Estimating woodland carbon sequestration from the Carbon Lookup Tables
Version 1.4
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Contents

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

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1. Introduction

The Workbook 'Carbon Lookup Tables' provides figures for woodland carbon sequestration for a range of scenarios. There are three sheets in the workbook:

- Carbon Lookup Table
- Max Sequestration Values
- Example prediction of project carbon sequestration

These are described below. Also set out in the workbook are example calculation sheets. These can be used by projects to assist them in completing their carbon calculation as set out below.

1.1 The Woodland 'Carbon Lookup Table'

The '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.

NOTE: This table only relates to woodland projects which do not involve clearfelling and restocking. Figures need to be adjusted if clearfelling (See 1.2).

Carbon Lookup Tables contain 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	A	Species	Standard abbreviation
	B	Initial Spacing	m
	C	Yield Class	Standard yield classes
	D	Management	Standard thinning or no thinning
Rate of carbon sequestration in each period.	E	Period	years
	F	Standing carbon	tCO_2e/ha/year
	G	Debris	tCO_2e/ha/year
	H	Total Carbon	tCO_2e/ha/year
	I	In-period cumulative total C	tCO_2e/ha/5-years
Cumulative CO_2e sequestered over time in the biomass	J	Cum. Biomass Sequestrn	tCO_2e/ha
Cumulative Emissions from Ongoing woodland management	K	Cum. Emis. Ongoing Mgmt.	tCO_2e/ha
Total Cumulative CO_2e sequestered over time	L	Cumulative Total Sequestrn	tCO_2e/ha
For information only: Carbon removed from forest during thinning	M	Removed from forest	tCO_2e/ha/year

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

1.1.1 Input values

Species (Major UK forest species).
17 major UK forest species are currently represented in the 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	*Fagus sylvatica*
OK	oak	*Quercus spp.*
SAB	sycamore, ash, birch (mix or pure species)	*Acer pseudoplatanus/ Fraxinus excelsior/ Betula spp.*
Conifer species	**Name**	**Botanical Name**
CP	Corsican pine	*Pinus nigra var maritima*
DF	Douglas fir	*Pseudotsuga menziesii*
EL	European larch	*Larix decidua*
GF	grand fir	*Abies grandis*
HL	hybrid larch	*Larix x eurolepis*
JL	Japanese larch	*Larix kaempferi*
LEC	Leyland cypress	*Cupressocyparis leylandii*
LP	lodgepole pine	*Pinus contorta*
NF	noble fir	*Abies procera*
NS	Norway spruce	*Picea abies*
RC	western red cedar	*Thuja plicata*
SP	Scots pine	*Pinus sylvestris*
SS	Sitka spruce	*Picea sitchensis*
WH	western hemlock	*Tsuga heterophylla*

Initial spacing (m) Tables currently contain initial spacings from 1.2m (ie 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 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 (eg 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 is 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 unthinned scenarios.

1.2 'Max Sequestration Values' for clearfell options

The figures given in the standard '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 CO_2e that could be claimed from the 'Carbon Lookup Table' (which assumes no clearfelling). These figures are found on the 'Max Sequestration 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	A	Species	Standard abbreviation
	B	Initial Spacing	m
	C	Yield Class	Standard yield classes
	D	Management	Standard thinning or no thinning
Long-term average carbon sequestration for various clearfell rotation lengths	E to T	Cap for clearfell scenarios of various rotation lengths	tCO_2e/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 CO_2e per hectare that can be claimed, in the first rotation only, where woodlands are managed on a clearfell regime.

1.3 Purpose of this document

The purpose of this document is to allow project applicants to use and interpret the values set out in the carbon lookup tables to come up with a prediction of carbon to be sequestered in a given project. Throughout it builds on an example of a Sitka spruce woodland and shows how this should be entered into the Project Design Document once the calculations are finalised.

Any calculations made by the project must be clearly set out in a spreadsheet and made available to the certification body.

2. Reading a carbon value from the 'Carbon Lookup Table' – basic

If your woodland creation project is represented in the table, for example if you plan to create;

- A 10ha Sitka spruce woodland
- with spacing 2.0m,
- predicted yield class 16,
- thinned to standard regimes, and
- you are NOT planning to clearfell the woodland at any time
- claiming carbon from year 0 to year 100

simply select these options by clicking on the 'down arrow' in the header of each of columns 1-4, and you will be presented with the information in Table 4.

Table 4: Example scenario from the Carbon Lookup Tables showing woodland carbon sequestration rates over a 200 year period.

Species	Spacing (m)	Yield Class	Management	Period (year)	Carbon Standing (tCO2e/ha/yr)	Debris (tCO2e/ha/yr)	Total (tCO2/ha/yr)	Cumulative in-period (tCO2e/ha/5yr period)	Cum. Biomass Sequestrn (tCO2e/ha)	Cum. Emis. Ongoing Mgmt (tCO2e/ha)	Cumulative Total Sequestrn (tCO2e/ha)
SS	2.0	16	Thinned	0-5	0.96	0.22	1.19	5.9	5.9	0.00	5.9
SS	2.0	16	Thinned	5-10	2.93	0.28	3.21	16.1	22.0	0.00	22.0
SS	2.0	16	Thinned	10-15	8.95	0.28	9.23	46.2	68.2	0.00	68.2
SS	2.0	16	Thinned	15-20	23.84	0.62	24.46	122.3	190.4	0.00	190.4
SS	2.0	16	Thinned	20-25	6.20	5.25	11.45	57.2	247.7	-0.23	247.4
SS	2.0	16	Thinned	25-30	9.42	0.58	10.00	50.0	297.7	-0.40	297.3
SS	2.0	16	Thinned	30-35	12.21	2.49	14.69	73.5	371.2	-1.48	369.7
SS	2.0	16	Thinned	35-40	12.18	0.81	12.99	65.0	436.1	-2.63	433.5
SS	2.0	16	Thinned	40-45	10.11	0.09	10.20	51.0	487.1	-3.80	483.3
SS	2.0	16	Thinned	45-50	7.41	0.04	7.45	37.3	524.4	-4.94	519.4
SS	2.0	16	Thinned	50-55	8.43	-1.13	7.31	36.5	560.9	-5.90	555.0
SS	2.0	16	Thinned	55-60	6.81	-1.10	5.71	28.6	589.5	-6.73	582.7
SS	2.0	16	Thinned	60-65	6.71	-0.87	5.84	29.2	618.7	-7.46	611.2
SS	2.0	16	Thinned	65-70	4.78	-0.65	4.13	20.7	639.3	-8.11	631.2
SS	2.0	16	Thinned	70-75	4.50	-0.55	3.95	19.7	659.0	-8.70	650.3
SS	2.0	16	Thinned	75-80	4.31	-0.46	3.85	19.2	678.3	-9.22	669.1
SS	2.0	16	Thinned	80-85	3.42	-0.40	3.02	15.1	693.4	-9.68	683.7
SS	2.0	16	Thinned	85-90	2.42	-0.36	2.06	10.3	703.7	-10.09	693.6
SS	2.0	16	Thinned	90-95	2.21	-0.34	1.87	9.4	713.0	-10.45	702.6
SS	2.0	16	Thinned	95-100	2.12	-0.30	1.82	9.1	722.1	-10.77	711.4
SS	2.0	16	Thinned	100-105	1.79	-0.26	1.53	7.7	729.8	-11.06	718.7
SS	2.0	16	Thinned	105-110	1.52	-0.23	1.30	6.5	736.3	-11.31	725.0
SS	2.0	16	Thinned	110-115	1.31	-0.20	1.11	5.6	741.8	-11.53	730.3
SS	2.0	16	Thinned	115-120	0.95	-0.17	0.78	3.9	745.7	-11.73	734.0
SS	2.0	16	Thinned	120-125	0.79	-0.16	0.63	3.1	748.9	-11.91	737.0
SS	2.0	16	Thinned	125-130	0.69	-0.14	0.54	2.7	751.6	-12.06	739.5
SS	2.0	16	Thinned	130-135	0.58	-0.13	0.45	2.3	753.8	-12.20	741.6
SS	2.0	16	Thinned	135-140	0.47	-0.11	0.36	1.8	755.6	-12.32	743.3
SS	2.0	16	Thinned	140-145	0.34	-0.10	0.23	1.2	756.8	-12.43	744.4
SS	2.0	16	Thinned	145-150	0.37	-0.09	0.29	1.4	758.2	-12.53	745.7
SS	2.0	16	Thinned	150-155	0.26	-0.08	0.18	0.9	759.1	-12.61	746.5
SS	2.0	16	Thinned	155-160	0.19	-0.07	0.12	0.6	759.7	-12.69	747.0
SS	2.0	16	Thinned	160-165	0.20	-0.06	0.14	0.7	760.4	-12.75	747.6
SS	2.0	16	Thinned	165-170	0.14	-0.05	0.08	0.4	760.8	-12.81	748.0
SS	2.0	16	Thinned	170-175	0.11	-0.05	0.06	0.3	761.1	-12.86	748.2
SS	2.0	16	Thinned	175-180	0.08	-0.04	0.04	0.2	761.3	-12.91	748.4
SS	2.0	16	Thinned	180-185	0.06	-0.04	0.02	0.1	761.4	-12.95	748.5
SS	2.0	16	Thinned	185-190	0.04	-0.03	0.01	0.0	761.5	-12.99	748.5
SS	2.0	16	Thinned	190-195	0.03	-0.03	0.00	0.0	761.4	-13.02	748.4
SS	2.0	16	Thinned	195-200	0.02	-0.03	-0.01	-0.1	761.4	-13.05	748.3

Then consider the length of your project: If the crediting period of your project is to be 100 years, from establishment to year 100, simply look at the cumulative total for period 95-100 and you will see that in this 'scenario' our model predicts that this woodland will sequester 711.4 tCO_2e/ha by year 100 (Final peach-coloured column).

Consider the size of your project: If you are planting 10ha then the total predicted sequestration for your project is 10 x 711.4 = 7,114 tCO_2e

3. Adapting the tables to your situation

3.1 Species – not in the table

If the species you are planting is not in the lookup tables, then use the table in Appendix 1 for broadleaved species and Appendix 2 for conifer species to work out which species in the tables most closely represents what you are planting.

For example

- if you are planting alder, then you should use the SAB (Sycamore/Ash/Birch) scenario in the lookup tables as the one which most closely represents your plans(see Appendix 1).
- If you are planting maritime pine you should use the lodgepole pine scenario in the lookup tables as the one which most closely represents your plans (see Appendix 2).

Please ensure you clearly state what assumptions you have made regarding species.

3.2 Species – mixtures

If planting a native woodland:
If planting a mixed native woodland with a number of different native species, then the best model to use is the SAB (Sycamore, Ash, Birch) model, which encompasses three species which grow and sequester carbon at different rates. This is the best model to singly represent any mix of native species. A conservative approach would be also to assume Yield Class 4, as this errs on the side of caution of known growth rates of native woodland in the UK.

Where Oak or Beech are a large proportion of the mixture, these individual species models can be used if desired for their proportion of the mix (see below) – together with SAB (Sycamore, Ash, Birch) to represent the minor species.

Other species mixes:
If you are planting a compartment with a mixture, then apportion an area of each species according to the % stems of each species planted, look them up individually and then add together.

For example if you are planting a 10ha wood which is 50% Sitka spruce, 30% Douglas fir and 20% European Larch see the apportionment of area in Table 5:

Table 5: Apportioning area to a species mix

Species	% stems	Area (ha)
Total Area		10
Sitka spruce	50	5
Douglas fir	30	3
European larch	20	2

This calculation assumes that the forest is being managed to maintain a consistent species mix over the period of the project. Please ensure that you clearly state what assumptions you have made regarding species mixes.

3.3 Spacing not in the lookup table

If the planting spacing you are using is not in the table, then use the closest spacing in the table. Make it clear in your calculations which spacing you have used.

3.4 Yield class – how to estimate

Yield class for your particular species and site should be predicted using Ecological Site Classification (ESC). This can be accessed online at:http://www.eforestry.gov.uk/forestdss/ Guidance on using ESC is also available at http://www.forestry.gov.uk/carboncode

A password is required to use this service – For further details see the website.

Note also that Ecological Site Classification provides regional (rather than site-based) estimates for yield class under future climate change scenarios (the 'Future Climate Analysis' table). If the predicted yield class of a particular species is likely to change over time (see the 'Future Climate Analysis'), this should be taken into account.

For **mixed native woodlands**, the assumption of Yield Class 4 is recommended alongside the use of the SAB (Sycamore, ash, birch) species model (see 3.2).

3.5 Management types

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 use the 'thinned' tables.

Clearfell after n years

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.

Again using our initial example of Sitka spruce woodland:

- A 10ha Sitka spruce woodland
- with spacing 2.0m,
- predicted yield class 16,
- thinned to standard regimes, and
- you are planning to clearfell the woodland on a 50 year rotation
- the land will have 2 years fallow between clearfell and restock
- claiming carbon from year 0 to year 100

If we were planning to clearfell at year 50, then by that time, we predict the woodland will have sequestered 519.4 tCO_2e/ha or 5,194 tCO_2e for a 10ha woodland. However this full amount cannot be claimed, only the long-term average. The long-term average tends to be between 30% and 50% of the cumulative total carbon sequestered over one rotation.

Use the sheet 'Max Sequestration Values' and select your scenario (SS, 2.0m, YC16, thin) as you did on the 'Carbon Lookup Table' sheet. Next look along the row to the figure relating to a 50-year rotation. This shows the long-term average is 234 tCO_2e/ha or 2,340 tCO_2e for a 10ha woodland.

This long-term average is the maximum amount of sequestration you can claim, irrespective of the length of the project, if clearfelled every 50 years. **Claims can be made as the carbon is sequestered in the first rotation up to the time this cap is reached**. The subsequent growth of the forest should continue to be monitored as per the Carbon Assessment Protocol for the remainder of the project duration.

Continuous Cover Forestry

Other management regimes such as Continuous Cover Forestry regimes 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.

3.6 Emissions from woodland management

Emissions due to establishment

Emissions due to establishment should be accounted for in year 1 of the project. These are not included within the lookup tables. The relevant values should be selected from Table 6, dependent upon the methods used for establishment, and then added into the project carbon sequestration calculations at year 1.

Table 6: Emissions due to establishment activities

Activity		tCO_2e/ha	Notes
Seedling Cost	1.2m spacing	-1.05	allows for GHG emissions at nursery
	1.4m spacing	-0.77	
	1.5m spacing	-0.67	
	1.7m spacing	-0.52	
	2.0m spacing	-0.38	
	2.5m spacing	-0.24	
	3.0m spacing	-0.17	
Fencing		-1.64	based on steel fence in a rectangular 5ha shape
Tree shelters		-0.82	based on 50% of fencing cost
Ground preparation **variable, depends upon method		-0.06	based upon diesel use in forestry ploughing
Herbicide use at planting and beat-up		-0.001	
Forest road building[1] **Does not include maintenance		-43.13 tCO_2e/km	'A' road average density = 0.006km/ha 'B' road average density = 0.01km/ha

[1] Whittaker *et al* (2008)

Fertilizer: We have not provided figures for emissions due to fertilizer used at establishment or during the life of the project, this should be included in calculations. If used, the CLA's CALM model can be used to give the emissions per hectare of fertilizer.

For example, for our woodland

- A 10ha Sitka spruce woodland
- with spacing 2.0m,
- predicted yield class 16,
- thinned to standard regimes, and
- you are planning to clearfell the woodland on a 50 year rotation
- the land will have 2 years fallow between clearfell and restock
- claiming carbon from year 0 to year 100
- will be fenced, we will prepare the ground by mounding, and will spray with herbicide at planting and beat-up to discourage weed growth.
- We will not be creating any new roads.

Emissions from establishment will be:

Activity	Cost tCO_2e/ ha	Cost tCO_2e for 10ha
Seedlings at 2.0m spacing	-0.38	-3.8
Fencing	-1.64	-16.4
Ground Preparation	-0.06	-0.6
Herbicide	-0.001	0.0
Total	**-2.231**	**-20.8**

Ongoing emissions from woodland management – thinning

Emissions due to thinning operations are included in the main carbon lookup table for scenarios where thinning takes place.

Ongoing emissions from woodland management – clearfell

We have not yet defined emissions from clearfell of a woodland. In order to estimate the emissions from a clearfell, subtract the 'cumulative emissions from management' from the year of clearfell from the 'cumulative emissions from management at year 200.

Using our example of a 10ha Sitka spruce woodland

- with spacing 2.0m,
- predicted yield class 16,
- thinned to standard regimes, and
- you are planning to clearfell the woodland on a 40 year rotation
- the land will have 2 years fallow between clearfell and restock
- claiming carbon from year 0 to year 100

The emissions from clearfelling at year 40 will be -13.05 tCO_2e/ha minus -2.63 tCO_2e/ha = -10.42 tCO_2e/ha. Or -104.2 tCO_2e for a 10ha woodland. This should be entered as an emission at year 40.

The second clearfell at year 82 should also be accounted for. It will be the same level of emission as the clearfell at year 40.

4. Bringing it all together and applying buffers

After completing all calculations, including consideration of

- soil carbon emissions and sequestration (see soil carbon information in project sequestration guidance)
- removal of vegetation at the start of the project (see project sequestration guidance)

all projects must apply 'buffers' to allow for precision of the model estimates as well as subtracting a carbon buffer to allow for the risk of impermanence. This section explains how to finalise calculations and put them into the tables provided in the Project Design Document.

4.1 What buffers do I need to apply?

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- **Precision:** All projects must allow a buffer of 20% to account for the precision of the model estimates.
- **Allowing for risks of impermanence:** All projects must assess the level of risk buffer. Table 7 outlines the range of possible risk values. Projects must select a level of risk for each category between the 'lower' and 'higher' risk projects. These should then be summed to get a total risk % between 15% and 40%. The level of risk in each case should be suitable to your project. See the guidance on Management of Risks and Permanence for further information. The Project Design Document also contains a table to assist in your calculation of project risk.

Table 7: Levels for permanence buffer for each risk category

Risk Category	**Contribution to overall risk rating**	
	Higher Risk Projects	**Lower Risk Projects**
Legal/Social	2%	1%
Project Management	3%	1%
Finance	5%	2%
Natural Disturbance: Fire	4%	2%
Natural Disturbance: Wind	6%	3%
Natural Disturbance: Pest & Disease	10%	3%
Natural Disturbance: Direct Climate Change Effects	10%	3%
Overall Risk Buffer **% of predicted CO_2e sequestration**	**40% (Max)**	**15% (Min)**

4.2 Example calculation of project carbon sequestration

The Carbon Lookup Tables contain 3 worksheets with example calculations which can be taken and adapted to fit your scenario:

- A Sitka spruce woodland which is thinned, no clearfell (this is also set out below)
- A Sitka spruce woodland which is not thinned, but is clearfelled at year 40
- A mixed native woodland

This example below explains to summarise your calculations to enable you to complete Tables 3, 4 and 5 in the Project Design Document (PDD), including applying buffers:

In the case of our example:

- a 10ha Sitka spruce woodland
- planted in 2011 and carbon being claimed for 100 years
- with initial spacing 2.0m,
- predicted yield class 16,
- thinned to standard regimes, and
- will be fenced, and will spray with herbicide at planting and beat-up to discourage weed growth.
- NOT creating any new roads.
- NOT planning to clearfell the woodland at any time
- assuming a permanence carbon buffer of 15%
- planted in England on organo-mineral soil which was previously used as permanent pasture (see soil carbon guidance and lookup table in project carbon sequestration)
- site was prepared by drain mounding with a 360° excavator with a drainage bucket (see 3.6 emissions from establishment and soil carbon guidance/ lookup table)
- no vegetation was removed at the start of the project (see project carbon sequestration guidance)

Lookup tables predict the project would sequester 7,114 tCO_2e by year 100. In the Project Design Document we need to show the sequestration for each 5-year period over the duration of the project, including subtracting buffers.

- First complete Tables 3 and 4 in the PDD with the background information and assumptions used in calculations
- In Table 5 of the PDD put figures from Carbon Lookup Tables (adjusted for woodland area) in column A.
- First subtract 20% precision buffer from figures from the Carbon Lookup Table and put in column B
- Include emissions from establishment or clearfelling in Column C
- Include emissions and/or accumulation from soil carbon in Column D
- Subtotal in Column E (=B+C+D). The emissions in columns C and D need to be subtracted from each row (from years 0-5 up to years 95-100)
- Calculate permanence carbon buffer as % of the subtotal (Column E) in column F
- Subtract permanence buffer (Column F) from subtotal (Column E) to get project carbon sequestration in column G (G=E-F)
- In column G you are left with the total you can claim for each 5 year period over the duration of the project. Overall the project is predicted to sequester 4,693 tCO_2e over 100 years.

***Table 3 from Project Design Document*: Timescales, buffers and caps, soil**

Project Basics	
Project start date	2011
Project duration (years)	100
Total net planting area (ha)	10
Biomass – buffers and caps	
Buffer applied for permanence (15 to 30%)	15%
Cap applied if clearfelling? *[state level, tCO_2e/ha]*	Not applicable
Emissions from establishment or felling	
Total emission from establishment (to be applied in year 1, tCO_2e)	-20.8tCO_2e
Total emissions from one clearfell (to be applied in the year(s) of clearfell, tCO_2e)	Not applicable
Soil – Carbon	
Soil type (Organic, organo-mineral, mineral)	Organo-mineral
Previous landuse (semi-natural, pasture or arable)	Pasture
Site preparation technique used, % soil carbon (0-30cm) assumed lost	Drain mounding – 360° excavator with a drainage bucket – 5% soil C loss
Soil carbon emission (tCO_2e)	-147tCO_2e
If previously arable site on mineral soil: Are you claiming any carbon sequestration? Yes/No	No

***Table 4 from Project Design Document:* Summary of assumptions made in carbon sequestration calculations**

Sectn No:	Species	Actual Spacing	Spacing used in Lookup tables	Management Regime from Lookup Tables	Yield Class (From ESC)	% of Area if mixture	Area (ha)
1	Sitka spruce	2.0m	2.0m	Thinned, no clearfell	16	100	10
						Total Area:	**10**

Table 5 from Project Design Document: **Example buffer calculation**

Cumulative to Year	A: Cumulative Carbon Sequestrn from lookup tables	B = 80% of A Cumulative Carbon Sequestrn Less 20% model precision	C: Negative Rem. vegtn and/or emiss. establishmt yr 1, emiss. Clearfell in yr of activity	D: Soil Carbon (loss in year 1 and cumulative accumuln if relevant)	E= B+C+D: Subtotal	F=15- 30% of E Risk buffer for permanence	G=E-F Net carbon sequestrn
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
5	59	47	-21	-147	-120	-18	-102
10	220	176	-21	-147	8	1	7
15	682	545	-21	-147	377	57	321
20	1904	1524	-21	-147	1356	203	1152
25	2474	1980	-21	-147	1812	272	1540
30	2973	2378	-21	-147	2210	332	1879
35	3697	2957	-21	-147	2790	418	2371
40	4335	3468	-21	-147	3300	495	2805
45	4833	3866	-21	-147	3699	555	3144
50	5194	4155	-21	-147	3988	598	3389
55	5550	4440	-21	-147	4272	641	3631
60	5827	4662	-21	-147	4494	674	3820
65	6112	4890	-21	-147	4722	708	4013
70	6312	5050	-21	-147	4882	732	4149
75	6503	5203	-21	-147	5035	755	4280
80	6691	5352	-21	-147	5185	778	4407
85	6837	5470	-21	-147	5302	795	4507
90	6936	5549	-21	-147	5381	807	4574
95	7026	5621	-21	-147	5453	818	4635
100	7114	5691	-21	-147	5523	828	4695

5. References

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Appendix 1: Default values to use for broadleaved species

Abbr.	Name	Botanical name	Use table for:
	Alder	*Alnus spp.*	SAB
AH (SAB)	Ash	*Fraxinus excelsior*	SAB
	Aspen	*Populus tremula*	SAB
BE	Beech	*Fagus sylvatica*	BE
	big leaf maple	*Acer macrophyllum*	SAB
BI (SAB)	birch (downy/silver)	*Betula spp.*	SAB
	bird cherry	*Prunus padus*	SAB
	black poplar	*Populus nigra*	SAB
	black walnut	*Juglans nigra*	OK
	Blackthorn	*Prunus spinosa*	SAB
	Box	*Buxus spp.*	SAB
	cider gum	*Eucalyptus gunnii*	SAB
	common alder	*Alnus glutinosa*	SAB
	common lime	*Tilia europea*	SAB
	common walnut	*Juglans regia*	OK
	crab apple	*Malus sylvestris*	SAB
	crack willow	*Salix fragilis*	SAB
	downy birch	*Betula pubescens*	SAB
	downy oak	*Quercus pubescens*	OK
	Elm	*Ulmus spp.*	BE
	English elm	*Ulmus procera*	BE
	field maple	*Acer campestre*	SAB
	goat willow	*Salix caprea*	SAB
	green alder	*Alnus viridis*	SAB
	grey alder	*Alnus incana*	SAB
	grey poplar	*Populus canescens*	SAB
	grey willow	*Salix cinerea*	SAB
	hawthorn species	*Crataegus spp*	SAB
	Hazel	*Corylus avellana*	SAB
	holly species	*Ilex spp.*	SAB
	Holm oak	*Quercus ilex*	OK
	Hornbeam	*Carpinus betulus*	BE
	horse chestnut	*Aesculus hippocastanum*	SAB
	Hungarian oak	*Quercus frainetto*	OK
	hybrid poplars	*Populus serotina/trichocarpa etc.*	SAB
	Italian alder	*Alnus cordata*	SAB
	large-leaved lime	*Tilia platyphyllos*	SAB
	Lenga	*Nothofagus pumilio*	SAB
	Lime	*Tilia spp.*	SAB
	London plane	*Platanus* x *acerifolia*	SAB
	mixed broadleaves		SAB
	Narrow-leafed ash	*Fraxinus angustifolia*	SAB

Abbr.	Name	Botanical name	Use table for:
	Norway maple	*Acer platanoides*	SAB
OK	oak (robur/petraea)	*Quercus spp.*	OK
	oriental beech	*Fagus orientalis*	BE
	other birches	*Betula spp.*	SAB
	other broadleaves		SAB
	other cherry spp	*Prunus spp.*	SAB
	other Eucalyptus	*Eucalyptus spp.*	SAB
	other Nothofagus	*Nothofagus spp.*	SAB
	other oak spp	*Quercus spp.*	OK
	other Poplar spp	*Populus spp.*	SAB
	other walnut	*Juglans spp.*	OK
	other willows	*Salix spp.*	SAB
	paper-bark birch	*Betula papyrifera*	SAB
	pedunculate/common oak	*Quercus robur*	OK
	plane spp	*Platanus spp.*	SAB
	Pyrenean oak	*Quercus pyrenaica*	OK
	raoul/rauli	*Nothofagus nervosa*	SAB
	red alder	*Alnus rubra*	SAB
	red ash	*Fraxinus pennsylvanica*	SAB
	red oak	*Quercus borealis*	BE
	Roble	*Nothofagus obliqua*	SAB
	Rowan	*Sorbus aucuparia*	SAB
	sessile oak	*Quercus petraea*	OK
	shagbark hickory	*Carya ovata*	BE
	shining gum	*Eucalyptus nitens*	BE
	silver birch	*Betula pendula*	SAB
	silver maple	*Acer saccharinum*	SAB
	small-leaved lime	*Tilia cordata*	SAB
	smooth-leaved elm	*Ulmus carpinifolia*	BE
	sweet chestnut	*Castanea sativa*	BE
SY (SAB)	Sycamore	*Acer pseudoplatanus*	SAB
	tulip tree	*Liriodendron tulipifera*	BE
	Turkey oak	*Quercus cerris*	OK
	white ash	*Fraxinus americana*	SAB
	white oak	*Quercus alba*	OK
	white poplar	*Populus alba*	SAB
	white willow	*Salix alba*	SAB
	Whitebeam	*Sorbus aria*	SAB
	wild cherry, gean	*Prunus avium*	SAB
	wild service tree	*Sorbus torminalis*	SAB
	wych elm	*Ulmus glabra*	BE

Appendix 2: Default values to use for conifer species

Abbr.	Name	Botanical name	Use table for:
	Armand's pine	*Pinus armandii*	SP
	Atlas cedar	*Cedrus atlantica*	NF
	Austrian pine	*Pinus nigra var nigra*	CP
	Bhutan pine	*Pinus wallichiana*	SP
	Bishop pine	*Pinus muricata*	CP
	Bornmuller's fir	*Abies bornmuelleriana*	NF
	Calabrian pine	*Pinus brutia*	SP
	cedar of Lebanon	*Cedrus libani*	NF
	Coast redwood	*Sequoia sempervirens*	GF
CP	Corsican pine	*Pinus nigra var maritima*	CP
DF	Douglas fir	*Pseudotsuga menziesii*	DF
EL	European larch	*Larix decidua*	EL
	European silver fir	*Abies alba*	NF
GF	Grand fir	*Abies grandis*	GF
	Grecian fir	*Abies cephalonica*	NF
HL	hybrid larch	*Larix x eurolepis*	HL
	Japanese cedar	*Cryptomeria japonica*	RC
JL	Japanese larch	*Larix kaempferi*	JL
	Korean pine	*Pinus koreana*	SP
	Lawson's cypress	*Chamaecyparis lawsoniana*	RC
LEC	Leyland cypress	*Cupressocyparis leylandii*	LEC
	loblolly pine	*Pinus taeda*	CP
LP	lodgepole pine	*Pinus contorta*	LP
	Macedonian pine	*Pinus peuce*	CP
	Maritime pine	*Pinus pinaster*	LP
	Mexican white pine	*Pinus ayacahuite*	SP
	mixed conifers		NS
	Monterey pine	*Pinus radiata*	CP
	mountain pine	*Pinus uncinata*	SP
NF	noble fir	*Abies procera*	NF
	Nordmann fir	*Abies nordmanniana*	NF
NS	Norway spruce	*Picea abies*	NS
	oriental spruce	*Picea orientalis*	NS
	other Cedar	*Cedrus spp.*	NF
	other conifers		NS
	other firs (Abies)	*Abies spp.*	NF
	other larches	*Larix spp.*	EL
	other pines	*Pinus spp.*	SP
	other spruces	*Picea spp.*	NS
	Ponderosa pine	*Pinus ponderosa*	SP
	red fir (pacific silver)	*Abies amabilis*	GF
SP	Scots pine	*Pinus sylvestris*	SP
	Serbian spruce	*Picea omorika*	NS
SS	Sitka spruce	*Picea sitchensis*	SS

Abbr.	**Name**	**Botanical name**	**Use table for:**
	slash pine	*Pinus ellottii*	LP
	Wellingtonia	*Sequoiadendron giganteum*	GF
WH	western hemlock	*Tsuga heterophylla*	WH
RC	western red cedar	*Thuja plicata*	RC
	western white pine	*Pinus monticola*	LP
	Weymouth pine	*Pinus strobus*	SP
	Yew	*Taxus baccata*	SP
	Yunnan pine	*Pinus yunnanensis*	SP