

Using the WCC Carbon Calculation Spreadsheet
Version 2.4
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Updates to versions

Version No	Date	Amendment	Who
1.0	19/08/2010	--	Vicky West
1.1	01/10/2010	Correction to calculation in 3.5 – Clearfell after n years. Does not affect method or outcome	Vicky West
1.2	14/01/2011	-Description of 'Max Clearfell Values' sheet at 1.2 -Addition of guidance on native species mixtures at 3.2 / 3.4 -Change to guidance on clearfell regimes at 3.5 -Further clarity on the Permanence/Risk buffer at 4.	Vicky West
1.3	21/07/2011	-Update to model: Slight changes to figures in examples. -Addition of emissions from woodland management	Vicky West
1.4	27/07/2012	-Slight amendment to 3.6 Emissions from Woodland Management, Table 6, Seedling Cost. -Reflect changes to Risk Rating	Vicky West
2.0	08/03/2018	-Update to match WCC Carbon Calculation Spreadsheet V2.0 and WCC Carbon Lookup Tables V2.0	Vicky West
2.4	March 2021	-Update to match WCC Carbon Calculation Spreadsheet V2.4	Vicky West

Disclaimer of Warranty – WCC Carbon Lookup Tables

The Woodland Carbon Code Carbon Lookup Tables are distributed 'as is' and without warranties as to performance or merchantability or any other warranties whether expressed or implied. In particular, there is no warranty for the predictions derived from the Carbon Lookup Tables as they are regarded as indicative and not prescriptive.

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1. Introduction

The Workbook 'WCC Carbon Calculation Spreadsheet Version 2.4' provides a template in which to carry out a prediction of carbon sequestration for a woodland project. There are a number of sheets in the workbook:

- Standard Project Carbon Calculator – for 'standard' sized (> 5ha) projects
- Small Project Carbon Calculator – for projects ≤ 5ha
- A Summary PIU table for any projects which have multiple parts to a calculation or for groups of projects to provide a total amount of carbon.
- 3 examples of use of the Standard Project Carbon Calculator for a Productive conifer clearfell project, a regularly thinned commercial project and a minimum intervention mixed native woodland project.

The workbook also contains the following pages of data used in the calculations:

- Biomass Carbon Lookup Table – Carbon sequestration over time for a number of species, spacing, yield classes and management options
- Clearfell Maximum Sequestration Values
- Species Lookup – Shows how all tree species are mapped to the available models

During 2021, the data behind the WCC Carbon Calculator is being reviewed and revised to incorporate new growth and yield models and to refine estimates of contributions from root and branch biomass. The revised estimates for some tree species may be more conservative than current predictions, particularly for the early growth period of broadleaved species. The WCC Carbon Calculator already subtracts 20% from modelled predictions and it is anticipated that these revisions will fall within this threshold.

2. How to Complete a Carbon Calculation using the workbook provided

Within the 'WCC Carbon Calculation Spreadsheet', both 'Standard Project' and 'Small Project' Carbon Calculators follow the same principle. The **blue 'assumptions' cells** need to be completed, and then the calculation should occur automatically.

2.1 Small project (≤ 5 ha net planting area)

The Small Project calculator is much simpler to use than the Standard Project calculator, as it makes certain assumptions about the establishment technique and the growth rate of trees planted. It conservatively estimates that broadleaves will grow at YC4 and conifers at YC12. If your project is likely to grow at better rates than this, you can claim more carbon sequestration upfront by using the 'standard' project calculator.

Only the blue boxes need to be completed and then the carbon calculation is automatic.

The Small Project Calculator can only be used for projects with 5 hectares net planting area or less, and only for projects which do not involve clearfelling. The maximum tree spacing should be 3.5m (or 816 stems per hectare). If your small woodland doesn't satisfy these conditions, use the standard project calculator

On the Small Project calculator you need to add to the first table (columns A-D):

1. Project name
2. Name of person completing calculation
3. Date of calculation

4. Project start date (=date planting was completed) consistent with your PDD
5. Country
6. Whether you are applying for the Woodland Carbon Guarantee if in England, and if so whether you plan to do 5-yearly or 10-yearly verifications (5-yearly is unlikely to be cost-effective for small projects).
7. Area of woodland creation which is:
 - a. Broadleaved minimum intervention
 - b. Broadleaved thinned
 - c. Conifer minimum intervention
 - d. Conifer thinned
8. To establish soil carbon emissions:
 - a. Soil type
 - b. Previous land-use
 - c. Site preparation technique
 - d. Area of land that was prepared

The prediction of the carbon to be sequestered will then be calculated automatically, and the 'Pending Issuance Units by Vintage' table should be copied to the Project Design Document.

As part of the validation process, we also need to see the species breakdown of the project. This should be added in columns F to K for validation but it does not form part of the carbon calculation.

2.2 Standard-sized project (over 5 ha net planting area)

If your project is larger than 5 hectares, or you do not meet the criteria to use the small woods calculator/ process, the Standard Project Carbon Calculator requires a few more inputs to be clarified by the project developer.

Within the WCC Carbon Calculation Spreadsheet there are three example calculations which should also help:

- A productive conifer scenario (no thinning, clearfell only)
- A productive conifer scenario (regular thin only)
- A mixed native woodland (minimum intervention)

The calculator is divided into a number of tables from Left to Right. The actions to take in each are described below.

2.2.1 Assumptions – Emissions from establishment

Table 1 (Columns A-E) brings together the assumptions about:

- The timing and area of the project (start date, duration, net planting area)
- The emissions generated whilst establishing the woodland
- The soil carbon emissions due to disturbing the soil during establishment
- The desire to claim for soil carbon accumulation

These emissions due to establishment are accounted for in year 1 of the project.

Timing and area:

Start date: Enter the start date in dd/mm/yyyy format. The start date is the date planting was completed and should match your PDD.

Project duration: Enter the project duration in years.

Net planting area: Enter the net planting area (excluding open space/open ground).

Country and whether or not you're entering the Woodland Carbon Guarantee:

Country: Select England/Scotland/Wales/Northern Ireland

If in England, are you using the Woodland Carbon Guarantee? Select Yes/No

If applying for the Guarantee, 5 or 10-yearly verifications? Choose whether you'd like to verify every 5 or every 10 years. Note that verifying every 5 years will only likely be cost-effective for large projects.

Emissions due to establishment:

- For seedlings, enter the spacing used and the area of seedlings planted.
- For Ground prep, tree shelters, fencing and herbicide, enter the area for which these are applicable. Remember a larger area could have been fenced, and herbicide could be applied more than once (double the area if two applications, etc.).
- If any forest roads are constructed, enter the length in km, even if the roads aren't planned to be constructed until far later on in the project.
- If any trees or vegetation was removed prior to the start of the project this should be accounted for separately. See Guidance on [3.3 Project Carbon Sequestration](#)

Soil carbon accumulation:

Under certain conditions, with minimal ground disturbance, soil carbon can accumulate as a woodland grows. Currently it is only possible to claim for this accumulation for a woodland managed as minimum intervention, which is on mineral soil and was previously in arable use. Select 'Yes' if you would like to claim soil carbon accumulation & it will automatically be included.

Baseline and Leakage:

Baseline: If your project might sequester a significant amount (more than 5% of what the woodland would sequester) without planting trees/managing for natural regeneration, this should be accounted for. Please see [the 3.1 Baseline Guidance](#) and ask the WCC Secretariat for further advice.

Leakage: If your project might cause significant emissions outside the project area (more than 5% of what the woodland would sequester), then you need to account for this. Please see the [3.2 Leakage Guidance](#) and ask the WCC Secretariat for further advice.

Project Details

Below the 'Establishment from emissions' table (rows 28-30), please remember to note:

Project Name: Make sure the name used is consistent across all documents

Calculation completed by: Add your name

Date calculation completed: Add the date the calculation was completed

Assumptions - Table 1, Example for a mixed native woodland

Assumptions - Emissions from establishment - Table 1

Project Basics				
Project start date				01 April 2021
Project duration (years)				100
Total net planting area - excluding open space (ha)				1.00
Country				England
If in England, Are you applying to the Woodland Carbon Guarantee?				No
If applying for the Woodland Carbon Guarantee, 10-yearly or 5-Yearly verifications?				N/A
Emissions from establishment	spacing (m)	area (ha)	tCO ₂ e/ha	tCO ₂ e
Seedlings	2.5	1.00	-0.24	-0.2
Ground Preparation (Fuel)		1.00	-0.06	-0.1
Tree Shelters		0.00	-0.82	0.0
Fencing		1.50	-1.64	-2.5
Herbicide		1.00	-0.001	0.0
Road Building		km	tCO ₂ e/km	tCO ₂ e
Roads		0.00	-43.13	0.0
Emissions from removal of trees or other vegetation at the start of the project				
<i>To be calculated separately if any trees or other vegetation is removed prior to planting. Show working on a separate sheet. See 3.3 Guidance</i>				0.0
Total Emissions from establishment				-2.8
Soil Carbon accumulation (currently only claimable for a site with mineral soil which was previously in arable use, managed with minimum intervention)				area (ha)
<i>If previously arable site on mineral soil: Over what area are you claiming Soil C Sequestration (ha)</i>				1.00
Baseline and Leakage				Yes or No
<i>Baseline: Will your project area sequester a significant amount without planting trees? (See Guidance 3.2). If yes, ask the WCC team for further assistance</i>				No
<i>Leakage: Will your project cause significant emissions outside the project area? (See Guidance 3.3). If yes, ask the WCC team for further assistance</i>				No

Project Name:	Example 1: Mixed Native Woodland, 1ha
Calculation Completed by:	Vicky West
Date calculation completed:	19-Nov-19
Version/date of biomass lookup tables:	Version 2.0 March 2018
Version/date of soil carbon tables:	Version 2.0 March 2018

2.2.2 Assumptions - Species, Spacing, Yield Class, Management

Table 2 provides the space to specify the actual areas/spacing of species planted and predicted yield classes and management (Columns G to V). You need to know the proportions of each species planted at a given spacing. There is space for 25 species/spacing/management options. If your woodland is very large and complex you could consider showing compartments with the same species/spacing/mgmt. structure together.

Complete the following columns:

Section (Column G): If your woodland has separate sections/compartments with different composition (in terms of species, spacing, management or establishment type (planted and natural regeneration/colonisation)) you can use this column to delineate the sections/compartments. This could be used if, for example:

- One section/compartments is a conifer mix and another is a broadleaved mix, or
- One section/compartments is planted at an average of 2m spacing and another at an average of 3m spacing, or
- One section/compartments is clear-felled on a regular rotation but another will be managed with minimum intervention, or
- One section/compartments is planted in year 20/21 and another section will be planted in year 20/22

Ideally, these separate sections/compartments will also be made clear on your map of the site.

Actual Species (Column H): Select the species planted from the dropdown list.

1. Note the use of **'Mixed Broadleaves'** or **'Mixed Conifer'** should be avoided. If you do use this category (for example as there isn't space for species, then specify which species used in 'additional information')
2. **Woody Shrubs:** Note that woody shrubs not included in the tree species list should be noted in the final row of the table (Row 30). These will not be included in the prediction of carbon sequestration, but at verification the carbon sequestered can be included in the assessment of actual carbon sequestration.

Actual Spacing (Column I): For each of your species/compartments, complete the actual spacing column. For native broadleaved woodlands where the planting could be 'clumped', use the average spacing across the NET area (excluding any open areas identified). For two compartments with different spacing, add a separate line for each (e.g. if one area is planted at 2m spacing and one is planted at 3m spacing).

Spacing used in Lookup Tables (Column L): There are only a limited number of spacing 'models' for each species. Choose the closest spacing option to your actual spacing. If your spacing is exactly half way between two options (e.g. you plant at 2.0m and the options are 1.5m and 2.5m), choose the wider spacing.

Wider spacing/less dense planting

Note the maximum spacing allowed as 'woodland' under the Woodland Carbon Code is 5m spacing, or 400 stems per hectare, as this is expected to create a woodland with at least 20% canopy cover.

If you plant/enable natural regeneration of broadleaves at a spacing wider than 3.5m (816 stems per hectare) then you need to make an adjustment and account for an 'effective area' at 3m spacing (the widest model currently available) as follows:

- Actual net area planted: 10ha
- Largest planting density in lookup table: 1,111 stems/ha 3m
- Actual planting density/spacing: 400 stems/ha (or 5m spacing)
- Effective area to claim in C calc = $10 \times 400 / 1,111 = 3.6\text{ha}$

If you plant/enable natural regeneration of Scots Pine at a spacing wider than 2.5m (1,600 stems per hectare) then you need to make an adjustment and account for an 'effective area' at 2m spacing (the widest model available) as follows:

- Actual net area planted: 10ha
- Largest planting density in lookup table: 2,500 stems/ha 2m
- Actual planting density/spacing: 625 stems/ha (or 4m spacing)
- Effective area to claim in C calc = $10 \times 625 / 2,500 = 2.5\text{ha}$

These estimates will be conservative. Wider spacings out to 5m are likely to be included in future models. When you monitor your project for verification, if the trees have grown more than predicted, you will be able to claim the 'extra' carbon sequestered at that time.

Note that this will mean the 'area claimed' (in column T) is less than the actual 'Net Area' (in Cell E7). Continue to use the actual 'Net Area' in your PDD and other documents.

Yield Class (Columns N and P):

Yield class for your particular species and site should be predicted using the Ecological Site Classification (ESC) tool. This can be accessed online: <http://www.forestdss.org.uk/geoforestdss/>. An ESC Manual is contained within the tool.

Note:

- ESC Version 4 produces a result using 'default' soil moisture and nutrient assumptions from a low resolution soil map. It is highly recommended that you conduct your own soil and/or vegetation survey to enable you to input more precise soil information into the ESC model. The ESC Manual explains how to do this.
- ESC Version 4 gives predicted Yield Classes in whole numbers (e.g. YC 4, 5, 6 & 7) whereas the Biomass Lookup Table only contains estimates for Yield Class in even numbers. If ESC suggests an 'odd' Yield Class, you should round down to the nearest even number (e.g. if ESC suggests YC5, use the model for YC4). Enter the Yield Class given by ESC in column N and the 'even number' Yield Class used for the carbon model in column P.
- ESC Version 4 provides estimates for yield classes under future climate change scenarios, for 2050 and for 2080. If ESC predicts that the yield class of a particular species is likely to be less favourable in a 2050 climate, then this should be taken into account. Use the following future climate scenario:
 - Medium-High 2050(A1b 3q0/AWC)¹

Management types (Column R)

There are models available for managing a stand as minimum intervention and thinning to standard regimes. There is also a method to deal with stands that are managed with regular clearfell.

¹ The numbers and letters denote the model option used in ESC, from those produced by the Met Office. It is close to the 'average' for the Medium-High scenario options.

A different thinning regime (either % thinned or timing of thinnings)

If you are thinning the woodland but using a thinning regime other than the standard 5-yearly thinning, you should still use the 'thinned' tables. If you only plan to thin a proportion of the woodland, or one compartment within a woodland then you can enter two lines – one area as 'No thin' and one area as 'Thinned'. You should use the 'Section' column to group together species within each section of the woodland and make the different management areas clear in the 'Further details' box at the bottom of the calculation page.

Clearfelling (Column U)

If you plan to clearfell and restock the woodland at any point in its future, then you can only claim sequestration up to the long-term average carbon stock of the site, as after each clearfell, the carbon stock in live trees on the site effectively returns to zero (albeit that a proportion will be retained in harvested wood products for a period of time). The long-term average carbon stock tends to be between 30% and 50% of the cumulative total carbon sequestered over one rotation. There are also emissions associated with the clearfell operation and these are accounted for within the long-term average carbon stock.

This long-term average is the maximum amount of sequestration you can claim, irrespective of the length of the project, if a project is regularly clearfelled. Claims can be made as the carbon is sequestered in the first rotation up to the time this 'Clearfell Cap' is reached, which tends to happen by year 25 or 35. The subsequent growth of the forest should continue to be monitored as per the Carbon Assessment Protocol for the remainder of the project duration.

Note that for projects involving clearfell, the minimum project duration is the shortest rotation length within the project (so if the first trees will be felled after 40 years, the project duration should be at least 40 years).

Enter the age of clearfell in column T for every species that will be clearfelled. You could have one section/compartment clearfelled at year 40 and one at year 60 for example and another section/compartment managed as minimum intervention.

Continuous Cover Forestry

Other management regimes such as Continuous Cover Forestry are not yet covered within the lookup tables. In the first instance you should use the standard thinning table if continuous cover is the longer-term objective.

Area (Column S and T)

Enter the area of each species/spacing/management option. Either enter the % area of each option in column S (and the area is automatically completed), or enter the actual area in column T – and make sure the % column reflects this.

Assumptions Table 2: Example for a Mixed Native Woodland

Sectn No:	Actual Species	Actual Spacing (m)	Species/Model from Lookup Table	Spacing used in Lookup tables (m)	Error check only - If 'ERROR' then check spacing (column L)	Yield Class in ESC (if different to YC used)	Yield Class Used in Lookup Tables	Error check only - if 'ERROR' then check Yield Class (column P)	Management Regime from Lookup Tables	% of Area if mixture	Area (ha)	Age at clearfell (years)	Clearfell Cap (tCO2e/ha)
	Pedunculate/common oak		OK	2.5	NO		4	NO	No_thin	20.00%	0.20	0	0.0
	Sycamore		SAB	2.5	NO		6	NO	No_thin	20.00%	0.20	0	0.0
	Birch (downy/silver)		SAB	2.5	NO		8	NO	No_thin	20.00%	0.20	0	0.0
	Aspen		SAB	2.5	NO		8	NO	No_thin	8.00%	0.08	0	0.0
	Alder		SAB	2.5	NO		4	NO	No_thin	10.00%	0.10	0	0.0
	Rowan		SAB	2.5	NO		4	NO	No_thin	10.00%	0.10	0	0.0
	Hazel		SAB	2.5	NO		4	NO	No_thin	7.00%	0.07	0	0.0
	Goat willow		SAB	2.5	NO		4	NO	No_thin	5.00%	0.05	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Select Species		Select Species First	Select Species First	NO		Select Species First	NO	No_thin	0.00%	0.00	0	0.0
	Woody Shrubs	Specify which woody shrub species here				Not accounted for in calculation - insert area of woody shrubs for completeness				0.00%	0.00	^^ only works with clearfell age multiples of 5 ^^	
Total Area										100.0%	1.00		

2.2.3 Projects established through natural regeneration/colonisation

If a woodland is to be established by natural colonisation rather than planting, trees are likely to take longer to establish and the WCC requires further consideration of the areas where natural colonisation is likely to be successful.

Participants are also reminded that an Environmental Impact Assessment determination for afforestation is necessary whether projects are planted, direct seeded or colonise naturally. The Woodland Carbon Code also requires a management plan to be in place and appropriate consultation with relevant organisations and neighbours to occur.

A natural regeneration/colonisation implementation plan should be submitted for validation and consider:

- **Current stocking density:** Current cover of established trees in the 'net area' should be less than 20% (i.e. not woodland). If there are some naturally colonised seedlings, this is a good indicator that natural colonisation could be successful, but it should be determined that current browsing levels or other site factors would prevent them from establishing without intervention.
- **Potential gross and net areas: From the potential 'Gross' area, exclude** rocky outcrops, deep peat, existing woodland (areas over 20% canopy cover) or other unviable areas to demonstrate a potential **net area**.
- **Seed source:** Identify the seed sources and areas within 50m of a seed source to be included in the 'claimable area'.
- **Survey the wider net area:** If you wish to claim upfront for natural regeneration areas further than 50m from a viable seed source, then you should undertake a survey² to determine the presence and condition of any existing seedlings. Where seedlings are present but compromised by browsing, a wider area can be included. We will provide further information on survey options in the near future.
- **Anticipated future stocking density:** The 'claimable area' should be capable of achieving at least 400 stems per hectare (to reach 20% canopy cover). If you anticipate the 'final' average spacing will be less than 3.5m spacing/816 stems per hectare then claim an 'effective net area' as described in 'wider spacing' in 2.2.2 above.
- **Soil moisture/nutrient status:** After a soil survey, the soil moisture/nutrient status should be very moist or drier, and the nutrient status very poor to rich (see Appendix 2).
- **Competition with other vegetation:** Consideration should be given to whether or not it is necessary to ensure successful colonisation through light cultivation (such as light patch scarification) or vegetation control through flailing, herbicide or grazing (pre-commencement, to encourage less coarse vegetation). Any vegetation removed and soil carbon changes due to cultivation should be accounted for in the same manner as planted sites.
- **Management of grazing animals:** Through exclusion or through deer management.
- **Subsequent management of regeneration:** Any plans to either respace dense regeneration or carry out enrichment planting should natural regeneration be slow to appear.

² Either the SF/SNH [Herbivore Impact Assessment](#) 'walk-through' survey, or the [WCC Year 5 stocking density survey](#).

In your carbon calculator, for the natural regeneration portion of your project, you should:

1. **Set out the Gross, Net and Claimable areas.** This will require some extra text to explain in the 'Further Comments' box at the bottom of the carbon calculator: For example:
 - **Gross Area:** An Estate might identify 100ha of land near to existing woodland where they are hoping to fence out/manage deer to encourage natural regeneration
 - **Net Area:** The Estate might map out 30ha of rocky outcrops, deep peat or other unviable areas (e.g. elevation, aspect, soil), giving a net area of 70ha. If regeneration occurs over this whole area it will be surveyed and all claimable at verification.
 - **Upfront claimable area:** Within that, areas within 50m of a seed source, or areas where a site survey suggests some seedlings (albeit compromised) are present, are identified as the 'upfront claimable areas'. For example, surveys might identify that 50ha of the 100ha is either within 50m of a seed source or already showing some evidence of seedlings, compromised by browsing. This is the area that would go into the carbon calculator and on which PIUs could be issued. Note that you will need to provide evidence of such survey data at validation to confirm the upfront claimable area.
2. **Choose the relevant Natural Regeneration 'species' options,** which are based on planted stands, but delaying their growth by 5 years:
 - Natural Regeneration – Mixed Broadleaves or
 - Natural Regeneration – Scots Pine
3. **Choose the relevant conservative 'Yield Class'** (only YC's 2 or 4 are options here)

In addition, for natural regeneration/colonisation you will be required to submit:

1. **Registration: Extra Map:** Provide a map which clearly shows the seed sources, gross, net and claimable areas at registration and any existing mature trees in the net area.
4. **Validation: Seedling Survey:** If you claim upfront an area greater than 50m from the seed source, you will need to provide survey data **confirming the presence and condition of any existing seedlings** in the 'claimable' area.
5. **Verification at year 5:** We do not expect the same level of successful establishment from a natural regeneration project by year 5.
 - If the project demonstrates a stocking density of at least 400 stems per hectare at that time with no concerns about browsing levels, the next verification will be at year 15 as normal.
 - If there are concerns about the rate of colonisation, the browsing levels or other health issues of the seedlings, the verifier may require either:
 - Further action to promote establishment – enhanced deer management, direct seeding or enrichment planting, or
 - An extra verification at year 10 to confirm continued progress.
6. **Verification at year 15:** By year 15 the site should have achieved the target stocking density within the claimable area, with acceptable grazing/browsing levels.
 - If natural colonisation is proving more successful than originally stated, any extra sequestration could be claimed from this point
 - If the project is still not sequestering as fast as predicted, then the carbon prediction would be reviewed at this stage.

2.2.4 Soil carbon emissions from site preparation

Disturbance of soil during ground preparation can lead to greenhouse gas emissions from the soil itself. The greater the volume of soil disturbance, the higher the level of emissions. This is especially an issue on organomineral soils with greater carbon content and potential for loss. These soil carbon emissions are accounted for in year 1 of the project. See [1.2 Eligible activities – soil type and landuse](#) for more information.

To calculate the emissions from soil disturbance during ground preparation, enter the soil type, previous land-use and site preparation technique using the dropdown menus (See Table 3, Row 34, Columns H-Q). If more than one technique is used across the site, enter the area of each in separate rows. There is the option to state 'negligible disturbance' for some or all of the site. The whole site should be considered (so the total area in this table should be at least the net planted area of the project).

Assumptions table 3: Ground Preparation and Soil Carbon emissions

Assumptions - Soil Carbon Emissions - Table 3. Input the previous landuse, soil type and site prep type . Use one line for each soil type/ soil prep type co

Previous Landuse	Soil Type	Disturbance/ Site Preparation	Area (ha)	% Soil Carbon Lost	Soil C Emissions (tCO ₂ e/ha)	Soil C Emissions (tCO ₂ e/area)
Arable	Organomineral	Low disturbance: Hand turfing, inverted, hinge & trench mounding, patch scarification, subsoiling, drains	1.00	05	-12.8	-12.8
Please select	Please select	Please select	0.00	0	0.0	0.0
Please select	Please select	Please select	0.00	0	0.0	0.0
Please select	Please select	Please select	0.00	0	0.0	0.0
Please select	Please select	Please select	0.00	0	0.0	0.0
Please select	Please select	Please select	0.00	0	0.0	0.0
			Total			-12.8

2.3 Pending Issuance Units by Vintage

This table will complete automatically in both the small project and standard project calculators (columns X to AC for small woods, and columns CO to CT for the standard project calculator). It is this table that will summarise the monitoring period (vintage) dates and determine how many Pending Issuance Units are issued for each vintage/monitoring period.

There are 3 versions of this table:

- Use the top PIU table unless you are applying to the Woodland Carbon Guarantee in England.
- If you are applying to the Guarantee, you need to use either the second or third version of the PIU table depending upon whether you wish to verify at 10-yearly or 5-yearly intervals (5-yearly will likely only be viable for large projects).

If you choose a project duration which is less than 100 years, you will need to amend the Pending Issuance by Vintage table to reflect the length of your project. For example, if you choose a project duration of 75 years, delete the data in the periods 75-85, 85-95 and 95-

100 (see below). Remember that for clearfell projects, the project duration is at least the length of the shortest rotation in the project.

This table should be copied and pasted into your Project Design Document when your calculation is finalised.

Verification: years since start date	Vintage Start Date	Vintage End Date	Total PIUs in vintage to be listed	PIUs to Buffer	PIUs to Project
5	01 April 2018	31 March 2023	35	7	28
15	01 April 2023	31 March 2033	612	122	490
25	01 April 2033	31 March 2043	1629	326	1303
35	01 April 2043	31 March 2053	1545	309	1236
45	01 April 2053	31 March 2063	935	187	748
55	01 April 2063	31 March 2073	545	109	436
65	01 April 2073	31 March 2083	337	68	269
75	01 April 2083	31 March 2093	259	51	208
85	01 April 2093	31 March 2103	240	48	192
95	01 April 2103	31 March 2113	247	50	197
100	01 April 2113	31 March 2118	86	17	69
Total			6470	1294	5176

If your project is less than 100 years, 'clear contents' from the relevant rows beyond your project duration (e.g. if your project is 75 years long, delete the last 3 vintages/periods)

Verification: years since start date	Vintage Start Date	Vintage End Date	Total PIUs in vintage to be listed	PIUs to Buffer	PIUs to Project
5	01 April 2018	31 March 2023	35	7	28
15	01 April 2023	31 March 2033	612	122	490
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55	01 April 2063	31 March 2073	545	109	436
65	01 April 2073	31 March 2083	337	68	269
75	01 April 2083	31 March 2093	259	51	208
Total			5897	1179	4718

2.4 Total for groups or compartments within a project

2.3.1 Multiple compartments within a project

If your project is complex with several compartments of different species or management, or is planted over more than one year, it might be easier to use a 'Standard Project Carbon Calculator' for each compartment or year. You will then need to add together the compartments to get a total figure for the project. Use the sheet 'SummaryPIU_Table_Groups' to add together the carbon sequestration (PIU table), and area/woodland type from each sheet/tab. Re-name this sheet/tab so it's clear what it refers to.

2.3.2 Multiple projects within a group

If you are submitting a group of projects for validation, it might be simpler to keep the carbon calculation for each project in a separate workbook. However, you can also copy the relevant Carbon Calculator to a new sheet so you have a separate sheet for each project. If you do this, you will also need to come up with a 'total' sequestration for your whole group. Use the sheet 'SummaryPIU_Table_Groups' to add together the carbon sequestration (PIU tables) and the area/woodland type from each sheet/tab. Re-name this sheet/tab so it's clear what it refers to.

3 Useful information to understand carbon sequestration

Both the small woods and standard size project calculators display other useful information to help understand the likely sequestration over time in your woodland creation project.

3.1: Total cumulative project carbon sequestration

- The cumulative carbon sequestration by the project is given at 5-yearly intervals (columns S-U in the small woods calculator and CJ to CL in the standard calculator). This is divided into the proportion that the project can sell or claim (the Total Claimable), and the proportion that will be set aside in the WCC Buffer (20% Risk Buffer).
- To the right of these is the average claimable sequestration per hectare by the end of each 5-year 'chunk' – this explains the tCO₂e/ha that you can claim for a project of a given length.

Cumulative total sequestration and average per hectare by the given year from the small woods calculator

M S T U V

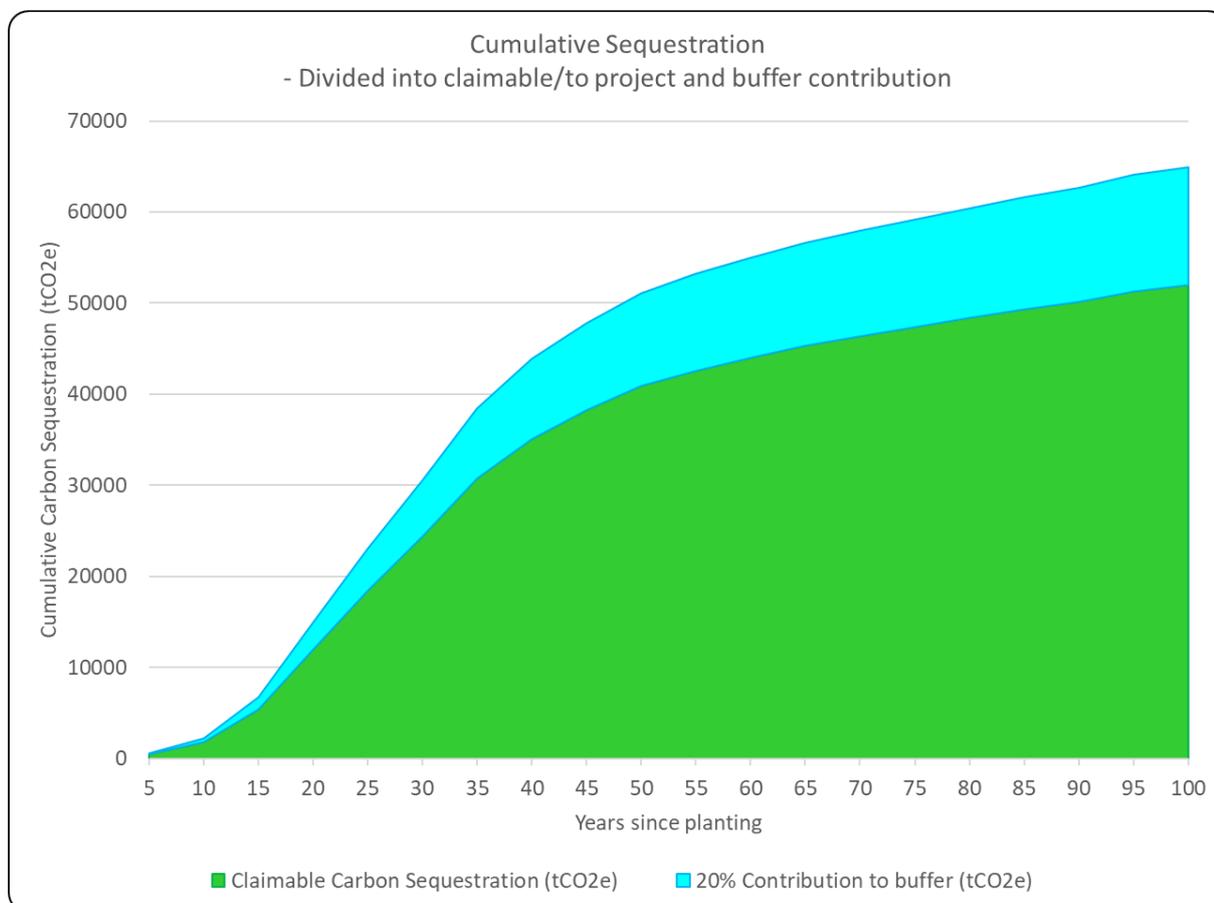
Sequestrn to year	Total project carbon sequestration (tCO ₂ e)	20% risk buffer (tCO ₂ e)	Total claimable carbon sequestration (tCO ₂ e)	Average total claimable sequestration per hectare by year x (tCO ₂ e/ha)
5	-2	0	-2	0
10	72	14	58	6
15	321	64	257	26
20	1044	209	835	84
25	1907	381	1526	153
30	2532	506	2026	203
35	2986	597	2389	239
40	3351	670	2681	268
45	3662	732	2930	293
50	4017	803	3214	321
55	4191	838	3353	335
60	4308	862	3446	345
65	4407	881	3526	353
70	4456	891	3565	357
75	4513	903	3610	361
80	4571	914	3657	366
85	4617	923	3694	369
90	4662	932	3730	373
95	4812	962	3850	385
100	4827	965	3862	386

By year 60, this 10 hectare project is predicted to sequester 4,308 tCO₂e, of which you will be able to sell/claim 3,446 tCO₂e in total, or 345 tCO₂e/ha



3.2 Graph showing the cumulative sequestration over time

To the right of the PIU tables is a graph showing the cumulative predicted sequestration over time for your project, divided into the claimable amount and the 20% that will be allocated to the WCC Buffer (See columns AE to AO in the small woods calculator and columns CV to DD for the standard project calculator).



4. References

Morison, J. Matthews, R.W. Miller, G. Perks, M. Randle, T. Vanguelova, E. White, M. and Yamulki, S. (2012) [Understanding the Carbon and Greenhouse Gas Balance of UK Forests](#). Forestry Commission, Edinburgh.

Randle, T.J. Jenkins T.A.R. and Matthews, R.W (2011). [The production of lookup tables for estimating changes in carbon stock forestry projects: A document for users of the Forestry Commission's Woodland Carbon Code](#). Forestry Commission, UK.

West, V. (2011). [Soil Carbon and the Woodland Carbon Code](#), Forestry Commission, Edinburgh.

Whittaker, C. Killer, D. Zybert, D. and Russel, D. (2008). **Life cycle assessment of construction of forest roads**. (Spreadsheet tool). Imperial college, London.

Appendix 1: The Makeup of the Biomass Carbon Lookup Table

1.1 The 'Biomass Carbon Lookup Table'

The 'Biomass Carbon Lookup Table' gives annualised sequestration rates at 5-yearly intervals for a range of woodland types in terms of species, initial spacing, yield class and management activity. A separate table deals with woodlands which are periodically clearfelled and another document deals with how the tables were constructed (Randle *et al* 2011). Morison *et al* (2012) provides a more technical description of the processes accounted for in modelling the carbon balance in forests.

The Biomass Carbon Lookup Table contains the information described in Table 1, for 5-yearly intervals, 0-5, 5-10, 10-15 etc. up to years 195-200:

Table 1: Description of Fields in the Woodland Carbon Lookup Tables

Purpose	Column	Contents	Units
Input values – Choose the situation most suited	B	Species	Standard abbreviation
	C	Initial Spacing	m
	D	Yield Class	Standard yield classes
	E	Management	Standard thinning or no thinning
Rate of carbon sequestration in each period.	F	Period	years
	G	Standing carbon	tCO ₂ e/ha/year
	H	Debris	tCO ₂ e/ha/year
	I	Total Carbon	tCO ₂ e/ha/year
	J	In-period cumulative total C	tCO ₂ e/ha/5-years
Cumulative CO ₂ e sequestered over time in the biomass	K	Cum. Biomass Sequestrn	tCO ₂ e/ha
Cumulative Emissions from Ongoing woodland management	L	Cum. Emis. Ongoing Mgmt.	tCO ₂ e/ha
Total Cumulative CO ₂ e sequestered over time	M	Cumulative Total Sequestrn	tCO ₂ e/ha
For information only: Carbon removed from forest during thinning	N	Removed from forest	tCO ₂ e/ha/year

Positive values represent carbon sequestration; negative values represent carbon emissions.

1.1.1 Input values

Species

17 major UK forest species are currently represented in the Biomass Carbon Lookup Tables (Table 2). There are 3 broadleaved scenarios (including Sycamore/Ash/Birch which is applicable to these species individually or as a mixture) and 14 conifer species.

Table 2: Species included within the woodland Carbon Lookup Tables

Broadleaved species	Name	Botanical Name
BE	Beech	<i>Fagus sylvatica</i>
OK	Oak	<i>Quercus spp.</i>
SAB	Sycamore, Ash, Birch (mix or pure species)	<i>Acer pseudoplatanus/ Fraxinus excelsior/ Betula spp.</i>
Conifer species	Name	Botanical Name
CP	Corsican pine	<i>Pinus nigra var maritima</i>
DF	Douglas fir	<i>Pseudotsuga menziesii</i>
EL	European larch	<i>Larix decidua</i>
GF	Grand fir	<i>Abies grandis</i>
HL	Hybrid larch	<i>Larix x eurolepis</i>
JL	Japanese larch	<i>Larix kaempferi</i>
LEC	Leyland cypress	<i>Cupressocyparis leylandii</i>
LP	Lodgepole pine	<i>Pinus contorta</i>
NF	Noble fir	<i>Abies procera</i>
NS	Norway spruce	<i>Picea abies</i>
RC	Western red cedar	<i>Thuja plicata</i>
SP	Scots pine	<i>Pinus sylvestris</i>
SS	Sitka spruce	<i>Picea sitchensis</i>
WH	Western hemlock	<i>Tsuga heterophylla</i>

Initial spacing (m) - Tables currently contain initial spacings from 1.2m (i.e. 6,944 stems per ha) to 3.0m (i.e. 1,111 stems per ha). The spacings shown depend upon the species.

Yield Class - The predicted yield class of the woodland. Again the options available vary with species from 4 (for beech) to 30 (for grand fir).

Management - Currently there are two options available:

- **Thin.** In this option the crop is regularly thinned to the standard 5-yearly thinning regime.
- **No Thin.** In this option there is no management intervention, and the crop is simply left to grow.

1.1.2 Rate of carbon sequestration in each period

Period - The period is indicated as 5-year periods since establishment. The tables run from the first period 0-5 years, to 195-200 years.

Carbon Standing - The rate of carbon sequestration for the whole tree (including roots, stem, branch and foliage) in each 5-year period.

Debris - The rate of sequestration for the debris (a positive figure indicates that more has been added to the debris 'pool' than has decayed from it (e.g. as litter fall or dead wood left in the forest at thinning)).

Total - Rate of carbon sequestration for the whole tree biomass plus debris. Soil carbon is dealt with separately.

Cumulative In-period - Five-year total of carbon standing plus debris. Again changes to soil carbon are dealt with separately.

1.1.3 Cumulative sequestration in biomass

Cumulative total carbon stored per hectare in the biomass as the forest grows from establishment to year 200.

1.1.4 Cumulative emissions from ongoing woodland management

Cumulative emissions (shown as negative) due to thinning operations.

1.1.5 Total cumulative sequestration

This column shows the net cumulative carbon sequestration taking into account the ongoing emissions from woodland management. **These are the figures that need to be used in calculations of carbon sequestered in a potential new woodland creation project.**

1.1.6 Removed from Forest

For completeness, this column shows the carbon that is removed from a woodland during thinnings. These figures should not be used in any calculations of carbon stored in woodland creation projects. They are shown to aid understanding of the difference between the thinned and un-thinned scenarios and to give an indication of the carbon stored in wood products removed from the forest.

1.2 'Clearfell_Max_Seq_Values' for clearfell options

The figures given in the standard 'Biomass Carbon Lookup Table' assume that woodlands are managed without clearfelling. If a woodland is to be managed on a clearfell basis, then an adjustment needs to be made to these figures, to find the long-term average carbon on the site when periodically clearfelling trees. This is effectively a 'cap' to the amount of CO₂e that could be claimed from the 'Biomass Carbon Lookup Table' (which assumes no clearfelling). These figures are found on the 'Clearfell_Max_Seq_Values' sheet (Table 3).

Table 3: Description of Fields in the 'Max Sequestration Values' Table

Purpose	Column	Contents	Units
Input values – Choose the situation most suited	B	Species	Standard abbreviation
	C	Initial Spacing	M
	D	Yield Class	Standard yield classes
	E	Management	Standard thinning or no thinning
Long-term average carbon sequestration for various clearfell rotation lengths	F to AK	Cap for clearfell scenarios of various rotation lengths	tCO ₂ e/ha

Species, Initial Spacing, Yield Class and Management - As per the Carbon Lookup Table and described in 1.1.

Cap for scenarios with varying rotation lengths - The long-term average amount of carbon that will be sequestered for each scenario, for a given rotation length (20 to 200 years). This is the maximum amount of CO₂e per hectare that can be claimed, in the first rotation only, where woodlands are managed on a clearfell regime. It also allows for the operational emissions from carrying out the clearfell within this 'cap'.

Appendix 2: Soil nutrient/ moisture types for natural regeneration/ colonisation

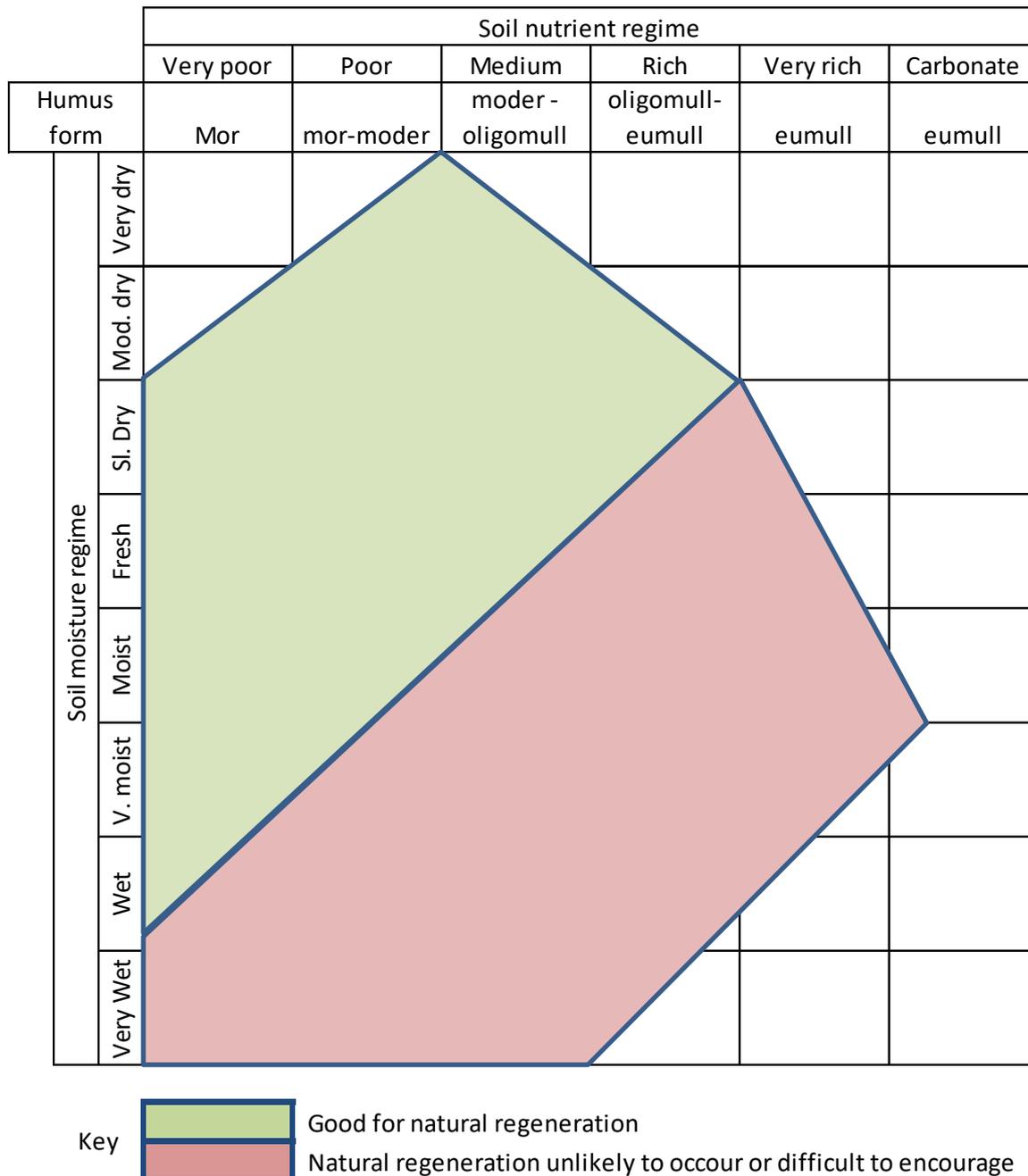


Figure 1. Ecological Site Classification soil moisture and nutrient regimes grid showing the prospects for natural regeneration of conifers (after Nixon and Worrell, 1999). Although species differ, natural colonisation of broadleaves by seed will tend to follow a similar pattern.