2. Soil manufacture and habitat creation

Trials have shown that an application rate of 20% by volume is sufficient for woodland establishment.

Topsoil manufacture, involves the blending of available soils with inorganic and organic materials such as PAS 100 compost to create a fit for purpose soil for the establishment of vegetation.

Manufactured soils often comprise green and/or food derived compost mixed with in situ or imported soils; and depending on the circumstances, other organic and inorganic materials, such as paper mill crumb, biosolids, and/or waste soils, may be incorporated.

PAS 100 compost has been used successfully in soil manufacturing on various brownfield regeneration projects including the creation of woodlands, amenity grasslands and even golf courses. It provides vital nutrients and organic matter which help to establish vegetation and support healthy growth and in turn promote habitat creation. Where there are sufficient soils or growing media on site, but they are of a poor quality i.e. poor physical structure and insufficient nutrient availability, compost can be incorporated as a soil improver. This differs to soil manufacture as it tends to be carried out in situ rather than blended from stock piles of material.

Cost savings and other benefits

- The use of compost in soil manufacture and improvement reduces the generation of waste by reusing site won soils and other materials. This reduces cost of disposal of on site materials as well as reducing costs associated with importing topsoil.
- The available nutrients and organic matter in compost can promote rapid habitat establishment whether it be amenity grassland, wildflower meadows or woodlands.
- Blending site won materials with compost to manufacture a soil reduces the risk of unwanted seed bank often found in imported soils.

Lambton former coke works

At Lambton former coke works, field trials assessed the benefits of PAS 100 compost mixed with on site materials and paper mill crumb to create a two metre soil profile. The manufactured soil was subsequently used for the creation of 23 hectares of woodland and 10 hectares of grassland.

The use of PAS 100 compost demonstrated significant benefits in tree establishment. The combination of the mix of compost to paper mill crumb using the loose tip emplacement method was shown to be the most effective means of woodland establishment. Whilst the use of wide or narrow track bulldozers resulted in excessive soil compaction.

Manufacturing soil on site rather than importing natural soils resulted in an estimated cost saving of £434,000 at the Lambton site. Observed rates of tree survival at similar regeneration sites suggest an estimated cost saving of around £18,000 at Lambton as a result of reduced tree mortality through loose tip emplacement of soils.

The choice of tree species is also an important consideration in woodland establishment on sites lacking natural soil resources. A significant proportion of “pioneer” species such as alder and birch are recommended.

Tree planting at Lambton former coke works
### Input - PAS 100 compost (0-20mm) with topsoil

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Compost (%)</th>
<th>Rate</th>
<th>Cost (£/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>5</td>
<td>125 m³/ha (64 t/ha)</td>
<td>£1,460</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>250 m³/ha (128 t/ha)</td>
<td>£2,420</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
<td>375 m³/ha (191 t/ha)</td>
<td>£3,365</td>
</tr>
<tr>
<td>25</td>
<td>20</td>
<td>500 m³/ha (255 t/ha)</td>
<td>£4,325</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>625 m³/ha (319 t/ha)</td>
<td>£5,285</td>
</tr>
<tr>
<td>40</td>
<td>5</td>
<td>200 m³/ha (102 t/ha)</td>
<td>£2,130</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>400 m³/ha (204 t/ha)</td>
<td>£3,660</td>
</tr>
</tbody>
</table>

Table 2-1: Cost of soil improvement using compost at different rates

0 – 20 mm grade PAS 100 compost from Scottish Water, costing £15/tonne in total (based on a cost of £7/tonne + £7/tonne for haulage + £1/tonne for spreading). The cost was approximately £500/ha for incorporation at 25 cm and £600/ha for incorporation at 40 cm.

Above costs are in addition to those associated with the standard land restoration practice at Lafarge’s Dunbar quarry (i.e. no compost or fertiliser applied along with the topsoil/subsoil mix). Spreading of topsoil/subsoil mix costs approximately £8,400/ha.

### Application of compost

The amount of compost that is appropriate to use for a site will depend on the properties of the compost to be applied, the quality of the soil forming material and the intended land end use of the reclamation project. Application rates will be site specific and influenced by factors such as the topography of a site, the soil infiltration rate, weather conditions prior to application and future weather patterns. Some guideline values are shown in Table 2-2.

To avoid adverse impacts from using compost in soil manufacture and improvement, consider the following:

- **Plant nutrient requirements**: applying the right quantity of compost is essential to ensure the soil has both the correct physical characteristics and nutrients to support healthy plant growth. Applying too much compost will make the soil too fertile which can lead to excessive soft tree growth, and weed growth which can increase maintenance costs. It also leads to reduced species richness of plant communities. If too little compost is applied, then plant growth may be stunted. Trials have shown that an application rate of 15% to 20% by volume is sufficient for woodland. Further guidance on mixing ratios for different soil-forming materials and end uses, is given in Appendix 2.

- **Handling and mixing materials**: it is important that compost and other soil forming materials are handled with appropriate equipment so that the right quantities are applied e.g. farming equipment such as a muck spreader and a tractor mounted rotovator could be used for in situ soil manufacture.
**Placement of soils**: a soil's physical structure can easily be damaged during handling and is therefore susceptible to compaction. Using a loose tip method rather than bulldozers will help minimise compaction from trafficking. For more information on soil handling and placement refer to the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, Defra7.

**Drainage**: in order that manufactured topsoils can function effectively, the subsoils on which they are placed must provide adequate drainage to sustain healthy root systems. Poor drainage can cause waterlogging which contributes to dieback, particularly for tree rooting.

<table>
<thead>
<tr>
<th>Goal of reclamation</th>
<th>Typical application rate* (t/ha)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat establishment/amenity land</td>
<td>50-100</td>
<td>Plant growth trials are recommended to ensure nutrient levels are not excessive for the intended purpose</td>
</tr>
<tr>
<td>Soil formation</td>
<td>100-500**</td>
<td>The application rate will vary depending on the condition of the soil</td>
</tr>
</tbody>
</table>

Table 2-2: Examples of application rates*

* The application rate of organic materials with low dry solids content (<25%) should be at the lower end of the range shown depending on site-specific conditions.

** Depending on site-specific environmental conditions, particularly in the case of colliery spoil, the maximum application rate may need to be higher than 500 t/ha, depending on the condition of the land, soil pH and the quality of the compost and other organic material(s) to be used. Application rates in excess of 500 t/ha would need to be justified to the environmental regulator and approved in advance.

The restoration of Broughton Craggs former landfill site

PAS 100 compost was mixed in situ with subsoil to manufacture topsoil at Broughton Craggs, a former landfill site. The manufactured soil was used to create a new woodland and meadow grassland landscape.

Monitoring has shown that the manufactured soil, comprising 20% green compost to 80% subsoil (by volume), has sustained a diverse flower rich grassland community and supported tree establishment⁸.

Wildflowers on manufactured soil, Whitehaven
Developing wildflower habitats on derelict land

Experimental trials were established at a site in Whitehaven to investigate the potential use of PAS 100 compost with crushed building aggregate, textile waste (carpet fibre) and quarry waste for the establishment of diverse wildflower habitats on derelict land.

Wildflowers establishment after soil manufacturing, Whitehaven

Soil preparation is essential prior to any compost or soil forming material application. This usually includes soil cultivation to some extent. If the site is predominantly made up of subsoil, deep tillage or ripping may be necessary to relieve compaction below the topsoil layer. Compost used for soil improvement is commonly spread over the treatment area and subsequently incorporated into the soil. The material should be incorporated into the soil as soon as possible after application to a maximum depth of 0.4m.

The use of different application methods, for instance, using different depth profiles or the inclusion of rotovation, can provide significant differences to the soil properties and plant establishment. For example, the depth of incorporation of compost with the soil-forming material to manufacture soil is much deeper, compared to the use of compost for soil improvement.

A purpose made single winged-tine ripper can be effective for compost incorporation within compacted soil or soils with a high stone content. It can also be effective on wet surface conditions that reduce traction of heavy duty agricultural equipment.

The plants to be used on a site location should be selected to match the soil conditions. For woodland establishment the choice of tree species must be carefully considered, as the nutrient demand varies between different species. Some trees, such as, alders and other nitrogen fixing species can establish better than others on nutrient deficient sites; therefore, they will require lower application rates of compost.

The vegetation type and site characteristics should be considered when choosing the depth of application. For example, at Cross Lane, north west England, a soil depth of 1m was used to establish woodland; 0.75m for shrub species and 0.5m for meadow grassland.

References

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4. WRAP (2009), The effect of green compost on the establishment of rough grazing, arable grazing & amenity trees on a restored limestone quarry in South East Scotland
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7. Defra (2009), Construction Code of Practice for the Sustainable Use of Soils on Construction Sites
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9. WRAP (2011), Creative Conservation Trials (Project Ref OBF009-018)
10. WRAP (2010), Establishment of wildflowers on soil platforms using PAS 100 compost
11. WRAP (2009), Development of vegetation communities on manufactured soils at Royal Ordnance Chorley (Buckshaw village) and Cross Lane, Wallasey, Wirral