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Green Infrastructure

- Green infrastructure describes all things green and living with urban areas, such as street trees, parks, green walls, green roofs, urban woodland, etc. Trees are a fundamental part of the Birmingham's green infrastructure.
- There are many good reasons for green infrastructure in our cities. Green infrastructure positively impacts public health from birth to death: new-borns from areas with higher levels of urban forest have a higher average birth weight (Donovan et al. 2011); children in classrooms with a view of green infrastructure have higher attention levels than those who do not (Li & Sullivan, 2016); adults have lower frustration and higher meditation when moving in greener streets (Aspinall et al., 2015); a view of nature following surgery can improve emotional well-being, reduce minor complications, and shorten hospital stays (Ulrich, 1984); and, wander-gardens and horticulture can reduce medication and falls for Alzheimer's sufferers (Detweiler et al. 2009).
- Green infrastructure also makes our cities more liveable and resilient to extreme weather. For example, green infrastructure can provide shade and improve thermal comfort on hot days (e.g. Norton et al., 2015). Green infrastructure can reduce the amount of surface run-off following heavy rainfall (e.g. Mentens et al., 2006; Forest Research, 2010), and therefore reducing the risk of urban flooding. Finally, green infrastructure can lessen the impact of against poor air quality. Globally, air pollution is the biggest environmental risk to health. Within the UK, poor outdoor air quality is linked to 50,000 deaths each year.
- This document provide evidence specifically on green infrastructure and air quality. I have summarised the key points from the relevant literature. If you wish to read the original scientific literature, I have provided the full reference list, and can provide the original material on request.

Green infrastructure can mitigate (lessen the negative impact of) poor air quality

If strategically designed, green infrastructure can be used to mitigate (lessen the negative impact of) poor air quality in urban areas (Abhijith et al., 2017). Road transport emissions are now the largest source of air pollution in urban areas in the UK. Please note that green infrastructure can never remove all the pollutants from air, and becomes less and less efficient as the distance from the pollutant source increases. The best way to improve poor air quality is to reduce road transport emissions.

Modelling studies indicate that:

- Large areas of green infrastructure, such as parks, generally have cleaner air for they contain fewer roads and traffic emissions.
- Trees and other green infrastructure influence wind flow. The combination of parklands, buildings, trees, and gardens creates a rough surface of different heights creating turbulence that increases mixing, and pollutant dispersion (Barnes et al., 2014).
- Green infrastructure such as hedges or shrubs, can be used as a barrier to increase the pathway between pollution source and receptor, which increases mixing and reduces pollutant concentration (Hewitt et al, <submitted>).
- In comparison to similarly sized grey infrastructure such as concrete walls or bricks, green infrastructure has a far greater surface area. This means that far more air pollution can be deposited on the surface of green infrastructure therefore more air pollution can be removed from the ambient air (Pugh et al, 2012).

Green infrastructure can exacerbate (worsen the negative impact of) poor air quality

Trees do not produce pollution. Air pollution comes predominantly from road transport. However, in certain circumstances, trees can make poor air quality worse. The best way to improve air quality would be to remove the emission sources (road transport), rather than the tree.

- Trees produce natural chemicals called volatile organic compounds. On very hot days with strong sunlight (e.g. during a heatwave) these volatile organic compounds can mix with pollution from road transport to form ozone. At ground level, ozone is a pollutant with negative health impacts. To be significant in terms of poor air quality this takes several hours, and needs many millions of trees. This effect is large-scale (not local street-level), and the ozone formation make take place hundreds of miles away from the original source**. Note: This should only be considered an issue when increasing the total number of urban trees by more than 10%** (Hewitt et al, <submitted>).
- Dense avenues of street trees with large interconnected canopies can trap air in street canyons therefor elimiting mixing. If the pollution source is located inside the canyon this causes fumigation – i.e. the air pollution is trapped inside the street canyon (Jeanjean et al., 2015). If the source is located outside of the canyon the canopies prevents mixing into the canyon, creating locally cleaner air (positive benefit). **Note: This is not an issue when planting new trees. Overtime (e.g. 10 years), when the new trees have grown canopies of a sufficient extent, the traffic emissions fleet should contain more electric cars and therefore this issue will become redundant.**

Full Reference List – I can provide these academic references if requested.

Abhijith, K.V., Kumar, P., Gallagher, J., McNabola, A., Baldauf, R., Pilla, F., Broaderick, B., Di Sabatino, S., Pulvirenti, B., 2017. Air Pollution Abatement Performances of Green Infrastructure in Open Road and Built-up Street Canyon Environments – A Review. Atmospheric Environment https://doi.org/10.1016/j.atmosenv.2017.05.014

Aspinall, P., Mavros, P., Coyne, R. and Roe, J., 2015. The urban brain: analysing outdoor physical activity with mobile EEG. *Br J Sports Med*, *49*(4), pp.272-276.

Barnes, M.J., Brade, T.K., Mackenzie, A.R., Whyatt, J.D., Carruthers, D.J., Stocker, J., Cai, X. and Hewitt, C.N., 2014. Spatially-varying surface roughness and ground-level air quality in an operational dispersion model. Environmental Pollution, 185, pp.44-51.

Detweiler, M.B., Murphy, P.F., Kim, K.Y., Myers, L.C. and Ashai, A., 2009. Scheduled medications and falls in dementia patients utilizing a wander garden. *American Journal of Alzheimer's Disease & Other Dementias®*, *24*(4), pp.322-332

Donovan, G.H., Michael, Y.L., Butry, D.T., Sullivan, A.D. and Chase, J.M., 2011. Urban trees and the risk of poor birth outcomes. *Health & place*, *17*(1), pp.390-393.

Forest Research. 2010. Benefits of green infrastructure. Report by Forest Research. Forest Research, Farnham.

Hewitt, C.N., Ashworth K., and MacKenzie, A.R., <submitted> Using green infrastructure to improve urban air quality (GI4AQ)

Jeanjean, A.P., Hinchliffe, G., McMullan, W.A., Monks, P.S. and Leigh, R.J., 2015. A CFD study on the effectiveness of trees to disperse road traffic emissions at a city scale. Atmospheric Environment, 120, pp.1-14

Landrigan, P., Fuller, R., Acosta, N., Adeyi, O., Arnold, R., Basu, N., Baldé, A., Bertollini, R., Bose-O'Reilly, S., Boufford, J., Breysse, P., Chiles, T., Mahidol, C., Coll-Seck, A., Cropper, M., Fobil, J., Fuster, V., Greenstone, M., Haines, A., Hanrahan, D., Hunter, D., Khare, M., Krupnick, A., Lanphear, B., Lohani, B., Martin, K., Mathiasen, K., McTeer, M., Murray, C., Ndahimananjara, J., Perera, F., Potočnik, J., Preker, A., Ramesh, J., Rockström, J., Salinas, C., Samson, L., Sandilya, K., Sly, P., Smith, K., Steiner, A., Stewart, R., Suk, W., van Schayck, O., Yadama, G., Yumkella, K. and Zhong, M. (2017). The Lancet Commission on pollution and health. The Lancet.

Li, D. and Sullivan, W.C., 2016. Impact of views to school landscapes on recovery from stress and mental fatigue. *Landscape and Urban Planning*, *148*, pp.149-158.

Mentens, J., Raes, D. and Hermy, M., 2006. Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century?. *Landscape and urban planning*, *77*(3), pp.217-226.

Norton, B.A., Coutts, A.M., Livesley, S.J., Harris, R.J., Hunter, A.M. and Williams, N.S., 2015. Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes. *Landscape and Urban Planning*, *134*, pp.127-138.

Pugh, T.A., MacKenzie, A.R., Whyatt, J.D. and Hewitt, C.N., 2012. Effectiveness of green infrastructure for improvement of air quality in urban street canyons. Environmental science & technology, 46(14), pp.7692-7699.

Ulrich, R., 1984. View through a window may influence recovery. *Science*, *224*(4647), pp.224-225.