index of vegetation before planting them in an urban area. In conclusion, the aforementioned vegetation characteristics were covered as a part of this review during the evaluation of vegetation impacts on air quality in different urban built environments.

3. Effect of green infrastructure on air quality in street canyons

Street canyons are a commonly found urban feature and typically consists of buildings along both sides of the road (Kumar et al., 2011; Vardoulakis et al., 2003). Vegetation planted in street canyons are typically part of urban landscaping strategies and are periodically maintained by landscape professionals employed within or on behalf of the local authorities. Green infrastructure in the urban street canyon can be classified as trees and hedges and specific details for both types are discussed in Sections 3.1 and 3.2, respectively.

3.1. Trees in street canyons

Trees are widely employed as an environmental tool to improve urban outdoor climate and are planted and/or managed as part of the urban landscaping in streets, parks, and other common accessible spaces. This section focuses on the impact of tree design characteristics on air quality based on their proximity to traffic emissions sources in a street canyon. There are many examples of trees being placed along the two sides of the street, an avenue style of planting or a single tree stand in the middle (Hofman et al., 2016; Kikuchi et al., 2007; Li et al., 2013). The spacing between trees varies and the physical dimensions change with species (Amorim et al., 2013; Kikuchi et al., 2007). The tree canopy is elevated from ground surface creating a clear area about one or 2 m and thus it is referred as high-level vegetation. On the other hand, hedges and bushes are mentioned as low-level vegetation as these have continuous leaf covering from the ground surface to top. It has been observed that trees can have an adverse effect on air quality within the street canyon (Gromke et al., 2008; Gromke and Ruck, 2007;

Salmond et al., 2013; Vos et al., 2013). Trees can reduce the wind speed in a street canyon, resulting in reduced air exchange between the air above the roof and within the canyon and hence leading to accumulation of pollutants inside the street canyon (Buccolieri et al., 2015, 2009; Gromke et al., 2008; Gromke and Ruck, 2007; Kumar et al., 2008, 2009; Jeanjean et al., 2017). Thus, pollutant concentrations in a street canyon with trees show higher concentrations compared with those without trees. Apart from common vegetation characteristics listed in Section 2, the other unique factors of street canyon and trees that affect pollutant exposure are aspect ratio, wind direction and speed, spacing between trees, distance from pollutant source to trees and the sectional area occupied by trees of the street canyon (Abhijith and Gokhale, 2015; Amorim et al., 2013; Buccolieri et al., 2011; Gromke and Ruck, 2012; Jin et al., 2014; Salmond et al., 2013; Vos et al., 2013). In addition, previous research have introduced parameters such as street tree canopy density (CD) that is defined as the ratio of the projected ground area of tree crowns to the street canyon ground area (Jin et al., 2014), and crown volume fraction (CVF) that is defined as the volume occupied by tree crowns within a street canyon section (Gromke and Blocken, 2015). Key flow patterns and pollutant dispersion in street canyon with and without various vegetation are shown in Fig. 1.

A limited number of field measurement based studies have assessed pollutant exposure in street canyons having trees inside them (Hofman et al., 2016, 2014, 2013; Hofman and Samson, 2014; Jin et al., 2014; Kikuchi et al., 2007; Salmond et al., 2013). Another strand of studies evaluated the impacts of trees on street level pollutant exposure through combined measurement and modelling studies (Amorim et al., 2013; Buccolieri et al., 2011; Hofman et al., 2016). These studies measured air pollutants at one or more locations in street canyons, which were then used for validating the model so that the validated model could yield concentration profiles inside the study area. These validated models also allow 'scenario analysis' by choosing desired locations and vegetation parameters for identifying the least pollution exposure scenario in the study area. As an effective tool, laboratory experiments in a wind tunnel (Gromke and Ruck, 2012, 2009, 2007) as well as dispersion and deposition modelling studies have extensively evaluated pedestrian pollutant exposure to local emissions sources in street canyons with trees (Balczó et al., 2009; Buccolieri et al., 2011, 2009; Gromke et al., 2008; Gromke and Blocken, 2015; Li et al., 2013; Moradpour et al., 2016; Ng and Chau, 2012; Ries and Eichhorn, 2001; Salim et al., 2011a, 2011b; Vos et al., 2013; Vranckx et al., 2015; Wania et al., 2012; Jeanjean et al., 2017). A comprehensive summary of these studies are provided in Supplementary Information, SI, Table S1 and detailed technical detail with key finding are tabulated in SI Table S2.

3.1.1. Effect of wind flow conditions

In general, all the studies summarised in Table 2 and depicted in Fig. 3 reported reduction in wind velocities within the street canyons and an increase in pollutant concentration in street canyons with trees than without the trees (Amorim et al., 2013; Buccolieri et al., 2011; Gromke and Ruck, 2012; Hofman et al., 2016; Jin et al., 2014; Kikuchi et al., 2007; Ries and Eichhorn, 2001; Salmond et al., 2013; Vranckx et al., 2015; Jeanjean et al., 2017). The majority of studies reported an average increase of 20–96% in concentrations of different pollutants due to the presence of trees in street canyons compared with those without the trees (Fig. 3). The presence of trees in street canyon led to reduced pollutant concentrations with an increase in wind velocity under different wind directions (Hofman and Samson, 2014; Wania et al., 2012). Typically, three main wind directions – perpendicular (90°), parallel (aligned, 0°) or oblique (45°) – were investigated in street

Table 2
Classification of street canyon studies based on wind direction and aspect ratio showing the percentage change in pollutant concentration with the presence of trees to tree free (detailed explanation of each study is provided in SI Tables 1, 2 and 3).

Wind direction	Aspect ratio	Pollutant	LAD/Porosity	Changes in concentration with trees to tree free	Studies
Perpendicular 90°	H/W < 0.5	SF ₆	97.5%, 96%	+21 to +41% average +27–105% leeward side –3 to –35% windward side	Buccolieri et al. (2011), Buccolieri et al. (2009), Abhijith and Gokhale (2015) Gromke and Ruck (2012)
		NO-NO ₂ -O ₃ , EC, PM ₁₀ , PM _{2.5} , PM ₁₀	0.2–2 m ² m ⁻³	Increase in concentration	Moradpour et al. (2016), Vos et al. (2013) Wania et al. (2012), Salmond et al. (2013) Jin et al. (2014) Wania et al. (2012)
	0.5 < H/W < 1.5	NO-NO ₂ -O ₃ , CO ₂ , SF ₆ , CO	0.5–4.25 m ² m ⁻³ 97.5%, 96% 0%	+8.92%–6.32% (other seasons) –0.58% (winter) Increase in concentration Increase in concentration +41% to +58% at leeward –37% to –49% at windward +20% to +58% average change	Moradpour et al. (2016), Li et al. (2013), Gromke and Ruck (2012), Salim et al. (2011a), Salim et al. (2011b) Gromke et al. (2008), Gromke and Ruck (2007), Gromke and Ruck (2009), Balczó et al. (2009), Buccolieri et al. (2009), Buccolieri et al. (2011), Ries and Eichhorn (2001), Ng and Chau (2012), Jeanjean et al. (2017)
		H/W > 2	CO	96%	+39% H/W = 2, +17% H/W = 4 Increase in concentration
Oblique 45°	H/W < 0.5	SF ₆ , CO	97.5%, 96%	+2–119% in leeward side	Buccolieri et al. (2011), Amorim et al. (2013), Abhijith and Gokhale (2015), Vos et al. (2013), Wania et al. (2012), Gromke and Ruck (2012)
		EC, NO-NO ₂ -O ₃ , PM ₁₀	0.2–2 m ² m ⁻³	+34–246% in windward side +12% to +146% average	Gromke and Ruck (2012), Buccolieri et al. (2011), Wania et al. (2012)
Parallel 0°	0.5 < H/W < 1.5	SF ₆ , PM ₁₀	97.5%, 96% 0.2–2 m ² m ⁻³	+66% to +91%. Maximum increase than other wind direction	Gromke and Ruck (2012), Buccolieri et al. (2011), Wania et al. (2012)
		NO-NO ₂ -O ₃ , SF ₆ , PM ₁₀	0.2–2 m ² m ⁻³ 97.5%, 96%	+38% average Increase in concentration	Moradpour et al. (2016), Gromke and Ruck (2012), Wania et al. (2012)
	0.5 < H/W < 1.5	CO, NO-NO ₂ -O ₃ , SF ₆ , PM ₁₀	97.5%, 96% 0.2–2 m ² m ⁻³	Decrease in concentration –16% and +40% average	Amorim et al. (2013), Moradpour et al. (2016), Gromke and Ruck (2012), Wania et al. (2012), Jeanjean et al. (2017)
		H/W > 2	NO-NO ₂ -O ₃	0.5–2 m ² m ⁻³	Increase in concentration Increase in concentration

canyon studies with respect to those without the trees. The studies on an isolated street canyon with trees reported higher and lower concentrations along the leeward and windward side of the canyon, respectively, under the perpendicular flow. Under oblique wind and parallel flow conditions, an increase in pollutant levels on both sides was reported along with increasing pollutant concentrations towards the outer end of the canyon (Abhijith and Gokhale, 2015; Buccolieri et al., 2011; Gromke and Ruck, 2012; Wania et al., 2012). Of the three wind directions studied, perpendicular flow is the most commonly investigated (Fig. 3). An oblique wind direction was identified as the worst scenario, resulting in an accumulation of pollutants on both sides of the canyon (Abhijith and Gokhale, 2015; Buccolieri et al., 2011; Gromke and Ruck, 2012).

Some studies also reported conflicting results for pollution distribution in the street canyons. For example, the parallel wind flow showed up to 16% improvement compared to the tree-free scenario, Table 2 (Amorim et al., 2013). Similarly, Jeanjean et al. (2017) observed reduction in pollutant concentration under parallel wind direction. The larger concentrations measured during parallel winds (with respect to the street canyon axis) were due to the channelling effect of pollutants emitted from an intense traffic corridor at the end of the canyon, while lower concentrations under perpendicular winds occurred due to the blockage of polluted air masses entering the street canyon (Hofman and Samson, 2014). Larger concentration changes were observed in street canyons that were aligned with the wind direction than street canyon with perpendicular wind direction (Gromke and Blocken, 2015). Furthermore, the detailed percentage change in pollutant concentration under various aspect ratio and wind direction of all studies considered in this review are given in Fig. 3. These variations account for local conditions, which have a significant impact on pollutant distribution within the street canyon.

3.1.2. Effect of aspect ratio and vegetation characteristics

There is a complex relationship between aspect ratios of street canyons and vegetation characteristics. The aspect ratio significantly affects pollutant dispersion because of alterations in air flow patterns (Zhong et al., 2016). As detailed in Table 2, the ‘street canyon’ investigated by past vegetation studies were mainly regular ($0.5 < H/W < 2$), deep ($H/W \geq 2$) or shallow ($H/W \leq 0.5$) as classified by Vardoulakis et al. (2003). In a vegetation-free street canyon, higher pollutant concentrations were observed for large aspect ratios (Buccolieri et al., 2011; Ng and Chau, 2012); this is mainly due to the reduced wind velocity and pollutant accumulation in deep street canyons. In presence of trees with the same density, higher NO_x concentrations were measured in deep street canyons (Moradpour et al., 2016) than shallow street canyons. The simplest explanation, as reported in the several computational fluid dynamics studies, is that the main mechanism of pollutant removal in the regular street canyon is the primary vortex. In deep street canyons, the primary vortex is split into two and hence makes them less effective in removing in street pollutants with the clean air above.

When considering vegetation characteristics, Janhall (2015) remarked on the ambiguity in choosing LAD or porosity for dispersion and/or deposition among published studies that makes it challenging to directly compare results of various studies. Even though past studies by Balczó et al. (2009) and Gromke (2011) have analysed the relationship between density parameters, there is a need for standardisation in the selection of these parameters in future studies, dealing with the deposition and dispersion. Studies examining the impact of trees in street canyons have considered LAD ranging from 0.2 to 5.12 m² m⁻³ and porosities between 96% and 99% as listed in Table 2. A number of studies noted an increase in pollutant concentrations with an increase in LAD and decrease in porosity due to pollutants accumulation inside the street canyons (Abhijith and Gokhale, 2015; Balczó et al., 2009; Buccolieri et al.,

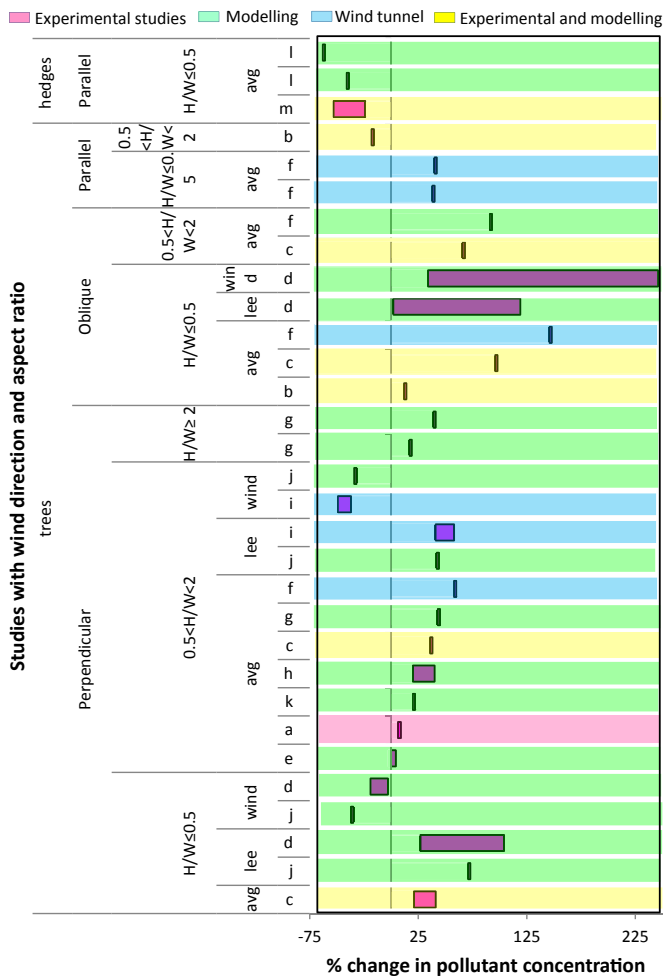


Fig. 3. Figure depicts published percentage change in different pollutant concentration with trees and hedges in street canyon compared to vegetation free scenario. Positive changes denote increase in pollutant concentration and negative change show reduction in pollutant concentration. Please note that bar shown are reported range of pollutant change by studies. The following letters refer to the work from: (a) Jin et al. (2014), (b) Amorim et al. (2013), (c) Buccolieri et al. (2011), (d) Abhijith and Gokhale (2015), (e) Li et al. (2013), (f) Gromke and Ruck (2012), (g) Ng and Chau (2012), (h) Balczó et al. (2009), (i) Gromke and Ruck (2009), (j) Buccolieri et al. (2009), (k) Ries and Eichhorn (2001), (l) Gromke et al. (2016), and (m) Li et al. (2016b).

2009; Gromke et al., 2008; Gromke and Ruck, 2012, 2009; Kikuchi et al., 2007; Salim et al., 2011a, 2011b; Vos et al., 2013; Wania et al., 2012).

While assessing the impact of aspect ratio and vegetation characteristics together, the past studies reported increased pollutant concentrations at street level due to a combined effect of vegetation LAD, aspect ratio and wind direction (Buccolieri et al., 2009; Moradpour et al., 2016). For example, Buccolieri et al. (2011) observed that under perpendicular wind conditions, the concentration increased in a regular street canyon with trees compared with those in the tree-free shallow street canyon. However, for an inclined wind direction, higher concentrations were observed in the shallow street canyon with trees than those in the tree-free regular street canyon. This abnormality was partially clarified by Moradpour et al. (2016). They examined the combination of different vegetation densities and aspect ratios and determined the critical exposure conditions at the breathing height in a street canyon. The denser vegetation resulted in worsening the air quality. The larger regions of higher concentrations were observed in street canyons that have aspect ratios of 0.5, 1.0 and 2.0 with

trees having LADs of 2.0, 1.5 and 1.0, respectively. Further studies assessing the combinations of wind directions, aspect ratios and LADs can provide a better understanding of the relationship between these variables.

Other important vegetation parameters are tree spacing, also known as stand density, and the cross-sectional area covered by them in street canyons. Increasing the spacing between tree crowns and/or lowering their cross-sectional areas can decrease pollutant concentrations in street canyons (Abhijith and Gokhale, 2015; Buccolieri et al., 2009; Gromke and Ruck, 2007; Ng and Chau, 2012). This variation in pollutant concentrations with tree spacing was found to be predominant in shallow street canyons than that in deeper canyons (Ng and Chau, 2012). Similarly, a numerical investigation showed a slight increase (1%) in pollutant concentration per unit percentage increase in CVF (Gromke and Blocken, 2015).

Different kinds of trees such as deciduous and evergreen produced seasonal changes in pollutant exposure in street canyon. During the summer seasons, pollutants were trapped in street canyon with deciduous trees, however, in winter, higher pollutant concentration was found in street canyon with evergreen trees (Jin et al., 2014; Salmond et al., 2013). Non-foliated deciduous trees had no effect on pollutant concentration during the winter season (Jin et al., 2014; Salmond et al., 2013). Similar to seasonal variations, Vranckx et al. (2015) simulated annual average changes in concentration in a shallow street canyon having trees under a variety of wind directions in a street canyon in Antwerp (Belgium). This study analysed deposition and dispersion of elemental carbon (EC) and PM₁₀ under different LADs, deposition speed (V_d) and drag coefficients (C_d). The reported annual average change ranged from 0.2 to 2.26% for PM₁₀ and 1–13% for EC. The presences of trees caused a lesser increase in PM₁₀ concentrations in comparison to EC and NO₂ (Vos et al., 2013), with the similar observation made for EC in a study by Vranckx et al. (2015).

3.2. Hedges in street canyons

Hedges or hedgerows consist of shrubs and bushes which grow less in size compared to trees and they are typically located at ground level, therefore typically representing the closest type of green infrastructure that exists to local emissions sources in an urban street canyon. Therefore, their performance for improving air quality is dominated by its ability to remove local sources of emissions and this is reflected in the results. They are usually planted along boundaries to serve as fencing or a living boundary wall. The shape of the hedgerows is commonly well maintained to a cuboidal or the other definite shapes (such as cuboidal bottom and spherical top) in the heavily built-up areas. Whereas, these may be allowed to grow with less pruning and maintenance along the sides of major highways. These low-level vegetation are usually a mixture of shrubs and other small vegetation. Hedges have comparatively less height and thickness than trees but possess higher leaf density.

Similar to trees in street canyons, hedges are planted along the streets in various configurations. Only a few studies examined the air pollution reduction potential of hedges in street canyon (Chen et al., 2015; Gromke et al., 2016; Li et al., 2016b; Vos et al., 2013; Wania et al., 2012). Key findings are provided in Table 3 and further detailed summaries are documented in SI Table S4. Three of these studies observed that hedges reduced pollutant exposure by 24–61% at the footpath areas in street canyons (Fig. 3). However, Vos et al. (2013) reported an increase in pollutant concentration with the presence of hedges in street canyons. Although, the study stated that it mainly focused on the general trend in pollutant concentrations with multiple vegetation scenarios in a built-up

Table 3
Summary of studies on air pollution impact of hedges in street canyon.

Study Location Methodology Climatic condition Pollutant	Street canyon H/W Wind direction Wind speed (m/s)	Dimensions (m)	Density- (LAD m ² m ⁻³ , Porosity %)	Key findings
Gromke et al. (2016) Modelling Fluent SF ₆	0.5 90° and 0° 4.65	Height 1.5 and 2.5 Width 1.5	Pressure loss coefficients-(permeability) 1.67 m ⁻¹ and 3.34 m ⁻¹	<ul style="list-style-type: none"> Hedgerows resulted in reduction of concentration Higher and less permeable hedge had more reduction in concentration Central single hedge was more effective in pollutant reduction than sidewise hedge Discontinues hedgerow (9 m spacing) showed the least reduction In parallel wind hedge on both sides showed improvement in air quality than a central hedge. Maximum area averaged pollutant reduction by Single centre hedge = 61% & Hedge on both side = 39% Measurement showed improvement with air quality with hedges Optimum heights for vegetation barriers are <ul style="list-style-type: none"> – 1.1 m and 2 m for H/W = 0.4 with maximum reduction at 2 m – 0.9–2.5 m for H/W = 0.18 with maximum reduction at 2 m – 1.1 m and 2 m for H/W = 0.78 with maximum reduction at 1.1 m Change in wind velocity has no effect on optimum vegetation height Experimental study showed concentration reduction of 53%, to 27% at 1.4 m & 36 to 24% at 1.6 m Hedge deteriorate air quality in street canyon When LAD increased concentration was increased.
Li et al. (2016b) Measurement and Modelling Fluent, Shanghai China-Mild monsoon Mean temperature 35 °C, mean RH 60% CO	0.4, 0.18, 0.78 90° 1, 2, 3, 20	Height 0.5, 0.9, 1.1, 1.5, 2.0, 2.5, 3.0, and 4.0 Width 1.5	0%	<ul style="list-style-type: none"> Measurement showed improvement with air quality with hedges Optimum heights for vegetation barriers are <ul style="list-style-type: none"> – 1.1 m and 2 m for H/W = 0.4 with maximum reduction at 2 m – 0.9–2.5 m for H/W = 0.18 with maximum reduction at 2 m – 1.1 m and 2 m for H/W = 0.78 with maximum reduction at 1.1 m Change in wind velocity has no effect on optimum vegetation height Experimental study showed concentration reduction of 53%, to 27% at 1.4 m & 36 to 24% at 1.6 m Hedge deteriorate air quality in street canyon When LAD increased concentration was increased.
Vos et al. (2013) Modelling ENVI-met PM ₁₀ , elemental carbon (EC) NO-NO ₂ -O ₃ .	0.35 45° and 90° 3	Height 1, 3,4 Width 1	2 & 5 m ² m ⁻³	<ul style="list-style-type: none"> Measurement showed improvement with air quality with hedges Optimum heights for vegetation barriers are <ul style="list-style-type: none"> – 1.1 m and 2 m for H/W = 0.4 with maximum reduction at 2 m – 0.9–2.5 m for H/W = 0.18 with maximum reduction at 2 m – 1.1 m and 2 m for H/W = 0.78 with maximum reduction at 1.1 m Change in wind velocity has no effect on optimum vegetation height Experimental study showed concentration reduction of 53%, to 27% at 1.4 m & 36 to 24% at 1.6 m Hedge deteriorate air quality in street canyon When LAD increased concentration was increased.
Wania et al. (2012) Modelling ENVI-met PM ₁₀ .	0.5,0.9, 1.2 0°, 45° and 90° 1, 3	Height 1.5	2.0 m ² m ⁻³	<ul style="list-style-type: none"> Measurement showed improvement with air quality with hedges Optimum heights for vegetation barriers are <ul style="list-style-type: none"> – 1.1 m and 2 m for H/W = 0.4 with maximum reduction at 2 m – 0.9–2.5 m for H/W = 0.18 with maximum reduction at 2 m – 1.1 m and 2 m for H/W = 0.78 with maximum reduction at 1.1 m Change in wind velocity has no effect on optimum vegetation height Experimental study showed concentration reduction of 53%, to 27% at 1.4 m & 36 to 24% at 1.6 m Hedge deteriorate air quality in street canyon When LAD increased concentration was increased.

environment. Hence, the above observation should be generalised cautiously by considering them as an outcome of an individual scenario.

Matching to the effect of trees on wind velocity in street canyons, hedges were found to reduce wind velocity with-in street canyon (Gromke et al., 2016; Li et al., 2016a, 2016b; Wania et al., 2012) but the effects on the wind velocity were lesser than trees (Wania et al., 2012). Hedges diverted air pollutant from reaching footpath area by generating local vortices (Gromke et al., 2016; Li et al., 2016b). Low permeable and higher (2.5 m) hedges showed more pollutant reduction at the footpath area. While a central single hedgerow (in the middle of the street canyon) showed maximum concentration reduction in street canyon compared to hedgerows along both sides of roads (Gromke et al., 2016). The optimum height of a hedge was obtained through simulation by assessing its sensitivity to wind velocity and aspect ratio of street canyons (Li et al., 2016b). This resulted in an optimum height between 1 and 2 m in both shallow as well as regular street canyons. Maximum pollutant reduction occurred at breathing height along the foot path of two shallow street canyons ($H/W = 0.18$ and 0.4) with a hedge of 2 m height. Likewise, maximum pollutant reduction observed in the regular street canyon ($H/W = 0.78$) with a hedge of 1.1 m height. Gromke et al. (2016) observed a maximum reduction in pollutant concentration in the shallow street canyon with a hedge of 2.5 m height. The above studies suggest an optimum height of hedges in shallow street canyons to be about 2 m but further studies under different street aspect ratios are warranted to generalise the hedge heights.

4. Effect of green infrastructure on air quality in open roads

An open road is an urban built environment feature in which both sides of the traffic corridor are open with generally detached,

single or multi-story buildings and other manmade structures. In open road conditions, trees as well as other vegetation such as hedges, shrubs and bushes, are planted or occur naturally along one or both sides of these corridors, and are referred to as 'vegetation barriers' or 'green belts' (Brantley et al., 2014; Chen et al., 2015; Islam et al., 2012; Morakinyo and Lam, 2016). These green belts offer a number of additional benefits including heat island mitigation, water runoff control and for aesthetic purposes (Escobedo et al., 2011). The role of vegetation barriers along open roads is examined in more detail in subsequent sections.

4.1. Vegetation barriers

In open roads conditions, vegetation can act differently than in street canyons. Nevertheless, rows of planted trees and other vegetation types provide a barrier between the road and population groups in adjacent residential areas, similar to that observed in a street canyon environment. This barrier effect leads to an accumulation of pollutant concentrations on the windward or upwind side of the vegetation, for example as observed in front of a hedge by Al-Dabbous and Kumar (2014). Vegetation barriers force polluted air to flow either over or to pass through the vegetation, and this is dependent upon porosity and physical dimensions (Tong et al., 2016). Low density (high porosity) vegetation results in the majority of air flowing through the barrier, whereas high density (lower porosity) leads to little or no infiltration, similar to the behaviour evident around solid barriers like low boundary walls (Baldauf et al., 2008; Bowker et al., 2007; Brantley et al., 2014). Downwind of vegetation barriers i.e. behind the vegetation, a wake zone is created and pollutant concentrations decrease with increasing distance from the road. The formation and extension of a wake zone, pollutant concentration profile before and after vegetation, and pollutant deposition and dispersion within the barrier

are controlled by wind direction and speed, position of vegetation, physical characteristic of the green belt (such as thickness, height and porosity), temperature, relative humidity, and the physical characteristics of leaves (Baldauf, 2017). A graphical representation of flow and pollutant dispersion patterns in open-road conditions are depicted in Fig. 2. In addition to the vegetation parameters described in the previous section, some studies considered shelterbelt porosity, which is the ratio of perforated area to the total surface area exposed to the wind (Islam et al., 2012), and is defined as the fraction of light that vertically penetrates tree cover for a given section (Yin et al., 2011).

In contrast to street canyon investigations, most green infrastructure studies examining pollution exposure in open road environments followed an experimental approach (Al-Dabbous and Kumar, 2014; Brantley et al., 2014; Chen et al., 2015, 2016; Fantozzi et al., 2015; Grundström and Pleijel, 2014; Hagler et al., 2012; Islam et al., 2012; Lin et al., 2016; Shan et al., 2007; Tiwary et al., 2008; Tong et al., 2016, 2015). In these cases, the source of emissions is predominantly linked to the adjacent roadway. However, in comparison to an urban street canyon environment, the contribution of background concentrations represent a lesser fraction of localised air pollution in these scenarios. A small number of studies either combined measurement and modelling (Morakinyo et al., 2016; Tiwary et al., 2005) or solely employed a modelling methodology (Morakinyo and Lam, 2016, 2015; Neft et al., 2016; Tiwary et al., 2005). A comprehensive summary of vegetation effects in open-road conditions and detailed technical features with key findings are given in SI Tables S5 and S6, respectively. The literature provided a number of examples of the positive effect of trees and bushes on air quality i.e. reducing pollutant concentrations at the street scale (Al-Dabbous and Kumar, 2014; Brantley et al., 2014; Chen et al., 2015; Islam et al., 2012; Lin et al., 2016; Shan et al., 2007; Tiwary et al., 2008, 2005; Tong et al., 2016), with some cases having mixed and limited effects (Chen et al., 2016; Fantozzi et al., 2015; Grundström and Pleijel, 2014; Hagler et al., 2012), or negative effects (Morakinyo et al., 2016; Tong et al., 2015) with details shown in Table 4. As shown in Fig. 4, the majority of the studies reported reductions in concentrations of between 15% and 60% for various pollutants with vegetation barriers along open roads. Most of the field measurement studies comparing downwind concentrations with and without the vegetation include background levels as part of their measurements. However, this is usually not the case with most of the modelling/wind tunnel studies that only account for the traffic emissions. Recently, Baldauf (2017) detailed the physical characteristics of vegetation barriers that influence air quality results, some of which are discussed in further details in the following sections.

4.1.1. Effect of thickness and density of green belt on air quality

The thickness and density of a green belt is a predominant physical characteristic that can alter near-road pollution exposure (Islam et al., 2012; Morakinyo and Lam, 2015; Neft et al., 2016; Shan et al., 2007). An increase in the thickness of a vegetation barrier can result in a direct reduction of pollutant concentrations (Neft et al., 2016; Tong et al., 2016), with a linear correlation to increasing filtration efficiency (Neft et al., 2016). Morakinyo and Lam (2016) reported pollutant removal/reduction from hedges can be positive or negative and it is not uniform across height and length from the barrier. Supporting this, Hagler et al. (2012) observed lower, higher and similar concentrations behind vegetation barriers when compared to open areas, as well as Lin et al. (2016) reporting differences in concentrations at different heights, with these variations in results due to irregular density characteristics along the length of the vegetation barriers examined. Morakinyo and Lam

(2016, 2015) proposed the need for design in locating hedges and the selection of a suitable thickness for these barriers, recommending the distance between the source and plume's maximum concentration (DMC) and placing tree rows or vegetation barriers close to the source or behind the DMC, ensuring sufficient thickness to cover the DMC and a height close to plume height. Similarly, studies by Islam et al. (2012) and Neft et al. (2016) recommended a minimum vegetation thickness of 5 m and 10 m to remove approximately 50% of total suspended particles (TSP) and nanoparticles (20 nm), respectively. In addition, Shan et al. (2007) recommended a minimum thickness of 5 m and an optimum thickness of 10 m for a minimum removal rate of 50% for TSP. Islam et al. (2012) proposed a structure of green belts in which hedges or smaller shrubs were placed in front and trees behind to improve TSP removal. The limited number of studies on this topic suggest that further investigation of the relationship between vegetation characteristics and emissions intensity is necessary prior to proposing practical recommendations on the thickness of a selected vegetation barrier to achieving specified desirable pollutant concentration reductions.

Densities of vegetation belts are commonly expressed in terms of LAD, canopy density (CD), and shelterbelt porosity. Canopy density is defined as the ratio between the projected area of the canopy and the total ground area of the green belt/forest. Pollutant removal improved with an increase in CD and LAD and decreased with an increase in shelter belt porosity (Chen et al., 2016; Islam et al., 2012; Shan et al., 2007; Tong et al., 2016), yet reductions in pollutant concentration were non-linear with respect to LAD (Steffens et al., 2012; Tong et al., 2016). An optimum CD of 70–85% was recommended for 50% or more TSP reduction and for maintaining a healthy green belt (Shan et al., 2007). Optimum shelter belt porosity proposed by studies were 20–40% and 10–20% for TSP and PM₁₀ respectively (Chen et al., 2016; Islam et al., 2012). Shan et al. (2007) observed that shelter belt porosity of less than 25%, the percentage of TSP removal was stable, recommending an optimum shelter belt porosity of 25–33% for 50% or more TSP removal. Increasing the canopy density over 85% and the shelter belt porosity over 40% resulted in a decrease or no change in pollutant removal as the vegetation was no longer acting as a permeable structure, and more like a solid barrier (Islam et al., 2012; Shan et al., 2007).

4.1.2. Effect of meteorological and climatic factors on air quality

Meteorological factors such as humidity, wind speed, wind direction and temperature are also known to affect neighbourhood air quality near open roads. The past studies revealed that the highest impact on PM₁₀ removal was exerted by relative humidity, followed by the wind speed and the least by temperature (Chen et al., 2015). Similarly, Fantozzi et al. (2015) observed high NO₂ concentrations with high relative humidity and low temperature. This indicates the important role of relative humidity in local air pollutant exposure analysis. Studies observed an increase in pollutant concentration with an increase in speed (Brantley et al., 2014; Morakinyo et al., 2016). Studies that examine wind direction have predominantly focused on assessing downwind pollutant concentrations in perpendicular wind conditions, with results suggesting that the greatest reductions occur behind the vegetation barriers for this wind direction (Brantley et al., 2014).

In addition to meteorological factors, seasonal variations and different climates impact the role of vegetation belts on pollutant exposure (Fantozzi et al., 2015; Grundström and Pleijel, 2014; Shan et al., 2007). Seasonal variations in pollutant concentration were captured through field assessments, with trees presenting the greatest improvement in air quality in summer (Fantozzi et al., 2015; Islam et al., 2012; Shan et al., 2007). Deciduous trees had

Table 4

Classification of studies investigated vegetation barrier in open road condition (detailed explanation of each study is provided in SI Tables 5 and 6).

Pollutant	Vegetation characteristics			changes in pollutant concentration compared to vegetation free condition	Studies
	Dimensions (m)	Type	Density ((LAI, LAD, Porosity, CD, shutter belt porosity)		
UFP	–	–	LAD 1–5 m ² m ⁻³	Filtration efficiency increases with a thickness linearly	Neft et al. (2016)
	Height 6, 9, Width 6, 12, 18, Height 4–8., Width 2–6.	Coniferous and evergreen tree	LAD 0.33, 1, 1.15 m ² /m ³	Reduction behind vegetation barrier	Tong et al. (2016)
	Height 3.4 Width 2.2 Height 6–8	Mixed vegetation	LAI (fall) 3–3.3, LAI (winter) 1–2.8	37.7–63.6% reduction in pollutant concentration behind barriers	Lin et al. (2016)
	Height 3.4 Width 2.2 Height 6–8	Coniferous plants	–	reduction in PNC at footpath at 1.6 m height was 77% –180° wind, 70%– 0° wind, 37%– 90° wind	Al-Dabbous and Kumar (2014)
	Height 6.1–7.2 Width 3.6–4.5	Evergreen tree stand	LAD 3.3 m ² /m ³	Increase in LAD reduces concentration	Steffens et al. (2012)
PM _{2.5}	Height 6.1–7.2 Width 3.6–4.5	Evergreen and deciduous tree stands	LAI 3–3.3 fall LAI 1–2.8 winter	Behind barrier, UFP concentrations were found to be lower, higher or nearly same as of open area	Hagler et al. (2012)
	Height 0.3,11,12, Width 1, Length 25,53	Mixed vegetation	Canopy Density CD = 0.7,0.9	Increase as well as decrease in concentration observed	Chen et al. (2016)
	–	–	Porosity 15.7%, 9.8%,21.9% (Derived photographic methods)	Concentration was higher downwind of trees than open fields	Tong et al. (2015)
	Height 1.5, 2, 3, 4, Width 1, 2, 3, 7.5 Length 20 Height 2, 4 Width 1, 2 Length 25, 20	Conifers vegetation barrier	LAD 2 m ² /m ³	The higher volume of vegetation barrier can increase filtration or collection of particulates	Morakinyo and Lam (2016)
PM ₁₀	Height 2, 3 Thickness 1, 8 Length 20 Width 2.5–3.5 Height 2.2 Width 1.6	–	LAD 2 m ² /m ³	Higher concentration was observed behind hedges. The increase of 25% and ~18% for perpendicular and oblique wind, ~80% and 40% with strong and calm parallel wind. Behind barrier, UFP concentrations were found to be lower, higher or nearly same as of open area	Morakinyo and Lam (2015)
	Height 1.7, 2.2, 2.4 Width 1.6, 1.7, 3.2	Hawthorn hedge	CD 65–91%	Reduction of 7%–15% 34% reduction in pollutant concentration was observed	Chen et al. (2015) Tiwary et al. (2008)
PM	Height 1.7, 2.2, 2.4 Width 1.6, 1.7, 3.2	Hawthorn, Holly, yew	–	Hawthorn- 66.2% and 83.5%, Holly- 58.3% and 76.1% Yew –17.5% and 20.5%,	Tiwary et al. (2005)
TSP	Height 0.3–12, Width 1.7–15, Length 20 -53	Mixed coniferous and evergreen vegetation	Shelter belt porosity 4–44%, CD 51–90%	Reduction in concentration behind vegetation barrier, maximum removal occurred in summer	Islam et al. (2012) Shan et al. (2007) Chen et al. (2016)
Black Carbon	Height 10, Length 5–78	Mixed vegetation	LAI 2.6 to 4.7	Reduction of 45–93% Reductions:12.4% 90° winds, 7.8% 0° winds, 22% maximum	Brantley et al. (2014)
CO	Height 4–8, Width 2–6	Mixed vegetation	LAI (fall) 3–3.3, LAI (winter) 1–2.8	23.6–56.1% reduction in pollutant concentration behind barriers	Lin et al. (2016)
NO ₂ -O ₃	–	Evergreen	–	NO ₂ removal rate 14–25% in January (highest concentration period), 35–59% in July (lowest concentration period)	Fantozzi et al. (2015)
	Height 8–10 m	Mixed deciduous trees	–	O ₃ concentration was higher in all conditions 7% reduction in concentration of NO ₂ within canopy 2% reduction of concentration of O ₃ (negligible)	Grundström and Pleijel (2014)

no effect on PM removal in winter, with similar concentration measured in open areas with no trees (Hagler et al., 2012; Lin et al., 2016). Evergreen trees are commonly planted along open roads to promote pollutant reductions in all seasons (Baldauf et al., 2013; Islam et al., 2012; Shan et al., 2007). When it comes to climatic zone, warmer climatic regions such as China, Bangladesh and Italy (evidence in SI Tables S5 and S6) showed significant reduction in pollutant concentrations with vegetation barriers (Chen et al., 2015, 2016; Fantozzi et al., 2015; Islam et al., 2012), while cooler climatic regions such as Sweden and Finland showed limited or no change in pollutant concentration with vegetation (Grundström and Pleijel, 2014; Setälä et al., 2013). No particular explanation for these differences was provided in these studies and warrant further investigations, therefore further research is required in future investigations to support recommendations for the role of green infrastructures in air pollution abatement.

Chen et al. (2016) observed that grass was ineffective in

capturing PM_{2.5} in comparison to trees and shrubs. Significant deposition of PM on herbaceous plants was measured along open roads with different traffic intensities in Berlin (Weber et al., 2014). The study observed that the rate of deposition on plant leaves depended on the intensity of traffic emissions, leaf characteristics and plant height.

5. Vegetation on building envelopes as a passive air pollution control measure

Green walls and green roofs are developed as sustainable building strategies which can increase vegetation cover in built up areas without consuming space at street level. These green infrastructure types were introduced for aesthetics purposes, but nowadays they are maintained and improved to create a sustainable urban environment. Green walls and roofs contribute to passive energy savings, reductions in ambient temperature and

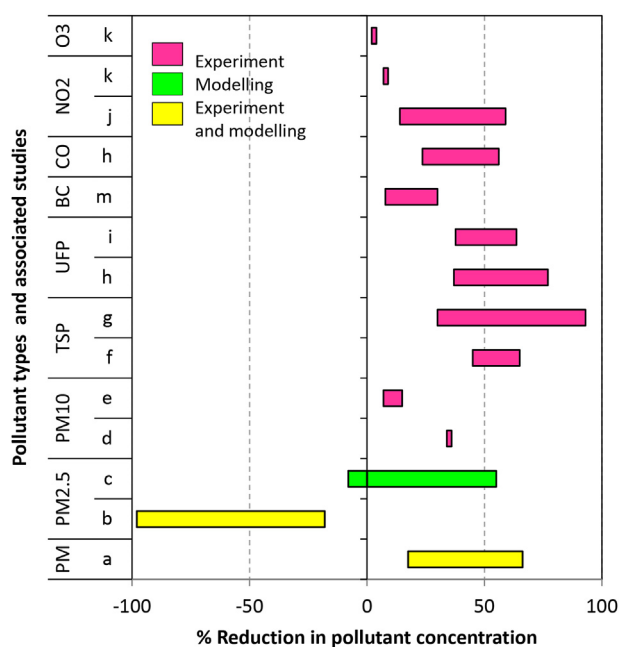


Fig. 4. Figure shows published percentage reduction in different pollutant concentration with vegetation barrier in Open road situations to the vegetation barrier free condition. The bars depict reported range of pollutant reduction by respective studies. The following letters refer to the work from a) Tiwary et al. (2005) (b) Morakinyo et al. (2016), c), Morakinyo and Lam (2016), d) Tiwary et al. (2008), e), Chen et al. (2015), f) Islam et al. (2012), g) Shan et al. (2007), h) Lin et al. (2016), i) Al-Dabbous and Kumar (2014), j) Fantozzi et al. (2015), k) Grundström and Pleijel (2014), m), Brantley et al. (2014).

mitigating the urban heat island effect, storm water management, air pollution mitigation, noise reduction and urban biodiversity (Berardi et al., 2014; Hunter et al., 2014; Manso and Castro-Gomes, 2015; Pérez et al., 2014, 2011; Vijayaraghavan, 2016). Previous studies mainly focused on thermal performances and energy savings of green walls and green roofs. However, unlike other green infrastructures such as trees and hedges, these forms of vegetation are directly attached to building surfaces and have not been considered as a measure of air pollution abatement.

5.1. Green walls

Green walls are vegetated vertical surfaces where plants are attached to the surface through various mechanisms. Green walls are broadly classified as 'green facades' or 'living wall'. Green facades are created by directly attaching hanging pots or shrubs to the wall (direct green façade), or attached the plants to the wall using special supporting features such as cables, ropes, mesh and modular trellises (indirect green facades or double skinned green facades). Living walls are created by attaching growing media to the vertical wall, and this relatively new technique is classified as 'continuous living walls' or 'modular living walls' (Manso and Castro-Gomes, 2015; Pérez et al., 2014, 2011; Susorova, 2015). A schematic representation of how green walls impact air flow and pollutant dispersion in street canyon and open road environments are shown in Figs. 1d and 2d, respectively. Green walls can improve air quality and improve air quality from both local emission sources and background concentrations, depending on the contribution each source of pollution.

Limited studies have assessed the reduction of air pollution due to green walls at a local scale in the built environment, but these studies have recognised the potential capabilities of pollution

removal (Joshi and Ghosh, 2014; Ottel el et al., 2010; Sternberg et al., 2010). Litschike and Kuttler (2008) recommended green walls as one of the planting concepts to reduce particulates through deposition without altering air exchange between the street canyon and air above it. Detailed summaries and important observations are listed in SI Table S7. Pollutant reduction along with a footpath in open roads (Morakinyo et al., 2016; Tong et al., 2016) and in a street canyon (Pugh et al., 2012) have been presented in research findings. Moreover, other studies on green walls reported effective collection of pollutants by the vegetation on the green wall (Joshi and Ghosh, 2014; Ottel el et al., 2010; Sternberg et al., 2010). Fig. 5a presents the results from published studies on green walls relating to pollutant concentrations. A city scale study showed significant improvement in air quality with the green wall (Jayasooriya et al., 2016), but reductions were not as substantial as the impact of trees (Jayasooriya et al., 2016; Tong et al., 2016). In open road conditions, a green wall resulted in dispersion patterns similar to the solid wall as a high concentration region in front of barrier (on road) and reduction behind the green wall (Morakinyo et al., 2016; Tong et al., 2016). In addition, vegetation cover on the wall removed pollutants through deposition (Joshi and Ghosh, 2014; Morakinyo et al., 2016; Tong et al., 2016). In a street canyon environment, green wall improved air quality in different street canyon aspect ratios ($H/W = 1$ and 2), with reductions of up to 35% for NO_2 concentration and 50% in PM_{10} concentration (Pugh et al., 2012). Common climbing plants such as ivy (UK) and Lianas species (in China) were found suitable for the green wall (Chen et al., 2016; Ottel el et al., 2010; Sternberg et al., 2010). The removal potential of pollutants using a green wall was shown to be influenced by street canyon geometry, wind speed, humidity and LAI (Joshi and Ghosh, 2014; Pugh et al., 2012). No variations in particle depositions were observed at different heights of the green wall near a traffic corridor (Ottel el et al., 2010). A study by Pandey et al. (2014) suggests that air pollution tolerance should be measured prior to selecting species for the green wall. These observations were made based on limited previous research, and further investigations are required to produce recommendations for determining the role of green walls on air quality.

5.2. Green roofs

A green roof is a vegetation planted on the roof of a building. Plants are cultivated on a growth media prior to being placed on the building rooftop and can consists of diverse vegetation, from mosses to small trees, growing substrate, filter and drainage material, root barrier, and insulation (Vijayaraghavan, 2016). These are classified as extensive, semi-intensive and intensive green roofs (Berardi et al., 2014; Vijayaraghavan, 2016). The location of this green infrastructure measure suggests that it may improve air quality by reducing pollutant concentrations from local emissions sources as well as background contributions. The most commonly adopted system is an extensive system which has a thin substrate layer with smaller plants such as grasses and mosses, due to its low capital cost, low weight and minimal maintenance. Whereas an intensive system requires high maintenance because of the thick substrate layer, which accommodates larger plants such as small trees, and this required more investment. A semi-intensive system is a hybrid option with a moderate substrate, maintenance, and capital cost. A typical green roof on a building in street canyon is showed in Fig. 1d. Green roofs help reducing energy consumption, managing runoff water, mitigating the urban heat island effect, air pollution mitigation and noise pollution and enhance ecological preservation (Berardi et al., 2014; Castleton et al., 2010; Czemi el Berndtsson, 2010; Oberndorfer et al., 2007; Saadatian et al., 2013; Vijayaraghavan, 2016).

Despite a number of studies examining various aspects of green

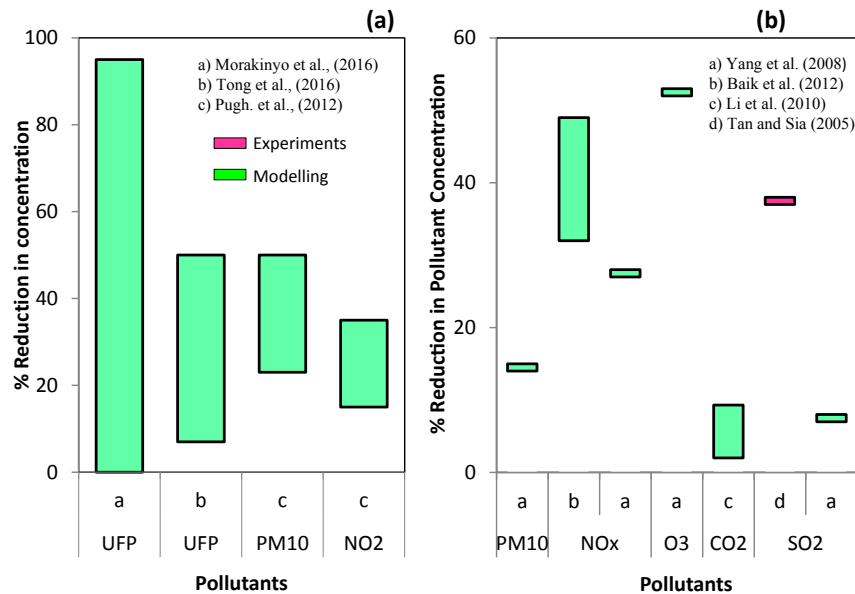


Fig. 5. Published percentage reduction in pollutant concentration with (a) green walls to green wall free case and (b) green roof to green roof free case. Bars show the reported range of reduction by respective studies.

roof, limited research has been emphasised on air quality improvement capabilities of green roofs (Baik et al., 2012; Berardi et al., 2014; Currie and Bass, 2008; Li et al., 2010; Rowe, 2011; Speak et al., 2012; Tan and Sia, 2005; Yang et al., 2008). Most studies noted significant pollutant removal by green roofs, despite being inferior to trees at both local scale (Speak et al., 2012) and city scale (Currie and Bass, 2008; Jeanjean et al., 2015). Low surface roughness and distance away from pollutant source were found as reasons for its lower impact (Speak et al., 2012). Detailed information on previous studies and their observations are given in SI Table S8. The cooling effect of a green roof and its impact on air quality in street canyons demonstrated a potential 32% reduction in pollutant concentrations with 2 °C cooling intensity at breathing level, due to enhanced canyon vortices and higher vertical dispersion arising from downward moving cool air (Baik et al., 2012). In comparison, Pugh, et al. (2012) recorded marginal pollutant removal by a green roof with no recognition of the associated cooling effect. Roofs near a traffic corridor exhibited a significant improvement of air quality (Speak et al., 2012) and the quantity of fine particles (less than 0.56 μm) emitted from vehicle sources decreased by 24% (Tan and Sia, 2005). The results for pollutant concentration reductions for studies with green roofs are summarised in Fig. 5b. The removal rate of green roofs is influenced by wind conditions, seasonal variations, plant characteristics and species, and green roof location (Currie and Bass, 2008; Li et al., 2010; Speak et al., 2012; Yang et al., 2008). Intensive green roofs can further increase pollutant removal (Currie and Bass, 2008; Yang et al., 2008). Green roofs have potential to be used as a method of air pollution abatement in combination with green walls.

6. Combination of green infrastructure with solid/nonporous (passive) objects

Solid passive methods such as noise barriers, low boundary walls, and parked cars can improve local air quality and detailed strengths and limitations of these physical interventions are reported in a comprehensive review by Gallagher et al. (2015). However, the combined effect of solid passive methods and vegetation on neighbourhood air quality is something that has only

received limited attention (Abhijith and Gokhale, 2015; Baldauf et al., 2008; Bowker et al., 2007; Tong et al., 2016). Furthermore, the combination of these interventions is realistic of what is evident in the urban environment. In research findings to date, the combination of these air pollution control measures improves pollutant dispersion characteristics for better air quality at local scales when compared to that obtained with individual interventions.

Some arrangements of passive methods complemented one another in reducing pollutant exposure than individual reductions. A modelling study by Bowker et al. (2007) observed a combination of trees and solid noise barriers resulted in enhanced dispersion leading to reduced pollutant concentration in downwind locations. Similarly, trees with a noise barrier caused additional mixing and turbulence, as well as filtering of airborne particles by trees, leading to consistent concentration reductions. As reported by Baldauf et al. (2008), CO and PM concentrations were reduced immediately behind a solid noise barrier and vegetation along an open road, in comparison to the case of no inclusion of vegetation, both scenarios providing better downwind air quality than no noise and/or vegetation barriers. The lowest PM number concentrations were observed behind the noise barrier with trees along the entire distance measured from the road. These studies demonstrate the role of additional green infrastructure to promote deposition in conjunction with dispersion of localised emissions. Combining trees with on-street car parking demonstrated how the combination of interventions had a greater impact on air quality than the vegetation only case (Abhijith and Gokhale, 2015), and smaller trees with spacing and high porosity combined with parallel parking reduced pedestrian exposure in parallel and perpendicular winds (Gallagher et al., 2013, 2011). An arrangement of trees on the windward side of the street, in combination with perpendicular car parking, improved air quality in oblique wind conditions (which is considered to be most polluted wind direction; Section 3.1). The combination of parked cars and trees presented the best air quality improvements for local source emissions. However, it is dependent on a combination of tree porosity, parking bay and local wind characteristics. For example, oblique car parking systems with trees showed an increase in pollutant concentration in street canyon

(Abhijith and Gokhale, 2015). Vegetation-solid wall combinations were also examined for multiple near-road conditions using modelling by Tong et al. (2016). The study identified that the largest pollutant reductions occurred when a solid wall and vegetation barrier were combined.

The findings indicate that special arrangements for combining vegetation and solid passive methods could provide lower pollutant exposure in both street canyon and open road conditions. Further real-world studies are needed for validation and practical application of outcomes.

7. From measurements, modelling and experiments to delivering policy change

The current status of research relating to the performance of green infrastructure on air quality presents a strong indication of its potential to mitigate pollution and has identified existing gaps in knowledge that still need to be addressed. However, transferring the findings of existing and future research into proposed generic recommendations is presented as the next milestone in this field.

Firstly, the findings from previous measurement studies have demonstrated the potential of green infrastructure for reducing personal exposure in street canyons and open roads under real world conditions. However, these studies have been restricted by their inability to directly compare precisely the same environment with and without green infrastructure, due to the timeframe required to implement mature trees, hedgerows or green roofs or walls in the same location. Therefore modelling and wind-tunnel experiments have been adopted and current findings originate from these studies as they allow for this comparison. However, their ability to replicate complex real-world meteorological conditions and traffic flow characteristics may provide uncertainty in these findings. In terms of developing recommendations, the use of modelling and experimental work can provide a strong indicator as to the expected performance of urban vegetation to affect local air quality, but validation of these findings are required from the data collected from previous measurement studies.

Secondly, the future for this research topic needs a focus on collating additional results from measurement studies in different meteorological and geometrical configurations. It also needs to encourage the openness of raw data from these studies to allow researchers using modelling and experiments to validate their findings. The development of generic recommendations requires a combined approach of each of these methods, as street canyon and open road environments are complex and subject to change. Therefore, the reach of measurement studies is constrained by budgets, while the ability of modelling tools can extrapolate findings for different climates and environments. The use of green infrastructure can play a part in responsive solutions to air pollution, and be more than aesthetic and cultural benefits.

There is a level of uncertainty in modelling and experimental results that does not exist in measurement studies, and this can only be addressed through further research. It also highlights the importance of this study and the synthesis of existing findings, to direct the next steps for green infrastructure research in terms of providing future guidance through generic recommendations to improve air quality in the urban environment.

8. Summary, conclusions and future outlook

Available studies on the air quality impacts of vegetation placed in street canyons, open roads, and building envelopes were reviewed. The whole process of assessments was focused on understanding how air quality is affected by different types of vegetation under specific urban environments. This review analysed

and listed factors affecting air quality such as urban morphology, meteorological conditions, vegetation characteristics, and observed both favourable and critical air pollution scenarios created by them. The common vegetation characteristics influencing neighbourhood air quality were discussed. Local scale pollutant exposure alterations made by street trees and hedges were recorded. Likewise, air quality changes due to green belts in open road conditions and vegetation on building envelopes such as green roofs and green walls were reviewed. The study focused on changes in pollutant concentration made by urban vegetation so that emerging findings can be used by urban planners for practical application. In addition, areas with a deficit in our knowledge or requiring further evidence are also identified for consideration by future studies to advance this research field.

The key conclusions arising are as follows:

- In a *street canyon* environment, high-level green infrastructure (i.e. trees) generally has a negative impact on air quality while low-level dense vegetation with complete coverage from the ground to the top of the canopy (i.e. hedges) hinder the air flow underneath and hence generally show a positive impact. Even though an oblique wind direction was identified as critical; improvements or deteriorations in air quality in a street canyon depended upon a combination of aspect ratio, vegetation density and wind direction. Increasing the spacing between trees and reducing the cross-sectional area occupied by tree canopies (through increased pruning and selecting smaller trees) can usually reduce street level personal exposure through increased ventilation. Available real world studies showed that surrounding built-up geometry can alter pollutant concentration profiles in street canyons. It was also noted that the predominant source of pollution in a street canyon environment was vehicular emissions, therefore the findings may reflect upon their impact on local emission sources more so than the background pollutant contributions. There are a limited number of studies examining hedges in street canyons, with results showing improvements in air quality and a proposed optimum height of hedge in shallow street canyons; detailed studies are required to provide favourable hedge dimensions and densities in different aspect ratios and meteorological conditions.
- In *open road* conditions, vegetation barriers have a positive impact on air quality with thick, dense and tall vegetation. Studies observed considerable pollutant removal through designing vegetation barriers closer to the pollutant source and plume's maximum concentration. In excess of a 50% reduction was observed with a 10 m thick green belt for numerous pollutants. The optimum density for a vegetation barrier was suggested by various studies. Evergreen species and other vegetation not prone to seasonal effects were proposed for vegetation barriers in open-road conditions. In a similar manner to research findings from street canyon studies, the source of pollutants (i.e. local or background) was not differentiated in open road studies, but these mitigation measures were also considered to have a more significant impact upon local emission sources. Relative humidity showed significant impact on pollutant removal by green belts indicating that climate and regional conditions need to be considered. The impact of vegetation on air quality varied between warmer and cooler climatic regions, which needs further investigation.
- Vegetation density has been represented by often dissimilar parameters in published investigations. This study observed the need for standardisation in expressing vegetation density, as it is important to facilitate a comparison of study outputs and to create generalised recommendations.

- The combination of vegetation and solid passive air pollution control measures has the potential to maximise the reduction in pollutant concentrations and improve personal exposure conditions, more than that achieved by any individual intervention in both street canyon and open road conditions.
- Only a small number of studies investigated air quality improvements for green roofs and green walls. Reported reduction in air pollutants with green walls ranged up to 95% than green wall free scenario and in the case of the green roof, the same was 2%–52%. However, their ability to remove pollutants were lesser compared to trees and vegetation barriers. Pollution reduction of green roofs was inferior to the green wall. These interventions require less spatial requirements than trees and green belts and can be part of building surfaces and structures such as bridges, fly-overs, retaining walls, and noise barriers. Further investigations are required to produce generic recommendations.

This review identified similarities in the designs and conditions of vegetation to achieve air quality benefits in open road and street canyon environment, although street canyon configurations are more complex and less easy to provide generic recommendations. Prior to implementing vegetation in street canyons, pilot modelling investigations can give possible locations and vegetation parameters to maximise its impact for least polluted conditions. Future investigations should focus on the impact of the relationship between vegetation and climatic zone, on air quality. Future studies should also focus on air pollution control potential of green roofs and green walls as both can be implemented in cities without consuming additional space.

Acknowledgements

This work is led by the University of Surrey's team as a part of the iSCAPE (Improving Smart Control of Air Pollution in Europe) project, which is funded by the European Community's H2020 Programme (H2020-SC5-04-2015) under the Grant Agreement No. 689954.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.atmosenv.2017.05.014>.

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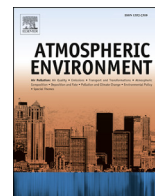
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Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

Atmospheric Environment

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Review

Review on urban vegetation and particle air pollution – Deposition and dispersion



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HIGHLIGHTS

- Combining deposition and dispersion helps designing urban vegetation related to air quality.
- The dilution of emissions with clean air from aloft is crucial; limit high urban vegetation.
- High concentrations of air pollutants increase deposition; vegetation should be close to the source.
- Air floating above, and not through, vegetation barriers is not filtered; decides barrier porosity.
- Differently designed vegetation catch different particle sizes.

ARTICLE INFO

Article history:

Received 6 August 2014

Received in revised form

20 January 2015

Accepted 21 January 2015

Available online 22 January 2015

Keywords:

Urban

Air quality

Vegetation

Deposition

Dispersion

Particle size

ABSTRACT

Urban vegetation affects air quality through influencing pollutant deposition and dispersion. Both processes are described by many existing models and experiments, on-site and in wind tunnels, focussing e.g. on urban street canyons and crossings or vegetation barriers adjacent to traffic sources. There is an urgent need for well-structured experimental data, including detailed empirical descriptions of parameters that are not the explicit focus of the study.

This review revealed that design and choice of urban vegetation is crucial when using vegetation as an ecosystem service for air quality improvements. The reduced mixing in trafficked street canyons on adding large trees increases local air pollution levels, while low vegetation close to sources can improve air quality by increasing deposition. Filtration vegetation barriers have to be dense enough to offer large deposition surface area and porous enough to allow penetration, instead of deflection of the air stream above the barrier. The choice between tall or short and dense or sparse vegetation determines the effect on air pollution from different sources and different particle sizes.

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1. Background

Urban vegetation is currently popular for the ecosystem services it can provide, such as reducing problems with flooding. Positive effects on air quality through filtration of polluted air are often mentioned, but without taking reduced dilution into account. As urban vegetation is also a way to abate the effects of climate change, e.g. rising sea level and global warming, many cities are increasingly including urban vegetation in their plans (Andersson-Sköld et al., 2015). A few reviews have been published in related areas, focussing on e.g. particle deposition on vegetation (Litschke and Kuttler, 2008); dry deposition on plant canopies (Petroff et al., 2008a); urban green space and social justice (Wolch et al., 2014);

and dispersion without the complication of vegetation (Xia et al., 2014). Many studies have attempted to estimate the economic benefits of improving air quality, although the effect of vegetation on urban air quality is not yet fully understood (Tiwary et al., 2009; Escobedo et al., 2011).

The aim of this literature review was to appraise the physical effects linking vegetation to air quality from two perspectives, deposition and dispersion, and to provide input on the design of urban vegetation related to air quality. Particulate pollutants were considered in particular, as they have major health impacts and as physical processes differ for different size classes, introducing an extra complication compared with gaseous pollutants. The physical processes were reviewed at different scales, including the effects of particle properties and vegetation properties. Emissions from vegetation were excluded, as was transformation of pollutants in

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the air. Dispersion was assessed by reviewing on-site measurements, wind tunnel studies and modelling approaches, with examples from both street canyons and vegetation barriers. Unfortunately, few experimental studies combining detailed descriptions of both dispersion and deposition were available for review.

This paper commences with a description of the deposition process, followed by vegetation and then dispersion within urban areas. Finally, the effects of vegetative barriers are described and recommendations on vegetation design are provided. All parts include measured and modelled data and each part ends with a short summary of the topic.

2. Deposition

Airborne particles and gas molecules can be deposited when they pass close to a surface. Most plants have a large surface area per unit volume, increasing the probability of deposition compared with the smooth, manufactured surfaces present in urban areas. For example, 10–30 times faster deposition has been reported for sub-micrometre (<1 μm) particles on synthetic grass compared with glass and cement surfaces (Roupsard et al., 2013). Particle size, among other parameters, has a great effect on deposition. Ultrafine particles, below ~0.1 μm, behave more like gas molecules and are deposited by diffusion; 1–10 μm particles impact on surfaces that force the air stream to bend; and particles >10 μm in diameter also fall to the ground by sedimentation (Hinds, 1999).

Deposition on vegetation is usually described as one-dimensional vertical deposition on a homogeneous layer of vegetation in the form of a forest or field. For urban applications, the vegetation is often merely single trees or bushes, or linear stands forming avenues and barriers, and the deposition process needs to be modelled in more detail. However, most of the physics can easily be described using the situation of an airstream passing a single leaf surface instead of a whole forest.

Simplified one-dimensional deposition is divided into transport from free air to the surface; across the laminar layer adjacent to the surface; and processes relating to surface properties. The deposition velocity, v_d , is often described as the reciprocal of resistance to deposition, R_{tot} (equation (1)). R_{tot} can be divided into a sum of resistances relating to each of these transport processes, namely R_a = aerodynamic resistance, R_b = boundary resistance and R_c = surface resistance (Davidson and Wu, 1990).

$$v_d = \frac{1}{R_{tot}} = \frac{1}{R_a} + \frac{1}{R_b} + \frac{1}{R_c} \quad (1)$$

The aerodynamic resistance is normally considered small compared with the other types and is thus set to zero, unless the study is focussing on particles with high settling velocity¹ (Hinds, 1999), i.e. with a particle diameter above 10 μm diameter (Slinn, 1982; Davidson et al., 1982). The deposition velocity is always larger than the settling velocity (Petroff et al., 2008a). In this context, the aerodynamic resistance is also related to dispersion. For aerodynamic resistance, R_a , meteorology is important and both R_a and the boundary layer resistance, R_b , depend on the reciprocal of the friction, or shear, velocity (Bruse, 2007; Petroff et al., 2008a).

Vong et al. (2010) showed that the deposition velocity measured for 0.2–0.5 μm particles depends on the atmospheric stability of the boundary layer, described by the Monin–Obukov length, L , and linearly on the particle diameter, D_p (equation (2)). Other dependencies are collected within the empirical constant A, which is

0.63 over pine forest (Vong et al., 2010), 1.35 over forests (Gallagher et al., 1997) and 0.2 over grass (Wesely et al., 1985).

$$v_d = A * u_* * D_p * \left(1 + \left(\frac{-300}{L} \right)^{2/3} \right) \quad (2)$$

The deposition velocity for super-micrometre particles increases with size due to increasing impaction rate and, for vertical deposition, settling velocity, while for sub-micrometre particles it decreases with size. The minimum deposition velocities reported in the literature are 0.1–0.3 μm (Slinn, 1982; Davidson et al., 1982; Litschke and Kuttler, 2008; Petroff et al., 2008a; Lin and Khlystov, 2011). Particulate matter (PM) size is often reported in large size classes, e.g. PM₁₀ includes particles <10 μm in diameter which have an average diameter of either 5.0 or 0.1 μm, giving deposition velocities differing by about 100-fold (Litschke and Kuttler, 2008). Number of particles emphasises smaller particles, while particle mass emphasises larger particles.

Discrepancies can also arise depending on the complexity of the measurements. For example, Freer-Smith et al. (2005) divided particles into size fractions obtained from samples in solution and attributed all dissolved particle mass to the sub-micrometre particle size range, i.e. to airborne sub-micrometre particle mass, which thus got a huge deposition velocity. Litschke and Kuttler (2008) reported that hygroscopic particles (marine) can increase their deposition velocity by 5- to 6-fold, changing the relative humidity from 40% to 99%, and with deposition 16- to 25-fold faster in 99.9% relative humidity. Thus if humidity is not stated in the literature source, the deposition velocity for hygroscopic particles might be difficult to use. Deposition velocity data obtained from net transport of particles to surfaces indicate that sticky surfaces have greater deposition velocity than dry surfaces, e.g. as shown for 18 μm particles by Petroff et al. (2008a). Many discrepancies between published deposition velocity values are due to differences not included in the analysis (Litschke and Kuttler, 2008; Petroff et al., 2008a).

Deposition velocity, v_d , for different types of vegetation is often measured in wind tunnels, which normally force all available air to pass through the vegetation. However, this is usually not the case under ambient conditions, where the air stream can pass above or around the vegetation (see section on Barriers). In a study where the particles tested were 0.01–0.1 μm in diameter and the wind speed was 0.3–1.5 m s⁻¹, cypress (*Cupressus leylandii*) and pine (*Pinus sylvestris* L.) hedges were found to be filters with an effective filter diameter in the same range as pine needles (Lin et al., 2012). Those results confirm earlier findings that deposition velocity decreases with size for sub-micrometre particles (Petroff et al., 2008a).

$$\text{Deposited amount (g/m}^2\text{)} = \text{LAI} * v_d * C * t \quad (3)$$

The amount of material deposited per unit ground area and time is often calculated by equation (3), where LAI is Leaf Area Index, i.e. the amount of vegetation surface area per m² of ground area; v_d is the deposition velocity; C is the air concentration of the pollutant; and t is the time. The definition of LAI varies slightly, see below. A detailed model for transport and deposition on needles was successfully applied to three different datasets by Petroff et al. (2008b), who found slight over-prediction of capture efficiency for super-micrometre particles in light winds. The model is based on a data review (Petroff et al., 2008a) and has been further developed for broad-leaved canopies (Petroff et al., 2009). These models include all different kinds of deposition of particles (diffusion, interception, impaction, sedimentation) but exclude some processes, e.g. interactions among particles and between particles and gases,

¹ Velocity of a falling particle under zero acceleration.

thermophoresis (impact of temperature gradients) and meteorological stability. The original model has since been simplified for larger scale modelling uses and is available as an open-source model (Petroff and Zhang, 2010). Kouznetsov and Sofiev (2012) describe all processes included in their model thoroughly and suggest a description of thermophoresis. However, the model still excludes turbulent impaction, which may be important as dense vegetation in forests reduces local wind speeds, while in urban areas single vegetation elements are normally not shielded.

Deposition is transport from a point in the air to a plant surface. As the description of deposition is simplified in different ways, the experimental set-up used for measurements must be described in detail when publishing deposition velocities and modellers using these data must consider the set-up thoroughly. Thus, deposition models should be transferred between different applications with great caution. The deposition velocity has a minimum around 0.1–0.3 μm particle diameter.

3. Description of vegetation

Vegetation density affects both deposition and dispersion. For deposition, the vegetation area is either described as LAI (leaf area/ground area, dimensionless) or as Leaf Area Density (LAD; leaf area/unit volume, $\text{m}^2 \text{m}^{-3}$ or $\text{m}^2 \text{m}^{-1}$). For dispersion, the porosity, drag force or pressure drop is measured. Many different measures are used in the literature, reducing comparability, and either deposition and dispersion is commonly estimated from the other, introducing large uncertainty.

LAI can be measured practically by cutting all leaves within a volume and measuring the surface area directly or by laser. For example, Bouvet et al. (2007) measured the LAI of four rows of maize with both a FASTRAK three-dimensional digitiser and manually, resulting in LAI values of 3.54 and 3.52, respectively. Other studies have measured pressure loss coefficient (Gromke, 2011). Optical porosity has proven useable for large particles (80 μm) and small vegetation elements (1–10 mm), but at low optical porosity the pressure drop is lower through vegetation barriers than through solid barriers (Raupach et al., 2001). Deciduous trees commonly have porosities of around 96–97.5%, with a pressure loss coefficient of 80–200 m^{-1} (Gromke and Ruck, 2012). In a study by Lin et al. (2012), the packing density in a wind tunnel, defined as the volume of vegetation divided by the tunnel volume, was 3.7% and 5.5% for juniper (*Juniperus chinensis*) branches of different orientation and 1.7% and 4.0% for pine, relative to LAD of 109 and 197, respectively, for juniper and 94 and 138, respectively, for pine.

The porosity changes at high wind speeds, with decreased porosity for broad-leaved trees and increased for conifers (Tiwary et al., 2005). The drag forces on trees decrease with increasing wind speed (Gromke and Ruck, 2008). At 10 m s^{-1} the capture efficiency and, to an even larger extent, the deposition velocity decrease for deciduous trees compared with at lower wind speeds (Beckett et al., 2000). Hedges of different species are affected by wind speeds only above a certain threshold, e.g. 0.8, 1.2 and 1.7 m s^{-1} for hawthorn, holly and yew, respectively (Tiwary et al., 2005).

As the amount of deposited mass is directly related to air concentrations close to the surface, Weber et al. (2014) ensured that the air concentrations around different herbaceous plants based on distance to the road were similar when measuring the mass deposited. They found that hairy leaves increased deposition substantially for 3–180 μm particles. Speak et al. (2012) analysed the deposits on different vegetation species on a rooftop and found greater deposition on grass and on hairy leaves than on other herbaceous plants.

Greater deposition velocities for conifers than deciduous trees have been found in several studies e.g. by particle capture of 0.8 μm NaCl particles in a wind tunnel (Beckett et al., 2000; Freer-Smith et al., 2004). The deposition velocity increased from 0.1 to 0.3 m s^{-1} to 2.9 m s^{-1} when the wind speed was increased from 3 m s^{-1} to 9 m s^{-1} (Freer-Smith et al., 2004). The relative deposition velocity on stems compared with leaves increased for smaller stems and larger leaves, while typical semi-arid region trees had low deposition velocities (thick leaves) (Freer-Smith et al., 2004). In other studies, Przybysz et al. (2014) found greater deposition on pine than on yew, and even less deposition on ivy (*Hedera helix* L.); soot particles had greater deposition velocities on needles than on broadleaved species (Hwang et al., 2011); and juniper gave larger deposition in wind tunnel tests than loblolly pine (*Pinus taeda*), but also affected the wind field more (Lin et al., 2012).

Particles, mainly the coarser fraction, are washed off from foliage during rain (Przybysz et al., 2014). If deposited in the leaf wax, the removal of particles with wind or rain is lower (Dzierżanowski et al., 2011). Measurements on 13 plant species showed that approximately 60% of the particle deposit was washed off with water, while 40% was included in the wax layer, with a large variance between species (Popek, 2013). Three-year-old needles had more polycyclic aromatic compounds (PAH) transferred into the needle wax, i.e. impossible to wash away with water and ultrasonic bath, showing an age effect on the wax in the needle surface (Terzaghi et al., 2013). Only particles smaller than 10 μm were encapsulated into the leaf/needle cuticle, i.e. could not be washed away by water (Terzaghi et al., 2013).

Using samples from more than 40 species, Saebo et al. (2012) found a positive correlation between particle deposition and hairy leaves and the wax content of the leaves. Thick leaves showed lower deposition for all particle sizes, apart from 0.2 to 2.5 μm particles. There was a 10–20 fold difference between different species in terms of particle deposition (Saebo et al., 2012).

Vegetation density or porosity is generally measured using several different parameters. High vegetation density increases deposition of pollutants that reside close to the surface, but can also hinder the transport of pollution towards the surface. There is a need for standardised measurements of vegetation density, increasing comparability between studies.

Different vegetation species have different deposition velocities even for the same particle size range, but the available data cannot yet give a parameterised description. Establishment of specific parameters to describe vegetation is important for standardising vegetation parameterisation in experiments. Hairiness and possibly wax content have been shown to increase deposition, while a difference between thick and thin leaves relating to particle size is also probable.

4. Dispersion in urban areas

Dispersion relies on descriptions of wind systems that transport and dilute air pollutants at different scales. Regional wind fields, including vertical layering, affect air pollutants at a larger scale, while fluid dynamics often describe air flows around obstacles in street canyons and inside vegetation barriers. Surface roughness is a simplification describing the effect of surface texture on the wind field and is used at different scales in the literature. The buildings in the urban area give a surface roughness in regional models, but need to be resolved as objects within the urban area. Resolving vegetation details like twigs and leaves is also sometimes needed.

Most dispersion studies exclude temperature effects, e.g. sunlit surface versus shadow (Lindberg et al., 2008) and sinking cold air (Baik et al., 2012). The temperature-humidity system is closely linked to vegetation, as plants tends to decrease temperature

differences in urban areas (Lee and Park, 2008).

A common subsystem of urban areas is the street canyon. For simplicity, the air flow in a street canyon is generally described for a constant, perpendicular rooftop wind that creates a vortex in the street canyon, forming a ground level wind that has the opposite direction from the rooftop wind (Oke, 1987) (Fig. 1). In reality, the vortex is affected both by building configuration and by vegetation (Ng and Chau, 2012, 2014). For wind directions parallel to the street canyon, the flow is channelled through the canyon, and other wind directions are considered combinations of the two. Street canyon vegetation gives different effects on dispersion in these two cases (Oke, 1987).

Salmond et al. (2013) used the difference between seasons, i.e. with and without leaves on the trees, to examine the effect of vegetation on air quality, implying a need to limit or understand other seasonal differences. They measured NO and NO₂ both at street level and one floor up, i.e. below and within the tree crowns. They found a rapid, large fluctuation in concentration in all data apart from one floor up during summer, showing the decreased mixing within the foliated tree crowns. During summer, the air pollutant concentrations differed less between leeward and windward sides of the street when wind direction was perpendicular to the street canyon, showing that the normally created street canyon vortex was reduced (Salmond et al., 2013). The NOx concentrations also differed more between the urban background and the street canyon during the foliated season (Salmond et al., 2013).

Buccolieri et al. (2011) measured and modelled the concentration of PM₁₀ in a real junction in two different wind directions by FLUENT (www.ansys.com). As one of the streets passing the junction had trees and the other did not, the ratio between the wind directions parallel to each street canyon was used to compare the modelled concentration ratio (1.1) to the measured (1.5). The modelled ratio for the same situation without trees was 0.3, emphasising the importance of including vegetation in the model (Buccolieri et al., 2011).

Wind tunnels are powerful tools for studying fluid dynamics, since it is possible to scale the fluid while keeping dimensionless numbers constant (<http://www.cfd-online.com>). However, scaling of complex vegetation is still a challenge (Gromke, 2011). Gromke and colleagues have studied this issue in detail and summarised many of their findings in a recent paper (Gromke and Ruck, 2012). A street canyon with a height/width (H/W) ratio of 1–2 was built in the wind tunnel with length 10 times the height of the buildings. The emissions were introduced as a line of point sources of inert gas and the traffic turbulence introduced by small rectangular plates moving with the traffic flow (Gromke et al., 2008). At both building walls, the concentration of the gas and wind speed were measured. In the first studies, the trees in the street canyon looked like small-scale trees, with spherical tree crowns on thin stems (Gromke and Ruck, 2007). The crowns had different porosity and different

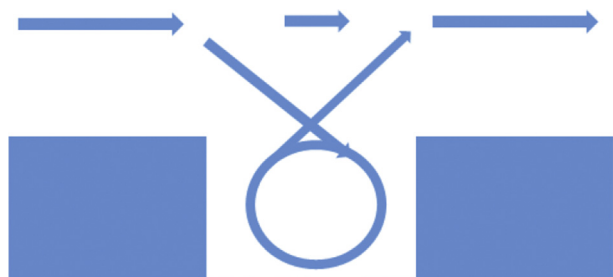


Fig. 1. The vortex of a street canyon with perpendicular wind direction.

material. To simplify the studies of different vegetation density, the trees were replaced with metal cages that were filled with different amounts of fibre filling. Test with empty cages and with filling in every second cage showed only minor effects on the flow (Gromke, 2011; Gromke and Ruck, 2012). More or larger trees increased the concentration and reduced traffic turbulence (Gromke and Ruck, 2007). The wind field was found to be disturbed by the presence of the tree at a distance of at least 5 times the crown diameter downwind (Gromke and Ruck, 2008) for the rather low tree porosity used (Gromke and Ruck, 2012). The largest effect on the wind field was from trees with high porosity (~97.5%) (Gandemer, 1981; Grant and Nickling, 1998; Frank and Ruck, 2005).

The wind tunnel findings above were used in CFD (Computational Fluid Dynamics) modelling (Gromke et al., 2008), where two different turbulence schemes, $k-\epsilon$ and RMA (Yakhov et al., 1992), were tested in the FLUENT model (www.ansys.com). Both gave slightly lower dispersion compared with the wind tunnel measurements, but the RMA scheme provided the best description of the measured wind tunnel data in this case. The Schmidt number (turbulence description) was decreased from the commonly used 0.7 to 0.3, approaching the recommendation of 0.4 for urban street canyons (Di Sabatino et al., 2007). For perpendicular winds, larger tree crowns increased the difference in pollutant concentration between the sides of the street, and for wind directions parallel to the street canyon, the effect of trees was limited. The effect of vegetation was greatest (by a factor of 3 at maximum concentration) for winds at a 45-degree angle (Buccolieri et al., 2011). For larger H/W-ratios (i.e. deeper or narrower street canyons), the effect of trees increased (Buccolieri et al., 2009). A Large Eddy Simulation model for street canyons with and without trees showed slightly over-predicted concentrations far from crossings, but still a close resemblance to the wind tunnel studies (Moonen et al., 2013). CFD models including vegetation improved resemblance between modelled and measured concentrations (Amorim et al., 2013a) and also improved calculation of exposure to traffic emissions in children walking different paths to school (Amorim et al., 2013b).

Most street canyon models describe vegetation as a sink for turbulence, but without considering deposition. Two studies using ENVI-met (<http://www.envi-met.com/>) showed higher pollutant concentration due to vegetation, both in street canyons (Wania et al., 2012) and between different buildings (Vos et al., 2013). Larger and denser trees greatly reduced the dispersion, while the impact was limited for smaller and sparser trees (Wania et al., 2012; Vos et al., 2013). Vos et al. (2013) recommends lower hedges or even walls between traffic and pedestrians, limiting polluted air transport to pavements and placing vegetation close to the source, increasing deposition (Vos et al., 2013; Pugh et al., 2012). Deep street canyons are more sensitive to larger tree coverage than shallower, and the building design can have a large effect on dispersion too (Ng and Chau, 2014).

Pugh et al. (2012) used a simplified model including the different concentrations in the street canyon and at rooftop height to calculate the deposition and demonstrated the importance of placing the vegetation close to the source. A thorough review of the state-of-the-art of environmental benefits of green roofs only dedicated a small section to air pollution (Berardi et al., 2014).

Some studies publish limited datasets to validate models, but extensive experimental datasets, including a thorough description of the vegetation inside urban areas, are needed to improve existing models.

Wind tunnel studies provide many insights into pollutant dispersion and e.g. the downscaling of vegetation adds large uncertainty to these studies. Thus, such studies are highly recommended and should be further linked to on-site measurements.

Dispersion modelling shows a negative impact on air quality if trees are introduced in trafficked street canyons, a limited effect from sparse street trees and positive effects of low barriers between traffic and exposed inhabitants. Dispersion modelling normally does not include the effect of vegetation on heat flux and buoyancy, which influence dispersion in urban areas.

5. Parks and regional deposition

The regional removal of pollutants by deposition on vegetation in urban areas has been calculated from reported deposition velocities and averaged concentrations, together with measured or estimated vegetation surface areas. Due to large spatial variability of both vegetation surface area and air pollutant concentrations, averaging problems are common.

Most studies calculate the total deposition from urban background concentrations and average LAI, and report PM₁₀ reductions of a few per cent (Nowak, 1994; Nowak et al., 2006; McDonald et al., 2007; Bealey et al., 2007; Litschke and Kuttler, 2008; Baumgardner et al., 2012). These calculations often do not take account of the limited dispersion due to increased amounts of vegetation. Meteorological inversion and spatial heterogeneity have been shown to have large impact on the vegetation effect (Escobedo and Nowak, 2009).

A study combining the UFORE model (Escobedo and Nowak, 2009) and GIS (Geographical Information System), forming i-Tree (<http://www.itreetools.org>), showed the possibility to use GIS-based systems to find areas where increased vegetation would be beneficial for air quality (Hirabayashi et al., 2012). This helped in abating ultrafine, but also coarse, particles with concentrations differing by several orders of magnitude within urban areas, while PM_{2.5} concentrations vary less within urban areas (Whitlow et al., 2011; Hagemann et al., 2014).

Quantifying the total amount of deposition over larger areas needs further studies, due to the large spatial variation in most air pollutants and in vegetation cover.

6. Barriers and varying pollution

Barriers between the source of pollution and humans can be used both as a way to change the wind system and for filtering the air, i.e. through dispersion and deposition. They are easier to study due to their simple geometry, but still include many interesting complications. Barrier studies are often performed at roadsides outside urban areas in order to limit disturbances to traffic, but the theory can help understand the effects on urban air quality. In one study in which wind speed was measured around an 8 m high cypress barrier, there was no effect of the barrier 160 m downwind (Tuzet and Wilson, 2007). Solid barriers reduced pollutant concentrations downwind of the barriers, with different reduction rates for different pollutants and different barriers. The measured pollutants reported include number of particles (20 nm, 75 nm and total; Baldauf et al., 2008); NO₂, black carbon (BC), CO, particle number and mass for sub-micrometre particles (Ning et al., 2010); and ultrafine particles (Hagler et al., 2012). At 20 times the barrier height, Ning et al. (2010) found higher concentrations than without a barrier.

One of the particle number peaks measured by Hagler et al. (2012) was used with the Comprehensive Aerosol and Gas Chemistry (CAGC) model by Wang (2013), working with FLUENT as the $k-\epsilon$ turbulence solver. With measured LAD, the model gave slightly larger capture of number of particles below 50 nm diameter than the measured value, but on using lower LAD the capture rate for number of larger particles became too low. The deposition velocity is related to particle size, but does not seem to include particle size-

differentiated wind speed effects (Steffens et al., 2012). Particles below 50 nm are common in traffic exhausts, but also difficult to model in the complex near road environment, where particle dynamics play an important role (Steffens et al., 2012). Hagler et al. (2012) found limited effect on particle concentrations from a vegetation barrier. This was attributed to low LAI (around 3 during summer) and gaps between the trees allowing transport of unfiltered air through the barrier (Hagler et al., 2012).

A maple and oak barrier with under-vegetation close to a road reduced BC concentrations by 12%, with a maximum reduction of 22%. Particles between 0.5 and 10 μm diameter showed a limited reduction in the study (Brantley et al., 2014). Twenty sites in Finland were analysed by diffusive sampling for particle deposition, NO₂ and a selection of VOCs at parallel sites with and without trees adjacent to the road (Setälä et al., 2013). The effect of vegetation was limited, even with under-vegetation; the reason might be low traffic impact on air quality as only NO₂ correlated to traffic flow at the site. During a shorter study, number of particles was reduced by one-third by vegetation compared with no vegetation, suggesting larger effects on exhaust particles (Setälä et al., 2013).

At four locations less than 2.2 m from a conifer barrier, numbers of particles of different sizes were determined: in an opening in the vegetation; close to the barrier at both sides; and inside the barrier (Al-Dabbous and Kumar, 2014). For wind directions from the road, the number of particles was slightly higher close to the road and at the barrier than in the opening. Directly after the barrier, the concentration had decreased by ~40%. All wind directions showed lower concentrations of particle numbers within and behind the vegetation than close to the road, again pointing to an effect on exhaust particles.

Many studies focus on dust and coarse particles (Raupach et al., 2001; Bouvet et al., 2007). Combined modelling and measurements around a barrier of four rows of 2 m high maize plants, with LAI of 3.5 and an optical porosity between 0.05 and 0.67, showed that a large quantity of 10–50 μm diameter glass beads passed above the barrier. Thus, deposition in the barrier was not possible for most of the glass beads. High porosity vegetation barriers are penetrated by air streams, allowing deposition of pollutants, while low porosity vegetation forces air streams to pass above it (Tiwary et al., 2005).

The effect of ~2 m high hedges on wind fields and concentrations of super-micrometre particles was attributed either to the wind field change or to the deposition in the hedge by Tiwary et al. (2005). For yew, the wind did not penetrate the hedge and most of the air passed above it, while the porosity was higher for holly and still higher for hawthorn. The collection efficiency at two-thirds the height of the barrier increased with particle size (from 0.8 to 15 μm) and decreased with porosity, with maximum collection efficiency for 15 μm particles of 3% for yew, 18% for holly and 27% for hawthorn (Tiwary et al., 2005). Tiwary et al. (2008) repeated the study for the hawthorn hedge and found similar collection efficiencies of 38%, 30% and 33%, implying statistically sound data.

Placing vegetation barriers close to a road increases the amount of deposition on the vegetation, as the concentration of dust is high when the plume impacts on the vegetation and as the full height of the plume passes through the barrier (Etyemezian et al., 2004). Tall oaks and cedars 25 m from a road halved PM₁₀ and PM_{2.5} concentrations, while tall prairie grass reduced the concentrations by 35% (Cowherd et al., 2006). A 100 m barrier of sparse vegetation reduced PM₁₀ concentrations by less than 10% and 17–25 μm particles by 25% (Etyemezian et al., 2004). For a model of urban areas, formed by placing containers on a field, Veranth et al. (2003) found an 85% decrease in PM₁₀. This large decrease was possibly related to the high friction velocity. If the barrier is too far from the road to capture the full plume height, the collection efficiency is low, e.g. 10 m high trees 60 m from a gravel road gave no detectable effect on

PM₁₀ concentrations (Mao et al., 2013). Mao et al. (2013) showed reasonable agreement between measured and modelled wind speeds, while dust concentrations differed, implying a need to improve the description of deposition in the model.

Pardyjak et al. (2008) described a simple quasi-2D Eulerian atmospheric dispersion model that accounts for dry deposition of fugitive dust onto vegetation and buildings, using measured $v_d \cdot LAD$ as input data calculating the total mass concentration in the dust plume. The model is easily available and helps planners to understand how vegetation design affects the plume concentration by relating the importance of each process to the relation between the turbulent diffusion time scale and the deposition time scale.

Focussing on the physical dispersion around trees, Endalew et al. (2009a, b) describe a model that resolves the tree by excluding the leaves in 3D as stem and twigs that can grow according to different parameters forming different tree types. The leaves are then added to the system as turbulence sinks that surround the stem and twigs. The drag force used in the model is calculated by leaf area density or leaf drag area in m^{-1} (Endalew et al., 2009a), drag coefficient and a sheltering factor (Endalew et al., 2009b). The sheltering factor is of greater importance in vegetation with a larger extension like parks, but also e.g. inside tree crowns. This approach has been compared to wind tunnel data on 1:10 scale trees and to modelling with the common horizontal averaging technique for wind speeds of 10 and 15 $m s^{-1}$ with positive results (Endalew et al., 2009a, 2009b). One or two trees are measured with photography techniques and a canopy can be formed by symmetry boundary conditions. In the wind tunnel, the roughness on tree branches without leaves was important, but gave no significant effects in real world, and unfoliated trees gave a 50% reduction of the wind speed in the centre of the canopy (Endalew et al., 2009a). There is a need for further studies of leafless vegetation.

Vegetation barriers have been studied more frequently than vegetated street canyons giving important insights into the effect of vegetation on air quality. They show the great importance of designing urban vegetation, carefully relating it to the kind of air pollution targeted. Thus, if not considering reduced dilution, vegetation barriers should be placed close to the road where the concentration is high and have at least the same height as the plume from the road. The barrier should allow polluted air to pass through, allowing deposition, or to pass above, protecting areas close behind the barrier.

Barriers are efficient study objects, as they reduce the complexity of studies of vegetation and air pollution. Different vegetation types and different kinds of pollution or particle sizes should be studied.

7. Conclusions

The effect of vegetation on urban air quality depends on vegetation design and on level of air pollution in the area. This review identified the following vegetation design considerations based on air quality arguments:

1. Dilution of emissions with clean air from aloft is crucial; the vegetation should thus preferably be low and/or close to surfaces.
2. Proximity to the pollution source increases concentrations of air pollutants and thus deposition; vegetation should be close to the source.
3. Air passing above, and not through, vegetation is not filtered; barriers should be high enough and porous enough to let the air through, but solid enough to allow the air to pass close to the surface.

Other interesting findings are that deposition of coarse particles

is more efficient at high wind speeds, while the opposite is true for ultrafine particles; and that vegetation density often changes due to strong winds. To improve deposition, the vegetation should be hairy and have a large leaf area index, but still be possible to penetrate.

7.1. Research outlook

Dispersion and deposition related to vegetation in urban areas are both interesting and vivid research areas. This review suggests that these areas be further combined, as the environmental problem in which they interact, urban air quality, is crucial to human health and results are rapidly transferred into policy. Thus, results from one area must be modified with results from the other before action is taken in urban planning.

The effect of non-foliated vegetation during wintertime needs further studies, as they might have an impact e.g. in northern countries with air quality problems during winter and spring. In these areas, air inversion during wintertime often limits dilution, so pollution levels might be high. There is also a yearly variation, with different particle sizes being most important during different parts of the year.

The deposition process differs substantially between different particle sizes and detailed interactions with various vegetation elements require combined studies of different particle sizes together with different plant species.

Barriers are important for experimental data collection due to their simple geometry, which is a requirement for detailed deposition and dilution studies. The possibility of studying roads where a barrier is present along only a part of the road, providing surroundings and emissions that are similar for stretches with and without vegetation, is very important. Barrier studies can give great insights into differences between pollutants and between different kinds of vegetation.

The description of the vegetation is important, as recommendations can scarcely include all available species, but must group them in some way. Parameters such as hairiness, stickiness, LAI, thickness of leaves etc., but also porosity and the species in question, are described in the literature. Vegetation can interact with air pollutants in more ways than these, however, e.g. through emissions from vegetation and active uptake of water and nutrients. Therefore studies of vegetation effects need to include these other factors before vegetation implementation in urban planning can be efficient.

This review examined the deposition and dispersion of particle pollution of all size classes and showed that the effects of urban vegetation on local air quality are complex, so different disciplines must work together to identify these effects. Such work must be described in great detail, as we do not yet understand all the parameters influencing the effects of vegetation on air pollution.

Acknowledgements

The work was funded by the Swedish Research Council Formas, the Swedish Energy Agency, the Swedish Environmental Protection Agency, the Swedish National Heritage Board and the Swedish Transport Administration, with a contribution from Stiftelsen Fredrik Bachmans Minnesfond. Dr. Petroff is acknowledged for detailed refereeing of the manuscript.

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From: Elaine Robson
Sent: 28 January 2018 23:16
To: Worringham, Mark
Cc: 'Elaine Robson'
Subject: Comments (2) re Draft Reading Borough Council Local Plan
Attachments: Lancet Comm on Pollution & Health 2017 PIIS0140673617323450.pdf

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Dear Mr Worringham,

This follows Comments (1) and carries a third attachment:

Comments below are on adjunct sections of the Draft New Plan:

CC3 Adaptation to Climate Change

The selection of trees and plants is related to changing climatic conditions and to Reading's future development

CC9 Securing Infrastructure

- Priority will be given to open space, green infrastructure and other measures to enhance or improve biodiversity
- Among those to be considered where a specific need is identified:
Off-site street tree and other tree planting (environmental improvements outside the Central Area)
Measures to tackle poor air quality or for ongoing air quality monitoring

EN14 Trees, Hedges and Woodlands

Existing assets will be protected and Reading's tree cover will be extended, while at the same time preparing for climate change.

The Council's ongoing tree strategy is robust and far-sighted but not focussed on mitigating air pollution.

EN16 Pollution and Water Resources

This section is not immediately relevant to Air Quality

Other Documents from Reading Borough Council

RBC Air Quality Action Plan (Update 2016)

p 14: the last entry tabulated mentions 10% increase in numbers of trees and plants (2010) by 2030, to help absorb pollution (also re mental health, climate change). Action via Planning and Parks.

RBC Air Quality Annual Status Reports for 2016 and 2017

The opportunity to read these reports has been very helpful, and if anything they support my suggestion.

The Lancet Commission on Pollution and Health (2017)

- In view of the long-term detrimental effects of air pollution on disease and mortality I attach a pdf of this recent review in case it is of interest

.....

I have not included draft text for my suggested brief addition to EN15, but could attempt this if time permitted. The sources I have quoted show that the use of green infrastructure to mitigate air pollution should be included in relevant planning applications and feature in the future development of Reading. Measures to deal with climate change, to maintain parks and trees and to improve biodiversity will not by themselves achieve the required focus.

Yours sincerely

Elaine Robson

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The Lancet Commission on pollution and health



Philip J Landrigan, Richard Fuller, Nereus J R Acosta, Olusoji Adeyi, Robert Arnold, Niladri (Nil) Basu, Abdoulaye Bibi Baldé, Roberto Bertollini, Stephan Bose-O'Reilly, Jo Ivey Boufford, Patrick N Breysse, Thomas Chiles, Chulabhorn Mahidol, Awa M Coll-Seck, Maureen L Cropper, Julius Fobil, Valentin Fuster, Michael Greenstone, Andy Haines, David Hanrahan, David Hunter, Mukesh Khare, Alan Krupnick, Bruce Lanphear, Bindu Lohani, Keith Martin, Karen V Mathiasen, Maureen A McTeer, Christopher J L Murray, Johanita D Ndahimananjara, Frederica Perera, Janez Potočnik, Alexander S Preker, Jairam Ramesh, Johan Rockström, Carlos Salinas, Leona D Samson, Karti Sandilya, Peter D Sly, Kirk R Smith, Achim Steiner, Richard B Stewart, William A Suk, Onno C P van Schayck, Gautam N Yadama, Kandeh Yumkella, Ma Zhong

Executive summary

Pollution is the largest environmental cause of disease and premature death in the world today. Diseases caused by pollution were responsible for an estimated 9 million premature deaths in 2015—16% of all deaths worldwide—three times more deaths than from AIDS, tuberculosis, and malaria combined and 15 times more than from all wars and other forms of violence. In the most severely affected countries, pollution-related disease is responsible for more than one death in four.

Pollution disproportionately kills the poor and the vulnerable. Nearly 92% of pollution-related deaths occur in low-income and middle-income countries and, in countries at every income level, disease caused by pollution is most prevalent among minorities and the marginalised. Children are at high risk of pollution-related disease and even extremely low-dose exposures to pollutants during windows of vulnerability in utero and in early infancy can result in disease, disability, and death in childhood and across their lifespan.

Despite its substantial effects on human health, the economy, and the environment, pollution has been neglected, especially in low-income and middle-income countries, and the health effects of pollution are underestimated in calculations of the global burden of disease. Pollution in low-income and middle-income countries that is caused by industrial emissions, vehicular exhaust, and toxic chemicals has particularly been overlooked in both the international development and the global health agendas. Although more than 70% of the diseases caused by pollution are non-communicable diseases, interventions against pollution are barely mentioned in the Global Action Plan for the Prevention and Control of Non-Communicable Diseases.

Pollution is costly. Pollution-related diseases cause productivity losses that reduce gross domestic product (GDP) in low-income to middle-income countries by up to 2% per year. Pollution-related disease also results in health-care costs that are responsible for 1.7% of annual health spending in high-income countries and for up to 7% of health spending in middle-income countries that are heavily polluted and rapidly developing. Welfare losses due to pollution are estimated to amount to US\$4.6 trillion per year: 6.2% of global economic output. The costs attributed to pollution-related disease will probably increase as additional associations between pollution and disease are identified.

Pollution endangers planetary health, destroys ecosystems, and is intimately linked to global climate change. Fuel combustion—fossil fuel combustion in high-income and middle-income countries and burning of biomass in low-income countries—accounts for 85% of airborne particulate pollution and for almost all pollution by oxides of sulphur and nitrogen. Fuel combustion is also a major source of the greenhouse gases and short-lived climate pollutants that drive climate change. Key emitters of carbon dioxide, such as electricity-generating plants, chemical manufacturing facilities, mining operations, deforestation, and petroleum-powered vehicles, are also major sources of pollution. Coal is the world's most polluting fossil fuel, and coal combustion is an important cause of both pollution and climate change.

In many parts of the world, pollution is getting worse. Household air and water pollution, the forms of pollution associated with profound poverty and traditional lifestyles, are slowly declining. However, ambient air pollution, chemical pollution, and soil pollution—the forms of pollution produced by industry, mining, electricity generation, mechanised agriculture, and petroleum-powered vehicles—are all on the rise, with the most marked increases in rapidly developing and industrialising low-income and middle-income countries.

Chemical pollution is a great and growing global problem. The effects of chemical pollution on human health are poorly defined and its contribution to the global burden of disease is almost certainly underestimated. More than 140 000 new chemicals and pesticides have been synthesised since 1950. Of these materials, the 5000 that are produced in greatest volume have become widely dispersed in the environment and are responsible for nearly universal human exposure. Fewer than half of these high-production volume chemicals have undergone any testing for safety or toxicity, and rigorous pre-market evaluation of new chemicals has become mandatory in only the past decade and in only a few high-income countries. The result is that chemicals and pesticides whose effects on human health and the environment were never examined have repeatedly been responsible for episodes of disease, death, and environmental degradation. Historical examples include lead, asbestos, dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), and the ozone-destroying chlorofluorocarbons. Newer synthetic chemicals that have entered world markets in the past

Published Online
October 19, 2017
[http://dx.doi.org/10.1016/S0140-6736\(17\)32345-0](http://dx.doi.org/10.1016/S0140-6736(17)32345-0)

This online publication has been corrected. The corrected version first appeared at thelancet.com on Nov 7, 2017

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[http://dx.doi.org/10.1016/S0140-6736\(17\)32588-6](http://dx.doi.org/10.1016/S0140-6736(17)32588-6) and
[http://dx.doi.org/10.1016/S0140-6736\(17\)32545-X](http://dx.doi.org/10.1016/S0140-6736(17)32545-X)

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2–3 decades and that, like their predecessors, have undergone little pre-market evaluation threaten to repeat this history. They include developmental neurotoxicants, endocrine disruptors, chemical herbicides, novel insecticides, pharmaceutical wastes, and nanomaterials. Evidence for the capacity of these emerging chemical pollutants to cause harm to human health and the environment is beginning to become evident. These emerging chemicals are of great concern, and this concern is heightened by the increasing movement of chemical production to low-income and middle-income countries where public health and environmental protections are often scant. Most future growth in chemical production will occur in these countries. A further dimension of chemical pollution is the global archipelago of contaminated hot-spots: cities and communities, homes and schoolyards polluted by toxic chemicals, radionuclides, and heavy metals released into air, water, and soil by active and abandoned factories, smelters, mines, and hazardous waste sites.

Cities, especially rapidly growing cities in industrialising countries, are severely affected by pollution. Cities contain 55% of the world's population; they account for 85% of global economic activity and they concentrate people, energy consumption, construction activity, industry, and traffic on a historically unprecedented scale.

The good news is that much pollution can be eliminated, and pollution prevention can be highly cost-effective. High-income and some middle-income countries have enacted legislation and issued regulations mandating clean air and clean water, established chemical safety policies, and curbed their most flagrant forms of pollution. Their air and water are now cleaner, the blood lead concentrations of their children have decreased by more than 90%, their rivers no longer catch fire, their worst hazardous waste sites have been remediated, and many of their cities are less polluted and more liveable. Health has improved and people in these countries are living longer. High-income countries have achieved this progress while increasing gross domestic product (GDP) by nearly 250%. The challenge for high-income nations today is to further reduce pollution, decarbonise their economies, and reduce the resources used in achieving prosperity. The claim that pollution control stifles economic growth and that poor countries must pass through a phase of pollution and disease on the road to prosperity has repeatedly been proven to be untrue.

Pollution mitigation and prevention can yield large net gains both for human health and the economy. Thus, air quality improvements in the high-income countries have not only reduced deaths from cardiovascular and respiratory disease but have also yielded substantial economic gains. In the USA, an estimated US\$30 in benefits (range, \$4–88) has been returned to the economy for every dollar invested in air pollution control

since 1970, which is an aggregate benefit of \$1.5 trillion against an investment of \$65 billion. Similarly, the removal of lead from gasoline has returned an estimated \$200 billion (range, \$110 billion–300 billion) to the US economy each year since 1980, an aggregate benefit to-date of over \$6 trillion through the increased cognitive function and enhanced economic productivity of generations of children exposed since birth to only low amounts of lead.

Pollution control will advance attainment of many of the sustainable development goals (SDGs), the 17 goals established by the United Nations to guide global development in the 21st century. In addition to improving health in countries around the world (SDG 3), pollution control will help to alleviate poverty (SDG 1), improve access to clean water and improve sanitation (SDG 6), promote social justice (SDG 10), build sustainable cities and communities (SDG 11), and protect land and water (SDGs 14 and 15). Pollution control, in turn, will benefit from efforts to slow the pace of climate change (SDG 13) by transitioning to a sustainable, circular economy that relies on non-polluting renewable energy, on efficient industrial processes that produce little waste, and on transport systems that restrict use of private vehicles in cities, enhance public transport, and promote active travel.

Many of the pollution control strategies that have proven cost-effective in high-income and middle-income countries can be exported and adapted by cities and countries at every level of income. These strategies are based in law, policy, regulation, and technology, are science-driven, and focus on the protection of public health. The application of these approaches boosts economies and increases GDP. The strategies include targeted reductions in emissions of pollutants, transitions to non-polluting, renewable sources of energy, the adoption of non-polluting technologies for production and transportation, and the development of efficient, accessible, and affordable public transportation systems. Application of the best of these strategies in carefully planned and well resourced campaigns can enable low-income and middle-income countries to avoid many of the harmful consequences of pollution, leapfrog the worst of the human and ecological disasters that have plagued industrial development in the past, and improve the health and wellbeing of their people. Pollution control provides an extraordinary opportunity to improve the health of the planet. It is a winnable battle.

The aim of this *Lancet* Commission on pollution and health is to raise global awareness of pollution, end neglect of pollution-related disease, and mobilise the resources and the political will needed to effectively confront pollution. To advance this aim, we make six recommendations. Additional recommendations are presented at the end of each Section. The key recommendations are:

(1) Make pollution prevention a high priority nationally and internationally and integrate it into country and city

planning processes. Pollution can no longer be viewed as an isolated environmental issue, but is a transcendent problem that affects the health and wellbeing of entire societies. Leaders of government at all levels (mayors, governors, and heads of state) need, therefore, to elevate pollution control to a high priority within their agendas; to integrate pollution control into development planning; to actively engage in pollution planning and prioritisation; and to link prevention of pollution with commitments to advance the SDGs, to slow the pace of climate change, and to control non-communicable diseases.

Targets and timetables are essential, and governments at all levels need to establish short-term and long-term targets for pollution control and to support the agencies and regulations needed to attain these goals. Legally mandated regulation is an essential tool, and both the polluter-pays principle and an end to subsidies and tax breaks for polluting industries need to be integral components of pollution control programmes.

(2) Mobilise, increase, and focus the funding and the international technical support dedicated to pollution control. The amount of funding from international agencies, binational donors, and private foundations that is directed to control of pollution, especially pollution from the industrial, transport, chemical, and mining sectors in low-income and middle-income countries is meagre and needs to be substantially increased. The resources directed to pollution management need to be increased within cities and countries as well as internationally. Options for increasing the international development funding directed to pollution include expansion of climate change and non-communicable disease control programmes to include pollution control and development of new funding mechanisms.

In addition to increased funding, international technical support for pollution control is needed in prioritisation and planning of processes to tackle pollution within rapidly industrialising cities and countries; in development of regulatory and enforcement strategies; in building technical capacity; and in direct interventions, in which such actions are urgently needed to save lives or can substantially leverage local action and resources. Financing and technical assistance programmes need to be tracked and measured to assess their cost-effectiveness and to enhance accountability.

(3) Establish systems to monitor pollution and its effects on health. Data collected at the national and local levels are essential for measuring pollution levels, identifying and apportioning appropriate responsibility to each pollution source, evaluating the success of interventions, guiding enforcement, informing civil society and the public, and assessing progress toward goals. The incorporation of new technologies, such as satellite imaging and data mining, into pollution monitoring can increase efficiency, expand geographic range, and lower costs. Open access to these data is essential, and consultation with civil society and the

public will ensure accountability and build public awareness. With even limited monitoring programmes, consisting of only one or a few sampling stations, governments and civil society organisations can document pollution, and track progress toward short-term and long-term control targets. Pollution control metrics should be integrated into SDG dashboards and other monitoring platforms so that successes and experiences can be shared.

(4) Build multi-sectoral partnerships for pollution control. Broad-based partnerships across several government agencies and between governments and the private sector can powerfully advance pollution control and accelerate the development of clean energy sources and clean technologies that will ultimately prevent pollution at source. Cross-ministerial collaborations that involve health and environment ministries, but also ministries of finance, energy, agriculture, development, and transport are essential. Collaborations between governments and industry can catalyse innovation, create incentives for cleaner production technologies and cleaner energy production, and incentivise transition to a more sustainable, circular economy. The private sector is in a unique position to provide leadership in the design and development of clean, non-polluting, sustainable technologies for pollution control, and to engage constructively with governments to reward innovation and create incentives.

(5) Integrate pollution mitigation into planning processes for non-communicable diseases. Interventions against pollution need to be a core component of the Global Action Plan for the Prevention and Control of Non-Communicable Diseases.

(6) Research pollution and pollution control. Research is needed to understand and control pollution and to drive change in pollution policy. Pollution-related research should:

- Explore emerging causal links between pollution, disease, and subclinical impairment, for example between ambient air pollution and dysfunction of the central nervous system in children and the elderly;
- Quantify the global burden of disease associated with chemical pollutants of known toxicity such as lead, mercury, chromium, arsenic, asbestos, and benzene;
- Identify and characterise the adverse health outcomes caused by new and emerging chemical pollutants, such as developmental neurotoxicants, endocrine disruptors, novel insecticides, chemical herbicides, and pharmaceutical wastes;
- Identify and map pollution exposures particularly in low-income and middle-income countries;
- Improve estimates of the economic costs of pollution and pollution-related disease; and
- Quantify the health and economic benefits of interventions against pollution and balance these benefits against the costs of interventions.

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Introduction

Pollution is one of the great existential challenges of the Anthropocene epoch. Like climate change, biodiversity loss, ocean acidification, desertification, and depletion of the world's fresh water supply, pollution endangers the stability of the Earth's support systems and threatens the continuing survival of human societies.¹ Pollution, especially pollution caused by industrial emissions, vehicular exhausts, and toxic chemicals, has increased sharply in the past 500 years, and the largest increases today are seen in low-income and middle-income countries. Yet despite its great and growing magnitude, industrial, vehicular, and chemical pollution in developing countries has been largely overlooked in international development and global health agendas, and programmes for pollution control have received little attention or resources from either international agencies or philanthropic donors. Pollution is now a substantial problem that endangers the health of billions, degrades the Earth's ecosystems, undermines the economic security of nations, and is responsible for an enormous global burden of disease, disability, and premature death.

Pollution is intimately linked to global climate change.^{2,3} Fuel combustion—fossil fuel combustion in high-income and middle-income countries, and biomass burning in inefficient cookstoves, open fires, agricultural burns, forest burning,^{4,5} and obsolete brick kilns in low-income countries—accounts for 85% of airborne particulate pollution and for almost all pollution by oxides of sulphur and nitrogen. Fuel combustion is the major source of greenhouse gases and short-lived climate pollutants that are the main anthropogenic drivers of global climate change (appendix pp 1–11).⁶

Pollution is very costly; it is responsible for productivity losses, health-care costs, and costs resulting from damages to ecosystems. But despite the great magnitude of these costs, they are largely invisible and often are not recognised as caused by pollution.⁷ The productivity losses of pollution-related diseases are buried in labour statistics. The health-related costs of pollution are hidden in hospital budgets.⁸ The result is that the full costs of pollution are not appreciated, are often not counted, and are not available to rebut one-sided, economically based arguments against pollution control.^{7,9}

The nature of pollution is changing and, in many places around the world, it is worsening. These changes reflect increased energy consumption, the increased use of new materials and technologies, the rapid industrialisation of low-income and middle-income countries, and the global movement of populations from rural areas into cities. Household air and water pollution, the forms of pollution that were historically associated with profound poverty and traditional lifestyles, are slowly declining. However, ambient air pollution, chemical pollution, and soil pollution, are all increasing.^{10,11} Key drivers of these types of pollution are: the uncontrolled growth of cities;¹² rising demands for energy; increasing

mining, smelting, and deforestation; the global spread of toxic chemicals; progressively heavier applications of insecticides and herbicides; and an increasing use of petroleum-powered cars, trucks, and buses. Increases in ambient air, soil, and chemical pollution over the past 500 years can be directly attributed to the currently prevalent, linear, take-make-use-dispose economic paradigm—termed by Pope Francis “the throwaway culture”¹³—in which natural resources and human capital are viewed as abundant and expendable, and the consequences of their reckless exploitation are given little heed.^{14,15} This economic paradigm focuses single-mindedly on GDP¹⁴ and is ultimately unsustainable: this model fails to link the economic development of human societies to social justice or to maintenance of the Earth's resources.^{1,2,15}

Scientific understanding of pollution and its effects on health have greatly advanced.^{16,17} New technologies, including satellite imaging,¹⁸ have enhanced the ability to map pollution, measure pollution levels remotely, identify sources of pollution, and track temporal trends.¹⁷ Sophisticated chemical analyses have refined understanding of the composition of pollution and elucidated links between pollution and disease.¹⁹ Large prospective, multi-year epidemiological studies, beginning with the studies by Pope and colleagues²⁰ in Utah and the Harvard Six-Cities study,²¹ have showed that pollution is associated with a much wider range of diseases, particularly non-communicable diseases, than was previously recognised. Pollution is now understood to be an important causative agent of many non-communicable diseases including asthma, cancer, neurodevelopmental disorders, and birth defects in children (appendix p 11); and heart disease, stroke, chronic obstructive pulmonary disease, and cancer in adults.^{22–34} In the absence of aggressive intervention, the number of deaths due to ambient air pollution are on track to increase by more than 50% by 2050.³⁵

Despite these advances in knowledge, there are still many gaps in information about pollution and its effects on health. These gaps include an absence of information in many countries on pollution levels and the prevalence of pollution-related disease; poor knowledge of the toxic effects of many chemicals in common use, especially newer classes of chemicals;^{36,37} incomplete information on the scope of exposures and burden of disease associated with toxic exposures at contaminated sites;³⁸ and inadequate information on the possible delayed effects of toxic exposures sustained in early life.³⁹ Also unknown is the exact shape of the dose-response functions used to estimate the relative risk of disease associated with pollution. In the case of fine-particulate air pollution, for example, the shape of the exposure–response association at both very low and very high exposure levels and the assumptions that underlie the integrated exposure–response function⁴⁰ used to estimate the relative risks of fine particulate (PM_{2.5}) exposure in

See Online for appendix

both the Global Burden of Disease (GBD) study^{41,42} and WHO analyses are not precisely known.²³

The good news is that, despite the great magnitude of pollution and current gaps in knowledge about its effects on human health and the environment, pollution can be prevented. Pollution is not the inevitable consequence of economic development. High-income and some middle-income countries have enacted legislation and issued regulations that build on new scientific knowledge about pollution and its health effects. These laws and regulations are based on the polluter-pays principle; they mandate clean air and clean water and set standards at levels that prevent disease, have established policies for chemical safety, have banned certain hazardous pollutants such as lead, asbestos, and DDT, and have effected clean-up of the worst of the hazardous waste sites.

Many of these proven, cost-effective control strategies are now ready to be exported and adapted for use by cities and countries at every level of income. Their application in carefully planned and well resourced campaigns can enable developing and industrialising countries to avoid many of the harmful consequences of pollution—to leapfrog over the worst of the human and ecological disasters that have plagued industrial development in the past—and to improve human health and wellbeing.

Contrary to the oft-repeated claim that pollution control stifles economic growth, pollution prevention has, in fact, been shown repeatedly to be highly cost-effective. In the USA, for example, concentrations of six common air pollutants have been reduced by about 70% since passage of the Clean Air Act in 1970 and, in the same time period, GDP has increased by nearly 250% (figure 1).⁴³ Every dollar invested in control of ambient air pollution in the USA not only improves health,⁴⁴ but also is estimated to yield US\$30 in economic benefits (95% CI \$4–88).⁴⁵

Another example of the economic benefits of addressing pollution is seen in the consequences of removing lead from gasoline in the USA. This intervention began in 1975 and, within a decade, had reduced the mean blood concentration of lead in the population by more than 90% (figure 2), almost eliminated childhood lead poisoning, and increased the cognitive capacity of all American children born since 1980 by 2–5 IQ points.⁴⁶ This gain in intelligence has increased national economic productivity and will yield an economic benefit of US\$200 billion (range \$110 billion–300 billion) over the lifetimes of each annual cohort of children born since 1980,⁴⁶ an aggregate benefit to-date of over \$6 trillion.^{47,48}

Yet, despite its harmful effects on human health, the economy, and the environment and, notwithstanding the clear evidence that it can be cost-effectively controlled, pollution (especially industrial, vehicular, and chemical pollution in low-income and middle-income countries) has been largely neglected.^{49,50} Work to control the biological contamination of drinking water^{51–54} and to curb

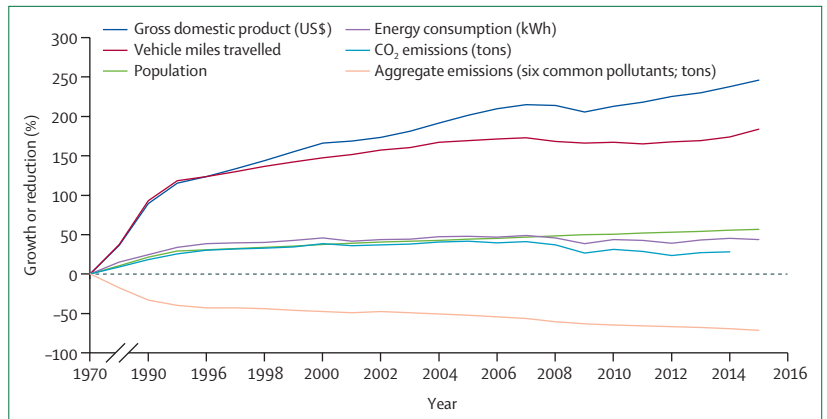


Figure 1: Pollution, population, and GDP in the USA, 1970–2015
Figure taken from reference 43, with permission.

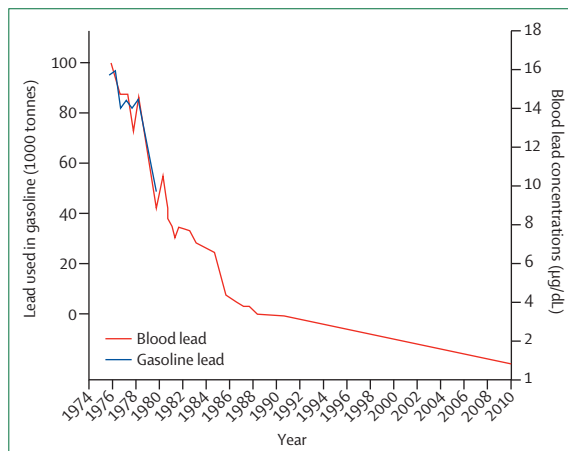


Figure 2: Correlation between population mean blood concentration of lead and lead use in gasoline in the USA, 1974–91
Taken from data that is publicly available from the Centers for Disease Control.

household air pollution produced by poorly ventilated cookstoves^{55–57} has occurred over many years and those efforts, along with new vaccines, antibiotics, and treatment protocols, have contributed to promising reductions in the morbidity and mortality associated with the traditional forms of pollution.^{58–60} However, the burgeoning problems of air, water, and soil pollution produced by modern industry, electricity generation, mining, smelting, petroleum-powered motor vehicles, and chemical and pesticide releases in low-income and middle-income countries have received almost no international attention or resources.^{49,50} Budgets for foreign aid from the European Commission, the US Agency for International Development, and most bilateral development agencies, private philanthropists, and major foundations have not included substantive funding for control of industrial, mining and transport-related pollution.^{50,61} The national and local resources directed toward the study and control of industrial, chemical, and vehicular pollution and the diseases that they cause within cities and countries are

For the Global Alliance for Clean Cookstoves see <http://cleancookstoves.org/>

For the US Agency for International Development see <https://explorer.usaid.gov/>

often meagre.⁶² Lastly, interventions against pollution are barely mentioned in the Global Action Plan for the Prevention and Control of Non-Communicable Diseases,⁶³ which is a major missed opportunity.

Several factors have contributed to the neglect of pollution. A persistent impediment has been the flawed conventional wisdom that pollution and disease are the unavoidable consequences of economic development, the so-called “environmental Kuznets hypothesis” (panel 1).^{64–73} This Commission vigorously challenges that claim as a flawed and obsolete notion formulated decades ago when populations and urban centres were much smaller than they are today, the nature, sources, and health effects of pollution were very different, and cleaner fuels and modern production technologies were not yet available.

Fragmentation of the agendas for environmental health and pollution control is another factor that has contributed to neglect of pollution. In many countries, responsibility for pollution-related disease falls between ministries of health and ministries for the environment, and too often belongs to neither. Air, water, soil, and chemical pollution are each regulated by different agencies and studied by different research groups. The consequence is that the

full scale of pollution and its contribution to the global burden of disease are not recognised. The separation of public health from environmental protection has also slowed the growth of research on pollution-related disease, led to the virtual elimination of coursework in environmental health science from the curricula of most medical and nursing schools, and impeded the development of environmental health policy.

In the international development agenda, neglect of the modern forms of pollution can be traced to the historical origins of overseas development assistance programmes whose goals, when they were launched at the end of World War 2, were to reduce poverty, improve maternal and child health, and combat infectious diseases in an era when much of the world was devastated and more than 50% of countries were classified as low-income.^{49,50} At that time, the predominant health problems of the developing world were infectious diseases and maternal and child mortality, and many overseas development programmes have been highly successful and have contributed to the control of these problems.⁷⁴ However, these programmes were never intended to address the more modern forms of pollution.

Finally, the opposition of powerful vested interests has been a perennial barrier to control of pollution, especially industrial, vehicular, and chemical pollution. These entrenched interests, which often exert disproportionate influence on government policy, impugn the science linking pollution to disease, manufacture doubt about the effectiveness of interventions, and paralyse governmental efforts to establish standards, impose pollution taxes, and enforce laws and regulations.⁷⁵ These interests act both within countries and internationally.

The aim of this *Lancet* Commission on pollution and health is to end the neglect of pollution, especially of the modern forms of pollution, in low-income and middle-income countries, to focus the world’s attention onto the silent threat of pollution-related disease, and to mobilise the national and international resources and the political will needed to effectively confront pollution.

To accomplish this aim and to mobilise the resources that will be needed to control pollution around the world, we have reviewed data on the health effects and economic costs of all forms of pollution: pollution of air, water, and soil, pollution in the workplace, and pollution by toxic chemicals (appendix p 15). We have also examined the links between pollution and poverty, injustice, and inequality. Finally, this Commission presents examples of cost-effective, proven strategies that can be adapted by cities and countries at every level of income to control pollution and prevent disease (appendix pp 63–107).

The work of this Commission on pollution and health builds upon work undertaken in the past decade by international organisations and bi-national funders to address the challenges of modern-day pollution, such as the World Bank Water and Sanitation Programme.^{76,77} WHO has established a Department of Public Health

For the World Bank Water and Sanitation Programme see <http://www.wsp.org/>

Panel 1: The environmental Kuznets curve

The Kuznets curve, developed by economist Simon Kuznets (1901–85), describes the association between economic inequality and per capita income over the course of economic development.⁶⁴ This curve illustrates Kuznets’ hypothesis that, as a society develops from a primarily agrarian to an urban, industrialised economy, market forces first increase and then, at a so-called “turning point” of per-capita income, decreases the overall degree of economic inequality in the society. These trends are shown as an inverted U-shaped curve.⁶⁵

The Kuznets hypothesis has been extended to environmental economics. Here, it is postulated that pollution and environmental degradation must increase in early stage economic development, that pollution will continue to increase up to a threshold of per-capita income, and that pollution will then decrease as the economy continues to grow. The postulated result is that high income and economic growth eventually lead to environmental improvements. This extension of Kuznets’ hypothesis has become entrenched as conventional wisdom in global environmental policy.^{66,67}

Despite the great certitude with which the environmental Kuznets hypothesis is sometimes promulgated, empirical and theoretical research finds that the historical evidence in support of this hypothesis is uneven, and that the underlying statistical methods are weak.^{70–72} Additional shortcomings are that the environmental Kuznets hypothesis fails to consider the movement of polluting industries from high-income to low-income and middle-income countries,⁶⁸ does not consider the health and environmental effects of modern classes of pollutants such as chemical carcinogens, neurotoxicants, and endocrine-disrupting chemicals,^{69–73} and does not consider the potential benefits to human health and the environment of newer, non-polluting energy sources.

The conclusions from this analysis are that pollution is not the unavoidable consequence of economic development, and that it is much more important to formulate sound laws, policies, and regulations to control pollution than to wait for an economy to reach a magical tipping point that will solve the problems of environmental degradation and pollution-related disease. The goal of this Commission is to catalyse the formulation of such policies.

and the Environment, which has become a global leader in documenting the effects of environmental threats to children's health.^{78,79} The UN Development Programme has taken on many components of the pollution control agenda. The World Bank financially supports several projects to control pollution. The UN Environment Programme also supports several programmes to control chemical pollution, some in partnership with WHO, and supports and oversees international agreements limiting the manufacture, environmental release, and global transport of persistent pollutants,⁸⁰ pesticides, hazardous waste, and mercury. The Strategic Approach to International Chemicals Management, housed within the UN Environment Programme, provides a platform for discussion on control of chemical pollution and toxic waste among a broad range of stakeholders (appendix pp 13–14). These global advances in controlling ambient air, chemical, and vehicular pollution are welcome⁸¹ and have produced important gains, such as phasing lead out from gasoline, endorsed by the Partnership for clean fuels and vehicles, incorporating air pollution into the health agenda,⁸² establishing programmes to control the addition of lead to paint,⁸³ and creating a pollution-focused trust fund within the World Bank.

Pollution defined

This Commission defines pollution as unwanted, often dangerous, material that is introduced into the Earth's environment as the result of human activity, that threatens human health, and that harms ecosystems; this definition is based on a definition of pollution developed by the European Union.⁸⁴

To provide a framework for organising scientific knowledge about pollution and its effects on human health and to help focus pollution-related research, this Commission has developed the concept of the pollutome (figure 3). The pollutome is defined as the totality of all forms of pollution that have the potential to harm human health. The pollutome can be viewed as a fully contained (nested) subset of the exposome.^{85,86} This model includes pollutant exposures during gestation, infancy, childhood, adolescence, adult life (including occupational exposures), and old age.

Because knowledge about the health effects of pollution varies by pollution type and ranges from the well characterised and quantified to the still emerging, we have divided the pollutome into three zones.

Zone 1 includes well established pollution–disease pairs, for which there are robust estimates of their contributions to the global burden of disease. The associations between ambient air pollution and non-communicable disease are the prime example.²³

Zone 2 includes the emerging effects of known pollutants, where evidence of causation is building, but associations between exposures and disease are not yet fully characterised and the burden of disease has not yet been quantified. Examples include associations between

PM_{2.5} air pollution and diabetes,^{24–26} pre-term birth,^{27–29} and diseases of the central nervous system, including autism in children,^{3,30–32} and dementia in the elderly.^{29,33} Soil pollution by heavy metals and toxic chemicals at contaminated industrial and mining sites provides another example of a potentially important, but not yet fully characterised or quantified source of pollution-related disease.^{38,87}

Zone 3 includes new and emerging pollutants,^{36,37} most of them chemical pollutants whose effects on human health are only beginning to be recognised and are not yet quantified. Several of these chemicals have become widely disseminated in the environment, and many are detectable in the bodies of most persons examined in national surveys, such as the Centers for Disease Control's national biomonitoring programme in the United States. At least some of these chemical pollutants appear to have potential to cause global epidemics of disease, disability, and death. This zone includes developmental neurotoxicants;^{37,88} endocrine disruptors;^{89–92} new classes of pesticides such as the neonicotinoids;⁹³ chemical herbicides such as glyphosate and nano-particles; and pharmaceutical wastes.^{94–96} These emerging chemical pollutants are discussed in detail in the appendix of this report (pp 2–11).

The list of diseases attributed to pollution will probably continue to expand as the environmental distributions and health effects of newer chemical pollutants are better defined and new exposure–disease associations are discovered. The health effects of pollution that are currently recognised and quantified could thus be the tip of a much larger iceberg.⁸⁸ As more research becomes available, some pollution–disease pairs that are currently placed in zones 2 and 3 of the pollutome could move up to

For the **Strategic Approach to International Chemicals Management** see <http://www.saicm.org/>

For the **Centers for Disease Control and Prevention national biomonitoring programme** see <https://www.cdc.gov/biomonitoring/>

For the **Partnership for clean fuels and vehicles** see <http://www.unep.org/transport/pcfvl/>

For the **World Bank pollution management and environmental health programme** see <http://www.worldbank.org/en/programs/pollution-management-and-environmental-health-program>

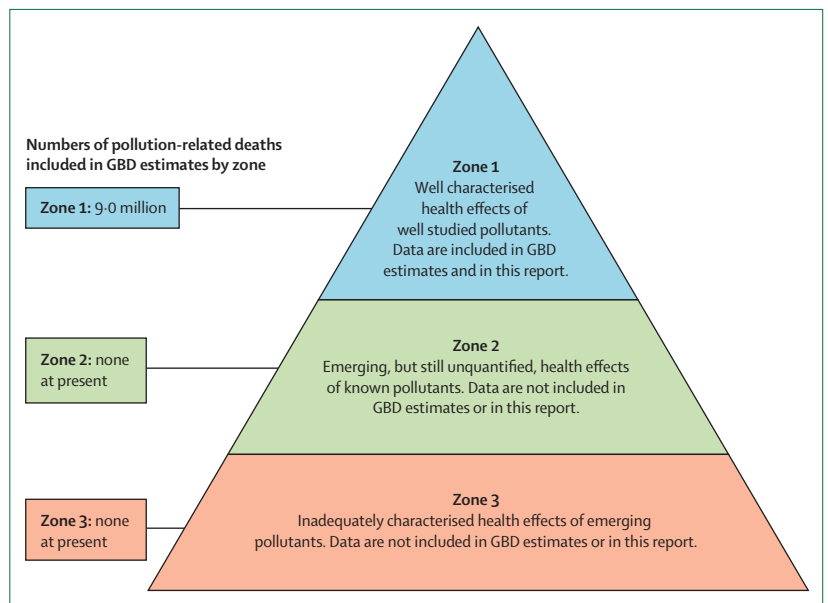


Figure 3: The pollutome

zone 1 and be included in future estimates of the global burden of disease. The numbers of deaths attributable to the forms of pollution included in zones 2 and 3 are unknown.

This Commission's work has been informed by the work of previous *Lancet* Commissions and Series, notably the Commission on Investing in Health,⁷² the Commission on the Political Origins of Health Inequity,⁷³ the Commission on Health and Climate Change,⁹⁷ and the Series on Public Health Benefits of Climate Change Mitigation Policies.⁹⁸ This Commission's deliberations were guided particularly closely by the findings of The Rockefeller Foundation-*Lancet* Commission on Planetary Health¹⁵ whose 2015 report described how human activity is changing the global environment, increasing risk of disease, and threatening the conditions that, ultimately, sustain all life on Earth.

This Commission was guided further by influential reports from international agencies, among them the 2016 report from WHO,⁹⁹ Preventing Disease through Health Environments, the World Bank's Shock Waves report¹⁰⁰ on climate change and global poverty, the World Bank's report,⁷⁷ Clean Air and Healthy Lungs, and the United Nations Environment report,¹⁰¹ Costs of Inaction on the Sound Management of Chemicals.

This report is organised into five Sections. Section 1 synthesises information on the burden of disease

attributable to pollution using data from the GBD 2015 Study^{41,42} coordinated by the Institute for Health Metrics and Evaluation, and supplemented by data from WHO^{99,102} and from Pure Earth.³⁸ Section 2 examines data on the economic costs of pollution and presents a detailed analysis of the economic losses that result from pollution-related disease. Section 3 examines the links between pollution, disease, and poverty and documents the marked inequities that characterise the global distribution of pollution and pollution-related disease and the disproportionate effects of pollution on children, the poor, the elderly, and other vulnerable populations. Section 4 presents pathways and priorities, case studies, and proven interventions that can be adopted and deployed to control pollution, prevent disease, and advance economic development. Section 5 outlines the Commission's plans for future initiatives.

Sustainable long-term control of pollution will require that societies at every level of income move away from the prevalent resource-intensive, and inherently wasteful, linear take-make-use-dispose economic paradigm, towards a new paradigm rooted in the concept of the circular economy (panel 2).^{15,103,104} In a circular economy, pollution is reduced through the creation of durable, long-lasting products, the reduction of waste by large-scale recycling, reuse, and repair, the removal of distorting subsidies, the replacement of hazardous materials with safer alternatives, and strict enforcement of pollution taxes.¹⁰⁵ A circular economy conserves and increases resources, rather than taking and depleting them. This societal transition is essential for promoting smart, sustainable, and inclusive growth that reduces pollution, promotes health, and prevents disease.¹⁰⁴

Limitations of the Commission

The Commission's economic analysis does not include information about the costs of environmental damage caused by pollution. The Commission recognises that the ecological damages due to pollution are substantial, but considered analyses of the costs of these damages to fall outside of the scope of our work.

Levels of pollution are changing and pollution caused by industrial, vehicular, and chemical emissions is increasing in many rapidly developing countries, but the Commission's analysis is based on data from the 2015 Global Burden of Disease study, information that is now 2 years old.

Section 1: The burden of disease attributable to pollution

In this Section, we review data for the global burden of disease and death attributable to pollution.^{23,38,42,99,106}

Methods

This review of the burden of disease and premature death due to pollution is based on a method for assessing disease burden that was developed in the 1980s by

Panel 2: Circular economy

A circular economy is an economic model that decouples development from the consumption of non-renewable resources and minimises the generation of pollution and other forms of waste by recycling and reuse.¹⁰⁴ In a fully circular economy, the only new inputs are renewable materials, and all non-renewable materials are recycled. The underlying assumption is that waste is an inherent inefficiency, a loss of materials from the system, and thus a cost.¹⁰⁴ Transition towards a circular economy will reduce pollution-related disease and improve health.

The three core principles of the circular economy are preservation of natural capital by reducing use of non-renewable resources and ecosystem management; optimisation of resource yields by circulating products and materials so that they are shared and their lifecycles extended; and fostering system effectiveness by designing out pollution, greenhouse gas emissions, and toxic materials that damage health.

The steps needed for transition towards a circular economy include large-scale transition to non-polluting sources of energy (wind, solar, and tidal), the production of durable products that require lower quantities of materials and less energy to manufacture than those being produced at present; incentivisation of recycling, re-use, and repair; and replacement of hazardous materials with safer alternatives.¹⁵

WHO.^{107,108} The core of this approach is the disability-adjusted life-year (DALY) concept, a summary metric of population health that combines information on mortality and disease into a single number to represent the health of a population, thus permitting comparisons of disease burden between countries, between diseases, and over time. The DALY method is at the core of the GBD project, a multinational study initiated by WHO in partnership with the World Bank and the Harvard School of Public Health,¹⁰⁸ and sustained today by WHO¹⁰² and the Institute for Health Metrics and Evaluation.^{41,42}

To examine the global burden of disease attributable to pollution risk factors, this Commission has relied principally on the 2015 estimates from the GBD study,^{41,42,106} coordinated by the Institute for Health Metrics and Evaluation. We also examine data from the 2012 WHO analysis^{99,102,109,110} of the global burden of disease caused by living and working in unhealthy environments.

Following the standard conservative practice of the GBD study^{42,106} and WHO,⁹⁹ this Commission has restricted its review to combinations of pollution risk factors and disease for which there is convincing or probable evidence of causal association. For this reason, numbers presented are likely to be underestimates of the full burden of disease attributable to the pollutant (figure 3).

In reviewing data on the burden of disease attributable to soil pollution caused by toxic chemicals and heavy metals at contaminated sites, this Commission has relied on information provided by the Blacksmith Institute/Pure Earth Toxic Sites Identification programme.³⁸ This programme obtains data on pollution caused by chemicals and metals at contaminated sites through field studies that use a protocol adapted from a US Environmental Protection Agency assessment tool.¹¹¹ Two particularly common types of contaminated sites are used lead-acid battery recycling sites, where lead is the principal pollutant, and artisanal and small-scale gold mining sites, where the principal pollutant is elemental mercury (which is used to extract gold from ore). We used the methods of Ericson and colleagues¹¹¹ to assess the burden of disease associated with lead-acid battery recycling sites, and the methods and data of Steckling and colleagues^{112,113} to assess the burden of disease associated with gold mining sites^{114–116}. These methods are described in detail in the appendix (pp 16–19).

The pollution risk factors examined by the Commission were: (1) air pollution: household air pollution, ambient fine particulate pollution (PM_{2.5}), and tropospheric ozone pollution; (2) water pollution: unsafe sanitation, and unsafe water sources; (3) soil, chemical, and heavy metal pollution: lead (including contaminated sites polluted by lead from battery recycling operations), and mercury from gold mining; and (4) occupational pollution: occupational carcinogens, and occupational particulates, gases, and fumes.

In reviewing disease burden in relation to national income, we have relied on the 2015 World Bank income classifications (high, upper middle, lower middle, and low). In reviewing disease burden in relation to geographical region, we have grouped countries using the regional groupings defined by WHO (Africa, eastern Mediterranean, Europe, Americas, southeast Asia, and western Pacific).

To examine temporal trends in the global burden of disease that are attributable to different forms of pollution, we have divided pollution into two broad categories: pollution linked to poverty and pollution linked to industrial development. Pollution linked to poverty includes household air pollution, unsafe water sources, and inadequate sanitation, the forms of pollution associated with profound poverty and traditional lifestyles in low-income and middle-income countries. Pollution linked to industrial development includes pollution produced by industrial emissions, vehicular exhausts, and chemical releases, and includes ambient fine particulate (PM_{2.5}) pollution, tropospheric ozone pollution, toxic occupational exposures, and soil pollution caused by heavy metals and toxic chemicals, including lead.

Main findings

The GBD study⁴² estimates that pollution-related disease was responsible for 9 million premature deaths in 2015—16% of total global mortality (table 1).^{42,99,102} The GBD study also estimates that disease caused by all forms of pollution was responsible for 268 million DALYs—254 million years of life lost and 14 million years lived with disability.¹⁰⁶ This information is available by country and region and is presented in the appendix.

WHO estimates that, in 2012, unhealthy environments were responsible for 12·6 million deaths worldwide—23% of total global mortality—and for 26% of deaths in children younger than 5 years.^{99,102,109,110}

The most important finding to be drawn from these two analyses is that both the GBD study and WHO find that pollution is a major cause of disease, disability, and premature death. The GBD study reports that pollution was responsible for an estimated 9·0 million deaths in 2015, whereas the WHO analysis concludes that living in unhealthy environments was responsible for 12·6 million deaths in 2012.

The difference between these two estimates of total mortality attributable to environmental factors mainly reflects differing definitions of environment. This Commission focuses strictly on pollution-related disease, as defined above. By contrast, the WHO definition of environment is broader and encompasses several risk factors that were not included in this Commission's analysis, including road accidents, ultraviolet and ionising radiation, noise, electromagnetic fields, occupational psychosocial risks, built environments, agricultural methods, and man-made climate and ecosystem change. Risk factors that were included

	GBD study best estimate (95% CI)	WHO best estimate (95% CI)
Air (total)	6.5 (5.7–7.3)	6.5 (5.4–7.4)
Household air	2.9 (2.2–3.6)	4.3 (3.7–4.8)
Ambient particulate	4.2 (3.7–4.8)	3.0 (3.7–4.8)
Ambient ozone	0.3 (0.1–0.4)	..
Water (total)	1.8 (1.4–2.2)	0.8 (0.7–1.0)
Unsafe sanitation	0.8 (0.7–0.9)	0.3 (0.1–0.4)
Unsafe source	1.3 (1.0–1.4)	0.5 (0.2–0.7)
Occupational	0.8 (0.8–0.9)	0.4 (0.3–0.4)
Carcinogens	0.5 (0.5–0.5)	0.1 (0.1–0.1)
Particulates	0.4 (0.3–0.4)	0.2 (0.2–0.3)
Soil, heavy metals, and chemicals	0.5 (0.2–0.8)	0.7 (0.2–0.8)
Lead	0.5 (0.2–0.8)	0.7 (0.2–0.8)
Total	9.0	8.4

Note that the totals for air pollution, water pollution, and all pollution are less than the arithmetic sum of the individual risk factors within each of these categories because these have overlapping contributions—eg, household air pollution also contributes to ambient air pollution and vice versa.

Table 1: Global estimated deaths (millions) due to pollution risk factors from the Global Burden of Disease study (GBD; 2015)^{99,101} versus WHO data (2012)^{99,101}

in the WHO analysis and not in this Commission account for more than 3 million deaths each year, thus explaining most of the apparent discrepancy between the two estimates (panel 3).^{117–120}

Some specific differences are seen between the two sets of estimates (figure 4).^{42,99} For example, the GBD study estimates that 4.2 million deaths in 2015 were because of ambient air pollution, whereas WHO attributes 3.7 million deaths in 2012 to this risk factor. The two analyses relied on similar approaches to comparative risk assessment, on the same sources of exposure data, and on the same integrated exposure–response functions⁴⁰ but, in 2014, the GBD study made changes to their computational methodology,⁴² which appears to account for most of the divergence.

The GBD study estimated that 2.9 million deaths in 2015 were associated with household air pollution, whereas WHO estimated 4.3 million related deaths in 2012. This difference can partly be explained by different approaches in quantifying exposure–outcome associations. The GBD study relied on the integrated exposure–response curve⁴⁰ to provide evidence for the effect size of non-communicable diseases, whereas WHO adapted relative risks for certain non-communicable diseases based on epidemiological evidence. Additionally, the GBD study has expanded data sources for personal exposure values for women, men, and children in the past 2 years.

The GBD study estimated that, in 2015, 1.8 million deaths resulted from diseases related to water pollution, whereas WHO estimated 0.84 million related deaths in 2012. This divergence appears largely to reflect

differing definitions of access to safe water. The GBD study considers access to safe water at both the water’s source and at the point of use, whereas WHO only considers access to an improved water source.

Diseases caused by all forms of pollution were responsible for an estimated 9 million deaths in 2015.⁴¹ Pollution is thus responsible for more deaths than a high-sodium diet (4.1 million), obesity (4.0 million), alcohol (2.3 million), road accidents (1.4 million), or child and maternal malnutrition (1.4 million). Pollution was also responsible for three times as many deaths as AIDS, tuberculosis, and malaria combined (figure 5)⁴¹ and for nearly 15 times as many deaths as war and all forms of violence.⁴¹ Only dietary risk factors (all combined) (12.1 million) and hypertension (10.7 million) caused more deaths than pollution; however, the Commission notes that approximately 2.5% of deaths due to hypertension are attributable to lead.

Pollution and non-communicable diseases

Non-communicable diseases account for most of the total burden of disease due to pollution—approximately 71%.⁴¹ In 2015, all forms of pollution combined were responsible for 21% of all deaths from cardiovascular disease, 26% of deaths due to ischaemic heart disease, 23% of deaths due to stroke, 51% of deaths due to chronic obstructive pulmonary disease, and 43% of deaths due to lung cancer (figure 6).⁴²

The relative risks of all non-communicable diseases associated with pollution increase as exposure to pollution increases. An integrated exposure–response function has been developed to describe these associations, and the health effects of air pollution are quantitatively consistent with those of tobacco smoke when their relative risks are plotted against a common metric of exposure to airborne fine particulates.¹²¹

The sources and nature of pollution change as countries develop and industrialise (figure 7).^{10,42} An unsafe water source, unsafe sanitation, and household air pollution are considered to be forms of pollution linked to poverty and the early stages of industrial development. Airborne fine particulate pollution, tropospheric ozone pollution, occupational chemical pollution, and soil pollution by heavy metals and chemicals (including lead) are considered to be forms of pollution linked to industrial development.

Changes to the distribution of pollution-related diseases occur in response to the changes that accompany development.¹¹ Thus deaths from pneumonia and diarrhoeal diseases—the diseases associated with household air pollution, water pollution, and poor sanitation—are slowly declining worldwide, although they still kill millions of people, particularly children in poor countries. These declines reflect reductions in the forms of pollution associated with traditional lifestyles in low-income and middle-income countries, and the advent of new vaccines such as the pneumococcal vaccine and the rotavirus vaccine;⁵⁹ new approaches to paediatric

Panel 3: WHO's programme on pollution and health

WHO has, for several decades, been a leader in conducting crucial evaluations of the health effects of pollution, and these assessments provide the scientific basis for pollution control policies in many countries. WHO is also a global leader in providing guidelines and in coordinating health-focused partnerships for pollution control.

WHO is now further expanding this work through the framework of the Sustainable Development Goals (SDGs). WHO is the custodian agency that monitors progress towards six SDG targets; this monitoring includes tracking several targets measuring the environmental health-related burden of disease within SDG 3. The following are examples of this work:

Ambient air pollution

- WHO has periodically reviewed the international literature on air pollution and developed Global Air Quality Guidelines.¹¹⁷ These are the primary reference points for air pollution standards worldwide. The latest version was published in 2006,¹¹⁷ and a committee has been formed to create an updated version in 2018.
- WHO hosts one of the largest databases of ambient air pollution measurements in cities. Currently, the publicly available WHO Global Urban Ambient Air Pollution Database contains air quality measurements from 3000 cities, representing 103 countries. In the past 2 years alone, the database has nearly doubled in size, with more cities now measuring air pollution concentrations and recognising the associated health effects than ever before. This database also provides inputs to the integrated models that use satellite remote-sensing and chemical transport models to estimate ambient air pollution exposure globally, including estimates for regions without any ground-level monitoring (eg, smaller cities and rural areas). The Global Urban Ambient Air Pollution Database also supports monitoring of urban air quality for SDG 11 indicator 11.6: "to reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management".¹¹⁸

Household air pollution

- WHO has developed guidelines¹¹⁹ for indoor air quality regarding household fuel combustion, which clarified the enormous health risks of burning kerosene, coal, and wood in the home, and has provided emission standards for home energy equipment used in cooking, heating, and lighting. This work filled a gap in health guidance for household energy interventions and is increasingly being adopted by development partners investing in improving access to energy in the homes of the poor worldwide.

- WHO has developed several tools and training programmes to build the capacity and understanding of countries and actors working in different sectors to effectively address household energy as a health risk. WHO is currently developing a Clean Household Energy Solution Toolkit (CHEST) to provide the guidance and tools necessary for countries to implement the WHO Guidelines for Indoor Air Quality: Household Fuel Combustion.¹¹⁹
- Monitoring access to clean energy in the home is led by WHO in close cooperation with partners performing household surveys (UNICEF, USAID, and the World Bank). The associated indicator, 7.1.2—the "proportion of population with primary reliance on clean fuels and technology"—is part of the Global Tracking Framework of Sustainable Energy for All and is used to show progress towards SDG 7, which follows WHO guidelines criteria.

Climate, pollution, and health

- WHO, the Climate and Clean Air Coalition, and UN Environment Programme have joined forces in the BreatheLife campaign to address the associated crises of air pollution and climate change. The campaign was announced in July, 2016, and launched at Habitat III in Quito, Ecuador.

Urban health

- WHO has established the Urban Health Initiative to reduce deaths and diseases associated with air and climate pollutants in cities, while enhancing health benefits from the policies and measures used to tackle climate pollution.

Water and sanitation

- WHO has produced authoritative guidelines and technical assistance on management of water quality, sanitation, and wastewater, and health for decades. Along with UNICEF, WHO is responsible for tracking the extent of human exposure to poor water, inadequate sanitation, and poor hygiene.

Toxic chemicals

- WHO is the leading international agency for chemical safety through its Intergovernmental Panel on Chemical Safety, which sets guidelines for dozens of commonly used chemicals. The importance of chemicals management is reflected by SDG target 3.9 on reducing deaths and illness from hazardous chemicals, and links to target 12.4 on the sound management of chemicals and wastes. Achievement of sound chemicals management requires a multisector, multistakeholder approach. To advance this work, the 2017 World Health Assembly approved a Chemicals Road Map to enhance the engagement of the health sector in the management of international chemicals.

(Continues on next page)

For the **WHO Global Urban Ambient Air Pollution Database** see www.who.int/phe/health_topics/outdoorair/databases/cities

For the **WHO Chemicals Road Map** see www.who.int/ipcs/saicm/roadmap

(Panel 3 continued from previous page)

Mercury

- WHO is supporting implementation of the Minamata Convention on Mercury and has developed guidance for phasing out mercury-containing instruments in the health sector.¹²⁰ Urgent attention by health departments and ministries is needed to address the phase out of import, export, and manufacture of mercury thermometers, sphygmomanometers, and other mercury-containing instruments in health care.

Cancer

- WHO's International Agency for Research on Cancer (IARC) has the responsibility of determining whether chemicals are human carcinogens and conducts a range of research on cancer worldwide. IARC provides evidence-based guidance on cancer control to countries around the world.

For the Health Effects Institute special report on the state of global air see <https://www.stateofglobalair.org>

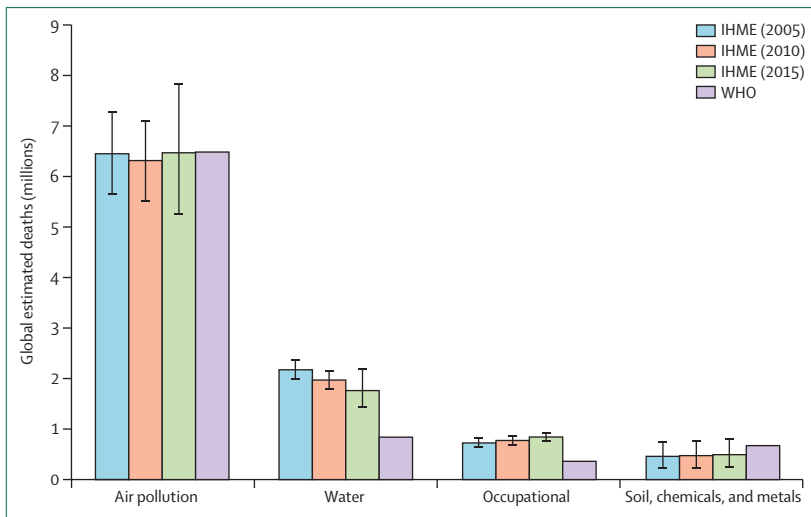


Figure 4: Global estimated deaths (millions) by pollution risk factor, 2005–15
Using data from the GBD study⁴² and WHO.⁹⁹ IHME=Institute for Health Metrics and Evaluation.

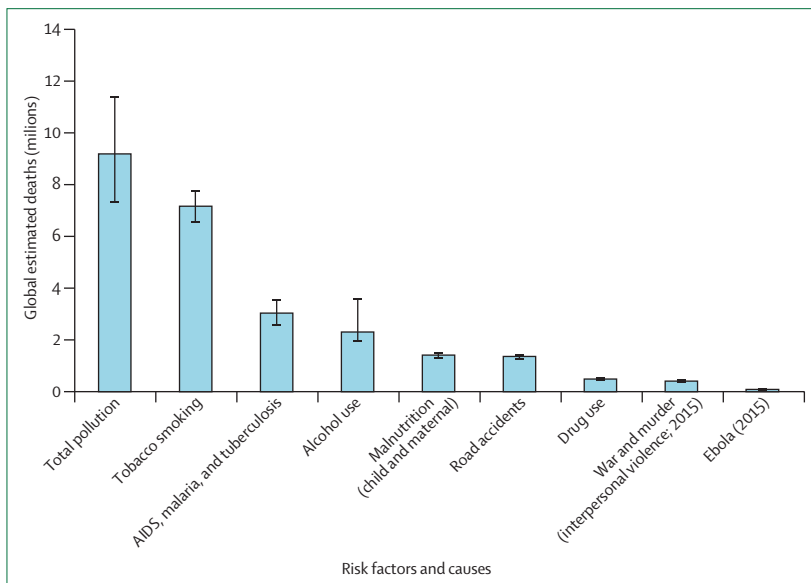


Figure 5: Global estimated deaths by major risk factor and cause, 2015
Using data from the GBD Study, 2016.⁴¹

therapy such as oral rehydration therapy;⁶⁰ and improved nutrition of young children and pregnant women.⁶¹

By contrast, the numbers of deaths caused by ambient air, chemical, and soil pollution—the forms of pollution associated with modern industrial and urban development—are increasing. The number of deaths attributable to PM_{2.5} air pollution is estimated to have risen from 3.5 million (95% CI 3.0 million–4.0 million) in 1990 to 4.2 million (3.7 million–4.8 million) in 2015, a 20% increase. Among the world's 10 most populous countries in 2015, the largest increases in numbers of pollution-related deaths were seen in India and Bangladesh, as reported by the Health Effects Institute. The increase in the absolute number of deaths and DALYs attributable to pollution reflects an increased population size, an ageing population, and increased levels of air pollution in low-income and middle-income countries.²³

An analysis of future trends in mortality associated with ambient PM_{2.5} air pollution finds that, under a “business as usual scenario”, in which it is assumed that no new pollution controls will be put into place, the numbers of deaths due to pollution will rise over the next three decades, with sharpest increases in the cities of south and east Asia.^{35,121} These trends are projected to produce a more than 50% increase in mortality related to ambient air pollution, from 4.2 million deaths in 2015 to 6.6 million deaths in 2050 (95% CI 3.4 million–9.3 million).^{35,122} These projections are corroborated by an analysis¹⁰⁷ of the health effects of coal combustion in China. Population ageing are major contributors to these projections of growth and absolute increased numbers of deaths from pollution-related disease.

A second analysis¹²³ examining the potential benefits of reducing PM_{2.5} pollution projects that aggressive controls could avoid 23% of current deaths related to air pollution. However, because of population ageing and consequent increases in age-related mortality from cardiovascular disease, chronic obstructive pulmonary disease, and lung cancer, and also because the exposure–response association between PM_{2.5} pollution and non-communicable diseases is relatively strong at lower levels of exposure but weaker at higher levels, Apte and colleagues¹²⁴ note that it will be easier to achieve reductions in mortality in less heavily polluted areas of western

Europe and North America than in heavily polluted regions in Asia.

Geography of pollution

In 2015, the greatest numbers of deaths due to pollution occurred in southeast Asia (3·2 million deaths) and the western Pacific (2·2 million deaths; figure 8).⁴² In this definition, southeast Asia includes India and the western Pacific region includes China. The highest population-based estimates of premature death and disease due to pollution are seen in the low-income countries of sub-Saharan Africa.⁴²

Pollution and poverty

92% of all pollution-related mortality is seen in low-income and middle-income countries, with the greatest numbers of deaths from pollution-related disease occurring in rapidly developing and industrialising lower-middle-income countries (figure 9).⁴² In the most severely affected countries, pollution is responsible for more than one in four deaths.⁴² In countries at every level of income, the health effects of pollution are most frequent and severe among the poor and the marginalised. Further discussion of the links between pollution, disease, and poverty is presented in section 3 of this report.

Disease and death due to pollution occur most frequently in the very young and the very old. Deaths due to all forms of pollution show a peak among children younger than 5 years of age, but most pollution-related deaths occur among adults older than 60 years of age (figure 10).⁴² By contrast, DALYs resulting from pollution-related disease are highly concentrated among infants and young children, reflecting the many years of life lost with each death and case of disabling disease of a child (figure 11).⁴²

Air pollution

Two types of air pollution—household air pollution and ambient air pollution—and two airborne pollutants—fine particulates and ozone—are considered in this Commission.²³ Pollution caused by oxides of nitrogen and by some short-lived climate pollutants is not fully accounted for in this Commission because the burden of disease due to these forms of air pollution is not separately quantified in the GBD study.

Although household and ambient air pollution are considered separately in deriving estimates of disease burden,^{42,99} they are both comprised of many of the same pollutants and often co-exist; for example, in low-income and middle-income countries, household cooking contributes to ambient particulate air pollution.^{55,56} Accordingly, the total numbers of deaths attributed to air pollution in the GBD study and in the WHO estimates are less than the arithmetic sum of the number of deaths attributed to each form of pollution alone.^{35,99,125}

Air pollution disperses globally. Airborne pollutants travel across national boundaries, continents, and oceans.^{126–128} An analysis¹²⁹ of emissions from Chinese export manufacturers found that, on days with strong westerly winds (winds blowing from China across the Pacific), 12–24% of sulphate concentrations, 2–5% of ozone, 4–6% of carbon monoxide, and up to 11% of black carbon pollution detected in the western USA were of Chinese origin.

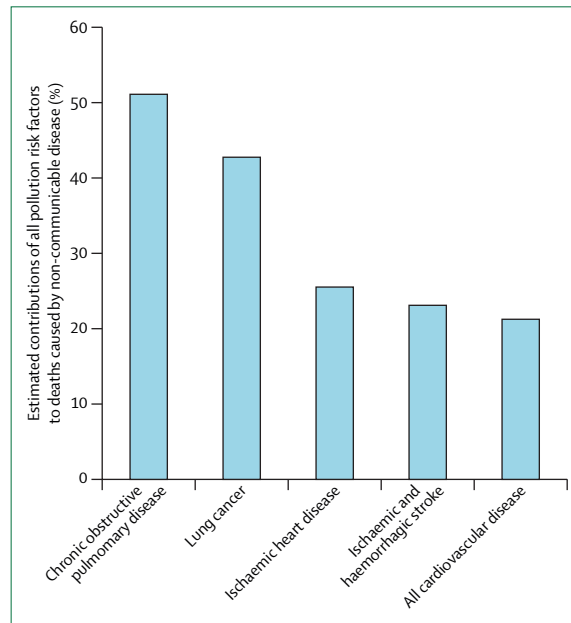


Figure 6: Estimated contributions of all pollution risk factors to deaths caused by non-communicable diseases, 2015
GBD Study, 2016.⁴²

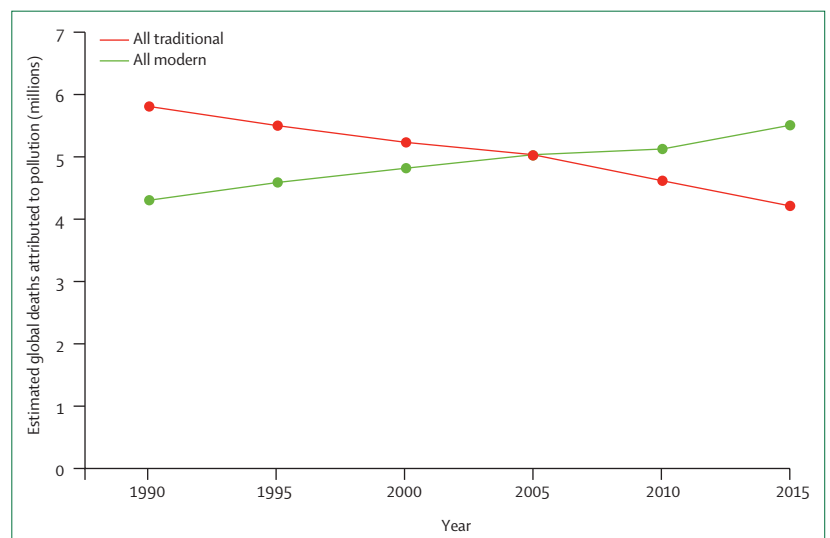


Figure 7: Estimated global deaths (millions) by pollution category, 1990–2015
GBD Study, 2016.⁴¹ All modern=modern forms of pollution, comprising ambient air, chemical, occupational, and soil pollution. All traditional=traditional forms of pollution, comprising household air and water pollution.

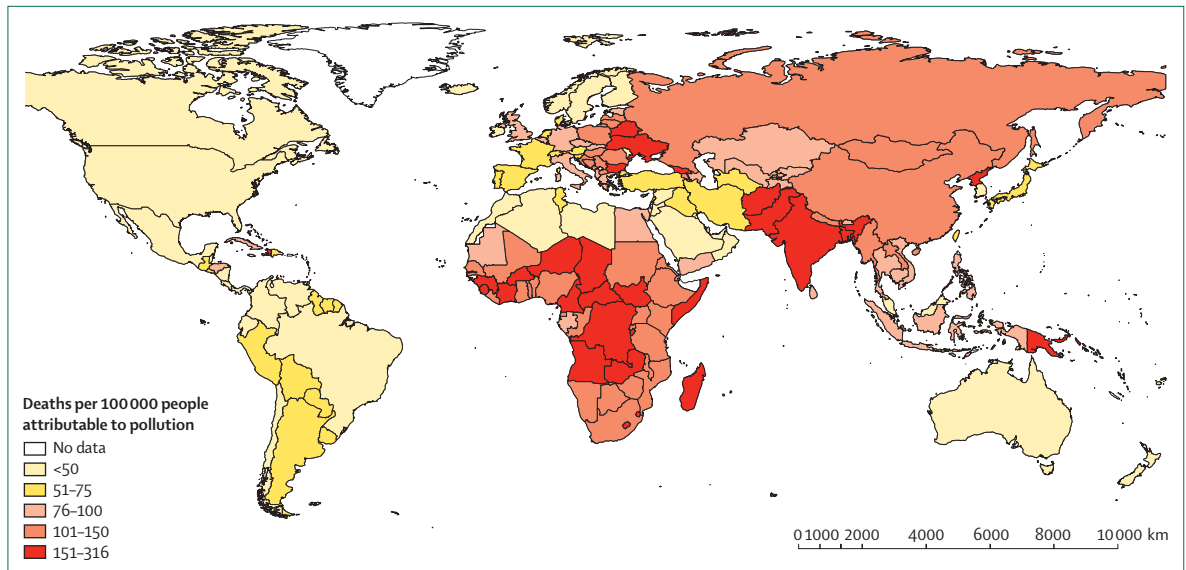


Figure 8: Number of deaths per 100 000 people that are attributable to all forms of pollution, 2015
GBD Study, 2016.⁴²

Air pollution and disease

PM_{2.5} is the best studied form of air pollution and is linked to a wide range of diseases in several organ systems.^{23,130} The strongest causal associations are seen between PM_{2.5} pollution and cardiovascular and pulmonary disease. Specific causal associations have been established between PM_{2.5} pollution and myocardial infarction,^{131–137} hypertension,¹³⁸ congestive heart failure, arrhythmias,¹³⁹ and cardiovascular mortality.^{24,140–143} Causal associations have also been established between PM_{2.5} pollution and chronic obstructive pulmonary disease and lung cancer.⁴² The International Agency for Research on Cancer has reported that airborne particulate matter and ambient air pollution are proven group 1 human carcinogens.^{34,40,144}

Fine particulate air pollution is associated with several risk factors for cardiovascular disease, including: hypertension,¹³⁸ increased serum lipid concentrations,¹⁴⁵ accelerated progression of atherosclerosis,^{146–148} increased prevalence of cardiac arrhythmias,¹³⁹ increased numbers of visits to emergency departments for cardiac conditions,^{132,133} increased risk of acute myocardial infarction,¹³¹ and increased mortality from cardiovascular disease¹⁴² and stroke.¹⁴⁹

Clinical and experimental studies suggest that fine airborne particles increase risk of cardiovascular disease by inducing atherosclerosis, increasing oxidative stress, increasing insulin resistance, promoting endothelial dysfunction, and enhancing propensity to coagulation.^{145,147,148,150}

Emerging evidence suggests that additional causal associations may exist between PM_{2.5} pollution and several highly prevalent non-communicable diseases. These include diabetes,²⁵ decreased cognitive function, attention-deficit or hyperactivity disorder and autism in

children,^{30,31,151,152} and neurodegenerative disease, including dementia, in adults.^{28,29,33} PM_{2.5} pollution may also be linked to increased occurrence of premature birth and low birthweight.^{27,153–159} Some studies have reported an association between ambient air pollution and increased risk of sudden infant death syndrome.¹⁶⁰ These associations are not yet firmly established, and the burden of disease associated with them has not yet been quantified, and they are therefore included in zone 2 of the pollutome (figure 3).

Water pollution

This Commission considers two types of water pollution: unsafe water source and inadequate sanitation.⁵¹ Many areas in low-income and middle-income countries lack

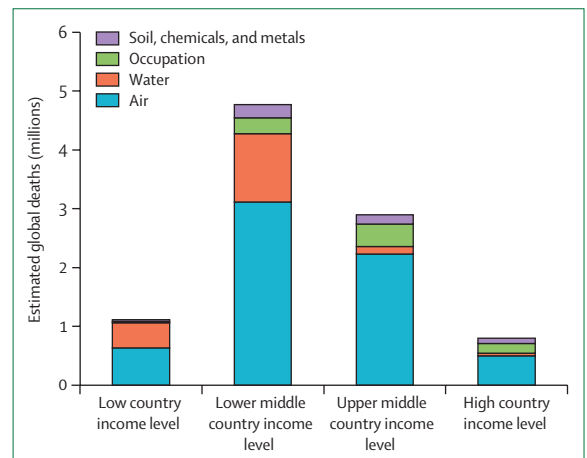


Figure 9: Estimated deaths by pollution risk factor and country income level, 2015
GBD Study, 2016.⁴²

acceptable water supplies and many people, particularly in rural areas in poor countries, have inadequate sanitation.⁵² Prevention technologies and systems exist, but poverty, lack of knowledge, and other priorities constrain the adoption of improvements.¹⁶¹

The problems of water supply and health are intensified where industrial pollutants contaminate water systems because treatments that control infectious agents are not effective in removing many toxic chemicals from drinking water. Improved analytical techniques have allowed identification of hundreds of industrial chemicals, pharmaceuticals, and pesticides in water systems. Some of the worst biological and chemical pollution of drinking water is seen in rapidly urbanising and industrialising lower-middle-income countries, where local waterways and groundwater are heavily polluted and serious health conditions are widely reported, but no alternative water sources exist.⁵³

The principal diseases linked to water pollution are acute and chronic gastrointestinal diseases, most importantly diarrhoeal diseases (70% of deaths attributed to water pollution), typhoid fever (8%), paratyphoid fever (20%), and lower respiratory tract infections (2%).⁴² These estimates include diseases associated with an unsafe water source, inadequate sanitation, and inadequate hand-washing. Polluted water and inadequate sanitation are linked, additionally, to a range of parasitic infections. These diseases affect more than 1 billion people, predominantly in low-income and middle-income countries.⁴¹

Water pollution also has effects on planetary health that extend beyond its effects on human health.¹⁵ Pollution of rivers, lakes, and the oceans from agriculture, manufacturing, and the extractive industries can have catastrophic effects on freshwater and marine ecosystems that result in the collapse of fisheries and the diminished livelihood of indigenous populations and others who rely upon fish as a major food source.^{162,163}

Most of the deaths caused by unsafe sanitation and unsafe water sources occur in children younger than 5 years of age. Increased numbers of deaths from waterborne pollution-related disease are also seen in adults older than 60 years of age.

Burden of disease due to water pollution

The GBD study⁴² estimates that, in 2015, 1.8 million deaths were attributable to water pollution, including unsafe water sources, unsafe sanitation, and inadequate handwashing. Of this total, 0.8 million deaths were estimated to be caused by unsafe sanitation and 1.3 million to unsafe water sources. The total burden of disease attributable to water pollution is less than the sum of the diseases attributable to each of its components because of overlaps between unsafe water source, unsafe sanitation, and inadequate handwashing. WHO data indicate that 0.28 million deaths were attributable to unsafe sanitation in 2012 and that unsafe water sources

were responsible for 0.5 million deaths.⁹⁹ As in the case of air pollution, the total number of deaths attributed to all forms of water pollution combined is less than the arithmetic sum of the deaths due to the individual types of water pollution because the various types of water pollution often co-exist and overlap with each other.

Trends in disease from water pollution

Targeted interventions to provide modern water and sanitation infrastructure began in the developing world as early as the 1950s, in the early days of international development assistance programmes. The Millennium

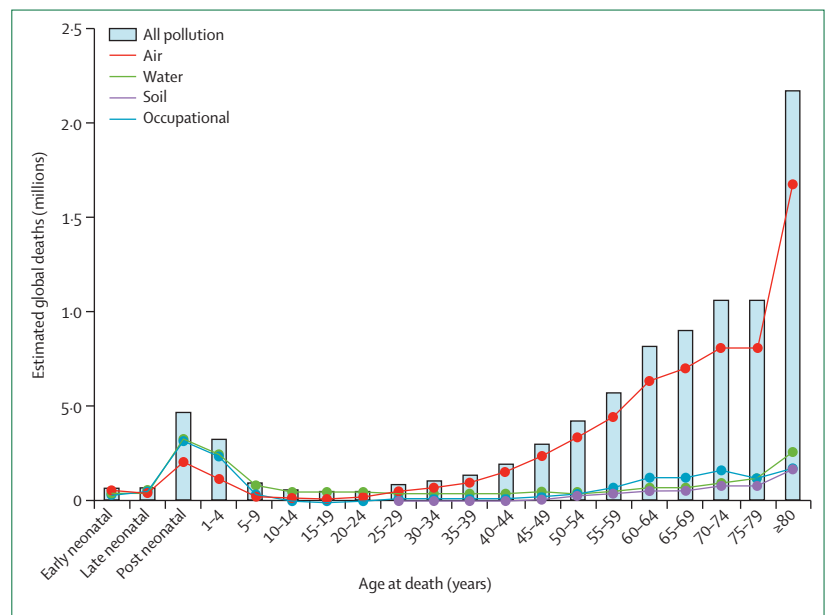


Figure 10: Estimated global deaths by pollution risk factor and age at death, 2015 GBD Study, 2016.⁴²

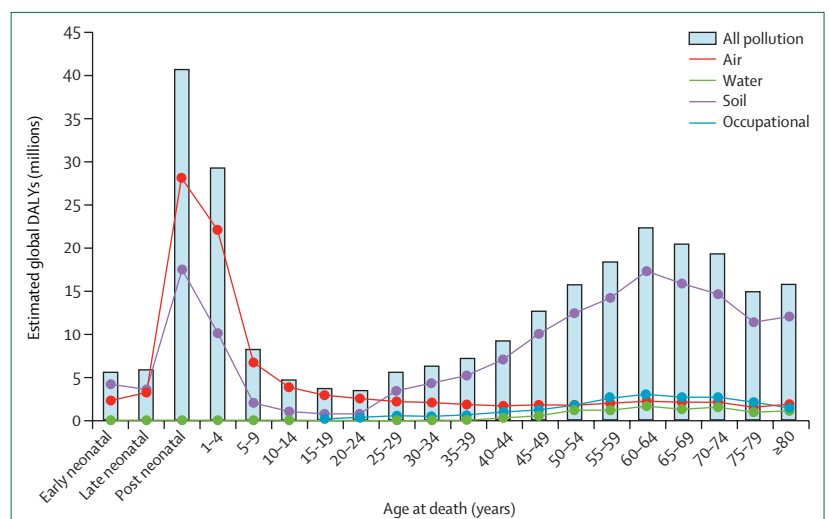


Figure 11: Estimated global DALYs by pollution risk factor and age at death, 2015 GBD Study, 2016.⁴² DALYs=disability-adjusted life-years.

Development Goals (MDGs) accelerated this work, and MDG Target 7C called on the global community “by 2015, to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation”. To track interventions against water pollution and waterborne disease, WHO and UNICEF established the Joint Monitoring Programme for Water Supply and Sanitation.⁵⁴

Substantial progress has been made in reducing water pollution and waterborne disease. Between 1990 and 2015, 2·6 billion people gained access to improved drinking water sources, 2·1 billion people gained access to improved sanitation, and the MDG Target 7C was met 5 years ahead of schedule. In this time, the number of children dying from diarrhoeal diseases decreased by almost 60%, from approximately 1·5 million deaths in 1990 to slightly greater than 0·6 million deaths in 2012. However, despite this progress, 2·4 billion people are still using unimproved sanitation facilities, including 946 million people who still practise open defecation.

For WHO data on numbers of water pollution-related mortalities see http://www.who.int/healthinfo/mortality_data/en/

Geography of water pollution and disease

Population-based estimates of the number of deaths from water pollution are highest in sub-Saharan Africa (figure 12).⁴² Large numbers of deaths are seen also in some southeast Asian countries. In the past two decades, China has greatly reduced mortality from waterborne infectious disease.⁴²

Importantly, these data do not reflect deaths from chemical pollution of water, because data for levels of chemical contamination of drinking water are not available for most low-income and middle-income

countries. Disease due to chemical contamination of drinking water is included in zone 2 of the pollutome (figure 3).

Soil, heavy metal, and chemical pollution

Comprehensive assessments of the health effects of most forms of soil, heavy metal, and chemical pollution have not yet been published. Lead is an exception, and has been studied extensively. Newer research on a few contaminated sites is beginning to report data for disease burden at these sites; at present, these estimates are limited to DALYs and do not include deaths.

Lead

People have used lead for centuries but, until the modern era, it was largely an occupational poison.¹⁶⁴ In the 19th and 20th centuries, lead moved beyond the workplace into air, water, and soil in countries around the world as a consequence of sharp increases in lead production that accompanied the Industrial Revolution. In the early 20th century, lead was incorporated, for the first time, into mass-market consumer products such as lead-based paint and gasoline. Global contamination of air, water, and soil resulted. Global production of lead has more than doubled since the 1970s and continues to rise. Increasing global manufacture of batteries for products ranging from mobile phones to cars, is the main driver of this increase.¹⁶⁵ 82% of deaths due to lead occur in low-income and middle-income countries.

In adults, chronic exposure to lead is an established risk factor for hypertension, renal failure, cardiovascular

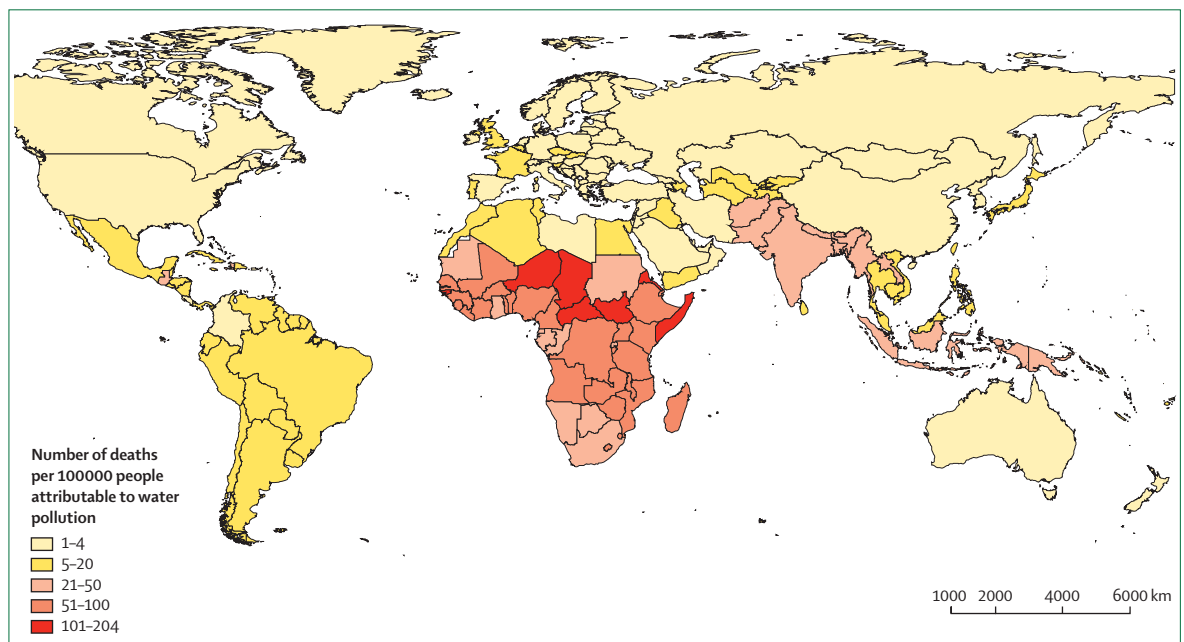


Figure 12: Number of deaths per 100 000 people due to water pollution, 2015
GBD Study, 2016.⁴²

disease, and stroke, especially among workers exposed in their occupations. Large-scale epidemiological studies²⁶ based on a national probability sample have confirmed that the causal association between lead, hypertension, and mortality from cardiovascular disease is evident even at very low blood lead concentrations.

Neurodevelopmental toxicity is the most important consequence of lead toxicity in children.¹⁶⁶ The neuro-behavioural sequelae of paediatric lead exposure include cognitive impairment,¹⁶⁷⁻¹⁷⁰ shortening of attention span with increased risk for attention deficit or hyperactivity disorder,¹⁷¹ and increased risk for antisocial and criminal behaviours.^{172,173} These effects can persist across the entire lifespan and result in decreased school performance, increased risk of drug abuse and incarceration, and decreased economic productivity. Lead causes neuro-behavioural damage in children at even the very lowest blood concentrations. WHO states that “there is no known level of lead exposure that is considered safe” (panel 4).^{30,32,37,88,91,173-177}

Trends in lead exposure

Despite continuing increases in global lead production, bans on the use of lead in petrol, paint, plumbing, and solder have produced substantial reductions in lead exposure and disease burden. Lead has now been removed from gasoline in more than 175 countries.

Despite these advances, several sources of occupational and community exposure to lead persist.^{38,178,179} Lead-glazed pottery is a notable source of exposure in several countries.^{169,180} Infants in the womb can be exposed to lead via transplacental transfer, and nursing infants can be exposed to lead in breastmilk.¹⁸¹ Children are at risk of exposure to lead-based paint in older housing^{182,183} and to lead that leaches into drinking water from lead pipes and solder.¹⁸⁴ Informal (so-called “backyard”) recycling of used lead-acid batteries is a widespread source of lead exposure for both workers and communities.¹⁸⁵

Estimates from the GBD study⁴² indicate that lead was responsible for 0.5 million premature deaths and for 9.3 million DALYs in 2015. This estimate is based entirely on adult deaths (15 years and older). Half of these deaths occurred in people aged 70 years and older. These estimates do not reflect exposures to lead at contaminated sites.¹⁸⁶ Although lead has caused child mortality in episodes of acute poisoning at heavily contaminated sites in low-income and middle-income countries,¹⁸⁷ it is not a major contributor to child mortality globally.

Cardiovascular diseases, including hypertension, coronary artery disease, stroke, cardiac arrhythmias, and peripheral arterial disease, account for the overwhelming majority of deaths attributable to lead in adults.^{26,188} These associations are evident at blood lead concentrations as low as 5 µg/dL.^{188,189} The GBD study⁴² estimates that lead exposure accounts for 2.5% of the global burden of ischaemic heart disease. Lead is also estimated to account

Panel 4: Pollution and neurodevelopment

Foetuses, infants, and children are particularly sensitive to neurotoxic pollutants, even at very low levels of exposure, because of the vulnerability of early-stage development of the human brain.^{91,174-176} Toxic exposure during so-called windows of vulnerability in early life can cause lasting damage to brain function. Lead poisoning in childhood has, for example, been linked to reduced cognitive function and also to juvenile delinquency, violent crime in adulthood, and lifelong reduction in economic productivity.³⁷ Neurotoxic pollutants are also linked to autism,¹⁵² attention deficit and hyperactivity disorder,^{89,177} and conduct disorders.¹⁷³

Exposure to neurotoxic pollutants is widespread as a result of fossil fuel combustion, industrial and agricultural production, and the extensive use of toxic chemicals in consumer products.³⁰ Routine biomonitoring studies have detected many dozens of toxic pollutants in the bodies of children and pregnant women.¹⁷⁵

Pollutants known to be toxic to the developing brain (in addition to lead) include mercury, combustion by-products such as polycyclic aromatic hydrocarbons and fine particulate matter, organophosphate pesticides, brominated flame retardants, phthalates, and polychlorinated biphenyls.⁸⁸ Many more commonly used chemicals, whose developmental neurotoxicity has not yet been discovered could be causing undetected damage to children today.

The social and economic costs of early life exposure to neurodevelopmental toxicants are great. Large economic and social gains can be realised through prevention of these disorders.³²

for 12.4% of the global burden of idiopathic intellectual disability (panel 4). The GBD analysis indicates that deaths in 2015 that were attributable to lead are as follows: cardiovascular disease (465 000 deaths), ischaemic heart disease (240 000), cerebrovascular disease (155 000), ischaemic stroke (68 000), haemorrhagic stroke (87 000), hypertensive heart disease (47 000), and chronic kidney disease (28 000).⁴²

WHO estimates that, in 2012, lead was responsible for 13.9 million DALYs¹⁰⁹ and that childhood lead exposure is responsible for mild to moderate mental retardation of 0.6 million children annually.¹⁹⁰

Pollution at contaminated sites

Polluted soil at contaminated sites threatens the environment and human health in communities worldwide. Most contaminated sites are relatively small, but the aggregate number of people affected globally by the many hundreds of thousands of extant sites is large.¹⁹¹ Polluted sites are most commonly contaminated by informal, small-scale, unregulated local industry or artisanal activity.¹⁹¹⁻¹⁹³ Sites can be contaminated by current industrial and mining activity, or they can be abandoned, legacy sites that were contaminated by previous operations.¹⁹⁴

The contaminants at polluted sites that pose the greatest threats to health are environmentally persistent substances such as metals, persistent organic pollutants (including persistent pesticides), and radionuclides. The metals most commonly encountered at polluted sites include mercury, lead, chromium, and cadmium.

Panel 5: Superfund legislation

Legislation to control contaminated waste sites was enacted in the USA in the aftermath of a series of environmental and public health disasters.¹⁹⁹ The major trigger occurred at the Love Canal (Niagara County, NY, USA), an unused channel between Lake Erie and Lake Ontario into which the Hooker Chemical Company had dumped toxic wastes from the 1940s until the 1960s. When it was full, the canal was covered with a clay seal, and homes and a school were built on top of this clay. However, the waste did not stay underground. The canal filled with water and, by 1976, heavy rain regularly caused toxic sludge to bubble up into the basements of the overlying homes and into nearby streams. By the time this site was recognised as a hazardous waste site, Love Canal contained an estimated 21 000 tonnes of discarded chemicals. Within a few years, a second major waste site was discovered near Louisville, KY. Known as the Valley of the Drums, the site contained thousands of steel drums full of chemical wastes that had accumulated over several decades.

These events made it clear to policy makers and the public that hazardous waste was an environmental and public health emergency. In response, the US Congress passed the Comprehensive Environmental Response Compensation and Liability Act on Dec 11, 1980. The law became known as the Superfund Act because it authorised the creation of a large fund that, from 1980 to 1995 was supported by a tax on the chemical manufacturing and petroleum industries, the two major producers of toxic chemical wastes. Many of the new hazardous waste sites subsequently being discovered were the result of actions by polluters who no longer existed. The tax was based on the polluter-pays principle and was intended to provide resources to remediate abandoned sites. In 1995, the US Congress allowed the tax on the chemical and petroleum industries to expire. Since that time, remediation of hazardous waste sites in the USA has been supported through general tax revenues.

remediation, has been funded by the US Federal Government since 1980^{199,200} and additionally by state governments. In Europe, similar programmes have been created and, since 2004, they have been subsumed under the Environmental Liability Directive of the European Commission, which establishes a framework to prevent damage and remediate hazardous sites based on the polluter-pays principle.²⁰¹

Burden of disease due to soil pollution by metals and chemicals at toxic sites

Based on data from the Blacksmith Institute/Pure Earth Toxic Sites Identification programme, we estimate that about 61 million people in the 49 countries surveyed to date are exposed to heavy metals and toxic chemicals at contaminated sites. Because this estimate reflects exposures at only a fraction of the total number of contaminated sites worldwide, further investigation will be required before the full magnitude of exposures at such sites and their contribution to the global burden of disease can be estimated.²⁰²

Two types of contaminated sites that have begun to be studied in detail are used lead-acid battery recycling sites and artisanal and small-scale gold mining sites (table 2).^{112,113,203} Lead poisoning from informal battery recycling is seen in low-income countries in all regions of the world.^{187,204–206} Artisanal and small-scale gold mining takes place worldwide, but is most highly concentrated in Africa.²⁰⁷ Details on methods for these analyses can be found in the appendix (pp 17–18).

We estimate that between 6 million and 16 million people are exposed to dangerous concentrations of lead each year at used lead-acid battery recycling sites.^{185,203} These exposures result in the loss of an estimated 0·87 million DALYs annually.²⁰³ We also estimate that between 14 million and 19 million artisanal and small-scale gold miners are at risk of occupational exposure to elemental mercury.¹¹² These exposures result in an estimated 2·9 million DALYs lost annually to elemental mercury poisoning.¹¹²

Occupational pollutants

Recognition of the health consequences of toxic occupational exposures dates to 200 BC,¹⁶⁴ and many of the diseases caused by occupational exposures were well known by the 1700s.^{208,209} The major epidemics of industrial disease that ravaged workers' health in the 19th and 20th centuries are, however, of relatively recent origin. Such diseases include coal workers' pneumoconiosis,²¹⁰ silicosis,¹⁶⁴ bladder cancer in dye workers²¹¹ leukaemia and lymphoma in workers exposed to benzene,²¹² and asbestosis, lung cancer, mesothelioma, and other malignancies in workers exposed to asbestos.²¹³ These conditions can be traced to the rapid, initially largely uncontrolled, industrialisation and reckless exploitation of natural resources that characterised the Industrial Revolution in western Europe, North America, Japan, and Australia.

	Artisanal small-scale gold mining		Used lead-acid batteries		Total median DALYs (range)
	Population exposed	Median DALYs	Population exposed	Median DALYs	
Africa	10·90	1·91	4·11	0·32	2·23 (0·97–3·49)
Eastern Mediterranean	0·30	0·05	1·54	0·10	0·15 (0·04–0·27)
Europe	2·35	0·43	1·45	0·07	0·19 (0·09–0·28)
Americas	0·37	0·07	5·53	0·22	0·50 (0·24–0·76)
Southeast Asia	0·37	0·07	3·73	0·13	0·29 (0·08–0·50)
Western Pacific	0·19	0·35	3·73	0·13	0·48 (0·20–0·76)
Total	16·70	2·96	16·80	0·87	3·83 (1·61–6·06)

Table 2: Estimated exposed populations (millions) and DALYs attributable to artisanal and small-scale gold mining and used lead-acid battery recycling by region, 2016^{112,113,203}

DALYs=disability-adjusted life-years.

Human exposure to contaminated soil at toxic sites can result from ingestion, inhalation, or dermal absorption.¹⁹⁵ Ingestion is the most common pathway. Children are at greatest risk of exposure because they play close to the ground and because of their common oral exploratory behaviour.^{196–198}

In high-income countries, substantial progress has been made in identifying and remediating contaminated industrial sites and, thus, in reducing exposures and associated disease. In the USA, the Superfund programme (panel 5),¹⁹⁹ a national programme for site

In high-income countries, the worst occupational exposures have now been controlled by legislation and regulation, backed by strong enforcement, and rates of occupational disease are down.^{164,214} Substantial progress has been made in controlling exposures to occupational carcinogens. Central to this success has been the work of WHO's International Agency for Research on Cancer, which has produced independent and objective analyses of the carcinogenicity of hundreds of chemicals. These analyses guide cancer control programmes in countries around the world

By contrast, occupational exposures to toxic pollutants have become highly prevalent in the past 50 years in low-income and middle-income countries.⁴² The worst of these exposures tend to occur in informal, small-scale, locally owned establishments where child labour is also a frequent problem.¹⁷⁶

Burden of disease due to toxic occupational pollutants

Occupational pollutants cause a wide range of diseases.^{164,215–217} The GBD study⁴² considers the burden of disease attributable to two types of occupational pollutants. These are occupational carcinogens— asbestos, polycyclic aromatic hydrocarbons, silica, sulphuric acid, trichloroethylene, arsenic, benzene, beryllium, cadmium, chromium, diesel exhaust, second-hand smoke, formaldehyde, and nickel—and occupational particulates, gases, and fumes.

The GBD study⁴² estimates that, in 2015, toxic occupational risk factors (not including occupational injuries or ergonomic factors) were responsible for 0.88 million deaths globally and for 18.6 million DALYs. Carcinogens were responsible for 0.49 million (55%) of the deaths from occupational exposures to toxicants and for 9.8 million DALYs. Asbestos was responsible for nearly 40% (0.18 million) of all deaths caused by occupational carcinogens. Exposures to particulates, gases, and fumes in the workplace were responsible for an estimated 0.36 million deaths and for 8.8 million DALYs.

WHO data indicate that, in 2012, occupational pollutants were responsible for 0.36 million deaths.¹¹⁰ Occupational respiratory carcinogens (arsenic, asbestos, beryllium, cadmium, chromium, diesel exhaust, nickel, silica) were responsible for 0.1 million of these deaths; occupational leukaemogens (benzene, ethylene oxide, ionising radiation) for 3000 deaths; occupational particulates, dusts, fumes, and gases for 0.23 million deaths; and acute occupational poisonings for 27000 deaths. WHO estimates that, in 2012, occupational exposures were responsible for 13.6 million DALYs.¹⁰⁹

Age distribution of deaths linked to toxic occupational pollutants

Most deaths attributable to occupational pollutants and, especially, to occupational carcinogens occur in people aged 50 years and older (figure 13).⁴² This pattern reflects the long latency of most occupational cancers.²¹³

Pollution sources not currently quantified

Many hundreds of new synthetic chemicals have entered world markets in recent decades, come into widespread use, and are now beginning to be recognised as potential threats to health. These chemicals have become extensively disseminated in the environment, are detectable in the bodies of almost all people examined in national surveys, and have the potential to cause global epidemics of disease, disability, and death. Most chemicals have undergone little or no assessment of their safety or potential hazards to human health.

Because the effects of these new chemicals on human health are only beginning to be recognised and their contributions to the global burden of disease are not yet quantified, they are currently placed within zone 3 of the pollutome (figure 3). Such emerging chemical pollutants are described below.

Developmental neurotoxicants

Evidence is strong that widely used chemicals and pesticides have been responsible for injury to the brains of millions of children and have resulted in a global pandemic of neurodevelopmental toxicity.^{37,88} The manifestations of exposure to these chemicals during early development include loss of cognition, shortening of attention span, impairment of executive function, behavioural disorders, increased prevalence of attention deficit and hyperactivity disorder, learning disabilities, dyslexia, and autism.³⁷

Prospective epidemiological birth cohort studies have been a powerful instrument for detecting associations between prenatal exposures to developmental neurotoxicants and disease.²¹⁸ Examples of pollution-related diseases in children that have been identified through prospective studies are: cognitive impairment, with decreased IQ in children exposed prenatally to

For IARC monographs on the evaluation of cancer risks to humans see <http://monographs.iarc.fr>

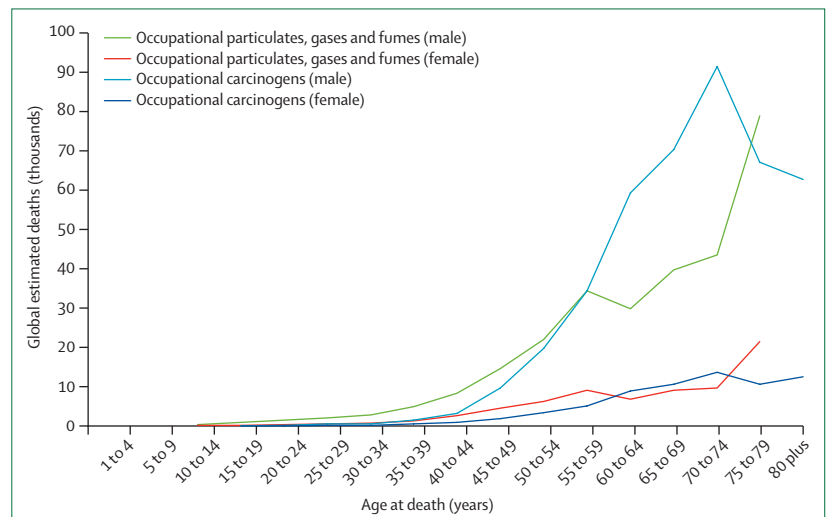


Figure 13: Global estimated deaths due to occupational carcinogenic and particulate exposures by age at death and gender, 2015
GBD Study, 2016.⁴²

PCBs;²¹⁹ reduced IQ and shortening of attention span in children exposed prenatally to methyl mercury;³⁷ microcephaly at birth, anatomical and functional delays in brain development, and autistic behaviours in children exposed prenatally to the organophosphate pesticide, chlorpyrifos;^{220,221} autistic behaviours in children exposed prenatally to phthalates;⁸⁹ cognitive impairment, shortened attention span, and disruptive behaviour in children exposed prenatally to brominated flame retardants;¹⁷⁷ and neurodevelopmental delays in children exposed prenatally to polycyclic aromatic hydrocarbons.^{32,175}

An important unanswered question is whether there are additional chemicals in use today whose ability to cause silent injury to the developing human brain has not yet been discovered.^{88,222,223}

Endocrine disruptors

Endocrine disruptors are chemical pollutants that mimic, block, or alter the actions of normal hormones.^{78,90–92} They include phthalates, bisphenol A, perchlorate, several pesticides, such as the orthophosphates, brominated flame retardants, and dioxins. Many endocrine disruptors are also developmental neurotoxicants. These chemicals are manufactured in volumes of millions of kilograms per year and are used widely in consumer products such as soaps, shampoos, perfumes, plastics, and food containers. Exposures in utero to even extremely low doses of endocrine-disrupting chemicals during early development can lead to permanent impairments in organ function and increased risk of disease. Prenatal exposures have been linked to autistic behaviours in children²²⁴ and to anomalies of the reproductive organs in baby boys.²²⁵

Pesticides

More than 20 000 commercial pesticide products, including insecticides, herbicides, fungicides, and rodenticides are available on world markets. More than 1·1 billion pounds of these products are used in the USA each year and an estimated 5·2 billion pounds globally.²²⁶ Some of the heaviest applications occur in low-income and middle-income countries where use and exposure data are scant. Experience with three categories of pesticides—the organophosphate insecticides, the neonicotinoid insecticides, and the synthetic herbicide glyphosate—illustrate the challenges posed by these new and inadequately tested pesticide chemicals.

The organophosphate insecticides are a large and widely used class of pesticides. Members of this class of chemicals are powerful developmental neurotoxicants, and prenatal exposures are associated with persistent deleterious effects on children's cognitive and behavioural function and with long-term, potentially irreversible, changes to brain structure that are evident on MRI.²²⁰ Toxicological studies of rodents exposed perinatally to organophosphates produce parallel findings.²²⁷

The neonicotinoids are a novel class of neurotoxic pesticides that were developed in the 1980s and whose use has risen substantially in the past decade. The neonicotinoid imidacloprid is now the most widely used insecticide in the world.²²⁸ In the USA, agricultural use of neonicotinoids was nearly 4 million kg in 2014.²²⁹

Neonicotinoids target nicotinic acetylcholine receptors in the insect nervous system.²³⁰ They are water-soluble and can persist for years in soils, dust, wetlands, and groundwater and are detected in commonly consumed foods. Substantial evidence indicates that neonicotinoids can have negative effects on the behaviour and health of bees and other pollinators at environmentally relevant concentrations.^{231,232} These chemicals are a suspected cause of bee colony collapse disorder. Despite their extensive use and known neurotoxicity to insects, very little information is available on the possible human health effects of the neonicotinoids.²²⁸

Chemical herbicides account for nearly 40% of global pesticide use and applications are increasing.²²⁶ A major use is in production of genetically modified food crops engineered to be resistant to glyphosate (Roundup), the world's most widely used herbicide. Glyphosate-resistant, so-called "Roundup Ready" crops, now account for more than 90% of all corn and soybeans planted in the USA, and their use is growing globally. Glyphosate is widely detected in air and water in agricultural areas, and glyphosate residues are detected in commonly consumed foods.

Epidemiological studies of agricultural workers who were exposed occupationally to glyphosate and other herbicides have found evidence for increased occurrence of non-Hodgkin lymphoma in these people. Toxicological studies of experimental animals exposed to glyphosate show strong evidence of dose-related carcinogenicity at several anatomical sites, including renal tubule carcinoma and haemangiosarcoma. On the basis of these findings, the International Agency for Research on Cancer has determined that glyphosate is a "probable human carcinogen";²³³ this finding is contested by glyphosate's manufacturer.

Thousands of tonnes of pharmaceutical waste are released into the environment each year, especially in high-income and middle-income countries, and measurable concentrations of several pharmaceuticals are detected in urban wastewater.^{95,96}

The sources of pharmaceutical waste pollution include discharges from pharmaceutical manufacturing plants, hospitals, agriculture, and aquaculture. Anti-inflammatory agents, antibiotics, oestrogens, anti-epileptics, caffeine, and cancer chemotherapy agents are among the compounds most commonly detected. In some locations, concentrations of the anti-inflammatory drug diclofenac have been reported to exceed predicted no-effect levels.^{234,235} Concern is increasing that these compounds could damage freshwater and salt water marine species through a range of toxicological mechanisms, including endocrine disruption.

Further information on these emerging chemical pollutants is presented in the appendix (pp 2–11).

Research recommendations

To increase knowledge of pollution and its effects in human health, this Commission recommends that research be undertaken to: (1) define and quantify the burden of neurodevelopmental disease in children and the burden of neurodegenerative disease in adults attributable to PM_{2.5} air pollution (zone 2 of the pollutome); (2) define and quantify the burden of diabetes attributable to PM_{2.5} air pollution (zone 2 of the pollutome); (3) define and quantify the burden of pre-term birth and low birth weight attributable to PM_{2.5} air pollution (zone 2 of the pollutome); (4) better quantify the burden of disease caused by chemical pollutants of known toxicity at contaminated sites, such as lead, mercury, chromium, arsenic, asbestos, and benzene (zone 2 of the pollutome); and (5) discover and quantify health effects associated with new and emerging chemical pollutants, such as developmental neurotoxicants, endocrine disruptors, novel classes of insecticides, chemical herbicides, and pharmaceutical wastes (zone 3 of the pollutome).

Section 2: The economic costs of pollution and pollution-related disease

Premature death and disease due to pollution impose great costs on national budgets and health-care spending, especially in rapidly industrialising low-income and middle-income countries. Diseases caused and exacerbated by pollution result in medical expenditures and in pain and suffering. Pollution-related disease can reduce labour force participation, labour market productivity, and economic output. In children, pollution-related disease can cause failure in school and perpetuate intergenerational poverty. Early life exposures to neurotoxic pollutants such as lead and mercury can impair cognition, diminish the ability to concentrate, and disrupt behaviour, thus reducing lifetime earnings. The costs of disease and premature death caused by pollution, especially the more modern forms of pollution, are rising rapidly.²³⁶

The costs of pollution-related disease are often overlooked and undercounted because they are associated with non-communicable diseases of long latency that extend over many years, are spread across large populations, and are not captured by standard economic indicators.^{7–9,237} These costs are much more difficult to calculate than the costs of pollution control, which are usually tangible and concrete.²³⁸ Although the costs of pollution-related disease can have large effects on the budgets of health ministries and increase spending in health systems, they are typically buried in general health expenditures and hospital budgets, hidden in productivity reports, do not affect the budgets of environment ministries, and are not attributed to pollution.⁹

The costs of pollution-related disease include: (1) direct medical expenditures, including hospital, physician, and medication costs, long-term rehabilitation or home care, and non-clinical services such as management, support services, and health insurance costs; (2) indirect health-related expenditures, such as time lost from school or work, costs of special education, and the cost of investments in the health system (including health infrastructure, research and development, and medical training); (3) diminished economic productivity in persons whose brains, lungs, and other organ systems are permanently damaged by pollution; and (4) losses in output resulting from premature death.

Pollution-related disease is responsible also for intangible costs, such as those of poor health in people made ill by pollution, disruption of family stability when a person of working age becomes disabled or dies prematurely as a result of pollution, and the loss in years of life to the person themselves.

A method to estimate the tangible costs of pollution-related disease was developed in the early 1980s by an expert committee convened by the Institute of Medicine.²³⁹ The core of this method is calculation of the so-called “fractional contribution” of pollution to causation of a particular disease.⁴¹ This environmentally attributable fraction is defined as “the percentage of a particular disease category that would be eliminated if pollution was reduced to the lowest feasible levels.”²⁴⁰ This fractional contribution is then multiplied by the number of cases of pollution-related disease in a population and by the average cost per case to calculate the total costs of pollution-related disease.

The cost of a case of illness is often measured by the medical expenses incurred when a person is ill (the direct costs of illness) and by the loss in productivity when a person dies prematurely or is disabled (the indirect cost of illness).²⁴¹ This method has been used to estimate the costs of pollution-related disease in children^{242–244} and of occupational disease in workers,²⁴⁵ has enabled quantification of the effects of pollution-related disease on GDP, and has provided a means to calculate costs that are typically externalised and not captured by standard accounting methods, and thus were previously hidden.⁷ Information derived from this so-called full-cost accounting method has proven to be a powerful lever for shaping public policy and is an effective antidote to one-sided arguments for not taking or delaying action against pollution that are based solely on the costs of pollution control.^{7,9}

The cost of illness approach to calculating costs of pollution-related disease works reasonably well in countries with strong public health data systems and robust information about the costs of disease. However, it is less applicable in countries without those resources. Therefore, the GBD study and WHO estimates of the burden of disease due to pollution are based primarily on data for premature deaths and do not adequately

reflect the full burden of pollution-related disease because, in many countries, researchers are not able to capture information about pollution-related morbidity. In countries where data are available relating pollution to morbidity and to the costs of disease, these costs are often substantial. Such studies suggest that the morbidity costs resulting from pollution-related disease might conservatively increase mortality costs by 10–70%,^{236,246,247} and some individual country studies suggest that the increment might be even greater: 25% for Colombia,²⁴⁷ 22–78% for China,²⁴⁸ and 78% for Nicaragua.²⁴⁹

A second shortcoming in using the cost of illness approach to estimate the health costs of pollution is that it can never capture the intangible losses caused by pollution-related disease, even when comprehensive data are available. For example, this method can neither measure the family disruption that follows the premature death of a mother or a father nor can it quantify the grief that follows the death of a child. Those losses are separate and qualitatively different from losses in income generated or in goods produced.¹⁴ Similarly, a method that is based solely on the effect of pollution on GDP cannot fully describe the negative effects of pollution on societal health, on diminished visibility in national parks, on ecosystem services, or the benefits of pollution control in enhancing national welfare.⁷²

To overcome these shortcomings in the cost of illness approach, economists have devised a second strategy to assess disease costs: the so-called “willingness-to-pay” method. This metric is a measure of how much people are willing to pay to reduce the risk of premature death.^{250–252} This approach captures individuals’ preferences for avoiding increases in risk of death by analysing their behaviour in risky situations (the revealed preference approach) or in hypothetical choice situations involving changes in their risk of death (the stated preference approach).

To aggregate data from willingness to pay (WTP) studies, economists have developed the Value of a Statistical Life (VSL) concept. The VSL is defined as the total of what many people would pay for small reductions in the probability of dying over the coming year that, together, add up to saving one life. For example, if each of 10 000 people were willing to pay US\$100 over the coming year to reduce their risk of dying by 1 in 10 000, one statistical life would be saved and the VSL would equal \$100×10 000, or \$1 000 000.

Multiplying the number of lives lost to pollution by the VSL provides an estimate of the health costs associated with pollution. Multiplying the number of lives that pollution control would save by the VSL provides an estimate of the benefits of pollution control.

Although the VSL method has the disadvantage of relying on estimates of what people say they will pay to reduce mortality risks, it overcomes many of the limitations that hinder efforts to estimate pollution-related

disease costs; for instance, by expanding estimates from those made solely in terms of productivity losses and effects on GDP. The VSL method has been used by governments in high-income countries and in Colombia, Malaysia, Mexico, and Peru, amongst others, to estimate the benefits of reducing pollution.²⁴⁶

Methods

This Commission uses both approaches in the current analysis. Economic losses from pollution-related disease are therefore measured in terms of lost productivity and health-care costs, and the costs of pollution-related disease are also presented using estimates derived from WTP studies. Costs associated with air, water, and lead pollution are included in this analysis, but costs associated with soil pollution are not yet available and are not included. To calculate the VSL in countries where no original studies are available, we have extrapolated estimates from other countries, taking differences in income levels into account.^{246,253} This method is described in the appendix (pp 25–28).

The economic benefits that result from the control of pollution and prevention of pollution-related disease are the same as the costs that result from pollution-related disease. Losses in economic productivity are a key component of the costs of pollution-related disease. When pollution-related disease results in the death of children or adults of working age, the economic output that those people would have produced is lost forever. The productivity losses associated with premature mortality are measured by calculating the output that an individual would have produced over his or her working life, summing these losses to the present.

Pollution-related disease also reduces the productivity of ill people while they are working. Hanna and Oliva²⁵⁴ estimated that the closing of a heavily polluting refinery in Mexico City, Mexico, increased the hours worked by people living near the refinery by 3·5%. Zivin and Neidell²⁵⁵ found that a 10 ppb reduction in ground-level ozone increased the productivity of farm workers in California, USA, by 5·5%. Chang and colleagues²⁵⁶ report that each 10 µg/m³ increase in outdoor PM_{2.5} concentrations reduced the productivity of factory workers by 6% in northern California, USA. Similarly, water pollution has also been shown to reduce adult productivity. An estimated 35 million people in Bangladesh are exposed to concentrations of arsenic in groundwater that exceed 50 µg/L and 57 million people are exposed to concentrations above the WHO standard of 10 µg/L. Carson and colleagues,²⁵⁷ who performed this study, estimate that reducing arsenic concentrations to the WHO standard would increase annual hours worked by the average household in their sample by 6·5%.

A method to measure lost output is to calculate its effects on a worker’s contribution to GDP. Table 3 shows reductions in GDP that result from pollution-related deaths as a percentage of a country’s GDP. Losses are reported by World Bank income group and pollutant

category (lead exposure, ambient air pollution, household air pollution, unsafe water, and unsafe sanitation. Because the magnitude of productivity losses is sensitive to the interest rate used to discount losses to the present (discount rate), this Commission gives results using two different discount rates (1.5% and 3%). For country-level data see appendix (pp 43–47).

Because pollution-related disease is most common in heavily polluted, low-income countries, productivity losses due to pollution-related disease are disproportionately high in these countries. Thus, in low-income countries, productivity losses due to pollution-related disease represent between 1.3% and 1.9% of GDP. By contrast, in lower middle-income countries, these losses amount to between 0.6% and 0.8% of GDP. In low-income countries, the largest productivity losses due to pollution-related disease result from lack of access to safe water and sanitation, followed by exposures to air pollution. Household air pollution alone causes losses of between 0.49% and 0.68% of GDP in low-income countries.

In upper middle-income and high-income countries, most economic losses attributable to pollution-related disease are due to ambient air pollution. These losses comprise a smaller fraction of GDP than in low-income and lower middle-income countries because there is generally less pollution in these countries and prevalence of pollution-related disease is lower. An additional factor that reduces the estimated costs of pollution-related disease in high-income countries is that more than 82% of deaths due to air pollution in these countries occur in people age 65 years and older. This reduces the calculated costs because the international definition of working age is 15–64 years of age and, hence, the economic contribution of premature death in people older than 65 years is not counted. In upper middle-income and high-income countries, estimated economic losses due to pollution-related disease in 2015 were more than US\$53 billion.

Additional economic costs of coal combustion not included in this analysis are costs related to disease and premature death in coal miners due to injuries and coal workers' pneumoconiosis; costs of lung cancer in coke oven workers; ecological and community costs of mountain top removal and strip mining; losses in property values near mines and along railroad rights-of-way; loss of timber resources; and crop losses due to water contamination.⁹

Pollution benefit-cost analyses

Benefit-cost analyses of water and sanitation improvements and improved cookstoves must account for the health benefits of these interventions, the time savings for households who no longer need to collect water or firewood, and the benefits associated with improved childhood health, such as greater educational achievement.

The health benefits associated with a project to improve water quality (eg, home disinfection of drinking water)

	Ambient air pollution and household air pollution	Unsafe water and unsafe sanitation*	Lead exposure	Total
High income	0.044% (0.048%)	0.0028% (0.0033%)	0.0027% (0.0029%)	0.050% (0.054%)
Upper-middle income	0.13% (0.15%)	0.019% (0.027%)	0.0054% (0.0059%)	0.15% (0.18%)
Lower-middle income	0.32% (0.40%)	0.28% (0.40%)	0.012% (0.013%)	0.61% (0.82%)
Low income	0.62% (0.86%)	0.70% (1.03%)	0.012% (0.013%)	1.33% (1.90%)
World	0.092% (0.11%)	0.033% (0.047%)	0.0042% (0.0046%)	0.13% (0.16%)

Results without parentheses discount future output at the rate of growth in per capita GDP plus 3%. Results in parentheses discount future output at the rate of growth in per capita GDP plus 1.5%. For the calculations see appendix (pp 25–26). *Includes, but is not limited to, no hand washing with soap.

Table 3: Productivity losses as a percentage of gross domestic product (GDP) by pollutant and World Bank income group

exceed the reduced mortality risk and lost productivity measured in this chapter, and also include reductions in morbidity due to diarrhoea, especially among children, and associated reductions in malnutrition.

Two studies that combine results from the medical literature to estimate the global benefits of various water and sanitation interventions suggest benefit-cost ratios greater than 1 for many interventions on the basis of health benefits and time savings. The average benefit-cost ratio for deep borehole wells with hand pumps is 4.64, whereas household water treatment with bio-sand filters yields an average benefit-cost ratio of 2.48.^{258,259} A cost-benefit analysis finds that improved water supplies, according to the WHO definition, yield a return of US\$2 for every dollar invested.

Despite general acceptance that well targeted water and sanitation interventions have positive benefit-cost ratios,^{260,261} the scale of these benefits can be questioned, given the number of uncertainties that are usually involved.^{262,263} Site-specific analysis and examination of the range of probable benefit-cost ratios can provide useful input to the process of making policy and project decisions.²⁶⁴

Neurotoxic pollutants can reduce productivity by impairing children's cognitive development. It is well documented that exposures to lead and other metals (eg, mercury and arsenic) reduce cognitive function, as measured by loss of IQ.¹⁶⁸ Loss of cognitive function directly affects success at school and labour force participation and indirectly affects lifetime earnings. In the USA, millions of children were exposed to excessive concentrations of lead as the result of the widespread use of leaded gasoline from the 1920s until about 1980. At peak use in the 1970s, annual consumption of tetraethyl lead in gasoline was nearly 100 000 tonnes.

It has been estimated that the resulting epidemic of subclinical lead poisoning could have reduced the number of children with truly superior intelligence (IQ scores higher than 130 points) by more than 50% and, concurrently, caused a more than 50% increase in the number of children with IQ scores less than 70 (figure 14).²⁶⁵ Children with reduced cognitive function

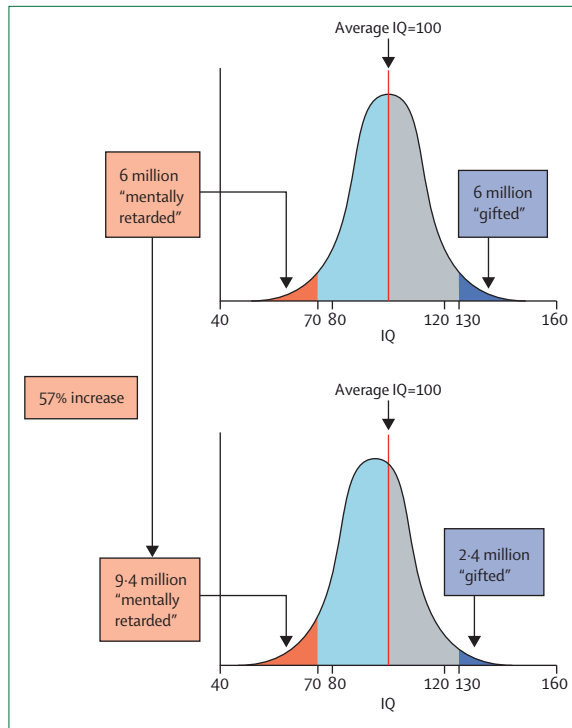


Figure 14: Model of intelligence losses associated with a mean 5-point drop in IQ of a population of 100 million
Figure taken from reference 265, with permission.

due to lead did poorly in school, required special education and other remedial programmes, and could not contribute fully to society when they became adults.

Grosse and colleagues⁴⁶ found that each IQ point lost to neurotoxic pollution results in a decrease in mean lifetime earnings of 1.76%. Salkever and colleagues²⁶⁶ who extended this analysis to include the effects of IQ on schooling, found that a decrease in IQ of one percentage point lowers mean lifetime earnings by 2.38%. Studies from the 2000s using data from the USA^{267,268} support earlier findings but suggest a detrimental effect on earnings of 1.1% per IQ point.²⁶⁹ The link between lead exposure and reduced IQ^{46,168} suggests that, in the USA, a 1 µg/dL increase in blood lead concentration decreases

mean lifetime earnings by about 0.5%. A 2015 study in Chile²⁷⁰ that followed up children who were exposed to lead at contaminated sites suggests much greater effects. A 2016 analysis by Muennig²⁷¹ argues that the economic losses that result from early-life exposure to lead include not only the costs resulting from cognitive impairment but also costs that result from the subsequent increased use of the social welfare services by these lead-exposed children, and their increased likelihood of incarceration.

Pollution-related disease has substantial effects on health-care expenditure. To quantify these costs, it is necessary to know the number of cases of each category of pollution-related disease in a population and the average health-care expenditure per case (appendix pp 29–31). These data are available for some high-income countries²⁷² but not for low-income and middle-income countries, except for Sri Lanka.²⁷³

Respiratory disease, cardiovascular disease, stroke, and cancer account for the largest proportion of the DALYs from pollution-related disease. Air pollution is responsible for half of the DALYs associated with lower respiratory tract infections and chronic obstructive pulmonary disease worldwide, and for a quarter of the DALYs resulting from ischaemic heart disease and stroke.^{42,106} Globally, 24% of the DALYs associated with cancers of the trachea, bronchus, and lungs are attributed to air pollution. The proportions of DALYs linked to each of these non-communicable diseases are higher in low-income and middle-income countries than in high-income countries (table 4).^{41,42} For country-level calculations see the appendix (pp 57–62).

Based on information from seven high-income countries, it can be estimated that air pollution, which accounts for 2.4% of all DALYs in these countries (panel 6),⁴² accounts for 3.5% of their total health expenditure; in 2013, this amounted to US\$100 billion. In Sri Lanka, a rapidly industrialising lower middle-income country where the burden of pollution-related disease is proportionately much larger than in high-income countries, air pollution accounts for 6.5% of all DALYs. Estimated expenditures on disease due to air pollution in Sri Lanka account for 7.4% of all health-care expenditures.

	Lower respiratory infections	Tracheal, bronchial, and lung cancer	Ischaemic heart disease	Ischaemic stroke	Haemorrhagic stroke	Chronic obstructive pulmonary disease	Cataracts
High income	12%	8%	13%	9%	11%	16%	1%
Upper-middle income	34%	30%	24%	20%	24%	41%	14%
Lower-middle income	57%	38%	35%	28%	31%	52%	25%
Low income	64%	48%	43%	36%	22%	51%	35%
Global	53%	24%	28%	37%	27%	44%	19%

Calculations based on data from the GBD 2015 Mortality and Causes of Death Collaborators (2016)⁴¹ and the GBD 2015 Risk Factors Collaborators (2016).⁴²

Table 4: Percentage of disability-adjusted life-years attributable to air pollution (household air pollution plus ambient air pollution) by disease and country income group

Globally, unsafe water and sanitation, including poor hand hygiene, are associated with 96% of DALYs due to diarrhoeal disease and with 95% of the DALYs linked to typhoid fever. In low-income countries, these percentages are even higher (97% for both diseases). Health-care expenditures on pollution-induced diarrhoea and typhoid are difficult to quantify due to inadequate data. However, the costs of treating these diseases, especially for children, represent only a small proportion of the health costs to society from these diseases^{274,275} and the impoverishing effect of these diseases can be as great, if not greater, than the direct cost of illness. For example, in children who survive diarrhoea, effects on nutritional status and school attendance are likely to far outweigh the costs of treatment. Repeated bouts of diarrhoea interfere with the body's ability to absorb nutrients and, in countries where many children are malnourished, compound the effects of poor nutrition.²⁷⁶ The negative effects of poor nutrition on labour force productivity²⁷⁷ and the effects of diarrhoea and other childhood diseases on school attendance are well studied.²⁷⁸ All of these effects are magnified in settings where poor households forego medical treatment but still suffer substantial impoverishment from the loss of household income or long-term disability, where the foregone treatment is a low-cost intervention that could have restored full labour market participation.

We define welfare losses from pollution-related disease as equal to household WTP to reduce pollution. When the VSL method is used to estimate the global costs of premature deaths attributable to pollution, the total in 2015 was more than US\$4.6 trillion, or 6.2% of world GDP (table 5).⁴²

This estimate of WTP to reduce pollution greatly exceeds the estimated costs of pollution-related disease that are derived from productivity losses alone for two reasons. Firstly, what people will pay to reduce their risk of death is much greater than the present value of lost output. When a person dies at age 35 years, the present value of productivity losses is about 20 times per capita GDP; in low-income countries, the ratio of the VSL to per capita GDP is between 40:1 and 50:1. Secondly, the VSL is applied to all premature deaths, not only those of adults at working age. Because 75% of deaths associated with lead pollution, 64% of deaths associated with ambient air pollution, 33% of deaths associated with unsafe water and sanitation, and 56% of the deaths associated with household air pollution occur at age 65 years or older, these deaths are excluded from economic calculations based on productivity losses. The VSL approach values these deaths by what people are willing to pay to avoid them. By contrast, the method based on productivity losses presented in table 3 assigns no value to deaths that occur at age 65 years or older.

Although pollution damages are highest, in absolute terms, in high-income countries, they are highest as a proportion of income in low and middle-income countries. Table 5 shows the damages associated with

Panel 6: Summary of Commission's estimates of the health costs of pollution-related disease

- In high-income countries, health-care spending on diseases caused by air pollution alone amounted to 3.5% of total health expenditures in 2013.
- In Sri Lanka, the only low-income or middle-income country for which data are available, health-care spending on diseases due to air pollution accounted for an estimated 7.4% of health-care spending in 2013.
- The costs of lost productivity from pollution-related disease are estimated to be between 1.3% and 1.9% of gross domestic product (GDP) in low-income countries, and between 0.6% and 0.8% of GDP in low-middle income countries.
- In high-income and upper-middle-income countries, the cost of lost productivity associated with pollution-related disease is estimated to have exceeded US\$53 billion in 2015.
- When the willingness-to-pay method is used to estimate the amount that people would be willing to pay to avoid premature death due to pollution-related disease, the total is estimated to be more than US\$4.6 trillion, which is 6.2% of global economic output.

each pollutant category, measured in 2015 US dollars at market exchange rates and as a percent of gross national income (which represents the sum of incomes earned by all residents of a country), and summarised by World Bank income category. The method used to calculate these damages is identical to that used in the Institute for Health Metrics and Evaluation-World Bank study;²⁷⁹ however, this Commission presents all figures converted to 2015 US dollars at market exchange rates rather than using purchasing power parity dollars. Because the ability to pay to reduce mortality risks increases with income, it is highest for high-income countries. The value of avoided mortality as a percent of income is, however, much higher as a proportion of income for low-income and middle-income countries—between 8.3% and 9.4% of gross national income, reflecting the fact that most pollution deaths occur in these countries.

Ambient and household air pollution together constitute the largest category of welfare damages for all groups of countries. In high-income and upper middle-income countries, the damages associated with ambient air pollution outweigh the damages associated with household air pollution—ie, eliminating all deaths due to ambient air pollution would yield higher benefits than eliminating all deaths due to household air pollution. The reverse is true in lower middle-income and low-income countries. The damages from unsafe water and sanitation remain substantial, constituting 39% of damages in low-income and 27% of damages in lower middle-income countries.

	Ambient air pollution and household air pollution	Unsafe water and unsafe sanitation*	Lead exposure	Total
High income	US\$1691 (3.52%)	US\$159 (0.33%)	US\$303 (0.63%)	US\$2153 (4.48%)
Upper-middle income	US\$1691 (8.37%)	US\$89 (0.44%)	US\$118 (0.59%)	US\$1898 (9.40%)
Lower-middle income	US\$367 (6.38%)	US\$143 (2.49%)	US\$28 (0.49%)	US\$538 (9.36%)
Low income	US\$18 (4.83%)	US\$12 (3.30%)	US\$0.740 (0.20%)	US\$31 (8.33%)
Total	US\$3767 (5.06%)	US\$404 (0.54%)	US\$451 (0.61%)	US\$4622 (6.21%)

For the calculations see appendix (pp 27–28). *Includes, but is not limited to, no hand washing with soap.

Table 5: Welfare damages (in billion US\$) and as percentage of gross national income by pollutant and World Bank country income group (2015)⁴²

The welfare losses presented in table 5 (for country-level calculations, see appendix pp 48–52) can also be used to estimate WTP for policies to control pollution. Table 6 shows estimates of the amount a person exposed to pollution would be willing to pay to reduce the risk of death from exposure to each pollutant source to zero, converted to 2015 US dollars at market exchange rates.⁴² For country-level WTP calculations, see the appendix (pp 53–56). This WTP estimate is the product of the VSL and the mortality risk associated with the pollutant, which is also shown. The WTP values indicate what a person would be willing to pay to reduce their risk of death due to pollution, assuming that they understood the risk. Some of these numbers might appear low—for example, the WTP per person for an improved water source in low income countries is US\$15 per person; however, this would almost be sufficient to cover the capital costs of installing a borehole well (approximately \$20 per person).²⁸⁰ Moreover, measures to control pollution yield benefits beyond reductions in mortality risk, such as convenience and comfort, in addition to health benefits. Reducing outdoor air pollution and smoke from burning solid fuels provides aesthetic and ecosystems benefits, and the health benefits of clean air.

Although high, these numbers almost certainly underestimate the full economic burden of pollution-related disease because of inadequate data in many countries on pollution and disease prevalence, poor knowledge of the toxic effects of many chemicals in widespread use,^{36,37} and lack of information on the possible effects later in life of toxic exposures sustained in early life. An issue that contributes to this underestimate is that calculations of productivity losses due to pollution understate the total value of output lost due to premature mortality because deaths of persons over age 64 are not counted in these calculations. It should also be noted that the economic approach for calculating productivity effects reflects only losses in output that are captured in GDP, and thus does not capture productivity losses in domestic work (child care, cleaning, and cooking) or in the informal sector.²⁸¹ Finally, GDP does not measure societal wellbeing.^{14,282}

The estimates presented here also do not capture the health savings that have been projected to result from

the reductions in air pollution that will arise from strategies to slow the pace of global climate change.² The evidence for health benefits of climate mitigation was reviewed in the *Lancet* Commission on Health and Climate Change.⁹⁷ The annual marginal benefits of avoided mortality from reductions in air pollution that will result from greenhouse gas mitigation strategies are estimated to range from US\$50–380 per ton of CO₂ abated, and are projected to exceed marginal abatement costs in both 2030 and 2050.

Research recommendations

We make several recommendations related to research on the economic costs of pollution. Research is needed to improve estimates of the morbidity costs of pollution. This requires measuring the morbidity associated with pollution, which is more difficult than estimating mortality. This improvement also requires valuing morbidity endpoints, which are more diverse than mortality.

Additionally, work is needed to improve estimates of the non-health benefits of reducing pollution. For traditional pollution problems, these estimates should include the value of time savings associated with water and sanitation interventions and improved cookstoves and the education benefits associated with reduced illness in children. For ambient air pollution, estimates should include the aesthetic value and the ecosystem benefits of cleaner air.

Section 3: Pollution-related disease, poverty, and the SDGs

The former Secretary General of the United Nations, Kofi Annan, has declared that “the biggest enemy of health in the developing world is poverty.”²⁸³ Pollution, poverty, poor health, and social injustice are deeply intertwined. Pollution and pollution-related disease most affect the world’s poor and powerless.²⁸⁴ Pollution’s victims are often the vulnerable and the voiceless. To understand the links between pollution, poverty, and pollution-related disease, it is necessary to elucidate the complex and multidimensional nature of poverty.²⁸⁵ Poverty is not simply a lack of money. Poverty results also in reduced access to education, health care, nutrition, and sanitation and impedes participation in legal and political processes, when such processes exist, and in civil society. When

	Ambient air pollution	Household air pollution	Unsafe water sources	Unsafe sanitation	Lead exposure
High income	US\$1472 (4.0)	US\$98 (0.7)	US\$11 (0.1)	US\$1 (0.007)	US\$264 (0.7)
Upper-middle income	US\$523 (6.8)	US\$214 (2.9)	US\$13 (0.2)	US\$5 (0.1)	US\$47 (0.6)
Lower-middle income	US\$85 (6.9)	US\$66 (5.7)	US\$39 (3.1)	US\$23 (1.9)	US\$10 (0.7)
Low income	US\$13 (4.1)	US\$23 (7.4)	US\$15 (4.8)	US\$11 (3.6)	US\$1 (0.4)
Average	US\$459 (6.2)	US\$123 (4.6)	US\$25 (2.0)	US\$14 (1.3)	US\$64 (0.7)

Numbers in parentheses are number of deaths associated with the pollutant per 10 000 people associated with the pollutant. For the calculations see appendix (pp 27–28).

Table 6: “Willingness to pay” per person (in US\$, 2015) to reduce risk of death associated with pollution, by World Bank country income group and pollution type⁴²

families lack access to food, clothing, and shelter, they do not have the resources to support even a minimum level of health.

This Section of the Commission report presents data documenting that pollution and pollution-related disease are concentrated among the poor and contribute to the intergenerational perpetuation of poverty. Pollution-related disease can result in lost income and increased health-care costs, thus imposing disproportionately great economic burdens on poor families and communities.²⁸⁶ In children, early-life exposure to neurotoxic pollutants can impair cognitive function and diminish the ability to concentrate, further contributing to school failure and reducing lifetime earnings. In example, a long-term follow-up study¹⁴⁴ of children exposed to lead reported that an elevated blood lead concentration at age 11 years was associated with lower cognitive function and reduced socioeconomic status at age 38 years, with diminished IQ, and downward social mobility. Moreover, poverty can worsen health, for example, by forcing people to live in environments that make them ill, without decent shelter, clean water, or adequate sanitation.²⁸⁷ When people live near polluting factories or downstream from hazardous waste sites, or when poor women have no alternative but to cook with traditional stoves in close quarters, or when children are forced to pick by hand through electronic waste to recover precious metals to sustain themselves and their families,²⁸⁸ poverty can exacerbate poor health.

Without political influence and with little power in most countries to control or prevent pollution, the poor have limited ability to determine the fate of their communities. Their dependence for survival on tight social networks further restricts their mobility and opportunities. The result of these interconnected forces is that poverty is a trap that often spans generations. The poor have disproportionately heavy exposures to pollution and disproportionately high amounts of disease, disability, and premature death.^{289,290} A major challenge to enlightened heads of government is to balance economic development that lifts people and communities out of poverty against pollution control and the prevention of pollution-related disease.

Pollution threatens fundamental human rights: the rights to life, to health, and to wellbeing.²⁹¹ It jeopardises the rights of the child, the right to safe work, and the

protection of the most vulnerable.²⁹² Pollution and pollution-related disease are often reflections of environmental injustice. Many countries recognise the right to a healthy environment as a basic human right linked to the right to life and other fundamental human rights.^{293,294} The right to a healthy environment also includes the right to safe food and water and adequate housing.^{293,294}

Recognition of the right to a healthy environment requires that all members of a society have unfettered access to information about sources and patterns of pollution; that they have the power to participate in environmental planning and decision making; and that there is an environmental regulatory agency and an independent judiciary that protect the environment from polluters, and the poor against pollution.²⁹⁵

Pollution and pollution-related disease are often reflections of environmental injustice. Robert Bullard, widely regarded as the father of the environmental justice movement,²⁹⁶ defines a core principle of environmental justice as “all people and communities are entitled to equal protection of environmental and public health laws and regulations.”²⁹⁷ Bullard stresses that environmental justice is a far-reaching concept that involves much more than equal enforcement of laws and regulations. In Bullard’s view, environmental justice is a basic human and civil right and requires meaningful and timely involvement of people and communities in decisions that affect their environment and wellbeing. In 1991 Bullard and his colleagues, at the first National People of Color Environmental Leadership Summit adopted 17 Principles of Environmental Justice.²⁹⁸ These principles were developed as a guide for organising, networking, and relating to government and non-government organisations.

Environmental injustice is the inequitable exposure of poor, minority, and disenfranchised populations to toxic chemicals, contaminated air and water, unsafe workplaces and other forms of pollution, and the consequent disproportionate burden among these populations of pollution-related disease, often in violation of their human rights. Environmental injustice has been characterised as a form of structural violence.²⁹⁹ In many instances, environmental injustice is linked to so-called “structural racism”.³⁰⁰

Panel 7: India's judicial system for pollution

During the UN Conference on Environment and Development in 1992, India committed to providing judicial and administrative remedies for the victims of environmental damage. To fulfil this commitment, India became the third country in the world to start a National Green Tribunal, a judicial body exclusively established to judge environmental cases. The National Green Tribunal was formed on Oct 18, 2010. The focus of this body is on the effective and expeditious resolution of cases relating to environmental protection and conservation of forests and other natural resources. The National Green Tribunal is mandated to make final judgments on applications and appeals within 6 months of their filing. The National Green Tribunal is comprised of judges, who are supported by environmental experts to provide informed guidance on environmental issues, to validate the Tribunal's legal judgments.

Cases such as the Vedanta Bauxite Smelter in Orissa, the Thermal Power Plants in Andhra Pradesh, and the Jaitpur Nuclear Power Plant in Maharashtra have seen controversy and protests. The involvement of the National Green Tribunal has resulted in amicable solutions to these cases, ensuring the people of the affected regions a safe and liveable environment. Before establishment of the National Green Tribunal there were numerous cases in which large industries were confronted by local people fighting for the environment.

Global spread of extractive industries: oil and gas production, mining, and smelting

Social and economic factors that have contributed to the global spread of environmental injustice and the inequitable exposure of poor and marginalised populations to pollution and disease include globalisation, which has caused the movement of hazardous industries such as chemical manufacture, steel making, pesticide production, and shipbreaking from higher income countries to low-income and middle-income countries. This movement has entailed low wages, little or no environmental and occupational regulation, and weak public health infrastructure. The consequences of these occupational and environmental conditions are disease and injury in underprotected workers, diseases caused by toxic chemicals in residents of communities near polluting facilities, and industrial explosions. Examples include the chemical explosion in Bhopal, India where a pesticide production factory that had been trans-shipped from the USA detonated and killed and injured thousands of workers and local residents; the global trade in asbestos that results in shipment of 2 million tons of asbestos annually to the world's poorest countries, where it will produce epidemics of lung cancer, mesothelioma, and other malignancies;²¹⁴ and the global trade in banned and restricted pesticides.

Transboundary transfers of hazardous and toxic wastes, such as electronic wastes and chemical wastes, from high-income to low-income and middle-income countries are a further cause of the global spread of environmental injustice. The global spread of artisanal and small-scale gold mining and the concomitant spread of occupational and community-wide exposure to elemental mercury and methylmercury are another example.^{112,113} The expansion of gold mining is driven by large increases in the global price of gold, which

encourage poor people to leave agriculture and other traditional occupations. Although small-scale mining is relatively profitable for the miners, it is highly exploitative in that the majority of the profits accrue with brokers and retailers, and the burdens of disease and environmental degradation fall almost entirely upon mining communities. Regional conflicts and wars, frequently driven by a desire for natural resources (namely oil, minerals, and timber) further aggravate these problems.

Environmental injustice exists in countries at all levels of income and development and in all regions of the world,^{284,301–303} as can be seen in the following examples and case studies.

Combating environmental injustice

To advance environmental justice and reduce the inequitable exposure of the poor and the marginalised, countries must develop legal mechanisms that provide recourse for environmental injustice. India's green court, for example, provides citizens with access to an independent judiciary that has the power to redress pollution injustices. Such a system, when connected with openly shared data on toxic exposures and health can serve as a powerful mechanism to address environmental injustice (panel 7).

Environmental injustice in North America is well documented. Recurrent racial and ethnic disparities have been documented in North America in exposures to various forms of pollution. A study of the ambient air pollution in New York City have documented that almost all diesel bus depots, places where buses idle their engines for hours while emitting pollutants, are in minority, mostly disadvantaged neighbourhoods. Disproportionately increased prevalence of asthma and other respiratory diseases have been documented among children in these communities.³⁰⁴ In the so-called "Cancer Alley" region of Louisiana, an 85 mile stretch along the Mississippi River where 125 companies manufacture a quarter of all petrochemical products made in North America, the US Commission on Civil Rights determined that the African-American community was economically disadvantaged and disproportionately affected by pollution from hazardous facilities.³⁰⁵ Another case study³⁰⁶ of environmental injustice in the USA relates to the exploitative uranium mining operations on Native American (Navajo) lands. Mining operations there depleted and contaminated the scarce water supply and produced high prevalence of lung cancer in Navajo underground miners, who suffered intense occupational exposures to radon.³⁰⁶ A final example involves the disproportionate exposures of Hispanic farm workers to acutely toxic organophosphate pesticides, such as parathion. Several cases of acute pesticide poisoning have resulted. Many of these workers are undocumented immigrants and, hence, afraid to protest environmental injustice and pollution.³⁰⁷

In Canada, environmental injustice occurs in the traditional lands of First Nations (indigenous peoples). First Nations are battling the Alberta Oil Sands Project in northern Alberta³⁰⁸ and exposure to Canada's worst air pollution hotspot in Ontario's so-called "Chemical Valley", where 40% of the country's chemical manufacturing is located.³⁰⁹

Environmental injustice issues are also prevalent in Europe.³¹⁰ In central and eastern Europe, some minority Roma people and refugee and displaced communities from Kosovo have faced environmental injustice. In Kosovo, camps for displaced Roma were located in an area polluted by toxic tailings from a lead mine. In Durrës, Albania, refugees from Kosovo were housed in a disused chemical plant that had previously produced sodium dichromate and lindane, compounds classified by the International Agency for Research on Cancer as class 1 (proven) human carcinogens.³¹¹

In Asia, the sustained economic growth that has enabled substantial reduction in poverty has simultaneously increased toxic pollution and environmental inequity.³¹² In China, a highly publicised example involved a paraxylene chemical factory in the city of Dalian, where residents feared that typhoons could breach chemical storage tanks and flood lower socioeconomic areas of the city with toxic material.³¹³

In India, a well studied example of environmental injustice is the disproportionate siting of mineral and metals extraction facilities in the Adivasi belt of central and northeast India where 70 million Adivasis—tribal people—live in extreme poverty and are disproportionately exposed to air, water, and soil pollution produced by these facilities.³¹³ In a landmark case linking the mining industry in the Adivasi belt to environmental injustice,³¹⁴ the Indian Supreme Court observed that the fundamental rights of citizens, guaranteed by the Constitution, included "the right of enjoyment of pollution-free water and air for full enjoyment of life".

In Africa, extraction of natural resources is a major driver of environmental injustice and pollution. In Zambia, the lead and zinc mines at Kabwe are among the world's most polluted places. Although these mines are no longer active, the residue left behind after decades of extraction by overseas-based companies have contaminated soil and the local water supply. Children in Kabwe have blood lead concentrations that are 5–10 times higher than the threshold concentration recommended by the US Centers for Disease Control and Prevention.³¹⁵ Mineral extraction has also been associated with environmental injustice in post-apartheid South Africa, where large-scale gold mining has resulted in epidemic silicosis among miners, many of them economic migrants from the poor countries of southern Africa surrounding South Africa.³¹³ Gold mining was also the cause of the 2010 tragedy in Zamfara State, Nigeria, in which 163 people in deeply impoverished communities, including 111 children, died of acute lead poisoning.³¹⁶

Similar events have been recorded in relation to gold mining in Ghana.

In Latin America, environmental inequality is evident in a series of clashes between extractive industries, particularly the mining industry but also oil and gas production, and indigenous communities. Examples include the Tia Maria copper project in Peru, operated by Mexico's Southern Copper Corporation, the world's second largest copper mining company, and the USA-based Newmont Mining Company's US\$4.8 billion Conga gold-copper project, Peru's biggest mining investment. Protests against the inequitable placement of these enormous projects on lands belonging to native peoples and the resulting disproportionate burdens of pollution, environmental degradation, and disease are reshaping basic paradigms of resource-based development. These struggles have forced contemporary legal systems, including legal systems in the high-income home countries of mining conglomerates, to accommodate indigenous world views and to correct, rather than perpetuate the unjust effects of economic growth upon the poor.^{313,317}

With the worldwide spread of toxic chemicals and modern-day pollution, interest has grown in investigating, documenting, and mapping environmental injustice. Information produced through these efforts, especially information documenting patterns of pollution at the local level, can provide powerful leverage to disproportionately exposed communities who are struggling to reduce their exposure and their inequitable burden of pollution-related disease.

In Europe, the Environmental Justice Atlas, a global online database, now lists information on about 2000 sites around the world where pollution and environmental injustice are documented or suspected. Linked to this database is Environmental Justice, Organisations, Liabilities and Trade, a global research project supported by the European Commission that is compiling The Map of Environmental Justice, an atlas of maps documenting the distribution of pollution and environmental injustice around the world.³¹⁸

Pure Earth, a New York-based environmental non-profit organisation has developed a Toxic Sites Inventory Program that includes information on about 3500 polluted sites—active and abandoned mines, smelters, factories, and hazardous waste dumps—a number that is still growing.³⁸ This database focuses on contaminated sites in low-income and middle-income countries and has served as a resource to the work of this Commission.

In the USA, the Environmental Protection Agency has developed an open-access mapping tool, EJSCREEN, that is available on the EPA website and makes data on environmental injustice publicly available. This tool overlays 12 environmental factors, including information on levels of airborne particulate matter, lead paint, and proximity to water discharges with six demographic factors, including income level and percentage of the population classified as minority. The resulting maps

For the Environmental Justice Atlas see <https://ejatlas.org/>

For EJSCREEN see <https://www.epa.gov/ejscreen>

enable people to check their neighbourhoods and to directly examine the intersection of pollution with poverty.

The global distribution of pollution and pollution-related disease illustrates the connections between pollution, poverty, and environmental injustice. 92% of pollution-related deaths occur in low-income and middle-income countries (figure 8). In countries at every level of income, the health effects of pollution are most frequent and severe among the poor and the marginalised. By far, the largest share of pollution-related diseases is the outcome of urban and household air pollution. However, water pollution and toxic occupational exposures are also crucial contributors to mortality and morbidity.

Air pollution, poverty, and environmental injustice

In 2015, more than 99% of deaths due to household air pollution and approximately 89% of deaths due to ambient air pollution occurred in low-income and middle-income countries.^{319,320} Several cities in India and China record average annual concentrations of PM_{2.5} pollution of greater than 100 µg/m³, and more than 50% of global deaths due to ambient air pollution in 2015 occurred in India and China.

Ambient air pollution in rapidly expanding mega-cities such as New Delhi and Beijing attracts the greatest public attention; however, WHO documents that the problem of ambient air pollution is widespread in low-income and middle-income countries and finds that 98% of urban areas in developing countries with populations of more than 100 000 people fail to meet the WHO global air quality guideline for PM_{2.5} pollution of 10 µg/m³ of ambient air annually.

Household air pollution offers an even starker example of the strong links between pollution and poverty.⁵⁷ Deaths due to household air pollution are highly concentrated in the world's poorest countries.⁵⁷ An estimated 3 billion people in low-income and middle-income countries, mostly in rural communities, use solid fuels (firewood, biomass, or charcoal) and traditional stoves for heating and cooking.⁵⁷ In sub-Saharan Africa, for example, firewood is the main source of fuel, as it is in many parts of south Asia. The use of biomass fuels is closely linked to gender inequality. Without access to the cleaner fuels and cookstoves available to many urban households, rural women in these regions and their children are disproportionately exposed to toxic fumes from smoky open fires. As they cook food for the family or study by the light of the stove, these women and children court sickness and premature death in a way their urban counterparts do not.

Water pollution, poverty, and environmental injustice

Poor water and inadequate sanitation and hygiene are also highly concentrated in the world's poorest countries. An estimated 2.5 billion people lack access to a basic toilet; 1 billion people defecate in the open; and 748 million people lack clean drinking water.³²¹ Poor

people living in rural areas, indigenous peoples, people with disabilities, and other marginalised groups are especially likely to lack these basic services.

A sharp gender gap is evident in the health and social effects of water pollution and inadequate sanitation. Girls are particularly severely affected by inadequate access to safe water because the task of collecting water falls disproportionately on them and because lack of water introduces a problem with menstrual hygiene. The many hours that girls in poor communities must spend fetching water increase the risk that they will miss school and, thus, remain trapped in their communities by lack of education. If a school does not provide safe, private toilets, monthly periods can also force girls to miss class or to leave school altogether.³²²

Of all deaths due to toxic occupational exposures, 92% occur in low-income and middle-income countries. This distribution reflects the fact that high-income countries have largely solved their worst problems of occupational exposure and reflects the international migration of polluting industries from high-income countries to poor countries.^{323,324}

As a consequence of globalisation and production outsourcing, pollution and pollution-related disease have become planetary problems.^{325,326} Dumping hazardous materials produced in high-income countries in poorer countries is a clear intersection between global pollution and environmental injustice. This dumping includes shipment of pesticides, industrial waste, and toxic chemicals that are no longer permitted in North America or the European Union to poor countries. For example, in 2006, 500 tons of toxic waste were transported from Amsterdam in the vessel *Probo Koala* and dumped in sites around Abidjan, Côte d'Ivoire. The toxic gas produced by the release of these chemicals resulted in 17 deaths and in more than 100 000 cases of respiratory and gastrointestinal disease.^{327,328} A second example has been documented at a large electronic waste site at Agbobloshie in Accra, Ghana.³²⁹ This site contains thousands of broken computers and other electronic components shipped from European countries in containers labelled "secondhand goods"; the European Union allows export of genuinely reusable electronic goods, but the material shipped to Agbobloshie is usually broken beyond repair and hardly reusable.³²⁶ Electronic waste dumpsites in poor neighbourhoods can be found worldwide, especially in the Asia-Pacific region. It is estimated that the global electronic waste market will quadruple in the next decade, from US\$9.8 billion in 2012 to \$41.4 billion in 2019.³³⁰

International action to address the global problem of dumping led to development of the 1989 Basel Convention on the Transboundary Movement of Hazardous Wastes and to conventions on persistent organic pollutants,⁸⁰ pesticides, mercury, hazardous waste, and chemicals. The European Union also joined the cause and has issued directives to limit international

For the Basel convention see <http://www.basel.int/>

dumping that include restrictions on hazardous substances and on waste electrical and electronic equipment, both promulgated in 2002. Although these conventions and directives are limited by weak enforcement and by structural impediments, such as the requirement in the Rotterdam Convention for complete unanimity amongst all participating countries before a pollutant can be proscribed, they have, nonetheless, helped to slow the global movement of toxic substances and reduce toxic pollution.

Pollution, poverty, and the UN's SDGs

The SDGs were adopted by the United Nations in September 2015 to guide the international development agenda until 2030. The SDGs are intended to advance human dignity in countries around the world.³³¹ It is of note that the predecessor to the SDGs, the Millennium Development Goals that guided global action until 2015, made no mention of pollution at all. By contrast, SDGs focus on the issue to an extraordinary extent, as noted in the introduction, and as befits an issue so integral to the fight against poverty. The main provision is, appropriately, in SDG 3 on good health and wellbeing, where SDG 3·9 commits the world community, by 2030, to “substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination”.³³² The other pollution-specific goal is SDG 6 on water and sanitation, in which SDG 6·3 calls, by 2030, to “improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally”.

However, the SDGs do not leave the issue there. Given the close linkages between poverty and exposure to toxic pollution and the need to reduce, if not eliminate, both, the SDGs seem to recognise that some actions to achieve the broader goals, such as SDG 1 (end poverty) and SDG 2 (end hunger), could, if unchecked, result in exacerbation of pollution exposures. Hence, pollution control must be central to agricultural and industrial development, if development of these is to be truly sustainable. To this end, the SDGs make repeated references to preventing and reducing pollution. These include SDG 2·4 (improving soil quality), SDG 7 (clean energy), SDG 9·4 (clean technologies and industrial processes), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), and SDGs 14–15 (water and land conservation). Achievement of these SDGs will also positively affect environmental justice and fulfil SDG 10 (reduced inequalities). Importantly, measures to reduce greenhouse gas emissions and short-lived climate pollutants, such as black carbon, will help achieve SDG 13 (climate action).

The SDGs are explicitly about sustainable development but, for development to be sustainable, it must both combat poverty and ensure equity. In 1987, the Report

of the World Commission on Environment and Development on “our common future” stated that sustainable development must assure the poor that they receive a fair share of the resources required to sustain their economic growth.³³³ With the growing recognition that pollution not only exacerbates poverty but leads to environmental injustice, sustainability of development is now also increasingly linked to equity. As observed in the Human development report 2011 by the United Nations Development Programme,³³⁴ sustainability and equity might not always be mutually reinforcing (although they can sometimes be), and the most feasible alternative solutions might require explicit and careful consideration of the trade-offs involved. Such an approach to pollution control will not only yield positive synergies between sustainability and equity but also ensure that the SDGs regarding poverty, pollution, and environmental justice are comprehensively met.

The Regional Action Plan for Intergovernmental Cooperation on Air Pollution for Latin America and the Caribbean, prepared by UN Environment Programme in the context of the Latin America and the Caribbean Forum of Ministers of Environment is an example of a high-level plan that sets out common directions for national governments to work together on broad issues.³³⁵ This Action Plan promotes collaboration towards the creation and adoption of national and local policies and programmes to reduce emissions of key pollutants and to achieve improvements in urban air quality in the region. The Action Plan covers broad supportive activities such as technical assistance, policy cooperation, methods, research, and awareness raising and monitoring. The Regional Action Plan will support and encourage the national and local administrations to develop and implement practical local plans to reduce the effects of air pollution.

Research recommendations

To reduce the inequitable exposure of the poor and the marginalised to pollution, this Commission recommends two key strategies. First, we recommend funding of research to document and map the disproportionate effects of pollution upon the poor, women, and girls be adopted as a priority by international health agencies. Additionally, a special focus should be placed on overseas development assistance to protect indigenous peoples and their communities from pollution and its harmful effects.

Section 4: Effective interventions against pollution: priorities, solutions, and benefits

A key message of this Commission report is that, with leadership, resources, and a clearly articulated, data-driven strategy, much of the world's pollution can be controlled and pollution-related disease prevented. Strategies to curb pollution have been developed, field-tested, and proven cost-effective. These strategies were developed initially in high-income countries and are now moving into

For the Rotterdam convention
see <http://www.pic.int/>

For the **Minamata convention**
see <http://www.mercuryconvention.org/>

middle-income countries. They are based on law and regulation, rely heavily upon technology, are subjected to continuous evaluation, are backed by strong enforcement, and incorporate the polluter-pays principle. These programmes are held accountable to targets and timetables. These successful, effective strategies for pollution control can be used as models and adapted to local circumstances in cities and countries at every level of income. Their application can enable developing cities and countries to leapfrog over the worst of the human and ecological disasters that have plagued economic development in the past.

A second key message is that control and prevention of pollution provide several benefits, both short-term and long-term, for societies at every level of income. The direct benefits of pollution mitigation include improvements in

air and water quality and improvements in health. The health benefits include reductions in disease incidence and prevalence, improvements in children's health, reductions in the numbers of premature deaths, increasing longevity, and substantial enhancements in quality of life. Indirect benefits include enhancing gender equity, alleviating poverty, increasing tourism, improving education, and enhancing political stability. Pollution control makes cities more liveable and attractive, benefits ecosystems, improves the economy and, when coupled with efforts to transition to clean fuels and to control emissions of greenhouse gases, pollution control can help to slow the pace of global climate change and accelerate the transition to a cleaner, more sustainable, circular economy.^{81,336,337}

These many benefits of pollution control underscore the reality that pollution is much more than merely an environmental challenge; pollution is a profound and pervasive threat that affects many aspects of human health and wellbeing.

Pollution control today builds on the successes of the past. The industrially developed countries were the first to control pollution, and many of their control strategies were adopted in the aftermath of environmental and public health disasters caused by pollution. Thus, in mid-19th century London, UK, putrid contamination of the River Thames and recurrent epidemics of cholera led to regulation of public drinking water sources³³⁸ and to the construction of large conduits for the removal of human waste and industrial pollution that now form the Thames Embankment.³³⁹ Episodes of severe air pollution with substantial loss of life, such as the Great Fog of London in 1952,³⁴⁰ and the Donora, Pennsylvania episode in the USA led to the passage of clean air legislation. Occupational and mining disasters catalysed the development of worker health and safety legislation. The discovery of contaminated toxic sites in the USA at Love Canal in New York and the Valley of the Drums in Kentucky led to legislation mandating clean-up of hazardous waste sites—the Superfund legislation.¹⁷⁵ An epidemic of congenital methylmercury poisoning in Minamata, Japan³⁴¹ led to global action to protect human health and the environment against mercury and culminated in adoption of the Minamata Convention.¹⁹⁸

In response to the rapid, poorly controlled growth of cities and the global spread of industrial production and chemically intensive agriculture, low-income and middle-income countries have become increasingly engaged in pollution control. Targeted interventions to control water pollution, improve sanitation, and reduce waterborne diseases were among the earliest efforts to control pollution in low-income and middle-income countries, and began as early as the 1950s. Bangladesh has long been in the forefront of this work,^{342,343} China has made extraordinary progress in control of water pollution and prevention of waterborne infectious disease (panel 8),^{344–354}

Panel 8: China's recent experience

In its 13th Five-Year Plan, for 2016, the Government of China acknowledged the dangers posed by pollution³⁴⁴ and set specific targets for environmental improvement and restriction of resource use.

Air pollution

- China adopted The Air Pollution Prevention and Control Law in 1987. This law and its subsequent revisions have resulted in an 10% national decline in particulate matter less than 2.5 µm (PM_{2.5}) between 2014 and 2016, despite extremely high particulate concentrations in certain cities such as Beijing.³⁴⁵ A 2016 amendment to the law explicitly mentioned, for the first time, the connection between environmental protection and public health.³⁴⁶
- China has increased its reliance on non-fossil energy sources (predominantly renewables and nuclear) from 9.4% of total energy use in 2010 to 12.0% in 2015, surpassing the 12th Five-Year Plan target of 11.4% by 2015. The most recent Five-Year Plan³⁴⁷ aims to increase non-fossil energy use to at least 15% by 2020, and to at least 20% by 2030.
- China has implemented a vast network of stations to monitor air quality in more than 400 cities. The capacity to track emissions has been central to developing policy and implementing data-driven regulatory frameworks.³⁴⁸

Water pollution

- China's most recent water pollution legislation, the Water Ten Plan, was adopted in April, 2015.³⁴⁹ This plan sets metrics and targets for ten major polluting industries. Among key targets to be met by 2020 are: more than 70% of water in seven key rivers shall reach Grade III or above; more than 93% of urban drinking water sources shall reach Grade III or above; reduce groundwater extraction and control groundwater pollution; and use of groundwater falling under the "very bad" category shall decrease to around 15%.
- The Ministry of Environmental Protection estimates that the Water Ten Plan will boost GDP by ¥5.7 trillion (US\$91 billion), with a ¥1.9 trillion benefit to the affected industries.³⁵⁰

Soil pollution

- The 13th Five-Year Plan calls for the establishment of laws to monitor, prevent, and remediate soil pollution. The goal is to make 90% of polluted arable land safe for agricultural use by 2020, increasing to 95% by 2030.³⁵¹ The Ministry of Environmental Protection estimates that the actions of the 13th Five-Year Plan could add ¥2.7 trillion (\$411 billion) to the nation's GDP and create around 2 million jobs.³⁵²
- The Five-Year Plan also details a nationwide soil quality monitoring programme.^{353,354}

and Peru has embarked on a programme to improve mine drainage.³⁵⁵

Air pollution control programmes are developing in cities in several low-income and middle-income countries, including Mexico City,³⁵⁶ Ulaanbaatar,³⁵⁷ and New Delhi.³⁵⁸ China is embarking on a national effort to reduce air pollution that includes a plan to dramatically increase reliance on non-polluting, renewable energy sources, and is on track to nearly triple its solar capacity between 2015 and 2020, adding 15 to 20 GW of solar capacity per year.^{123,359–361}

Most countries now have programmes in place to address some aspects of pollution, and almost all have established frameworks for regulatory control of industry, although staffing, resources, and enforcement capacity are variable.³⁶² This Section of the Commission report enumerates the benefits of pollution control, describes key elements of successful pollution control strategies and the responsibilities of stakeholders, and it concludes with recommendations.

The benefits of pollution control

Examples of pollution control and its benefits are presented in this section, panels 9 and 10,^{119,131,363–367} and in the appendix (pp 63–107).

One benefit afforded by pollution control is reduction of household air pollution by providing liquefied petroleum gas and bio-gas and by providing affordable electricity that is produced by non-polluting, renewable energy sources to replace wood chips, coal, charcoal, and cow dung as cooking fuels. These interventions not only reduce exposures to airborne particulates, thereby improving health, but they also produce short-term and long-term economic returns to local communities because households (especially women) are able to spend less time collecting wood, or processing dung for cooking, and thus have more time to devote to economically productive activities (for women) or education (for girls).³⁶⁸

A second benefit is improvements in sanitation that are achieved by providing clean water and toilets. These interventions not only reduce prevalence of waterborne disease but they also allow more children, especially girls, to attend school.³⁶⁹ These improvements benefit tourism and help lift the economy in developing countries, since a reputation for clean beaches, an unpolluted environment, biodiversity, and safe food and water can help to lure discerning tourists and increase their spending.³⁷⁰

Another benefit is seen in shifting the energy sector from coal-fired power plants to cleaner gas-fired plants, and, better yet, to low-polluting renewable energy sources such as wind, tidal, geothermal, and solar. These interventions not only reduce pollution and improve the cardiorespiratory health of entire populations, but they will also sharply reduce greenhouse gas emissions, and increase the efficiency of electricity generation.³⁷¹

Additional benefits are produced by controlling urban air pollution by upgrading public transportation, encouraging active transport (walking and cycling), reducing sulphur content of motor fuels, promoting use of low-emission and zero-emission vehicles (while concurrently cleaning the energy supply), and restricting car and trucks from city centres. These interventions not only improve air quality, but will also reduce childhood asthma, reduce incidence of cardiovascular disease, stroke, and diabetes in adults, and enhance the quality of urban life.^{372,373}

Another benefit in controlling pollution is that remediation of highly contaminated sites in densely

Panel 9: Partial successes in reducing air pollution from cookstoves

China's National Improved Stove Programme

- China's National Improved Stove Programme (1982–92) has distributed 180 million improved cookstoves to people in rural areas of China, in conjunction with provincial programmes. This programme is among the world's largest and most successful national programmes for improved stoves.³⁶³ The initiative aimed primarily to increase efficiency and thus reduce the use of biomass fuel. Middle-income households were targeted in this programme, and households were expected to purchase the stoves themselves.³⁶⁴ All improved cookstoves had chimneys, and some had blowers for more efficient combustion.
- With regard to the primary objective of achieving better fuel efficiency, China's programme lowered household air pollution levels, but, unfortunately, this reduction was not sufficient to meet China's indoor air quality standards and substantial exposures remained. A fundamental problem was that the stove designs did not reduce emissions, but focused on fuel efficiency and, at best, moved the smoke outside, where it still caused exposures. Nevertheless, the programme showed that large-scale effects could be achieved by a well organised and well supported effort that was coordinated nationally, but with substantial local participation. Additionally, an epidemiological study of household stove improvement that was undertaken in a cohort of 21 232 Chinese farmers followed from 1976 to 1992 showed that stove improvement was associated with a greater than 30% reduction in incidence of lung cancer.³⁶⁵

Indian National Programme on Improved Chulha

- A second national programme at a similar scale to the Chinese programme, the Indian National Programme on Improved Chulha stoves, which operated from about 1984 to 2001, was reported to have had little effect on fuel efficiency nationally, and even less in reducing long-term exposure to smoke.³⁶⁶

Gyapa Stoves Project, Accra, Ghana

- An African example of a successful cookstove intervention was the Gyapa Stoves Project in Accra, Ghana. In 2000, 95% of Ghanaian households used solid fuels to power stoves.³⁶⁷ This was a much higher percentage than the estimated 73.4% for the rest of northwest Africa. Many homes in Ghana were poorly ventilated and the burning of solid fuels, such as savannah wood, was inefficient and contributed to deforestation and ecosystem imbalance. To address this problem, EnterpriseWorks/VITA, Shell Foundation, and USAID partnered in 2002 to implement a programme to replace traditional coal-pots with improved stoves called the Gyapa Stove. The Gyapa stove requires 50–60% less fuel than traditional stoves and produces less smoke. This project was unusual in that it aimed to create a sustainable business model that helped the local economy by creating jobs to manufacture the stoves. In 2008, 68 000 stoves were sold in Accra and Kumasi. Air quality was found to have improved by 40–45%.

Panel 10: Cleaner fuels and indoor air

In the past 2 years, major advances have made clean fuels more available in several countries. Examples of programmes to introduce cleaner fuels are the following:

The Indian liquefied petroleum gas programme

- In 2016, India set a goal of providing access to liquefied petroleum gas to 50 million additional poor families in 3 years through a large programme that was operated through the national oil companies. In 2016, more than 10 million households have already been targeted through the national Give it Up campaign, in which middle class families voluntarily give up their liquefied petroleum gas subsidy to a family who are below the poverty line, and corporate responsibility funds are earmarked for the upfront costs.

Ecuador’s electric induction stove programme

- In Ecuador, the national government has developed a major programme to change every traditional cookstove in the country to an electric induction stove. Electric induction stoves are 50% more efficient and faster than gas or normal electric cooking, and have other advantages, including improved safety. This transition is possible because Ecuador has nearly universal electrification, much of it derived from hydroelectric projects. Other countries, including Paraguay and Bhutan, also have hydropower potential, and both are currently undertaking preparatory studies.
- Ultimately, it is clear that any household use of solid fuel has negative effects on health and that the eventual goal should be the elimination of solid fuel and its replacement with cleaner sources of energy. In the interim, in areas and countries where elimination of solid fuel is not immediately possible, transition to the cleanest biomass stoves should be strongly encouraged.¹¹⁹ Millions of lives can be extended every year among the poorest populations in the world by such a transition, but the challenges are still great.
- Progress in implementing clean energy is tracked by the International Energy Agency at both the national and sectoral levels, which has shown some advances in the generation of cleaner energy nationally, but inadequate progress in meeting transportation goals. The International Energy Agency concludes that “strong actions linked to stated targets need to be pushed forward to achieve the clean energy potential”.

populated areas will reduce the prevalence of poisoning by toxic chemicals and heavy metals, will enhance land values, and encourage urban redevelopment. Brownfield remediation projects have been successful in covering the expense of clean-up by the private sector.²⁰⁰

Reductions of exposures to lead from pottery (panel 11)^{374–376} and paint will reduce childhood lead poisoning and thus enhance the intelligence, creativity,¹⁶⁹ and economic productivity of entire societies.⁴⁶

A final benefit of pollution control results from bans on the production and use of asbestos, which will reduce asbestosis, lung cancer, and malignant mesothelioma and will therefore produce substantial gains in economic productivity by preventing serious illness and premature death and will also result in reductions to health-care costs. In conclusion, well designed and executed pollution control strategies will advance attainment of many of the UN’s SDGs.¹⁶

Essential components of pollution control programmes

Planning processes that prioritise interventions against pollution, link pollution control to protection of public

health, and integrate pollution control into development strategies are the first step to dealing with pollution. Defining and prioritising interventions enables a focus on cost-effectiveness and creates roadmaps for comprehensive solutions.

The key societal underpinnings for successful pollution control at any level of development include courageous and visionary leadership by heads of government—mayors, governors, and heads of state—along with an engaged, informed, and empowered civil society. It is also important that there be a shared societal commitment to protecting human health and advancing social justice and a carefully designed, evidence-driven package of pollution control policies.

Effective plans to control pollution require support from many sectors of society and, therefore, must involve collaborations among many agencies and organisations within and outside governments, and nationally and internationally. These stakeholders must be fully integrated into a city’s or a country’s development agenda. If they are to be successful, these efforts must include not only ministries of health and environment, but also ministries of finance, energy, industry, agriculture, and transport. Pollution control policy cannot exist in isolation.

Successful strategies rely on a mix of primary prevention approaches that eliminate pollution at source, coupled with downstream pollution control technologies, such as filters and stack scrubbers, that remove pollutants from the waste stream after they have already been formed. Examples of highly transformative strategies for pollution control that are based on primary prevention include shifting the mix of energy sources in a city or country away from polluting fuels toward non-polluting, renewable fuels;³⁷⁷ use of safer feedstocks in industrial production, such as feedstocks produced by the burgeoning technologies of green chemistry, which eliminate use of hazardous feedstocks and production of materials that can cause injury to human health and the environment;³⁷⁸ incentivising the adoption of clean production technologies; and enhancing access to efficient, affordable public transportation.³⁷⁹ Primary prevention can also be achieved by banning highly hazardous and carcinogenic materials such as asbestos, benzene, PCBs, and DDT, as has been successfully achieved in many countries. Primary prevention of pollution based on the elimination of pollution at source is inherently more effective than downstream control technologies, such as stack scrubbers or water filters that reduce the amount and toxicity of pollutant emissions after they have already been formed. Primary prevention of pollution at source is also essential for accelerating transition to a more sustainable, circular economy.

Further elaboration of these themes and case studies on pollution control are presented in the appendix (pp 63–82). The key elements of all successful pollution control plans are discussed in the following sections.

Establish ambitious but attainable targets and timetables for pollution control

Targets and timetables are essential for programmes to control pollution; these provide benchmarks and metrics for assessing progress towards pollution control. This Commission recommends establishing specific numerical targets and deadlines for pollution control and prevention of pollution-related disease in every city and country, along with incentives for meeting deadlines and penalties for failing to meet them.

Pollution control targets must be appropriate for each country's level of income and development and guided by the WHO pollution control targets. These targets will be most effective when they are focused on pollution sources that are established to be priorities and must be integrated into commitments to meet the SDGs and to reduce greenhouse gas emissions.

Prioritise interventions

It is crucial that pollution control programmes establish and adhere to a robust, systematic, and transparent system for prioritising pollution control that is based on assessment of health effects, environmental damages, and cost-effectiveness of control of various pollution sources. A robust system for assigning priority will avoid the pitfall of prioritising interventions on the basis of political expediency^{380,381} or because they happen to be an item in the evening news.

Quick, highly visible successes are extremely important in gaining public support for a pollution control programme. It is therefore essential that intervention plans identify pollution sources whose early control will result in quick wins. Rapid, measurable improvements in public health, especially in the health of children, are powerful levers for building public and political support.

Key steps in ranking pollution sources in terms of their health effects, a key process of an effective health and pollution action plan, are as follows: (1) examine the frequency and severity of disease attributed to various types of pollution using data from national sources and data from the GBD study, and use this information to prioritise interventions against pollution; (2) for each type of pollution apportion the relative contributions of different exposure sources; (3) evaluate the efficacy of new programmes that have potential to reduce health effects from each pollution source, review existing programmes for efficacy and reach, and identify performance gaps and legal, regulatory, and enforcement gaps; (4) identify potential interventions (new and expanded) for those exposures for which there are dramatic effects on health outcomes and measurable indirect benefits, and evaluate these interventions for cost-effectiveness; (5) focus not only on high-visibility sources of pollution, but also on pollution sources that historically have received less attention, such as household air pollution, contaminated sites, lead (including lead in pottery glazes, lead in paint, and lead from other sources

Panel 11: Mexico's challenge: combating lead pollution

Pottery is produced in more than 10 000 artisanal, mostly small scale, workshops across Mexico. Most workshops use inexpensive, low temperature kilns that are not capable of firmly binding lead glaze to the clay. Lead is therefore released from the glaze into food. Lead has been used for centuries to glaze pottery in Mexico, and pottery is a pervasive source of population exposure to lead.³⁷⁴⁻³⁷⁶ Beginning in the 1990s, the Mexican Government determined that prevention of lead poisoning must be a national public health priority and launched a multipronged approach strategy that included interventions against the use of lead in pottery.

The following are key elements of the control strategy:

- Undertake a comprehensive survey of artisanal workshops, to identify those using lead-based glazes
- Track producers and distributors of lead-based glaze and distributors and producers of lead-free glaze to understand the routes to market
- Notify producers and intermediaries that Mexican federal standards impose an absolute prohibition on the use of lead-based glazes in ceramics used for preparing or serving food
- Engage with producers of lead-free glaze to assist them in improving their product to better match the appearance of lead-glazed ceramics and to facilitate distribution
- Create market incentives for use of lead-free ceramics
- Strengthen enforcement of the federal lead glaze standard through improved monitoring and targeted inspections
- Launch a broad communications campaign to educate pottery makers and the public about the dangers of lead-glazed pottery and to advertise the high quality and enhanced safety of lead-free glazes

that might be specific to a specific culture), and occupational risks, including asbestos; (6) review the benefits of interventions against pollution and health improvement, considering the roles of gender equity, alleviation of poverty, slowing of the pace of climate change, increased tourism, economic growth, improved education, and political factors (panel 12);³⁸²⁻³⁸⁷ (7) bring all relevant agencies into the prioritisation process, including senior representatives of ministries of health, environment, industry, development, finance, transportation, energy, planning, and legislative branches, and civil society, if possible; and (8) begin implementation with those programme areas where past experience will be a strong return on investment, as measured by benefit to public health and the possibility for early victories: examples include removing lead from paint or pottery, cleaning up highly visible toxic hotspots, banning asbestos, or publishing a ranked list of the most important pollution sources in a city or country, involving the media in advertising early successes.

Establish robust systems for environmental monitoring and public health tracking

High quality metrics that monitor pollution and track progress towards national and local pollution prevention and disease control goals are essential to the success of any health and pollution action plan. Early establishment of public health and environment monitoring systems should therefore be a priority. Evidence-driven updates at

Panel 12: Cost-effective policies to improve access to safe water and sanitation

Disinfection kits for home drinking water and ceramic filters are low-cost technologies for purifying drinking water in rural households without access to safe water. Latrines are a cost-effective solution to open defecation. Chlorination of home drinking water costs between US\$50 and \$125 per lifeyear saved; ceramic filters cost between \$125 and \$325.³⁸²

A seemingly attractive solution to improving access to safe drinking water and improving sanitation would be for donors to distribute chlorination kits, filters, and latrines free of charge. Empirical studies have shown, however, that this approach is ineffective and wastes resources because not all households will use disinfection kits for home drinking water, even when they are provided free of charge. A better solution would be to charge for the technology and subsidise the purchase. Studies suggest that people who pay something for a product are more likely to use it.³⁸³ Another effective approach is to distribute vouchers to households that can be redeemed when a kit is purchased.³⁸⁴ Requiring households to redeem the voucher separates the households that are likely to use the kit from those that are not.

Lowering the price of ceramic drinking water filters and latrines, which have a large upfront cost, can substantially increase their uptake.^{385,386} However, subsidies can be expensive. Microfinancing schemes that spread the cost of water filters or latrines over time have been effective in increasing uptake at a lower cost to funders than total subsidies.³⁸⁷ This approach allows a larger number of households to be covered for a given expenditure of funds and has the added benefit of gaining household and community ownership of the improvement. Composting toilets might have some advantages in some circumstances, for example where there is no sewage system.

regular intervals are crucial. We encourage governments to consider creation of a central data coordination system that acts as a focus and point of reference for all data on pollution—household, ambient, and occupational. This system should provide validated information and synthesised reports to the public and could be a basic source of raw data for regulators, researchers, and policy makers.

The economic costs of pollution include not only productivity and health costs, but also costs resulting from destruction of ecosystems and loss of key species such as pollinators and fish stocks that convey great benefits to human beings and are crucial to sustaining life on earth. Like the economic losses that result from pollution-related disease, the costs of environmental degradation are mostly invisible. These costs are not captured by standard economic indicators and are buried within the uncounted, unpaid costs of modern industrial and agricultural production.

The Economics of Ecosystems and Biodiversity is a global initiative sponsored by the UN Environment Programme that addresses the challenge of quantifying the economic losses that result from environmental degradation. This initiative applies a structured approach to valuation of ecological losses, explores the visible and invisible costs and benefits that flow from ecosystems into the economy, and evaluates how these flows might change under different policy interventions. The initiative examines the potential consequences of policy reforms that realign incentives and fiscal policy in both

negative (ie, polluter-pays) and positive (ie, beneficiary-pays) ways. These scenarios can be analysed and juxtaposed against a scenario in which no changes are made, to identify more sustainable pathways.^{388–390}

Monitoring air pollution typically involves a combination of ground-level monitoring and atmospheric dispersion modelling to determine air pollution concentrations and their distribution.^{391,392} Low-cost air pollution monitors to measure levels of pollutants on the ground represent an important advance.³⁹³ The use of satellite-based remote sensing to estimate levels of air pollution is gaining increased attention, although the coverage and interpretation of satellite data is still being refined.³⁹⁴

The importance of accurate epidemiological data for the prevention and control of disease has been recognised since the work of pioneers such as William Farr,³³⁸ who documented patterns of disease and death during the great cholera epidemic in Britain of 1848–49. National and international programmes for the systematic collection, consolidation, evaluation, and rapid dissemination of data on morbidity and mortality have become a core component of the global public health infrastructure.^{395,396}

There are still many gaps in knowledge, especially in poor countries with insufficient resources for systematic data collection.³⁹⁷ Therefore, only a third of the world's population and only 5% of Africa has usable information on causes of death. China and India have both been redeveloping their verbal autopsy registration systems, in which cause of death is based on data provided by field-trained personnel, and these data systems are improving.³⁹⁸ Limitations in the quality of public health data reduce the accuracy of global estimates of the burden of disease related to pollution.

Accountability

Accountability is of paramount importance, and programmes for pollution control and prevention must be continuously assessed and held accountable to targets and deadlines using both process metrics (the number of regulations established, monitors installed, or tests performed) and outcome measures (reductions in levels of pollution in air and water, or improvements in health status). Monitoring data and data on progress toward achieving targets and timetables must be made publicly accessible to citizens and civil society.^{399–401}

Carefully selected metrics provide an essential foundation to monitoring and accountability. The Health Effects Institute has developed a taxonomy of metrics that can be used to track the progress of pollution control programmes. Regarding air pollution programmes, a summary of metrics suggested by The Health Effects Institute include regulatory metrics, emissions metrics, and pollutant metrics.³⁹⁹

Establish a sound chemicals management programme

A high proportion of the 140 000 chemicals and pesticides in commerce have never been adequately tested for safety

For the Health Effects Institute
<http://www.wsp.org/>

or toxicity.³⁶ Information on potential toxicity is publicly available for only about half of the commercial chemicals with high production volume that are in widest use, and information on developmental or reproductive toxicity is available for fewer than 20% of these widely used chemicals.⁴⁰² Because of the failure to test chemicals for toxicity, populations around the world today are exposed to hundreds of untested chemicals and recurrent episodes of disease and environmental degradation have resulted.³⁶

To address the problem of population exposure to untested chemicals of unknown hazard, high-income countries are beginning to develop chemicals management programmes.^{403,404} Mandatory testing of chemicals for safety and potential toxicity, coupled with the imposition of controls or bans on the manufacture and use of toxic chemicals are the two linchpins of these policies.³⁶ High-income countries have the resources to establish their own chemical testing programmes such as those supported by the European Chemical Agency and the US National Toxicology programme. Low-income and middle-income countries must rely on results from those testing agencies and on findings on chemical safety and toxicity promulgated by international bodies of high repute that are independent of the chemical manufacturing industry such as WHO's International Programme on Chemical Safety,¹⁰⁹ the International Agency for Research on Cancer, UN Environment Programme,¹⁰¹ and the Ramazzini Institute.

Establish and enforce environmental laws and regulations and base regulation on the polluter-pays principle

A strong body of law⁴⁰⁵ and clear, transparent, impartially enforced regulations are crucial components of policy packages for pollution control in all countries.

Experience in the USA documents the importance of law and regulation in reducing pollution. Through national regulations established under the US Clean Air Act, the USA has reduced concentrations of six common air pollutants by 75% since 1970 while increasing GDP by nearly 250% (figure 1).⁴³ Every dollar invested in control of ambient air pollution in the USA is estimated to yield US\$30 in benefits (95% CI \$4–88).⁴⁵

The State of California has also deployed a suite of laws and policies to control air pollution that, in some instances, are even stronger than US federal regulations.⁴⁰⁶ California's policies to reduce traffic-related air pollution include low-emission vehicle standards, a low-sulphur gasoline standard, diesel emissions standards, and financial incentives for replacement and retrofit of high-polluting vehicles. Additional policies that have been very successful include requirements for cleaner diesel fuels in marine vessels and railroad locomotives, and requirements for cleaner diesel fuels for stationary diesel engines and agricultural equipment. Policies to reduce emissions

from stationary pollution sources include legally mandated reductions in emissions of oxides of nitrogen and sulphur, mandatory reviews of emissions from new sources, and source-specific emissions standards. Application of these standards has resulted in reductions in levels of major air pollutants by more than 70% in California, produced measurable improvements in children's respiratory health,⁴⁴ and has accomplished these goals in a time when the GDP has risen sharply, thus documenting, yet again, that control of pollution does not stifle economic development or societal advancement.⁴³

Application of the polluter-pays principle is an important component of environmental regulation. The imposition of legally mandated requirements that polluters pay for their pollution and its clean-up create a powerful incentive to adopt new, more efficient production technologies that will reduce pollution. Application of the polluter-pays principle forces polluting industries to acknowledge and account for the previously externalised costs of pollution. Lastly, application of the polluter-pays principle can generate revenues that help to support the costs of pollution control programmes.

As a corollary to imposing the polluter-pays principle, it is important that governments also end subsidies to polluting industries such as coal, oil, gas, and chemical production. When polluting industries are granted subsidies by governments, these governments and the taxpayers who support them are indirectly paying to be polluted.

A competent, independent, non-corrupt judiciary provides an essential back-up to environmental laws and regulation.⁴⁰⁷ An independent judiciary is needed to ensure the fair and impartial application of regulatory standards and to protect people, especially indigenous people and their lands, from the damaging effects of polluting industrial activities. For further discussion on existing national and international chemical control legislation and agreements, see the appendix (pp 13–14).

Engage with the private sector

This Commission emphasises that multiple stakeholders should be involved in controlling pollution and preventing pollution-related disease, including top government leaders, but also key civil servants, business, academia, and civil society. Carefully listening to the views of the most important and influential stakeholders (both formal and informal) can help to ensure that all the parties who can advance (or derail) programmes are taken into account.⁷⁷

Enlightened business leaders can be powerful advocates for pollution control and disease prevention. The creation of incentives by governments for non-polluting industries can be powerful catalysts for innovative action, as seen by the rapid development of solar power systems and the organic food industry.

For the European Chemical Agency see <https://echa.europa.eu/information-on-chemicals>

For the Ramazzini Institute see <http://www.ramazzini.org/en/>

Support city-level initiatives to encourage active transport: reward walking and cycling, increase access to and affordability of public transport, and minimise use of motorised transport

Cities now house more than half of the world's population, a fraction that is growing rapidly, are responsible for 75% of greenhouse gas emissions, and account for 85% of global economic activity.^{408,409} Cities, especially rapidly growing cities in low-income and middle-income countries, have some of the world's highest concentrations of ambient air and chemical pollution and the highest prevalence of disease caused by these forms of pollution.

Important initiatives are now underway in cities around the world to reduce emissions of both pollutants and greenhouse gases, and to make cities more resilient and sustainable. Several organisations at the local, national, and global levels have contributed to this progress and they include the Regional Plan Association in New York, the World Bank's Eco2Cities initiative, and the UN Department of Economic and Social Affairs urbanisation planning programmes.

Mayors have been powerful actors in efforts to control pollution and pollution-related disease, and visionary mayors have resurrected formerly blighted cities and turned them into places of extraordinary beauty and high livability.⁴¹⁰ This Commission commends initiatives to launch urban design and planning initiatives that reimagine cities through building green spaces, parks, and walkways, encouraging active transport (such as walking and cycling), and increasing access to and affordability of public transport. Such programmes are discussed in detail in the 2016 *Lancet* Series on City Planning and Population Health.^{411,412}

Willingness to confront vested interests

Planning and prioritisation processes regarding health and pollution do not always proceed smoothly. The analyses regarding trade-offs between economic development and pollution are nuanced and vary substantially from industry to industry and country to country. In general, when public health externalities are included in the assessment, even primary industries like heavy manufacturing and mining achieve better long-term macroeconomic performance when strong controls for pollution management are in place.^{413,414} However, these analyses can be complex and often contentious. Projections of growth rates and of the burden of pollution-related disease should look at sliding ranges of benefit, since low-polluting industries might provide substantial net benefits to a community. Heads of government who successfully confront vested interests, bring agencies together, reduce environmental injustice, control pollution, and prevent pollution-related disease can reap great praise, build a legacy, help the world achieve the SDGs, and earn an honoured place in history.

The next section of this Commission report outlines the contributions that various stakeholders—government,

civil society, and health professionals—can make to pollution control.

Responsibilities of governments and major foundations

National, state or provincial, and city governments are powerful actors in efforts to control pollution and prevent pollution-related disease. Governments in countries at all levels of income have made remarkable victories against pollution.

Leadership by the head of government—the President, Prime Minister, Governor or Mayor—is of the utmost importance. Heads of government are uniquely well positioned to educate the public and the media about the importance of preventing pollution-related disease and can create a vision for a country or a city without pollution. These heads of government also have the power to bring together several agencies within their governments—health, environment, finance, transport, industry, energy, and development—to make pollution control a priority.

Heads of government also have great power to address the so-called “political economy” of pollution.⁴¹⁵ Much pollution, especially industrial pollution, is produced by vested interests that profit by externalising the costs of production and discharging unwanted wastes into the environment. These individuals and organisations will typically resist efforts to control pollution. Heads of government have unique power to overcome this resistance and to negotiate just settlements that reduce pollution and achieve social justice. Experience in countries at all levels of income shows that pollution control can be accomplished in the face of powerful opposition, but that the task is seldom easy and requires committed leadership and broad partnerships across civil society.

Responsibilities of international agencies

International development organisations, including UN agencies, multilateral development banks, bilateral funding agencies, private foundations, and non-governmental organisations, have important responsibilities in pollution control and prevention of pollution-related disease that complement and extend the role of governments. These agencies should elevate pollution prevention within the agendas of international development and global health and substantially increase the resources they devote to pollution, establishing it as a priority in funding mechanisms.

These agencies should build on existing global data platforms to develop a central platform to monitor and coordinate information on all forms of pollution globally, and should consider convening a bi-annual conference on pollution.

International agencies should also provide resources to reduce pollution-related disease in low-income and middle-income countries by:

(1) encouraging the development of action plans regarding health and pollution, both nationally and

regionally, and of specific pollution control projects that set time targets; (2) building data tracking systems to collect information on pollution and disease; (3) supporting direct interventions against pollution where such actions are urgently needed to save lives; (4) supporting interventions against pollution when international action can leverage local action and resources; (5) building professional and technical capacity within governments; (6) strengthening the capacity of universities in low-income and middle-income countries to research environmental health science and to train future health and environmental professionals; and (7) supporting research programmes in environmental health science in partnership with international academic institutions, including clinical and epidemiological studies to learn more about the undiscovered links between pollution and non-communicable disease.

This Commission also calls on international foundations and private donors to come together with governments around the world to establish dedicated international development funding specifically dedicated to the control of industrial, vehicular, mining, and chemical pollution. Such funding will be most effective in curbing pollution when its award is contingent upon host countries' implementation of the polluter-pays principle and ending financial subsidies and tax breaks for polluting industries.

Several design options for dedicated pollution control funding could be considered. The first is a new standalone fund analogous to GAVI (the Vaccine Alliance) or the Global Fund to Fight AIDS, Tuberculosis and Malaria, in which private philanthropists and foundations provide start-up monies that are then periodically replenished by governments. Another option is a large trust fund that is hosted and managed by an existing global institution, such as a multilateral development bank or a foundation. Alternatively, a virtual fund with contributions based on explicit agreements could be used. Finally, expansion of existing funding instruments for international development assistance could be used, including funds specifically designated for pollution control.

Responsibilities of citizens and civil society

Citizens and civil society organisations in countries and cities around the world have important responsibilities in the prevention of pollution, and non-governmental organisations have an important role in many countries in holding governments and companies accountable for pollution control and prevention of pollution-related disease. Civil society organisations can contribute to pollution control by acting as watchdogs, by serving as representatives of the public interest, and by advocating for specific policies, regulations, and practices (panel 13).³⁵⁰ Civil society groups, especially those that are well funded and science-based, are a powerful force to

Panel 13: Case study: the power of civil society in controlling urban air pollution

National and city governments have key roles in solving pollution problems. But governments cannot act alone. The political will to create, implement, and sustain successful pollution control policies over the long term requires the involvement of citizens and civil society from many sectors. For example, in the winter of 2010–11, hourly air quality data from Beijing began, for the first time, to be publicly released by both the Chinese Government and the United States Embassy. Soon thereafter, so-called “airpocalypses” during winter were documented, and Beijing’s air quality data began to be discussed extensively in local and international media. This unprecedented access to real-time air quality data spurred software developers to build apps, pushing the data out to millions. Through apps, social media, and general media outlets, the citizens of Beijing began, for the first time, to feel the air pollution problem in new, immediately accessible, and data-driven ways.

Since that time, China has invested in several programmes to mitigate air pollution. An expanded network of air quality monitors has been installed in Beijing and across the country. Stricter regulatory policies have been implemented. New emergency action plans for high-pollution days have been developed and promulgated. Simultaneously, public interest in pollution has not waned. In 2015, a popular television journalist, Chai Jing, made an independent documentary “Under the Dome” that discussed the effects of air pollution on health, which went viral across the country and then the world. The number of research publications on air pollution in Beijing have exponentially increased.

It is difficult to pinpoint the exact contributions of the policy, activism, technology, research, and media communities to the successful pollution control effort in Beijing and their effects on each other, but clearly their combined efforts are beginning to make a positive difference. Since 2014, government sources in Beijing have reported year-to-year decreases in annual average PM_{2.5} concentrations, and these findings are consistent with data for decreasing concentrations of PM_{2.5r}, as calculated from the monitor on the United States Embassy.³⁵⁰

Although Beijing and China still have a long way to go to clean their air, this case study documents the power of community involvement in pollution control and the crucial importance of data.

represent poisoned populations. These organisations can highlight omissions in policy and advocate for change.⁴¹⁶ The best of these organisations provide solid policy support to government action and take a long-term, broad view of issues in their actions and recommendations.⁴¹⁷

Responsibilities of health professionals

Physicians, nurses, and other health professionals have important responsibilities in helping societies to confront the challenges of pollution and pollution-related disease as they have educated societies around the world about the dangers of nuclear war and global climate change.

Health professionals can begin by controlling pollution and reducing carbon emissions from hospitals and health-care facilities and by reducing pollution and carbon-intensive energy sources in their own lives. Health professionals can support local, regional, and national planning efforts and emphasise the links between pollution and health, develop new transdisciplinary educational curricula that build knowledge of environmental health science and about

the health effects of pollution, and support research in exposure science, environmental science, health policy research and health economics.

Partnerships between government, civil society, and the health professions have proven powerfully effective in past struggles to control pollution. For example, in the ultimately successful effort to remove lead from gasoline, which was fiercely resisted for many years by the lead industry, partnerships were built between government agencies, health professionals, and civil society organisations.

Interventions against pollution

Table 7 gives a brief overview of interventions, effective policy solutions, and institutional needs by pollution type. Strategies to improve water and sanitation and to reduce indoor air pollution typically take the form of subsidies, especially in low-income countries, whereas policies to reduce pollution from stationary and mobile sources usually rely on regulation, often in the form of standards. Many of these strategies are policy-based and enforcement-based,⁴¹⁸ not requiring large governmental investments.

Section 5: Conclusion—the way forward

Pollution is the largest environmental cause of disease and premature death in the world today. Pollution poses a massive challenge to planetary health¹⁵ and deserves the concentrated attention of national and international leaders, civil society, health professionals, and people around the world. Yet, despite its far-reaching effects on health, the economy and the environment, pollution—especially the rapidly growing threat of industrial, vehicular, and chemical pollution in low-income and middle-income countries—has been neglected in the international assistance and the global health agendas. Strategies for control of industrial, chemical, and automotive pollution in developing countries have been deeply underfunded.^{49,50}

The goal of this Commission is to raise global awareness of the importance of pollution, to end neglect of pollution-related disease, and to mobilise the resources and the political will that are needed to effectively confront pollution.

To achieve this aim and advance progress toward the elimination of pollution, members of this Commission

	Ambient air (outdoor) pollution	Household air pollution	Water pollution and sanitation	Contaminated soil and water
Short-term interventions	Identify sources of key pollutants to enable targeted interventions; target control of stationary sources and install dust management systems; establish monitoring systems; mandate improved fuel quality and engine standards; and design and implement effective enforcement systems	Review current interventions—eg, cleaner fuels and cookstoves—and determine the most scalable strategies; targeted education campaigns; expand support for successful current systems	Expand campaigns for handwashing and improved sanitation; review and expand successful small-scale facilities; develop planning for river basin-wide construction of sanitation facilities; initiate construction of expanded sanitation facilities	Create inventories of polluted sites; test solutions with low-cost pilots for highly toxic sites; clean-up of high-impact sites; provide technical assistance and training
Medium-term interventions	Establish requirements for cleaner vehicles, including testing stations (controls on diesel vehicles, catalytic converters, converting to gas); provide incentives for use of electric and hybrid vehicles; upgrade public transport fleets	Expand access to clean fuels and cleaner cookstoves; upgrade heating and other solid fuel systems	Expand individual household connections for water and sewers	Establish disposal facilities; expand remediation projects; develop remediation industry; support brownfields pilot projects
Long-term interventions	Expand or upgrade public transit; facilitate active commuting by constructing walkways and cycle paths; create mechanisms to discourage vehicle use	Full (possibly universal) access to clean fuels	Upgrade existing drainage and sewage treatment	Establish regional and national toxic sites remediation programmes
Policy and institutions	Undertake source apportionment to identify the most important sources of pollution; establish and prioritise control targets and timetables; establish a high-level intersectoral Steering Committee; involve the public and civil society organisations	Define the target population; identify the responsible government agency with a mandate for health improvement; formulate a practical strategy for upgrading or switching fuels; define financial incentives	Define the target population; calculate the level of service required to achieve goals; community involvement strategy; establish a financial strategy	Establish policy and targets; generate specific policies for small and medium-sized enterprises, artisanal and small-scale gold mining, and other sectors; provide a clear mandate to the responsible government agency; define local powers and responsibilities; define and enable structures of financial support
Building capacity	Achieve adequate monitoring and testing of major air pollutants and emission sources; develop understanding of source contributions; use vehicle testing stations	Establish monitoring mechanisms; identify, review, and support local distributors and providers	Contracts or agreements with utilities providers; and strengthen community-level partnerships	Establish regulations and standards; approve technical support providers—eg, laboratories, testing firms—; expand regulation of active polluters; impose the so-called polluter pays principle; end government subsidies for polluting industries
Common gaps and structural issues	Expansion to less well resourced secondary cities	Reduction or elimination of use of solid fuels for heating	Financial sustainability in an era of increasing water shortage	Requirement of special measures at large-scale sites, such as polluted rivers

Table 7: Short-term, mid-term, and long-term interventions against pollution and the infrastructure and actions required to support them

and contributors to this report have initiated a series of activities within different sectors and countries that will extend beyond the life of this Commission and are intended to prevent pollution and save lives. At a global level, several authors of this Commission are in early stages of designing a Global Pollution Observatory, to be housed within the Global Alliance for Health and Pollution. This new observatory will be an international, multidisciplinary collaboration that is focused on coordinating information regarding all forms of pollution in countries around the world and developing solutions based on successes already achieved in other countries. We intend that this observatory will operate in close partnership with the Institute for Health Metrics and Evaluation, UN agencies, Future Earth, the Planetary Health Alliance, and major non-governmental organisations concerned with the wellbeing of the Earth's environment. A major function will be to provide data that assist countries in prioritising pollution initiatives, tracking pollution, and using pollution control metrics, including investments against pollution in countries around the world and to make these data publicly and easily available. The precise metrics to be followed are under consideration, but possibilities include monitoring country-by-country data on the status of regulations against each type of pollution; measuring exposures to key pollutants, country-by-country and regionally; reporting detailed country-by-country statistics on disease and premature death by pollution risk factor, to track performance towards the goals suggested in this report; tracking national and international investment into expanded research on disease and death due to pollution (especially soil pollution caused by heavy metals and toxic chemicals), including studies to discover new and previously unrecognised health effects of pollutants; tracking investments related to interventions against pollution, country-by-country (which can be broken down by source of investment and whether the investment is national or international and public or private); and developing a database to report the cost-efficacy of interventions against pollution, measured in terms of health outcomes.

In partnership with *The Lancet*, the Global Alliance on Health and Pollution plans to revisit the data on health and pollution periodically, and to publish updated information on global trends in pollution, pollution-related disease, and pollution control on a regular basis. The Global Alliance on Health and Pollution will also explore hosting a biennial conference on pollution that will include UN agencies, governments, and representatives of civil society and will review pollution control strategies, share project successes, and explore opportunities and the most cost-effective strategies for pollution control.

At the country level, work is underway to expand health and pollution planning in partnership with governments in low-income and middle-income countries. This work involves multiple organisations and agencies, including

the Global Alliance on Health and Pollution, the World Bank, WHO, the UN Environment Programme, and the UN Development Programme. New programmes to educate global leaders and government agencies about proven solutions to pollution are also in development.

Activities to strengthen the involvement of the public and civil society in pollution control are essential because public concern provides a major impetus for governments to act against pollution. A new website is being developed by the Global Alliance on Health and Pollution to show current and, in some cases, real-time data related to pollution in countries across the world. This geocoded website links databases showing air pollution, water pollution, and soil contamination. Users can zoom down to the communities where they live, see the available information, and post their own stories and pictures about pollution. The website will incorporate a link for people to connect with local government organisations for solutions.

These efforts are only the beginning, and there is much more to be done. This Commission encourages all efforts to bring the issue of pollution to public attention and supports all solutions to reduce the enormous health burden of this major, yet often hidden, global threat.

Contributors

PJL and RF developed the concept and objectives for the Commission. The full Commission met on two occasions (Nov 9–11, 2015, and June 16–17, 2016) in New York, NY, USA, with an additional meeting in January, 2016 (limited to the Health and Pollution working group, also in New York). The Commission formed four working groups to examine the burden of disease associated with environmental pollution, to calculate the economic costs of documented pollution-attributable global deaths and DALYs, to explore the intersection between pollution and inequality, and to evaluate and develop strategies and roadmaps for successful pollution control. Each working group was responsible for the design, drafting, and review of their individual sections. Working Group 1 (Health) was led by PJL. Working Group 2 (Economics) was led by MLC and AK. Working Group 3 (Environmental Justice) was led by KS. Working Group 4 (Interventions) was led by DHa and RF. Working Group leaders, along with Yewande Awe of the World Bank and Tim Kasten of UN Environment comprised the Report Steering Committee. All authors contributed to the identification of key issues and the selection of four main report sections. As co-chairs of the Commission, PJL and RF planned and coordinated all activities of the Commission, the development and review of the report drafts, and the preparation for external peer review. PJL and RF reviewed and edited all sections of this report. All authors reviewed each stage of the report and approved the final version. PJL wrote the first and subsequent drafts of the Introduction, with input from OA, MLC, RF, AH, AK, KVM, JP, and KRS. For Section 1, PJL wrote the first and subsequent drafts, with input from NB, RB, SB-O'R, JIB, PNB, TC, CM, JF, VF, DHu, BLA, KM, CJLM, FP, LDS, PDS, KRS, WAS, OCPvS, and GNY. For Section 2, MLC and AK wrote the first and subsequent drafts, with input from MG, PJL, KVM, and ASP. For Section 3, KS wrote the first and subsequent drafts, with input from OA, AH, PJL, KVM, MAM, JRo, KRS, AS, and GNY. For Section 4, DHa wrote the first draft, with subsequent drafts written and edited by RF and PJL, with input from NJRA, OA, RA, ABB, NB, AMCS, JF, AH, DHu, MK, BLo, KM, MAM, JDN, JP, JRa, JRo, CS, KRS, AS, RBS, KY, and MZ.

Declaration of interests

BLA served as an expert witness in California for the plaintiffs in a public nuisance case of childhood lead poisoning, in a Proposition 65 case on behalf of the California Attorney General's Office, in a case involving lead-contaminated water in a new housing development in Maryland, in a Canadian tribunal on a trade dispute about using lead-free galvanised

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wire in stucco lathing, and as a plaintiff on a case involving lead-poisoned children in Milwaukee, Wisconsin, but he received no personal compensation for these services. His expert witness fees are deposited in a research and training fund at Simon Fraser University (Burnaby, BC, Canada). MG reports grants from the US Agency for International Development, the National Science Foundation, the International Growth Centre, and the Laura and John Arnold Foundation outside the submitted work; MG also reports more than US\$10 000 in stocks and bonds, including in firms that pollute and firms that are affected by pollution, as part of a diversified portfolio. All other authors declare no competing interests.

Acknowledgments

Overall coordination of the report was led by Elena Rahona, whose team included Amy Chart, Samantha Fisher, Rachael Kupka, Yaqi Li, Karen McGill, Myla Ramirez, Anthony Rivera, Petr Sharov, Angela Bernhardt, Russell Dowling, Eric Fecci, and Carol Sumkin at Pure Earth; Alvara McBean at Icahn School of Medicine at Mount Sinai; and Kelsey Pierce at Institute for Health Metrics and Evaluation. Several people lent their expertise to contribute to certain sections of the report: Bret Ericson, Christa Hasenkopf, Greg McGruder, and Nadine Steckling. The Commission received invaluable technical advice and input from many individuals, including Gilles Concorde and Marie Concorde, Elena Craft, James Godbold, Nathalie Gysi, Andrew McCartor, Sumi Mehta, Conrad Meyer, Radha Muthiah, Dietrich Plass, Ananya Roy, Baskut Tuncak, and Birgit Wolz. In particular, the authors would like to thank the following people for coordinating input from different teams: Yewande Awe, Jostein Nygard, Ernesto Sanchez-Triana, and Momoe Kanada (World Bank); Annette Prüss-Üstün (WHO); Jill Hanna and Maria Pachta (European Commission); Loic Viatte (Swedish Ministry of Environment and Energy); Katherine Swanson and Andrea Pavlick (US Agency for International Development), Mathy Stanislaus (while serving for the US Environmental Protection Agency during the Obama Administration), Kara Estep, Mohammad (Mehrdad) Forouzanfar, and Jeff Stanaway (Institute for Health Metrics and Evaluation); Tim Kasten, Fanny Demassieux, Achim Halpaap, and Pierre Quiblier (UN Environment), Natalia Linou, and Douglas Webb (UN Development Programme); and Nilgün Tas (United Nations Industrial Development Organization). This Publication is made possible by financial assistance from the European Union, UN Industrial Development Organization, the Swedish Ministry of Environment and Energy, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Royal Norwegian Ministry of Health and Care Services, the US Agency for International Development, the US National Institute of Environmental Health Sciences, the Icahn School of Medicine at Mount Sinai, and Pure Earth. The Global Alliance on Health and Pollution (GAHP) served through Pure Earth as secretariat for the Commission. GAHP is a collaborative body that coordinates and advocates for solutions on pollution and health in low-income and middle-income countries. Members include international agencies such as World Bank, UN Environment, United Nations Development Programme, and United Nations Industrial Development Organization, and government agencies globally. The Commission sought input and consultation from the members of GAHP, experts at the World Bank, World Health Organization and the World Health Organization network of Collaborating Centers in Children's Health and the Environment, the Consortium of Universities in Global Health, the Pacific Basin Consortium for Environment and Health, the Superfund Research Program of the US National Institute of Environmental Health Sciences, and a number of Non-Governmental Organizations including the Global Alliance for Clean Cookstoves, Clean Air Asia, Human Rights Watch, the Environmental Defense Fund, Global Poverty Project, and World Resources Institute. The contents of this publication are the sole responsibility of Pure Earth/GAHP Secretariat, the Icahn School of Medicine at Mount Sinai, and *The Lancet*, and can in no way be taken to reflect the views of the European Union or other donors or individual GAHP member agencies. The authors note that they are serving in their personal capacity. The opinions expressed in this article are the authors' own and do not reflect the views of their respective employers.

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HOUSE OF COMMONS
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Alison Bell
Director of Environment & Neighbourhood Services
Reading Borough Council
Civic Offices
Bridge St
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CC: Giorgio Framalico (Head of Planning, Development and Regulatory Services);
Mark Worringham (Planning Policy Team Leader)

Our Ref: MR1272

9 February 2018

Dear Alison,

Re: Proposed development at Reading Golf Course (Kidmore End Road)

I'm writing to express my opposition to the Reading Golf Course development in the draft Local Plan. I have met with residents of Emmer Green, and am satisfied that this draft plan runs counter to Council planning policy.

Whilst I accept that the decision will ultimately be made by the local planning committee, I would like to put my opposition to this draft plan on record prior to its submission to the Secretary of State on 31st March 2018. I fear that, if this submission is accepted by the Secretary of State, future planning applications will be something of a formality. As such, I would like to argue the case against this plan in advance of it becoming a point of conflict and contention between the Council and residents of Emmer Green further down the line.

Reading Borough Council has (in line with Labour Party national policy) rightly prioritised regeneration on brownfield sites in its own planning policy, rather than on greenfield sites such as this one. There is enough brownfield land in Reading to accommodate for our development needs. As such, I see no reason to build in open spaces on the outskirts of town.

Moreover, I do not believe that Reading Borough Council ought to sanction a development that would come at such a high cost in terms of pollution and traffic. Given a lack of transport links in this area (further outlined below), my constituents have calculated that the development would bring car movements per day. Consequently, Emmer Green would experience a potential ten-fold increase in traffic in Emmer Green (which hardly has the infrastructure to cope with this growth, in a town already plagued

by car traffic). The Golf Course itself, furthermore, is a 'green lung' – absorbing carbon emitted in other parts of Reading. Building on it would, therefore, come at a cost to the total level of carbon emissions produced by this town.

In fact, this planning application is in direct conflict with Council planning policy, and also the Government's 25-year Environment Plan, as regards:

1. Future developments being within walking- or cycling-distance from amenities and employment opportunities (which is not the case here).
2. Developments having easy access to public transport (again, not the case in this instance).
3. Preserving open spaces, such as the Golf Course.
4. Preventing further boundary developments, in areas like that around Kidmore End Road.

Finally, my constituents are also concerned regarding potential conflicts of interest within the planning committee and department. As 'confidential' communication within the Golf Club itself has stated that each member stands to earn a six-figure sum for the potential future sale of land, it is incumbent on me to stress that no Golf Club member (or relative of a Golf Club member) should be involved with the decision itself. I would like any Council official or Councillor involved with the planning process to declare any conflict of interest of this nature publicly, before the planning committee meets.

I would be grateful if you could let me have a reply dealing with the points raised here, and if you would reconsider this draft submission.

With best wishes,

Yours sincerely

Matt Rodda MP

ROPEMAKER PROPERTIES

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		Miss
First Name		Emma
Last Name		Greening
Job Title <i>(if applicable)</i>		Senior Planner
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PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Policy H4- Build to Rent Schemes

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Is sound?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

My Client wishes to raise an objection to this policy as it is considered to be overly onerous and will ultimately prevent build to rent developments coming forward.

The recently published Government White Paper 'Fixing our Broken Housing Market' is clear that there is a need to diversify the housing market including introducing build to rent.

The policy sets out a number of criteria which need to be met as part of the policy and the following comments can be made.

- Are secured in single ownership providing solely for the rental market for a minimum 30-year term with provision for clawback of affordable housing contributions should the covenant not be met; and*

There are two elements to the first point firstly, the issue of single ownership. Many build to rent schemes are owned by funds and smaller funds are beginning to go into partnership to be able to invest in build to rent. It is therefore suggested that the policy could state 'single entities' rather than single ownership.

The second element is the restrictive covenant which seeks sites to remain in the rental market for a period of 30 years. There is no evidence provided within the supporting documentation as to why this period has been chosen. My Client is generally finding that a restrictive covenant of 7 years is suitable with a maximum of 10 years. Any period beyond this and developers are struggling to secure financing for developments. It needs to be acknowledged that the build to rent market is still emerging and as such policies need to be flexible enough to accommodate a changing market.

The Planning Practice Guidance (ref: 10-018-20150326) does not specify any specific timescales for a minimum period of time and indeed suggests that each scheme should be determined on a case by case basis to each scheme remains viable. As a result, the policy should be amended to require a minimum term to be agreed with the applicants.

2. *Provide tenancies for private renters for a minimum of three years with a six-month break clause in the tenant's favour and structured and limited in-tenancy rent increases agreed in advance; and*

This is overly restrictive and looks to control the market. The policy should be flexible enough for a length of tenancy to be mutually agreed between the landlord and tenant. Whilst it is acknowledged that some people will want a long-term tenancy there are other who would be looking for a shorter term. It is most likely that build to rent schemes will be located in the centre of Reading which is likely to have a large number of professionals who would want a shorter-term tenancy. This appears to be straying into property law rather than planning policy

3. *Provide a high standard of professional on-site management and control of the accommodation; and*

It is agreed that build to rent schemes should provide high quality accommodation, but it is not entirely clear how this will be enforced.

4. *Meet Reading Borough Council's Rent with Confidence Standards; and*

This appears to be linked to point 3 above, and it is agreed that build to rent schemes should provide high quality accommodation.

5. *Provide for a mix of unit sizes in accordance with Policy H2; and*

This is not entirely clear, policy H2 sets out a mix requirement, which differs from that set out in policy CR6 within the centre of Reading. As has been set out above, the mix within developments should be flexible enough to take into account the constraints of the site and market conditions at the time an application is made.

6. *Meet the standards of design set out in Policy H4; and*

Clearly there is a typo here, as the wrong policy is referenced. It is therefore not possible to make comment on this.

7. *Provide 30% on-site affordable housing, either in accordance with Policy H2 and any relevant Supplementary Planning Document; or in the form of Affordable Private Rent Housing as defined and set out in a relevant Supplementary Planning Document.*

It is agreed that build to rent schemes should provide affordable housing in line with policy. There is a typo within the policy as it assumed that this is in relation to policy H3. This clearly needs to be subject to viability and the associated costs

with bringing a site forward, particularly a brownfield site.

There is no definition within the documents on what is 'Affordable Private Rent Housing'. If this allows for increased flexibility within the affordable Housing offer then this is welcomed.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

The NPPF at paragraph 182 sets out a number of tests which must be met before a plan is considered sound and the following comments can be set out in relation to this:

Positively prepared: It is acknowledged that this policy seeks to provide guidance for build to rent, however the policy appears to be restrictive rather than encouraging of this emerging sector of development.

Justified: As has been set out above, there appears to be no evidence provided to set out why restrictive covenants should be placed on a permission for 30 years, nor why tenants should be required to sign up for three years. The only example of build to rent currently in Reading is the recently permitted former BMW site which only has a covenant of 20 years and no requirement for a minimum tenancy period. The detail within this policy is therefore unjustified and untested.

Effective: By setting overly onerous requirements for build to rent, it is unlikely to meet Government objectives.

Consistent with National Policy: The policy is not considered to be consistent with National Policy. The NPPF requires the Local Plan to be built on an evidence base, and there appears to be no evidence to support the wording within this policy. The NPPG suggests that LPA can explore putting minimum time limits on these schemes, but this is not a specific requirement.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

These are new policies to take into account the changing market and as such they should be the subject of discussion.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
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PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Policy CR10 Tall Buildings

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

On behalf of my Client; Ropemaker Properties Ltd, we wish to raise an objection to this policy. Within previous Consultations we have set out our concerns that the evidence base for this policy has not been updated from the original 2007 Report on tall buildings.

This policy is therefore overly restrictive and out of date. The wording of the policy is almost identical to the Central Area Action Plan which was adopted in 2009 (pre-NPPF).

Paragraph 158 of the NPPF is clear that Local Plans need to be based on *"adequate, up to date and relevant evidence about the economic, social and environmental characteristics and prospects of the area"*.

Since the publication of the original report in 2007, the sky line in Reading has/ is changing significantly with development permitted within the Station Quarter, and the erection of Chatham Place, amongst others. Basing the text of this policy on a report which is over 10 years old is clearly not in accordance with paragraph 158 of the NPPF.

The current thrust of government policy within the White Paper 'Fixing our broken housing market' is an emphasis on using land more efficiently. Paragraph 1.52 of the White Paper sets out that *"authorities and applicants need to be ambitious about what sites can offer particularly where demand is high land is scarce and where there are opportunities to make effective use of brownfield land"*. At paragraph 1.53 it further states that development should *"make efficient use of land and avoid building at low densities and should address the particular scope for higher density housing in urban locations that are well served by public transport"*.

As we have set out in our previous comments on this policy, having regard to previous development within the western cluster, together with the general thrust of government policy and the need for Reading to meet its OAN, the Tall Building Strategy Area clearly needs to be updated and reviewed. This would allow for density to be increased further and additional homes to be built in the centre of Reading which is a highly sustainable location.

The land to the north of Chatham Street at Weldale Street is considered to be a suitable location for a tall building, the proximity of the site to the Chatham Street tower would help to create a cluster. Returning to the Tall Building Strategy the Weldale Street site is located within character area 13 which is a significant area comprising of two Major Opportunity Areas as defined by the Central Area Action Plan. This assessment suggests that the *“degraded townscape condition all contribute to a high capacity for the development of tall buildings”*. Whilst it is appreciated that not all of this area could accommodate a tall building, the southern half of the character area at Weldale Street could comfortably accommodate a tall building and help to contribute to the overall vision for the western area.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

The NPPF at paragraph 182 sets out a number of tests which must be met before a plan is considered sound and the following comments can be set out in relation to this:

Positively prepared: The policy is not considered to be positively prepared as it is based on outdated evidence. The Council should be looking to meet its full OAN and therefore it should be looking at opportunities to increase density, particularly within the town centre.

Justified: The evidence to support this policy is over 10 years old, and no evidence has been provided to demonstrate that it is still relevant.

Effective: Whilst it is acknowledged that the policy has met some of its original objectives, it has clearly not been effective all areas. For example, the western cluster was originally intended to have a number of tall buildings, most notably building over the IDR. To date only one tall building has come forward and as such the original vision has not been realised over the plan period of the CAAP and it should not be repeated verbatim in a new Local Plan without additional evidence

to support it.

Consistent with National Policy: Clearly the restrictive nature of this policy does not accord with the thrust of national policy which is looking a building at higher densities, especially around transport hubs. The arrival of Crossrail and existing transport links means that Reading should be embracing tall buildings.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

These issues should be debated within a public forum

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		Miss
First Name		Emma
Last Name		Greening
Job Title <i>(if applicable)</i>		Senior Planner
Organisation <i>(if applicable)</i>	Ropemaker Properties Ltd	Hunter Page Planning
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Address 2		18 High Street
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Town		Cheltenham
Post Code		GL50 1DZ
Telephone		01242 230066
E-mail		Emma.greening@hunterpage.net

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

CR12- West Side Major Opportunity Area

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

My Client; Ropemaker Properties Ltd welcomes the continued inclusion of site CR12b Great Knolly Street and Weldale Street within the Local Plan.

As you will be aware, there is currently a resolution to grant planning permission on approximately half of this allocation for 429 dwellings. As has been set out in previous representations, there is clearly the potential for significantly more dwellings than the indicative potential within the policy.

In the first instance, Reading should be seeking to meet its own OAN, and should therefore be ambitious about the development potential of sites, particularly those in close proximity to the town centre and Readings high quality transport links.

The HELAA has identified that recent developments within the town centre, have been achieving higher densities than those set out in the plan and given the general thrust of government policy within the White Paper, the Plan should seek to increase densities wherever possible particularly on city centre brownfield sites close to transport links.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

In order to make this policy sound, the density for site CR12b (Great Knolly Street and Weldale Street), should be increased to reflect the resolution to grant permission on half of the site for 429 dwellings, and also the evidence within the HEELA which suggests at 3.5 that recent new-build developments within the town centre have been achieving 325dph. and on the fringe 200dph. clearly this is subject to constraints, but the Plan should be ambitious in the numbers that can be achieved on sites.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

ROWE, DR SIMON

From: Rowe, Simon
Sent: 29 November 2017 12:59
To: Planning Policy
Cc:
Subject: Comments on reading the Draft REading Borough Local Plan

This is an EXTERNAL EMAIL. STOP. THINK before you CLICK links or OPEN attachments.

Hi

I have read through the Draft local plan. This is an impressive well-thought-out document which covers a large number of concerns already (far more than I had !) and is easy to read online, apart from the large number of landscape tables at the end of the document – can the PDF be altered to display these correctly online ?

However I have the following comments which I would be grateful if you could consider them :

1. Biodiversity/Green Links : Many large developments like office blocks and flats have areas of plants, both trees and 'ground covering' shrubs. Yet rarely are any of the ground cover species *flowering*. If they were, this would give a welcome source of food to insects and birds and increase the bio-diversity of the city, and decrease its negative impact. Can the document be amended to suggest this ?
2. Biodiversity : Also could thought be given to get a balance between trees and bare paving areas. The recent development of Vastern Road and the Station approaches took away many trees planted in the paved areas and did not replace them. Some encouragement to provide the solution recently adopted in the Caversham Precinct, where trees have been inserted in such a way as to require less future maintenance ? The more trees you have in your urban environment, the more reduced water runoff and CO2 emission benefits could be achieved, though I realise that trees can bring their own issues.
3. Transport : Cycling - **Can I urge that much much better consideration be given to cyclists needs on the road network ?** The recent Vastern road re-development shows that cyclists concerns are given minor considerations at the end of the process – the station roundabout is a cyclist death trap, especially going from the railway bridge to Reading Bridge. I have raised this already with no result. Cycle access to the station from Caversham is much much improved with the new bridge, but where the cyclists go **beyond** the station is still fraught with narrow congested roads and poorly thought out layouts for junctions. Cyclists are not allowed to cycle through the station underpass – this is sensible but widely ignored and there should be a **safe cyclist route under the railway**.
4. Heritage : This may be a matter of opinion, (!) but as well as preserving Reading's heritage and the fine buildings the city possesses, why not also have a hit-list of hideous eyesores which should be replaced asap when vacant?. The old Energis building opposite Apex plaza, and the old KwikFit building opposite the Prudential building would have been on my list! Vacant and unused for years, eyesores for decades. Here too could be listed the many derelict sites around Reading – are there powers available to force these sites to be put back into use ?
5. Transport : Where access is being improved could sufficient provision be given to pedestrians AND cyclists ? Paths wide enough for both ? So many paths are too narrow.
6. Transport: Air Quality Reading has some of the worst traffic light synchronisation I have ever experienced. Time after time one green light leads to a red, leading to endless stop/idle/start cycles which must decrease the air quality enormously, especially outside the rush hours. Could it be considered that at certain times (maybe 11pm to 5am) many traffic lights are switched off ? Can anything be done like this outside rush hours ? Also, Vastern Road is subject to many unnecessary delays with the fixed synchronisation.
7. Transport: Where a development has a substantial air quality impact, can the developer be required to fund a certain number of trees ? RBC could supply a list of many sites that need more tree planting ?
8. Affordable Housing : The council **MUST** be tough on this. Otherwise many vital but lower paid jobs will have to commute into the city from elsewhere, or be vacant
9. Transport: Has any feasibility study been done on a new station to the south of Calcot and/or SouthCote ?
10. Caversham Specific Area Plan : Section 8.2.1(a) – only mentions 'pedestrian' links. **How about cycles?**

I hope at least some of these points are helpful. Thank you for an opportunity to comment

With best regards,
Dr Simon Rowe

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ROXHILL DEVELOPMENTS LTD

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BY POST AND EMAIL

25189/A3/SF

23 January 2018

Dear Sir or Madam

PRE-SUBMISSION CONSULTATION – DRAFT READING BOROUGH LOCAL PLAN

Please find enclosed representations on behalf of Roxhill Developments Ltd.

Yours faithfully


SIMON FLISHER
Director

simon.flisher@bartonwillmore.co.uk



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Draft Reading Borough Local Plan Pre-Submission Consultation

Representations on behalf of Roxhill Developments Ltd

January 2018

**Draft Reading Borough Local Plan
Pre-Submission Consultation**

Representations on Behalf of Roxhill Developments Ltd

Project Ref:	25189/A5
Status:	Final
Issue/Rev:	-
Date:	23 January 2018
Prepared By:	SF
Checked By:	DG
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Ref: 25189/A5/SF/djg
Date: 23 January 2018

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1.0 INTRODUCTION

- 1.1 These Representations have been prepared by Barton Willmore on behalf of Roxhill Developments Ltd ('Roxhill'). They provide information in order to assist the Local Plan Inspector with the forthcoming Public Examination of the draft Reading Borough Local Plan that has been prepared by Reading Borough Council ('RBC').
- 1.2 The information contained within these representations follows previous responses by Roxhill to the Reading Call for Sites in October 2015, Issues and Options in March 2016, Housing and Economic Land Availability Assessment in November 2016 and Regulation 18 consultation in June 2017.
- 1.3 Roxhill is currently working to bring forward the delivery of new development on a Site to the south of Island Road, on land which was formerly used for landfill purposes. The potential to develop land in this area has been previously recognised through the current adopted Development Plan:
- a. The adopted RBC Core Strategy Key Diagram shows the area (and the land to the west extending up to the railway line) as 'Undeveloped Land'. It is the only specific area shown as being subject to this designation in the Borough. The Key Diagram also identifies the broader area in which the site sits as 'South West Reading';
 - b. Core Strategy Policy CS10 (Location of Employment Development) states that major employment uses, including industrial and storage and distribution, will be located in the A33 corridor within which the Site sits or in the Core Employment Areas. Supporting text to the policy acknowledges that the A33 corridor is currently a relatively successful industrial and warehousing area and is likely to continue to be needed in employment use (Paragraph 5.9);
 - c. It is noted that the Site was previously promoted by Cemex UK for a distribution centre and concrete batching plant through the submission of representations at the time that the Sites and Detailed Policies Development Plan Document was being prepared by RBC (2010-2012). Whilst the land was not formally allocated within that policy document, RBC did conclude that there is sufficient guidance in the local planning policies to judge an employment development on its merits (within its Statement of Public Participation published in July 2011):

“The Island Road site falls within the A33 corridor, which is identified in the Core Strategy as being the main location for additional industrial and warehouse uses. There is therefore sufficient guidance within the LDF to judge a proposal along the lines suggested here, were one to emerge, on its merits, taking into account landscape and settlement boundary issues, without a specific allocation”.

- d. It is also noted that RBC agreed that the Site should be removed from the Kennet and Holy Brook Meadows Major Landscape Feature. RBC’s Main Modifications document, published in February 2012, explained that this change “may give more scope for employment development that could contribute to the local economy”;
- e. In this way, through previously adopted local planning policy documents, RBC has already acknowledged the potential of the Site to accommodate employment development through the submission of a planning application.

1.4 Pre-application discussions have commenced in connection with a planning application for the development of the Site for employment development. Project meetings between Roxhill and RBC took place in February and November 2016 (ref 160091). The technical and environmental reports that would be required by RBC in order to support a planning application are currently in preparation, further to an Environmental Impact Assessment Screening Opinion in February 2017 (ref 170101). It is expected that a planning application for the development of the Site will be submitted to RBC later in 2018.

2.0 REPRESENTATIONS

To which part of the Local Plan does this representation relate?

2.1 Policy SR1 – Island Road Major Opportunity Area.

Do you consider that the Local Plan is legally compliant, sound, and fulfils the duty to co-operate?

2.2 Yes.

Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

2.3 Policy SR1 provides that the Island Road area will be a major new location for industrial and warehouse development; providing jobs and economic benefits in one of the areas of greatest need. It is the main opportunity in the Local Plan to meet the identified needs for industrial and warehousing land in Reading to which Policy EM1 makes reference.

2.4 Policy SR1 sets out RBC's strategic requirements for development in the Island Road Major Opportunity Area including the provision of new business space and a range of environmental considerations.

2.5 More specific provisions have been made by RBC in relation to the sub-area of the Island Road Major Opportunity Area in the control of Roxhill (SR1a). The Local Plan provides that, within this sub-area of some 32ha, the former landfill site will be developed for warehouse uses (indicatively 95-116,000sqm) with some potential for industrial uses where it would not cause detrimental impacts to residential development. It goes on to state that the development should not cause negative effects on human health or the wider environment, the noisiest elements should be located away from residential development, and an adequate landscape buffer should be provided.

2.6 We consider that, overall, Policy SR1 meets the test of soundness for the following reasons:

- a. The allocation is positively prepared, because it seeks to meet objectively assessed needs for new industrial and warehousing development and takes account of the requirements of the wider Functional Economic Market Area (FEMA):

- RBC's latest Sustainability Appraisal (November 2017) recognises that the Island Road Major Opportunity Area would bring significant positive effects with regard to economic development and employment and a tendency towards positive effect with regards to CO2 emissions, adaptation to climate change, pollution, the natural environment, landscape character and sustainable transport. Specifically in the context of sub-area SR1a, significant positive effects have been identified in respect of (a) minimisation of consumption of and damage to undeveloped land and (b) facilitation of sustainable economic growth and regeneration including employment opportunities for all and support for a successful, competitive and balanced economy that meets the needs of the area;
- Policy SR1 would have the effect of providing employment opportunities across a range of occupation types and skill levels; reflecting the way in which modern large scale commercial developments incorporate a range of usable spaces including for storage, drivers and office-based staff. In this way, Policy SR1 represents an opportunity to contribute towards objectives that are set out in the Thames Valley Berkshire LEP's Strategic Economic Plan, including addressing the pockets of economic activity and unemployment in Reading, where 360 (8.4%) of 16-18 year olds are not in education, employment or training; recognising the importance of the connectivity of the area for the growth of the economy, particularly links to London including the M4; and acknowledging that the Reading/Wokingham/Bracknell urban area is a major centre of economic activity with significant potential for future growth. Based on south east commuting patterns within the transport and storage sector it is assumed that 60% of the future workforce for the Island Road Major Opportunity Area would commute from within 20km; equating to a 30 minute drive time. By looking at the occupation profile within a 20km radius of the site and identifying those residents currently seeking employment it is possible to understand the potential labour supply. Within this area there are around 380,330 residents (aged 16 to 74) within employment, including 16,500 employed within the transport and storage sector. The average proportion of residents across the South East working within this sector is 5.2%. Based on this average, areas within the 20km radius which exhibit an above average proportion of residents working within the industry have been identified. It is also evident that a large area within Reading has a higher than average proportion of residents employed within the transport and storage sector. There are particular opportunities to make connections between the Island Road Major Opportunity Area and existing areas within the southern part of Reading with concentrations of residents seeking employment in this sector. Indeed, it is

noted that RBC adopted an SPD in respect of 'Employment, Skills and Training' in 2013, which seeks to translate these objectives into S106 obligations through the development management process;

- Island Road is well positioned as an opportunity to assist in the management of the relationship between employment development and housing in South Reading, in the context of the need for additional employment land and the extent to which there is currently a skills deficit in this area. Indeed, the Local Plan specifically acknowledges that South Reading represents the largest concentration of deprivation in the Borough (Paragraph 6.1.5), with particular issues with regard to skills and qualifications and five lower super output areas within the 20% most deprived according to the Indices of Multiple Deprivation (ONS, 2015). In this way, the new employment and skills opportunities associated with the allocation have the potential to assist with improved prosperity and social mobility across South Reading;
- The Berkshire Strategic Housing Market Assessment (February 2016) highlights that, with the development of internet shopping, there has in recent years been a growing demand for Class B8 space for high specification warehousing in Berkshire. More recently, the Central Berkshire FEMA Economic Development Needs Assessment (October 2016) underpins the quantum of need identified in the Local Plan and affirms that Reading is perceived to be a strong industrial location, benefitting from excellent strategic connectivity and labour force (Paragraph 3.36). It also confirms that South Reading and the A33 corridor, within which the allocation is located, represents the prime location from an industrial occupier perspective. This area combines strong demand and very low levels of new industrial development in recent years, which has resulted in a severe shortage of industrial property (Paragraph 3.39), albeit some new development has recently come forward on a speculative basis (for example application ref 141789);
- It is important to highlight the overall economic importance of industrial and warehouse development. Its importance is illustrated in research published by the British Property Federation ('Delivering the Goods – the economic impact of the UK logistics sector', December 2015). The report focuses on the following factors:

-
- i. *Logistics is an economic contributor* – The sector directly supports a minimum of 56,000 businesses and 710,000 employees in the UK and economic productivity in the sector is estimated at £100 billion GVA per year;
 - ii. *Challenging perceptions* – Average salaries in the logistics sector (£28,000) are above the national average (£20,000) and logistics companies work closely with local schools, colleges and employment agencies;
 - iii. *Technological progress* – The sector is modernising and pushing technological boundaries to meet rising demand and supply challenges. This is driving a need for more employees to respond to increased technological efficiency as well as demand for skilled employees in electrical and mechanical engineering, IT and analytics;
 - iv. *Measuring individual scheme effects* – Modernisation is leading to higher employment densities for some premises and GVA per employee is around £51,000 per year, rising to £75,000 by 2035;
 - v. *The future of logistics* – The sector's economic productivity is projected to grow by 83% between 2013 and 2035 and the e-commerce sector is projected to grow by 10% per year by 2021, reaching £48 billion;
- Similarly, the Government's Industrial Strategy (November 2017) sets out 'Grand Challenges' in response to the global forces that will shape future opportunities. These commit to putting the UK at the forefront of the artificial intelligence and data revolution, maximising the advantages for UK industry of the global shift to clean growth, becoming a world leader in shaping the future of mobility, and harnessing the power of innovation to help meet the needs of an ageing society;
 - In this way, in seeking to meet objectively assessed needs for new industrial and warehousing development, Policy SR1 is well aligned with the advice of the British Property Federation and the Government's Industrial Strategy;
- b. The allocation is justified as the most appropriate strategy by RBC's evidence base:
 - Alongside the Berkshire Strategic Housing Market Assessment and the Central Berkshire FEMA Economic Development Needs Assessment (referenced above), the latest Reading Housing and Economic Land Availability Assessment (November

2017) notes the difficulty in identifying capacity to accommodate industrial and warehousing space within the Borough over the plan period (Paragraph 6.4), which serves to highlight the importance of meeting need within the sites where capacity has been identified;

- Sub-area SR1a comprises three HELAA plots (WH017, WH020 and WH047). All three are confirmed in the HELAA as potentially suitable and also available and achievable.
- c. The allocation would be effective, because it would be deliverable over the plan period:
- Table 10.1 (Implementation Timescales) identifies that Policy SR1 will be delivered in the short term within the first five years of the plan period (2016-2021);
 - We can reconfirm the deliverability of Policy SR1, because sub-area SR1a is currently the subject of pre-application discussions between Roxhill and RBC. The technical and environmental reports that would be required by RBC in order to support a planning application are currently in preparation, further to an Environmental Impact Assessment Screening Opinion in February 2017 (ref 170101). It is expected that a planning application for the development of the Site will be submitted to RBC later in 2018. On this basis, we consider that sub-area SR1a is deliverable within the first five years of the plan period.
- d. The allocation would be consistent with the requirements of national planning policy:
- The National Planning Policy Framework confirms that the economic role of planning is to build a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation (Paragraph 7). It states that every effort should be made objectively to identify and then meet the business needs of an area and respond positively to wider opportunities for growth, taking account of market signals (Paragraph 17). Local planning authorities are required to plan proactively to meet the development needs of business and support an economy fit for the 21st Century, including by setting out a clear economic vision and strategy for the area which positively and proactively encourages sustainable economic growth and identifies strategic sites for inward investment to match the strategy (Paragraphs 20-21);

- We consider that Policy SR1 is consistent with these requirements of national planning policy in respect of economic growth and business needs.

2.7 Therefore, we consider that Policy SR1 meets the tests of soundness. We expect that Roxhill would deliver the new employment uses that are envisaged for sub-area SR1a and thereby realise the economic development goals that RBC is looking to achieve.

Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound.

2.8 Notwithstanding our support for the overall soundness of Policy SR1, it is considered that the Local Plan would benefit from minor modifications.

2.9 For the sake of clarity, in the following modifications new text is shown in bold and text to be deleted is shown in strikethrough.

2.10 The recommended minor modifications are as follows:

1. The text in Policy SR1 which specifically relates to sub-area SR1a concludes by commenting that "Development should be considered as a comprehensive whole". It is considered that the meaning of this comment is unclear. Moreover, it might be construed as an unnecessary constraint to development, given that (a) HELAA Sites WH017 and WH047 are in different ownerships and (b) in practice commercial occupiers may be identified for different parts of sub-area SR1a at different times. As part of the pre-application process, Roxhill (the owner of WH017) and RBC (the owner of WH047) are currently in discussion regarding access arrangements with the intention of ensuring that satisfactory access arrangements are provided for the whole of sub-area SR1a. However, in practice, both Roxhill (in relation to WH017) and RBC (in relation to WH047) could conclude that development is best brought forward as either one overall or two separate planning applications. The policy should be sufficiently flexible to accommodate both scenarios. Therefore, in order to reflect the objective of ensuring that the whole of sub-area SR1a can be flexibly developed in due course by both Roxhill and RBC, it is considered that the text should be amended as follows:

"Access to the ~~d~~Development should be considered as a comprehensive whole".

2. Figure 6.2 identifies the area of land to the immediate north of sub-area SR1a as “Nearby sensitive location – wildlife and landscape”. However feasibility plans that have been submitted to and discussed with RBC as part of the pre-application process have shown that part of this area could accommodate a new managed landscaped wetland area as part of the Sustainable Drainage Strategy for sub-area SR1a. This wetland area would enable a number of benefits to be realised, including benefits for water management and ecology, together with a more efficient layout within sub-area SR1. As a consequence, it is considered that the key relating to this area should be amended as follows:

“Nearby sensitive location – wildlife, ~~and~~ landscape **and water features**”.

It is considered that this minor modification would also ensure that Policy SR1 is more consistent with Policy EN12 (Biodiversity and the Green Network). Policy EN12 already confirms that water features are appropriate within the Green Network, because it states that “New development shall demonstrate how the location and type of green space, landscaping and water features provided within a scheme have been arranged such that they maintain or link into the existing Green Network and contribute to its consolidation”.

3. Figure 6.2 identifies landscaped buffers along the northern boundaries of sub-areas SR1a and SR1b. However the two buffers do not join up and there may be the potential over the longer term for further landscaping to ‘complete’ the buffer to be provided alongside an element of additional ‘infill’ commercial development on the northern side of Island Road, on the inert filled land that lies between sub-areas SR1a and SR1b. This further landscaping could also take account of any final alignment of the potential alternative MRT route. This inert filled land lies within the Kennett and Holy Brook Meadows Major Landscape Feature (Policy EN13) but outside the Fobney Island Nature Reserve (Policy EN7Sb).

Notwithstanding the provisions of the Local Plan, it is considered that the longer term development potential of the land between sub-areas SR1a and SR1b could be revisited through a planning application or future review of the Local Plan, taking account of design, environmental and sustainability considerations. In the event of ‘infill’ commercial development on the inert filled land, there is also the potential to provide the potential alternative MRT route through this area.

4. The reference to a “Potential alternative Mass Rapid Transit route” along Island Road and through sub-area SR1a should be amended. It is inconsistent with the current focus on the route along the A33 corridor and the alignment of the unnecessarily wide curve along the north west corner of sub-area SR1a would also restrict the amount of economic development that could be realised within sub-area SR1A. A recommended realignment of the route in a way that is consistent with the development of sub-area SR1a is illustrated in red on the following image:



5. The second criterion of Policy SR1 does not accord with the requirements of Paragraph 113 of the National Planning Policy Framework, because it makes no distinction between significant/insignificant effects and does not adopt a criteria-based approach. Our suggested rewording is as follows:

~~“Through sensitive design, layout and landscaping, ensure that development does not detract from the character and appearance of the Kennet Meadows major landscape feature. Sensitive design, layout and landscaping should be used in order to minimise the potential for significant adverse effects on the Kennet Meadows major landscape feature”.~~

6. The third criterion of Policy SR1 should be amended in order to make clear that it is intended to make reference to significant environmental effects and not insignificant effects, as follows:

“Avoid **significant** negative impacts on drainage...”

7. For the sake of clarity and consistency with Figure 4.8, the seventh criterion of Policy SR1 should be amended to make reference to the proposed Mass Rapid Transit route, as follows:

“Safeguard land which is needed for **proposed** mass rapid transit routes and stops”.

- 2.11 It is considered that the above changes should be introduced as minor modifications in advance of the adoption of the Local Plan.

APPENDIX 1
REPRESENTATIONS FORM

Reading Borough Council
Pre-Submission Draft Local Plan
November 2017
Representations Form



Please return by Friday 26th January 2018 to: Planning Policy, Civic Offices,
Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

Personal Details

Agent's Details *(if applicable)*

Title

--

Mr

Mr

First Name

--

Simon

Simon

Last Name

--

Flisher

Flisher

Job Title *(if applicable)*

--

Director

Director

Organisation *(if applicable)*

Roxhill Developments Ltd

Barton Willmore

Roxhill Developments Ltd

Barton Willmore

Address 1

C/O Agent

The Observatory

C/O Agent

The Observatory

Address 2

--

Southfleet Road

Southfleet Road

Address 3

--

Ebbsfleet

Ebbsfleet

Town

--

Kent

Kent

Post Code

--

DA10 0DF

DA10 0DF

Telephone

--

01322 374660

01322 374660

E-mail

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simon.flisher@bartonwillmore.co.uk

simon.flisher@bartonwillmore.co.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Refer to accompanying representations.

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant? Yes No

Is sound? Yes No

Fulfils the duty to co-operate? Yes No

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

Refer to accompanying representations.

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

Refer to accompanying representations.

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes

No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

The representations relate to a large employment allocation in the plan.

B7. Do you wish to be kept informed of planning policy matters?

(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Please keep me informed of all planning policy matters:

ROYAL BERKSHIRE FIRE AND RESCUE SERVICE

RBFRS Consultation Response to Reading Infrastructure Delivery Plan November 2017

RBFRS welcome the opportunity to respond to the ongoing consultation regarding the development of Reading Borough Local Plan. As the plan develops, RBFRS will be pleased to engage in the development of specific projects. In the short term, this response focuses directly on the Reading infrastructure delivery plan.

General Comments

Water Supply (page 19) - RBFRS note that any development has a requirement to consider water supply for firefighting operations and recommend the continuance of regular contact with the RBFRS Operational Support and Policy department.

Electricity (page 21) – RBFRS recommend that any new or refurbished electrical supply system be flood protected.

Fire & Rescue (page 39)

Strategy: Services are delivered by the Royal Berkshire Fire and Rescue Service (RBFRS) on behalf of Royal Berkshire Fire Authority (RBFA). They have produced a [Five Year Integrated Risk Management Plan 2015-2019](#)^[g1], which includes key projects for the period.

RBFRS's primary role is to deliver effective prevention, protection and emergency response services to reduce community risk. The integrated risk management plan outlines how the Service identify and assess risks and provides high level plans to manage those risks

Existing provision and capacity issues: RBFRS has four fire stations in the Borough, namely Caversham Rd, Wokingham Rd, Whitley Wood and Dee Rd. These provide four emergency fire engines crewed 24/7 by full-time staff. The Whitley Wood station also serves as a training facility..Additionally, the RBFRS headquarters are near J12 of the M4.

RBFRS has a response standard of arrival within 10 minutes of a call for 75% of all emergency incidents.

Impact of future growth: The location of the existing fire stations is considered adequate with regard to travel times. However, additional development is viewed as [likely to increase incident types](#)^[g2], including the two highest risks to the public: road traffic collisions and dwelling fires.

Priorities for meeting need: It is likely that proposed developments and growth will have an impact on the demand for the Fire Service and may necessitate the provision of additional resources, but the RBFRS has not identified additional capital infrastructure requirements at this time.

Designing safety into the built environment including fire prevention, reduces risk and therefore demand on the Fire and Rescue Service.

Some of these measures are included in the building regulations but RBFRS also recommends the inclusion of domestic and commercial sprinklers. ^[g3] This may limit the need to alter existing fire service provision in new development areas, thus reducing associated costs for proposed provision. This would also reduce casualties, reduce damage and protect the environment. RBFRS welcome the opportunity to work with the Council and developers to fully discuss the benefits of such systems.

A recent review of the fire station locations across the brigade area concluded that the level of service can be improved by relocating the whole-time fire station from Dee Road to a new fire station facility, preferably in Theale. This would improve the level of operational cover toward the west of ^[d4] Berkshire. Until such time as any new fire station is built in Theale, the Dee Road crews and appliance will remain in their current location for the time being.

In addition, information from local authorities about future growth patterns to 2036, along with existing demand pressure and analysis of emerging risks are feeding into RBFRS long term planning. Consideration of where the most effective locations for fire stations are within the area will be kept under review.

ROYAL BOROUGH OF WINDSOR AND MAIDENHEAD

Planning Policy
Place Directorate
Royal Borough of Windsor and Maidenhead
Town Hall
Maidenhead
SL6 1RF
Email address - planning.policy@rbwm.gov.uk

15 March 2018

Planning Policy
Reading Borough Council
Civic Offices
Bridge Street
Reading
RG1 2LU

Regulation 19 Consultation Response

Dear Planning Policy Team,

Thank you for the opportunity to respond to your Pre-Submission Draft Local Plan Consultation.

RBWM's comments are as follows:

Pre-Submission Draft Local Plan

H1 - The Royal Borough of Windsor and Maidenhead agrees that the housing requirements of Reading Borough Council should be met by the three Local Authorities within the Western Berkshire Housing Market Area.

TR2 - RBWM welcomes Reading Borough Council's commitment to continuing to work with neighbouring authorities and the TVBLEP.

Duty to Cooperate Statement

2.3.6 - The Memorandum of Understanding (MoU) between the six authorities was not signed by RBWM. RBWM welcomes the amendment to this paragraph to reflect this fact. However, it should be noted that RBWM is willing to continue to cooperate and work towards the formation of an agreed MoU in the future. In addition, discussions involving RBWM and South Bucks District Council have suggested that they would also like be involved in any future discussions regarding a MoU.

Yours sincerely

Garry Thornton
Senior Planning Policy Officer

Reading Borough Council
 Pre-Submission Draft Local Plan
 November 2017
 Representations Form



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 Bridge Street, Reading, RG1 2LU or email planningpolicy@reading.gov.uk

PART A - YOUR DETAILS

	Personal Details	Agent's Details <i>(if applicable)</i>
Title		
First Name		
Last Name		
Job Title <i>(if applicable)</i>		
Organisation <i>(if applicable)</i>		Royal Borough of Windsor and Maidenhead
Address 1		Town Hall
Address 2		St Ives Road
Address 3		
Town		Maidenhead
Post Code		SL6 1RF
Telephone		
E-mail		planning.policy@rbwm.gov.uk

PART B - YOUR REPRESENTATION (please use a separate form for each representation)

B1. To which part of the Local Plan does this representation relate?

Whole Plan

B2. Do you consider that the Local Plan: (please tick as appropriate)

Is legally compliant?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Is sound?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Fulfils the duty to co-operate?	Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

B3. Please provide details of why you think the Local Plan, or part of the plan, is or is not legally compliant, sound and/or complies with the duty to co-operate.

n/a

Please continue on another sheet if necessary

B4. Please set out the modifications that you think would make the Local Plan, or part of the plan, legally compliant and/or sound. Please provide specific wording where possible.

n/a

Please continue on another sheet if necessary

B5. If you are seeking a modification to the plan, do you wish to appear in person at the public examination?

Yes No

B6. If you wish to appear in person, please briefly outline why you consider this necessary.

No

B7. Do you wish to be kept informed of planning policy matters?
(please tick as appropriate)

Please keep me informed of the progress of this Local Plan:

Y

Please keep me informed of all planning policy matters:

Y