8 – Soils, Air and Water

8. Soils, air and water

8.1 Soils

This section looks at the soil types and geology, and assesses the potential impact of tree planting and the project implementation on their structure and function. During the screening and consultation the soils were identified as 'needing to be considered', therefore this section provides a brief assessment.

8.1.1 **Background**

8.1.1.1 The dominant land use for the site is arable, with a long history of farming. Maps from the 1700s show field patterns suggesting a predominantly farming history for at least the past 300 years. As such these soils are largely disturbed through ploughing and cultivation and modified by herbicide and pesticide use more recently.

8.1.1.2 The arable land is described as grade 3 and makes up approximately 18 Ha of the total land holding. The agricultural land classification system allows agricultural land to be graded from best (grade 1) to worst (grade 5) and provides a consistent, country-wide system of land classification. Grade 3 arable land is described as being suitable for extensive arable cropping, rotational grassland e.g. cereals, oilseed rape & beans or grass leys for dairy cows, beef, sheep and hardwood forestry mainly.

8.1.1.3 The Heartwood Forest project will ultimately take 326 Ha of arable land out of production over a maximum phased period of ten years. Whilst historically there have been periods when woodland has been converted to agricultural use, the creation of Heartwood Forest can be considered permanent given the Woodland Trust's objectives. There is no mitigation/compensation against this loss, i.e. there is a net loss of arable land. However when compared to the wider social, health and biodiversity benefits, we believe there is a net positive social impact. Our position regarding loss of arable land is shown in volume 1 appendix 17.

8.1.2 **Soil types and Geology**

8.1.2.1 The predominant soil type association is Batcombe (582a), described as fine silty over clayey and fine loamy over clayey soils with slowly permeable subsoils and seasonal water logging. This soil type is found across the entire site, except immediately adjacent to both sides of the B651 road and the field directly to the east of the B651. Here the soil type is classified as Charity 2 (571m), described as well-drained flinty fine silty soils in valley bottoms.

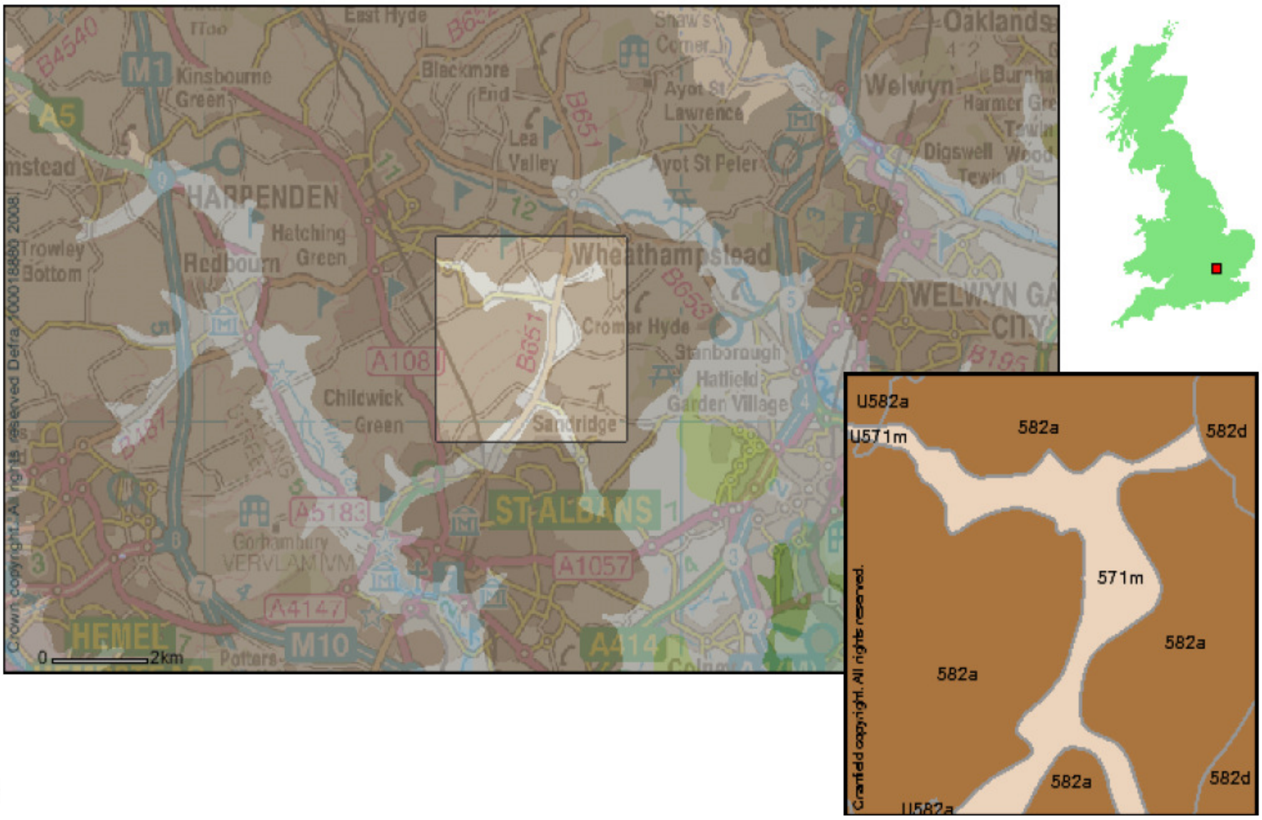

Fig 8 - 1 Soils – spatial distribution

8.1.3 Soil characteristics are broadly described as –

Batcombe (582a) Hydrogeological rock type – clay with flints and plateau drift.
Slowly permeable soils with slight seasonal waterlogging and moderate storage capacity over slowly permeable substrates with negligible storage capacity. They pose an intermediate risk to pesticide leaching and a moderate risk to run-off and adsorption.

Charity 2 (571m) Hydrogeological rock type - chalk
Free draining permeable soils on chalk or chalky substrates with relatively high permeability and moderate storage capacity. Ground water expected at moderate depths, intermediate pesticide leaching risk, but low run-off risk and moderate adsorption potential.

8.1.4 **Impacts on soils**

8.1.4.1 The most significant impact on the soils will be through woodland and meadow creation, leading to improved soil stabilisation and increasing level of organic matter[1]. Cultivation results in a less-stable soil structure, more exposed topsoil which can be subject

[1] Woodland Trust (2008) Position Statement: Impact of UK's native woodland on the water environment, downloaded at:
http://www.woodlandtrust.org.uk/SiteCollectionDocuments/pdf/water-position.pdf

to erosion over a long period of time. Evidence of falling soil levels can be seen to the north of Puddler's Wood where field margins are higher than the field soil level, showing topsoil loss, likely to be as a result of cultivations and subsequent erosion. The creation of woodland and meadows on arable land will stabilise the soils through the vegetation root network and through the reduction in disturbance. An increase in soil organic matter as a consequence of reduced soil disturbance and mineralisation, together with leaf fall and woody debris will increase the soil's ability to store carbon and absorb water.

8.1.4.2 Ground preparation for wild-flower meadows has the potential to impact soil structure. Soil inversion is one technique used to reduce the nutrients in the topsoil necessary to successfully establish wild flowers which are not good competitors with more vigorous vegetation. Whilst the reduction in soil fertility would have a negative impact on agricultural use, it is beneficial however for meadow creation and wild flower establishment. The lower organic matter content of subsoils also makes them more liable to erosion, however the establishment of a meadow should ensure that this effect is temporary and short lived.

8.1.4.3. Woodland creation requires few herbicide and pesticide applications compared to arable farming. Chemical weeding of trees would be for approximately 3-5 years during establishment and only affects a small proportion of the ground area (around 10%). Thereafter chemical application would not be required. Residual herbicides are unlikely to be used in the creation of Heartwood Forest. The presence of any residual herbicides or other chemicals as a result of agriculture will be reduced as a result of woodland creation.

8.1.4.4 Hard surfacing proposed for car parking, access tracks and some paths will have a low impact. The land area which is likely to be surfaced is less than 0.6% of the total project area. The main predicted impact is that water percolation rates may be reduced, where currently they are slowly permeable. This may result in small amounts of run-off onto adjacent soils. Overall impact is considered negligible.

8.1.5 **Mitigation**

8.1.5.1 The impact on soils is considered to be moderately positive as the project will lead to increased soil stability and higher organic content, resulting in increased infiltration and reduced run-off, reducing the probability of surface water flooding and erosion. Design planning for car parks, access tracks and surfaced paths will need to consider surface water run-off if a non-permeable surface is used, however surfacing is likely to be a stone subbase and type-1 stone top surface, allowing a degree of water percolation. Any topsoil removal for hard surfacing will be retained on site.

8.2 Air Quality

8.2.1 **Background**

Throughout the scoping exercise and consultation, the Heartwood Forest project as a whole was considered to have relatively low impact on air quality. Trees and woods are known to have positive impacts on air quality, particularly in areas which are not well wooded. Heartwood Forest will be created in an area of relatively high woodland cover (9%), however localised long-term benefits in particular are expected to result.

Recent policy to improve air quality in the UK has led to studies of the impact of trees and woodland in reducing air pollution and the effect of trees in reducing respiratory disease or the effects of chronic respiratory conditions[2].

Trees improve air quality by:

- Absorbing gaseous pollutants such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and ozone (O_3).
- Intercepting particulate matter (PM) such as dust, pollen, and smoke.
- Releasing oxygen (O_2) through photosynthesis.
- Transpiring water and shading surfaces, thus lowering local air temperatures, thereby reducing O_3 levels (McPherson et al., 2002).

The air quality improvement effect of trees is proportionately greater in urban than rural areas per unit area of trees, since in urban areas trees are closer to sources of air pollution and greater population.

8.2.2 **St Albans district**

8.2.2.1 The Environment Act 1995 required local authorities to review the quality of air within their areas. The review had to consider the current air quality and the likely air quality in the year 2005 against national air quality standards. Areas that did not or were unlikely to meet these standards were designated as Air Quality Management Areas (AQMAs)

8.2.2.2 St Albans District Council originally declared six AQMAs throughout the district, linked to traffic movements and junctions on the M25, and M1 to the south and west of Heartwood Forest. Through further assessment these were reduced to one area shown below suggesting that levels of nitrogen dioxide were originally overestimated.

[2] Crabtree, R. (2009) The Value of the benefits arising from trees and woodland in the UK, A report for the Woodland Trust

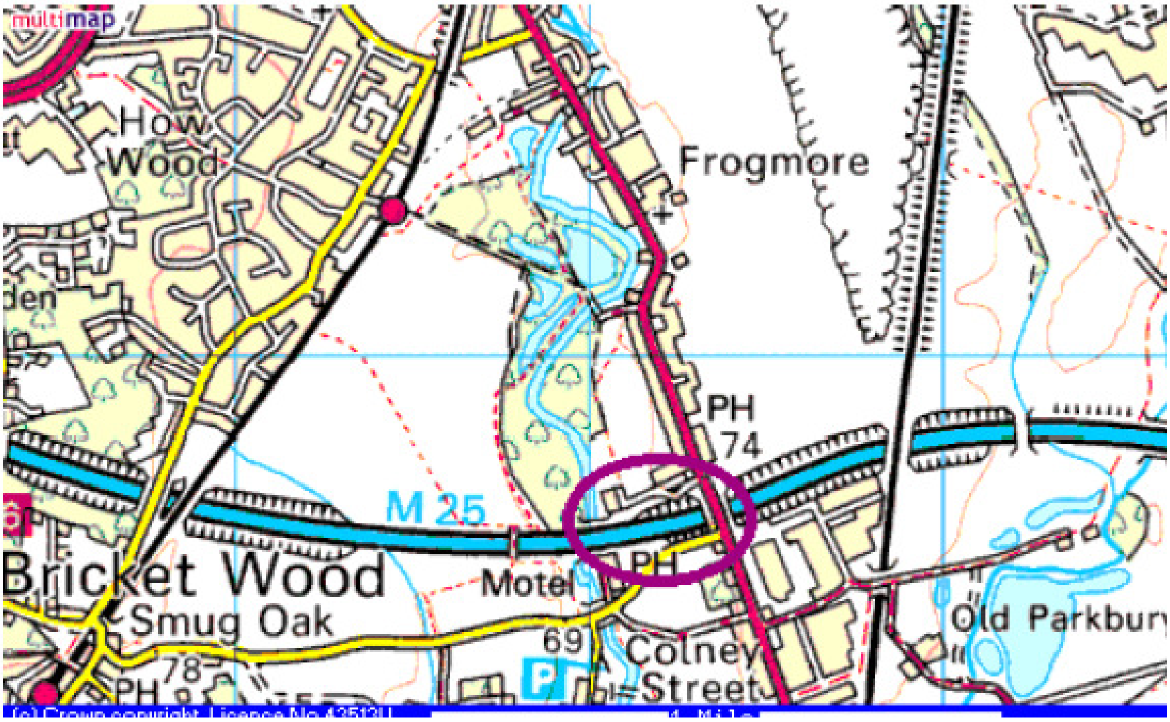

Fig 8 - 2 Frogmore AQMA, St Albans

A detailed assessment in 2008, recommended the declaration of two more AQMAs, located to the north of London Road and the east side of Peter's Street close to the town centre.

8.2.2.3 The district monitors nitrogen dioxide levels across the district via 35 different monitoring sites. The site closest to Heartwood Forest is on Wheathampsted high street, with a range of 13 – 37 micrograms/cubic meter. The target mean average to meet air quality standards for nitrogen dioxide is 40 micrograms/cubic meter. Information from the Hearts and Beds air quality partnership website shows St Albans district as a whole generally within air quality standards over an annual period for all pollutants, however ozone levels exceeded the standard at times. The AQMAs identify areas where this is being exceeded or is likely to be exceeded in the future.

8.2.2.4 In 2003 a report "air quality action plan for St Albans City and District Council" put in place measures to retain good quality air within the district. The primary objective focuses on the AQMAs, and the secondary objective looks at the district as a whole, largely based on transport planning and protecting the environment.

8.2.3 **Impact Assessment – air quality**

8.2.3.1 Trees are effective in removing nitrogen dioxide sulphur dioxide, ozone and particulate matter (e.g. PM_{10}), from the air. The layered canopy structure of trees, which has evolved to maximise photosynthesis and the uptake of carbon dioxide, provides a surface area of between two and twelve times greater than the land areas they cover[3].

8.2.3.2 Particulate matter is captured through deposition on leaf and bark surfaces and this is the main dry absorption route. The process of dry deposition is complex, depending upon tree type. Deposition varies depending on the density of the foliage, leaf form, tree spacing and surface topography. Particulate capture occurs when an air stream is disrupted as it passes the aerodynamically rough plant surfaces, while the particle continues in a straight line and strikes the obstacle, either through direct interception or electrostatic attraction.

8.2.3.3. It is recognised that some broadleaved tree species such as willow, aspen and sessile oak can emit volatile organic compounds (VOCs). Rates of emission depend on tree species; however ash and field maple and silver birch along with some conifer species were shown to significantly improve air quality[4]. The effects of Page: 239
the choice of tree species on air quality is more significant in urban environments, and therefore considered negligible compared to the net gain achieved through the planting as a whole.

8.2.3.4 Heartwood Forest is approximately three miles from designated AQMAs and is therefore not predicted to contribute any marked effect on the air quality.

8.2.3.5 Heartwood Forest is bisected by the B651 which is a busy road, particularly during peak traffic flow times. Historically the main sources of air pollution in the UK were the high levels of smoke and SO_2 arising from the combustion of sulphur-containing fossil fuels such as coal. A major source of air pollution now stems from traffic emissions. Petrol and diesel motor vehicles emit a variety of pollutants, especially carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs) and particulate matter (PM_{10}). These significantly affect urban air quality. In addition, photochemical reactions resulting from the action of sunlight on NO_2 and VOCs from vehicles lead to the formation of ozone, a secondary pollutant.

Heartwood Forest is predicted to have a positive effect on air quality at a local level through absorption of pollutants as a result of vehicle emissions. This is likely to be experienced directly by properties where the forest location is directly between the road and the property. Heartwood Forest will itself act as a barrier to the B651 to visitors using the site and be a pleasant place to visit.

8.2.3.6. There is likely to be an increase in road traffic as a result of visitors arriving by car. CO_2 emissions from visitors are predicted to be fully compensated by the planting proposed. The intention is to encourage people to visit by other means. However it is

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[3] Broadmeadow, M.S.J. and Freer-Smith, P.H. (1996). *Urban Woodland and the Benefits for Local Air Quality*, Department of Environment, HMSO, London.

[4] Stewart, H., Owen S., Donovan R., MacKenzie R., and Hewitt N. (2002). *Trees and Sustainable Urban Air Quality*. Centre for Ecology and Hydrology, Lancaster University.

inevitable, particularly in the short term, that access by car will be in the region of 60% of all visits. Many of these will already be travelling in the area, or would have been visiting other access areas in the locality, therefore the assessment of exact vehicle increase is difficult to determine.

Heartwood Forest is likely to lock up in the region of 137,652 tonnes over a 100 year period, equating to 1,377 tonnes/year. Using government figures, average car journeys will emit 162g/CO_2/mile. The trees at Heartwood Forest potentially have the capacity to lock up carbon equivalent to 5.4m car miles/year. Given that our visitor base and therefore the majority of visitors are likely to be from a 2.5 mile (4km) radius, and that a vast majority will be visiting the area for other purposes, visitor arrivals by car are predicted to have a negligible effect and no overall impact as a result of the project. We will, however, promoting existing cycling and walking routes and green transport alternatives.

8.2.4 **Mitigation**

8.2.4.1 Overall the Heartwood Forest is predicted to have a positive impact on air quality, and therefore no mitigation measures are required, however we will promote green travel and alternative methods of visiting to the car, as increasing pressures on transport have the potential to negatively effect air quality.

8.3 Water

8.3.1 This section looks at impacts on both water quality and water quantity. During the screening process and consultation process, water was not raised as a concern, therefore will only be considered briefly. The likely impacts are based on comparable research. There has been little research on the impacts on water from afforestation on arable land. A full literature review was undertaken for the Woodland Trust in 2008 – "Woodland actions for biodiversity and their role in water management"[5].

8.3.2 **Background**

8.3.2.1 There are currently no streams, rivers or areas of permanent standing water on the land proposed for Heartwood Forest, although occasional springs occur around the ancient woodland to the north-west of the site. The wood names Pismire Spring, Well Wood and Puddler's Wood indicate a wet area and presence of water closer to the soil surface.

[5] *Calder, I.R., Harrison, J., Nisbet, T.R., & Smithers, R.J. (2008). Woodland actions for biodiversity and their role in water management. Woodland Trust*. www.woodland-trust.org.uk/water

8.3.2.2 Heartwood Forest lies within the River Lee water-catchment area covering approximately 865 sq km. Water quality is reported to be good in the Upper Lee, and poor in the Lower Lee catchment.

8.3.2.3 The water table level is unknown.

8.3.2.4 Reports suggest a single local flash flooding event in 2007 affecting Sandridge High Street and Harness Way. Heartwood Forest rises from Sandridge village by approximately 30m to the north-west. There have also been a number of floods associated with the River Lee within Wheathampsted, approximately two miles north of Heartwood Forest.

8.3.3 **Impact assessment - water quality**

8.3.3.1 Water draining from native woodland generally has a lower nutrient level than water draining from more intensive land uses. Native woodland will generally absorb nutrients arising from atmospheric deposition. Woodland does not require input of fertiliser, as a result there is less run-off resulting in less eutrophication of water systems. Broadleaved woodland has the ability to intercept and remove nutrients such as nitrates, from water draining from adjacent land particularly where it flows within the upper soil layers.

8.3.3.2 Tree canopies capture atmospheric pollutants. Pollutants can promote acidification of surface and ground waters in highly-polluted areas, although broadleaved woodland captures fewer pollutants than coniferous woodland and its impact on acidification is smaller.

8.3.3.3 As we will be replacing an intensive arable system with native woodland using a minimum of pesticides, the planting at Heartwood Forest is likely to have a positive impact on water quality. Any impact is likely to be localised. The impact may not be detectable given the lack of watercourses on-site and the distances to nearest watercourses via other farmed land. The site for Heartwood Forest does appear to have ground water which is failing WFD requirements due to the levels of chemicals. Whilst the woodland creation will have a beneficial impact on ground water quality, it may not be detectable due to the significant lag times needed to detect change in ground water status. It would also be difficult to isolate the impact from the input of chemicals from surrounding land uses which drain into the same ground water body.

8.3.4 **Impact assessment - water quantity**

8.3.4.1 Trees and woodlands tend to reduce yield more than shorter vegetation and arable crops. This is via loss as transpiration and reduction in rainwater reaching the ground as a result of interception by the leaves, branches and trunks and subsequent evaporation from these surfaces. In the UK, interception by broadleaved woodland can be up to 25% of the annual rainfall.

8.3.4.2 Soil infiltration rates are often increased in woodland due to the increased organic matter and improved soil structure, increasing the soil's ability to receive and store water.

8.3.4.3 Changes in water yield are very difficult to detect at a catchment scale when woodland creation or removal involves less than 20 per cent of the catchment. As with existing woodland, the reduction in water yield is greater with conifers and short rotation coppice, as compared to broadleaf woodland, however there is some evidence that at smaller scales, woodlands can reduce small floods at hillslope or headwater catchment scales[6].

8.3.4.4 Changes in water yield are difficult to detect at a catchment scale when woodland creation or removal involves less than 20 per cent of the catchment. The scale of Heartwood Forest means it is unlikely to have any impact on water yield at this geographical level.

8.3.4.5 Locally, there is a probability that Heartwood Forest will have a positive impact on localised flooding, particularly from surface water flooding. It is expected that surface water flooding will be reduced, through interception of precipitation by the trees and from an increase in the soil's ability to absorb water. Additional benefits in the form of reduced erosion may be expected in the longer term, e.g. the main surfaced bridleway which leads north from Pound Farm currently showing channels in the surface from surface water run-off which are likely to improve.

8.3.5 **Mitigation**

8.3.5.1 Overall, Heartwood Forest is likely to have a residual positive impact on water quality and quantity. The implementation phase will use herbicide to control weed growth, however chemical use will be kept to a minimum and will be significantly lower than that for agricultural crops. The chemical application rate compared to arable farming is low- and short-term, and unlikely to involve the use of residual compounds.

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[6] Environment Agency (2008) Delivery of Making Space for Water HA6 Catchment Scale Land-Use Management HA7 Land Management Practices Review of existing delivery mechanisms Final Report January 2008, downloaded at: http://www.defra.gov.uk/environ/fcd/adaptationandresilience/ha6ha7/deliverymech.pdf