Technical Document

Guidance on the use of BSI PAS 100 compost in soil improvement
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We work with businesses and individuals to help them reap the benefits of reducing waste, develop sustainable products and use resources in an efficient way.

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Introduction

Compost is a soil ameliorant and as such it can be used to enhance the conditions of existing soils by improving the organic matter content, the supply of nutrients and the soil structure. This is particularly important where land has suffered from past human and industrial activities. BSI PAS 100 compost as a soil improver has been trialled on a number of brownfield sites, including former open cast coal mines, quarries, steelworks and landfill sites, and also for a variety of land end uses, such as woodland and grassland development, energy crop production, ornamental parks and gardens and general landscaping.

**Cronton Colliery, Knowsley**

A trial using BSI PAS 100 compost was undertaken on the former Cronton Colliery site in Merseyside. BSI PAS 100 green compost was successfully mixed with the spoil surface to ameliorate spoil conditions sufficiently to establish a wildflower grassland.

**Creative Conservation Trials at the former Rhodia site, Whitehaven, Cumbria**

This trial at a former chemical production site in Cumbria monitored various mixes of topsoil, green compost, wool rich shred, quarry waste and screened brick waste, to measure their effect on wildflower establishment and growth.

**Quality Compost helps restore brownfield sites in Ayrshire, Scotland**

The aim of this project was to examine the use of quality compost with or without additional recycled minerals (rock dust) for the redevelopment of land. Two contrasting sites were used for this work: a restored quarry at an exposed location; and an active restoration site at the edge of a landfill (mineral soils).
BSI PAS 100 and the Quality Protocol for Compost set out requirements for compost feedstock materials, the composting process, testing requirements and the quality of the end products.

Compost should meet the requirements of BSI PAS 100, including the specification limits on toxic elements, physical contaminants, stone concentrations and stability.

BSI PAS 100 sets minimum requirements on compost production to ensure it is an appropriate and safe product for use in soil improvement. A summary of the tests required or/and recommended for the use of compost in soil improvement is presented in Table 1.

A procedural specification has also been developed for landscape architects, which provides specification clauses and guidance notes for the use of compost in soil improvement. This covers the application of compost for soil improvement in topsoil preparation for grass establishment, in planting beds and pits. These requirements are summarised in Table 2.
Soil/site investigation and testing

The aim of soil amelioration is to increase the organic matter of the soil. In some instances, a minimum soil organic matter content of 5% will be appropriate but individual requirements will be determined by end use and soil analysis. Soil and site characteristics should be determined before and after compost application. Site investigation should take place to:

- Understand the type and composition of soils and soil forming materials on site. A soil survey should be conducted by a suitably qualified individual or organisation. This will help to identify the presence and quality of existing site materials and determine the type and level of improvement required by understanding the nutritional requirements, organic matter or pH adjustments required;

- Identify the appropriate soil improvement activities to be conducted to suit the requirements of the plant species to be established.

If the project takes place on a brownfield site that is potentially contaminated further investigation is required:

- Conduct a risk assessment of the potential contamination on site and identify source(s), pathway(s) and receptor(s);

- Identify and assess contamination on site and locate contamination hotspots;

- Identify any necessary action to be taken, suited to the site end use and the type and concentration of the contamination; and

- Monitor to confirm contamination is remediated or contained.

Forgemasters Initial Tree Monitoring

This project consists of a SUDS landscape scheme in a former carpark within the Forgemasters (steel works) near the River Don. The scheme includes the planting of young, 'standard' trees of mixed species and the planting of ground cover plants on topsoil produced with BSI PAS 100 compost.

Figure 3: Forgemasters

Quality compost opens up new uses for brownfield land on Teesside

The project consists of five one-hectare sites in Teesside - former landfill and sewage sites, a shipyard, a capped slag heap and a former coke works - to investigate the potential for the production of renewable energy sources on brownfield land.
Soil preparation

Establishment of wildflowers on soil platforms using BSI PAS 100 compost

A trial at Redding Park, near Falkirk has been set up to investigate the role of compost in the establishment of wildflowers on a housing development.

Field trial using Green and Food-derived composts in energy crop production on brownfield land

This project comprised a small-scale field trial to grow three energy crops on a former whinstone quarry, near Colinsburgh in East Fife. It examined the feasibility of growing miscanthus, oil seed rape and reed canary grass on the western (0.4 ha) part of the site, by applying and comparing green and food derived composts to replicated plots. The project also includes a scoping study to determine the potential for energy crop production on brownfield sites in Scotland.

During soil preparation, cultivation of the soil is considered beneficial and depending on the soil characteristics, deep tillage or ripping might be essential to relieve compaction. Any materials that could potentially interfere with planting and site maintenance, such as large stones and clay balls (above 75mm in any direction), roots, rubbish and debris and other materials should be removed.

Reducing soil compaction is critical to ensure compost has been incorporated correctly into the soil.

In a WRAP brownfield regeneration trial at Dalquhandy (a former open cast coal mining site), the use of heavy duty agricultural equipment for cultivation and compost incorporation was not successful due to the presence of compacted spoil, a very high stone content in the spoil, and very wet surface conditions that reduced traction. A purpose made single winged-tine ripper with a tracked vehicle to pull it, followed by a stone picking operation, was identified as an appropriate method for preparing the site prior to treatment application in this instance.

The use of food derived compost as fertiliser in willow biomass crop production on reclaimed land, Cockle Park Farm, Northumberland

This trial investigates the effect of applying BSI PAS 100 compost to a SRC willow crop growing on land restored after opencast coal mining.

Figure 4: Trial site with established plant cover

Figure 5: Short rotation coppice willow on quality composted soil
Soil texture

The physical properties of soil-forming materials determine how they will behave and give an indication of how they will perform when they are mixed with other materials. Physical properties can be split into structural and behavioural properties. Structural properties include: texture and stoniness, bulk density, porosity, air permeability, aggregate size distribution and material consistency. Behavioural properties include infiltration, hydraulic conductivity, heat capacity and strength.

The texture of a soil can be defined using the classification triangle in Figure 6. Identifying the texture of the soil and the content of clay, sand and silt is essential in determining mixing ratios for soil improvement. Further guidance can be found in Compost specifications for the landscape industry.

Figure 6: Soil textural classification triangle showing limiting percentage of sand, silt and clay sized particles for the mineral texture class.

Establishment of SRC willow on restored soils at the St Ninians open cast coal mine

This trial has been established to assess the effect of applying BSI PAS 100 green compost on a soil recently reinstated after disturbance by opencast mining to produce soil suitable for Short Rotation Coppice willow production.

Assessment of the potential for using BSI PAS 100 food-derived and green composts in energy crop production on brownfield sites in Scotland

This project explores the use of BSI PAS 100 compost in energy crop production at a former whinstone quarry near Colinsburgh in East Fife. Evidence to date shows that compost treated soils are more friable and have a better structure than untreated soils.


This field trial set up at the CORUS Skinningrove Works site near Teesside examines the impact of BSI PAS 100 compost use on the establishment and growth of reed canary grass in steelworks soils.
Application of compost

Damside - soil amelioration on former open cast coal sites

The Damside WRAP trial (brownfield regeneration on a former opencast coal site) was designed to assess the effect of applying BSI PAS 100 compost on a mixture of indigenous stony spoil and subsoil to produce useable topsoil. Monitoring of the soil conditions six months after application suggested that optimum application rates were evident and application levels above this had no further positive effect on crop growth.

According to the Compost specifications for the landscape industry, compost use in grass establishment and in planting beds should be applied uniformly over the treatment area at an average depth of 25 to 50mm, followed by incorporation to a minimum depth of 150mm by rotavation.

Additional fertilisers or adjusting agents, such as lime, might be necessary depending on the soil conditions and they should always be applied prior to incorporation. Compost spreading and incorporation should be done carefully to avoid unwanted excessive soil compaction. The soil should be raked prior to seeding, hydraulic seeding, planting, or laying turf.

Where compost is blended with excavated soil and used as backfill for planting pits, a planting hole equal in depth to the root mass and 2 to 3 times its width, should be excavated. The root mass should be placed on firm soil and the top of the root mass should be levelled. Table 3 presents compost mixing ratio guidelines that have been used effectively for different planting requirements in backfill applications. The Good Practice Guide provides further mixing ratio examples from WRAP case studies.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Soil:compost Mixing ratios (v/v)</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Shrubs, bulbs and herbaceous plants</td>
<td>3:1</td>
<td>Where soils are sandy, or subsoil</td>
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<tr>
<td>Species that require low nutrient levels</td>
<td>4-5:1</td>
<td>Low soil quality is more favourable</td>
</tr>
<tr>
<td>Trees</td>
<td>4:1</td>
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</table>

During application, blended soil should be placed around the root mass and firm occasionally. No fertilisation should be applied to the backfill material. The soil should be watered thoroughly after planting.

The application of compost should be avoided at times that are likely to cause greater nuisance to the general public, or when the climatic conditions are liable to cause disturbance. Application on slopes should be done after careful consideration. As a general guideline, application on slopes greater than 25 degrees should be avoided. However, specific engineering solutions, such as compost blankets or socks may be utilised for steeper slopes and erosion control. Vegetation should be planted as soon as possible following preparation of the site.

The effect of green compost on the establishment of rough grazing, arable grazing and amenity trees on a restored limestone quarry.

Lafarge Dunbar quarry, SE Scotland is the first in the UK to test the potential for using BSI PAS 100 quality compost in its ongoing land restoration programme. This project aimed to determine the economic viability of using BSI PAS 100 quality compost in restoring land for amenity and agricultural purposes.

The trial used the highest practical compost application rate (25% by volume). This provided a faster establishment of ryegrass and the most complete soil, when compared to lower rates. However, these application rates are site specific and might not be suitable in all cases.
Monitoring and aftercare

Ongoing monitoring and aftercare are essential to maximise the long-term benefits of compost application and to identify any potential problems as soon as possible. The monitoring and aftercare programme should be defined at the start of the project and should be developed to suit the requirements of the site. Typical aftercare programmes include:

- Checking soil properties and contaminants and comparing results to the baseline values recorded during site investigation;
- Assessing vegetation establishment, species variability, growth and health; and
- Assessing the overall state of the environment at the site, including watercourses and amenities (if relevant).

Monitoring and aftercare surveys should take place at set intervals: for example at 6 months, 1 year, 2 years and 5 years, with an additional optional survey after 10 years. Surveys should be undertaken by qualified individuals.

**Establishment of amenity grass on shale subsoil at the Dalquhandy open cast coal site**

Mixing ratios of compost with soils and other organic/ inorganic materials vary considerably for different sites and land end uses. The WRAP Dalquhandy trial was designed to assess the effect of applying BSI PAS 100 green compost on indigenous shale subsoil following open cast coal extraction. Results show that the addition of compost to bare shale enables a high-value grass sward to be established. A higher application rate (1,250t/ha instead of 625t/ha) of compost provided small benefits to the vegetation, which suggests that the lower rate could be more attractive from a financial perspective.

**Trials to test the establishment of short rotation coppice willow on brownfield sites using food-derived BSI PAS 100 compost – Frodsham Silt canal sludge deposits at the 40 hectare Frodsham Dredging Grounds have been treated with food-derived compost for soil improvement to support healthy growth of SRC willow as a biomass crop. The trial will evaluate the potential for biomass yield when BSI PAS 100 food-derived compost is used to improve native substrate materials.**

**Trials to test the establishment of short rotation coppice willow on brownfield sites using food-derived BSI PAS 100 compost – Bickershaw Colliery**

Deep-mined coal spoil at the former Bickershaw Colliery has been treated with compost for soil improvement to support healthy growth of SRC willow as a biomass crop.

The trial’s specific aim is to establish the feasibility and efficacy of food derived compost for ameliorating coal mine spoil to create soils suitable for good growth.
Sources of further information and case studies

WRAP’s Compost Calculator allows potential compost users to quantify the financial values of the key nutrients (nitrogen, phosphorus and potassium) present in compost, when compared with inorganic fertilisers. The values presented in the calculator are based on the typical total nutrient contents of composts, and current market prices for fertilisers.

WRAP’s Compost Calculator is available at:

http://www.wrap.org.uk/farming_growing_and_landscaping/compost_calculator.html

WRAP also provide a ‘Find a compost supplier near you’ search tool to help potential users find a local supplier who is able to provide compost that meets the specific requirements of the intended application.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Description</th>
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<tbody>
<tr>
<td>Ayrshire</td>
<td><strong>Woodland establishment on restored land using PAS100 and recycled minerals</strong>&lt;br&gt;The project examines the use of quality compost with or without additional recycled minerals (rock dust) for the redevelopment of land. Two contrasting sites have been used for this work: a restored quarry in the village of Drongon; and an active restoration site at the edge of Shewalton landfill (mineral soils), near Irvine.</td>
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<td>Cronton Colliery, Knowsley</td>
<td><strong>Restoring a former colliery to a wildflower habitat</strong>&lt;br&gt;A trial using BSI PAS 100 compost was undertaken on the former Cronton Colliery site in Merseyside. The compost was mixed with the spoil to establish a wildflower grassland habitat.</td>
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<td>Damside, Scotland</td>
<td><strong>Soil amelioration on former open cast coal sites</strong>&lt;br&gt;This project was designed to assess the effect of applying BSI PAS 100 compost on a mixture of indigenous stony spoil and subsoil.</td>
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<td>Dalquhandy Open Cast Coal Site</td>
<td><strong>Establishment of amenity grass on shale subsoils</strong>&lt;br&gt;BSI PAS 100 green compost was applied on indigenous shale subsoil (restored ground from open cast coal extraction). The early signs are that the addition of compost to bare shale has enabled a high-value grass sward to be established where it had not been possible to do so before.</td>
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<tr>
<td>Dunbar, SE Scotland</td>
<td><strong>The effect of green compost on the establishment of rough grazing, arable grazing &amp; amenity trees on a restored limestone quarry in South East Scotland</strong>&lt;br&gt;Lafarge’s Dunbar quarry was the first in the UK to test the potential for using BSI PAS 100 quality compost in its ongoing land restoration programme. This project aimed to determine the economic viability of using BSI PAS 100 quality compost in restoring land for amenity and agricultural purposes.</td>
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<td>Bickershaw Colliery</td>
<td><strong>Trials to test the establishment of short rotation coppice willow on brownfield sites using food derived BSI PAS 100 compost</strong>&lt;br&gt;Deep-mined coal spoil at the former Bickershaw Colliery has been treated with compost for soil improvement to support healthy growth of SRC willow as a biomass crop. The trial’s specific aim is to establish the feasibility and efficacy of food derived compost for ameliorating coal mine spoil to create soils suitable to establish SRC willow crop for biomass.</td>
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<td>Colinsburgh, East Fife</td>
<td><strong>The use of food derived compost to establish biofuel crops of brownfield land</strong>&lt;br&gt;A field trial conducted on the former whinstone quarry near Colinsburgh in East Fife to determine the feasibility of growing energy crops on brownfield land.</td>
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<td>Lumley, Teesside</td>
<td><strong>Energy crops on a former landfill site</strong>&lt;br&gt;This case study determines the effect of different application rates of BSI PAS 100 compost on the establishment of SRC willow crops and on weed suppression when the crop is grown on agricultural land and on a landfill site.</td>
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<tr>
<td>Skinningrove, Teesside</td>
<td>Impacts of BSI PAS 100 compost to establish reed canary grass as a biomass crop. A field trial at the Corus Skinningrove site has been set up to examine the impacts of using quality compost blankets to restore steelworks land for biomass, control fugitive dust and improve biodiversity.</td>
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<td>Teesside</td>
<td>Biomass crop production on five brownfield sites on Teesside. The project comprised five one-hectare sites in Teesside – former landfill and sewage sites, a shipyard, a capped slagheap and a former coke works – to investigate the effectiveness of the use of BSI PAS 100 compost to facilitate the production of energy crops on brownfield land.</td>
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<td>Westfield, Fife</td>
<td>The use of food derived compost as a top dressing for Short Rotation Coppice willow. This trial examines the use of food derived compost as a top dressing applied at varying rates to short rotation coppice willow planted on a partially restored open cast mine in Fife.</td>
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<td>Frodsham Dredging Grounds,</td>
<td>Trials to test the establishment of short rotation coppice willow on brownfield sites using food derived BSI PAS 100 compost. Silt canal sludge deposits at the 40 hectare Frodsham Dredging Grounds has been treated with food derived compost for soil improvement to support the development of SRC willow as a biomass crop. The trial will evaluate the potential for biomass yield when BSI PAS 100 food derived compost is used to improve native substrate materials.</td>
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<td>Manchester</td>
<td>St Ninians, Fife Establishment of SRC willow on restored soils at the open cast coal mine. The trial at St Ninians was established to assess the effect of applying BSI PAS 100 green compost on a soil recently reinstated after disturbance by opencast mining. The trial determines if BSI PAS 100 green compost can be used for establishing Short Rotation Coppice (SRC) willow.</td>
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<td>Falkirk, Scotland</td>
<td>Establishment of wildflowers on soil platforms at a housing development using BSI PAS 100 compost. A trial at Redding Park, near Falkirk was established to investigate the suitability of using BSI PAS 100 compost to establish wildflowers and limit the need for expensive importation of topsoil when dealing with degraded brownfield sites.</td>
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<tr>
<td>Northumberland</td>
<td>Biomass Trial using food derived compost. The use of food derived compost as a fertiliser in willow biomass crop production on reclaimed land.</td>
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</table>

References

3. WRAP (2003), Compost specification for the landscape industry.
5. WRAP (2009), Establishment of amenity grass on shale subsoils at the Dalquhandy open cast coal site. WRAP trailblazer project.
6. WRAP (2008), The potential for biofuel crop production on a former coal washing site in Kinglassie, Fife.
7. WRAP (2009), Damside -Open cast coal site. WRAP trailblazer project.
8. 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. WRAP trailblazer project.
9. WRAP (2010), BSI PAS 100 Compost Good Practice Guide
10. WRAP (2010), Compost in erosion control, Sustainable Urban Systems and green roofs
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Front cover photography: Habitat restoration at the former Rhodia site, Whitehaven

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