



**Programme Area:** Bioenergy

**Project:** Characterisation of Feedstocks

**Title:** D1 Detailed Schedule of Work

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### Abstract:

The primary objective of this 2015/16/17 Project was to provide an understanding of UK produced biomass properties, how these vary and what causes this variability.

This 86 page report is the second of seven deliverables produced as part of Phase 1 (2015/16) of the Characterisation of Feedstocks Project and the second of two under Milestone 1. The purpose of this deliverable was to describe the rationale for both the experimental design and the decisions taken. Deliverable 2 was to provide technical details to enable the ETI to check the technical validity of the project, in particular that feedstocks and soils would be representatively sampled, sample integrity would be maintained, approved laboratory methods would be used, and that both the statistical analyses and database design would be fit for purpose.

The report provides the following: how sampling consistency will be assured; the design for the planned database; the roles and responsibilities between all parties involved in sampling, data collection and lab analysis. Of interest may be the following: a 5 page section on rationale for the experimental approach – page 4 (as marked) and Appendix 2 starting page 35 (as marked).

### Context:

The Characterisation of Feedstocks project provides an understanding of UK produced 2nd generation energy biomass properties, how these vary and what causes this variability. In this project, several types of UK-grown biomass, produced under varying conditions, were sampled. The biomass sampled included Miscanthus, Short Rotation Forestry (SRF) and Short Rotation Coppice (SRC) Willow. The samples were tested to an agreed schedule in an accredited laboratory. The results were analysed against the planting, growing, harvesting and storage conditions (i.e. the provenance) to understand what impacts different production and storage methods have on the biomass properties. The main outcome of this project is a better understanding of the key characteristics of UK biomass feedstocks (focusing on second generation) relevant in downstream energy conversion applications, and how these characteristics vary by provenance.

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**ETI Project Code:** BI2010

**Project Title:** Characterisation of Biomass Feedstocks

**Deliverable title:** Detailed schedule of work

Reference: D1

Participant lead: Forest Research

Other participant: E.ON Technologies (Ratcliffe) Ltd.

Submission date: 9<sup>th</sup> June 2015

Version number: v2

*Not to be disclosed other than in line with the terms of the Technology Contract*

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## Executive Summary

Sampling protocols for all first harvests to assess the overall condition of five biomass resource types and also the within-field variation of *Miscanthus* and willow SRC have been agreed within the Consortium. These protocols are fit-for-purpose but are still being refined in response to emerging issues. The essential details of sampling protocols for all stored samples have also been agreed within the Consortium. The analyses for all plant and soil samples have been confirmed. Procedures are in place to ensure that a) the identity of samples is clear when they are received for analysis and b) site, provenance, and sample characteristics can be unambiguously linked. A good working relationship between Forest Research (FR) and E.ON has been established. There are clear lines of communication between the Energy Technologies Institute (ETI) and FR allowing the swift resolution of some practical concerns, e.g. varietal differences within willow and poplar; interval between first and second harvest. Health, Safety and Environment requirements have been met with only very minor additional information to be provided.

Field sampling in accordance with the plan outlined in Deliverable 1 is underway and lab analysis has started. The next deliverable (Deliverable 2: Methodology, sampling consistency report and database design), which is scheduled for 9<sup>th</sup> April, provides a detailed rationale for the sampling design and feedstock characteristics assessed; it also explains the significant decisions taken to address issues that emerged as the project progressed. Deliverable 1 should be read in tandem with Deliverable 2.

The very significant challenge is to co-ordinate with many growers, each harvesting according to unpredictable factors (mainly weather, field conditions and machinery availability), to collect samples that are representative of commercial reality and at the same time give the maximum possible information about factors influencing the biomass feedstock characteristics.

## Introduction

The purpose of this deliverable is to ensure that there is a comprehensive plan in place that meets the needs of the ETI project and that can and will be used to monitor progress of the Project. It will allow the FR/E.ON team to demonstrate that they understand the requirements of the Project and how it integrates with the Techno-economic assessment of biomass pre-processing technologies project. Furthermore it will allow the ETI to check that the Project requirements can and will be met. For ease of reference, D1's description and acceptance criteria are given in Appendix 1.

The objectives are to provide the following information:

- A schedule of work detailing the list of feedstocks to be sampled
- The type, number and source of samples to be collected
- A plan for gathering provenance data
- A planned schedule of laboratory preparation and testing to be carried out
- A clear plan for delivering the ETI project objectives

Deliverable 1 (D1) should be read in tandem with Deliverable 2 (D2): Methodology, sampling consistency report and database design), which provides a detailed rationale for the sampling design and feedstock characteristics assessed; it also explains the significant decisions taken to address issues that emerged as the project progressed.

## Internal roles and responsibilities

The roles and responsibilities are essentially as proposed in the bid document:

- The Project Manager is Dr Helen McKay (FR)
- The Chief Technologist is Steve Croxton (E.ON).
- Dr Geoff Hogan (FR) is responsible for networking with feedstock suppliers, data mining and drafting communications including reports.
- Day-to-day management for sample analysis lies with Dr Will Quick (E.ON)
- Day-to-day management of the collection of field samples and their associated data lies with Michael Wall (FR).
- The FR Field Station Manager at Fineshade (Liz Richardson) is responsible for the field staff either undertaking direct sampling or collaborating with crop suppliers where joint sampling has been agreed.
- Andy Peace (FR) advises on the statistical aspects of sampling design and data analysis.

Nevertheless because of the extreme time pressure to identify suitable sites before plant growth resumes in the spring Helen McKay has had to assume some responsibility for reporting rather than Geoff Hogan.

### **Work plan**

The schedule of work, which includes field and laboratory sampling, statistical analysis, reporting and interaction with the ETI, is attached below in Table 1.

**Biomass feedstocks.** Five biomass types are included: *Miscanthus*, willow short rotation coppice (SRC), poplar SRC, poplar short rotation forest (SRF) as the example of broadleaved SRF, and Sitka spruce (as the example of conifer SRF).

**Rationale for choice of species representative of SRF feedstocks.** Poplar was selected as representative of broadleaved woody species of particular interest to medium to large-scale bioenergy users. Sitka spruce was selected as representative of conifer woody species of interest to medium to large-scale bioenergy users and which was expected to be available at reasonable scale in the future. By contrast conifer species currently available because of phyto-sanitary reasons, such as pines and larch, were not selected because they are unlikely to be planted at scale in the future. An in-depth rationale is given in D2.

**Rationale for choice of variety.** There is some evidence that clonal differences within both willow and poplar can be substantial. Two approaches were considered to minimise the effect of varietal differences compromising the project's objectives – ensure that the sample is representative of all clones planted at each sampling site or sample only one clone that is present at all sites. We decided to follow:

- a. the former approach where we are assessing the impact of climate, soils and management on feedstock characteristics (here we take 10 samples across the field and then bulk them before subsampling for analysis)
- b. the latter approach where we are assessing within-field variation (taking 20 samples from across individual fields).

**Rationale for choice of sites.** The approach of stratifying Britain on the basis of climate and soil and then sampling from three locations within each combination of climate and site, gives a statistically sound design which facilitates subsequent analyses to separate out the most important sources of variability in feedstock characteristics. The application of a regular grid appears to give a good spread of sampling locations but is less likely to provide samples from across the breadth of growing conditions. An in-depth rationale is given in D2.

The proposed sampling matrix, as outlined in the bid documentation of September 2014 when the start date was expected to be October 2014, is shown below in Table 2. Our planned sampling design of three replicate sites in each combination of climatic zone and broad soil type remains. Thus the overall approach has not been changed, however the delayed start has meant that the sampling times are delayed and the interval between harvest times will be reduced. Moreover the selection of sites for sampling has been of necessity reactionary and difficult to plan. The risks are that the data are less clear cut than expected because there is not the ideal distinct time interval between harvest times and the dataset is not complete.

Our current (13<sup>th</sup> March) sites are shown in Appendix 3-8; sample spreadsheets of site details show the key site details but not for example contact details or internal comments.

Table 1. Revised schedule of work to deliver BI2010 project objectives.

Stage	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16
<b>WP 1. PLANNING</b>													
Task 1. Finalise project brief	■												
Task 2. Organise input to regular meetings with ETI		■	■	■	■	■	■	■	■	■	■	■	
Task 3. Finalise internal roles and responsibilities	■												
Task 4. Finalise sampling strategy, analytical tests	■												
Task 5. Chair regular teleconferences	■	■	■	■	■	■	■	■	■	■	■	■	
Task 6. Oversee communications with ETI		■	■	■	■	■	■	■	■	■	■	■	
Task 7. Sign off contract reports		■	■			■			■				■
<b>WP 2. STATISTICS</b>													
Task 1. Design the sampling methodology	■	■											
Task 2. Analyse existing and new data				■	■				■		■		
Task 3. Compile database						■			■	■	■		
Task 4. Summarise the statistical results.									■	■	■		
<b>WP 3. DATA MINING</b>													
<b>WP 4. SAMPLE COLLECTION</b>													
Task 1. Identify potential suppliers of feedstock	■	■											
Task 2. Confirm selection of suppliers and field samples		■	■	■				■					
Task 3. Confirm and document sampling design and methodology		■	■	■	■	■	■	■	■				
Task 4. Agree a schedule of sample deliveries to the lab at E.On		■	■	■	■	■	■	■	■				
Task 5. Obtain records of associated site and crop information	■	■	■	■	■	■	■	■	■				
Task 6. Liaise with suppliers prior to sampling visit		■	■	■	■	■	■	■	■				
Task 7. Schedule Research Workers complete sample collection	■	■	■	■	■	■	■	■	■				
<b>WP 5. SAMPLE ANALYSIS</b>													
Task 1. Confirm the optimum suite of chemical and physical analyses	■												
Task 2. Agree sampling methodology	■	■											
Task 3. Agree schedule of deliveries to labs		■	■	■	■	■	■	■	■				
Task 4. Overseeing analysis at E.On, including sample archiving		■	■	■	■	■	■	■	■	■			
Task 5. Liaise with subcontractor laboratories			■	■	■	■	■	■	■				
Task 6. Provide results, including historic records of biomass				■	■	■	■	■	■	■	■		
<b>WP 6. REPORTING AND COMMUNICATION</b>													
Task 1. Provide progress reports to ETI	■	■	M	■	■	S	■	■	■	M	■	■	■
Task 2. Draft intermediate report to agreed scope and format								■	■				
Task 3. Draft any other communications as required by ETI, FR and E.On													
Task 4. Draft final report and Exec Summary to agreed scope and format													M



Table 2. Original sampling approach

Species	Climatic zone	Soils	Harvest	Fraction	Time of sample	Replicates	Number of sites
<i>Miscanthus</i>	warm moist warm dry	light medium heavy	February April	whole	at harvest in field prior to baling 1 month uncovered	3 sites	108
Willow SRC	warm moist warm dry	light medium heavy	January March	whole	at harvest 1 month outside	3 sites	72
Poplar SRC	warm moist warm dry	light medium heavy	January March	whole	at harvest 1 month outside	3 sites	72
Conifer SRF	cold wet warm moist	mineral organic	Oct/Nov Jan/Feb	trunk stems/branches	at harvest 3 months outside	3 sites	96
Conifer SRF	cold wet warm moist	mineral organic	Oct/Nov Jan/Feb	bark	at harvest	3 sites	24
Poplar SRF	warm dry warm moist	mineral organic	Oct/Nov Jan/Feb	trunk stems/branches	at harvest 3 months outside	3 sites	96
<b>Option 1 – in-field variation</b>							
<i>Miscanthus</i>	Select one	One	March/May	Whole	At harvest	3 sites and 20 points	60
Willow SRC	Select one	One	January	Whole	At harvest	3 sites and 20 points	60
<b>Option 2 - Leaf Properties</b>							
Poplar SRC	Select one	Med/Heavy	September	Leaves only	before harvest	3 sites	9
Willow SRC	Select one	Light	September	Leaves only	before harvest	3 sites	9
<b>Pellets</b>	n/a	n/a	n/a	whole	before and after pelleting		12
						<b>Total of all</b>	<b>618</b>

**Analytical assessments** to be performed are listed below (Table 3) using UKAS accredited methodologies which are listed in Appendix 9. A comprehensive explanation of the choice of assessments is given in Appendix 2 of D2. In summary, the characteristics investigated were selected on the basis of their expected impacts on the downstream processing and conversion of the feedstocks.

Table 3. Analytical tests (Codes A to E are described in Table 4) carried out on each feedstock and plant part showing the total number of samples in each category

Source Material and Sets Required	A	B	C	D	E
Broad-scale sources of variation					
<i>Miscanthus</i>	108	108	36	36	108
Willow SRC	72	72	24	24	72
Poplar SRC	72	72	24	24	72
Conifer SRF	120	72	24	24	72
Poplar SRF	96	48	16	16	48
Option 1 - In-field variation	120	120	120	120	120
Option 2 - Leaves	18	18	18	18	18
Pellet samples	12	12	12	12	12
<b>TOTAL</b>	<b>618</b>	<b>522</b>	<b>274</b>	<b>274</b>	<b>522</b>

Table 4. Codes describing analyses sets carried out on feedstock and soil showing the total number of samples in each category

Summarised sample matrix of samples		
Analysis Sample Sets	Code	Number of samples
Sample Prep, Moisture, Ash, Volatile Matter, GCV, NCV, Cl, S, C, H, N	A	618
Ash Composition (SiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>3</sub> , TiO <sub>2</sub> , CaO, MgO, NaO, K <sub>2</sub> O, Mn <sub>3</sub> O <sub>4</sub> , P <sub>2</sub> O <sub>5</sub> , BaO, SO <sub>3</sub> ) Plus trace metals (Ba, Be, Cr, Co, Cu, Mo, Ni, V, Zn)	B	522
Trace Metals (Hg, Pb, Cd, As, Se, Sb)	C	274
Halides (Br, F) (note Cl analysed in every sample)	D	274
Ash fusion temperature	E	522
Soil Analysis (pH, Lime recommendation, P, K, Mg, Mn, Cu, Na, Ca, Zn, Mo, Fe, B, S, C.E.C, percentage of Sand/Silt/Clay, Textural Classification, Organic Matter content). Total Nitrogen, Chlorine. + an Option on Heavy Metals (Pb, Ni, As, Cd, Hg, Cu, Zn, Se, Co) on a random selection of sites or sites deemed to be of likely high risk	F	78

**Provenance data** to be collected for each site and sampling time are tabulated below (Table 5). They are related back to the laboratory data by means of an agreed code (specified in the sampling protocols) that is attached to all samples sent to the laboratory. An in-depth rationale for the information collected and description of the assessments is given in D2.

Table 5. Data to be collected for each site and sampling time before, during, or after the field visit.

<b>Provenance data</b>
<i>Desk collection (before or after field sampling)</i>
Site unique identifier
Species
Age
Site type
Grid reference
Fertiliser application (including sewage sludge) : dates, forms, application rates
Pesticide application: dates, forms, application rates
Cultivation: dates, depths
Drainage
Sale price of most recent crop
Varieties
Spatial distribution of varieties

<i>Field collection</i>
. Sampling phase
. Location of waypoint position
. Photo of the crop at each waypoint*
. Photo of the ground at each waypoint*
. Visual assessment of stoniness*
. Air temperature at 1.5m height*
. Soil temperature at 10cm depth*
. Visual assessment of recent weather conditions i.e. snow or frost present, recent heavy rain etc.
. Site aspect for the site as a whole
. Slope percentage (%) for the site as a whole
. Rainfall between <i>Miscanthus</i> cutting and baling

\*(except where sampled from chip piles)

**Feedstock suppliers.** Details are shown in Appendix 4 for *Miscanthus*, and Appendix 6 for willow SRC. Poplar sites (both SRC and SRF) are plotted in Appendix 7.

**Progress.** Actual first harvest sampling times of *Miscanthus* and willow SRC are shown in Appendix 4 and 6 respectively. All first harvest of conifer SRF will be completed w/c 16<sup>th</sup> March.

The protocols of field methods are fit-for-purpose but are still being refined in response to emerging issues and are therefore described as working protocols. Ones for sampling and handling *Miscanthus* for overall-field condition and within-field variation are inserted in Appendix 10. Following discussions with ETI about how to minimise the impact of willow varietal differences, initial overall-field condition is being assessed immediately after each field has been harvested by sampling from the chip piles; working protocols for sampling and handling these chip samples for willow SRC are inserted in Appendix 11. The modifications to sample in-field variation of willow SRC are as described for *Miscanthus* in Appendix 10. Appendix 12 gives the current SRF sampling protocol for conifers; the sample procedure for poplar will be similar except that a) no poplar bark will be collected and b) stem samples will be moved from site to a common secure yard for storage (we were advised that any stems left on site are likely to be stolen). Protocols for poplar SRC have not been drafted yet but the various components are covered in the willow SRC protocol. Deliverable 2 contains updated and complete protocols.

## Database

To maximise its accessibility within the present contract and any subsequent investigation, the final database is expected to be presented as Excel spreadsheets, with accompanying metadata describing the data and each data field. The critical point is that each sample has a unique identifier therefore the Excel format can be converted to a more structured relational database, e.g. Access, if agreed. Excel is sufficiently flexible for our data, provided they are described appropriately, to be pulled into the format required by the linked modelling project. The component spreadsheets will be collated in mid-June and finalised following discussion with the ETI Project Office and relevant contact for the linked modelling project.

## Conclusions and next steps

Sampling was not possible until late February because of the delay in concluding the contract. Consequently it seems improbable that the planned intervals between first and second harvests as stated in the bid document will be achieved. Several options for delaying some sampling until the autumn were discussed through the ETI Project Manager and it was decided at that point to work to the original target of completing all fresh sampling this spring.

There is steady progress in securing samples and dispatching them for laboratory analysis. Sampling is being done following clear protocols that meet the project's requirements. H&S procedures have been scrutinised, requiring only minor editing, and are being followed.

The governance and project management of the early stages of this contract have been thorough and considerate. There is excellent communication among the project team to resolve any difficulties that might otherwise delay or compromise the field sampling. Progress is monitored on a weekly and often daily basis.

Deliverable 2 'Methodology and sampling consistency report and database design' is due on 9<sup>th</sup> April. Its purpose is to enable the ETI, its reviewer(s) and members to check that samples will be representatively sampled, that sample integrity will be maintained and that approved laboratory methods will be used; it will also ensure that the database design is fit for purpose. D2 also provides a detailed rationale for project team's selection of sampling design, provenance information being gathered, and the feedstock characteristics being analysed; lastly the reasoning behind key decisions made to address emerging issues is outlined.

## Appendices

### Appendix 1. Description of D1 and Acceptance Criteria

Deliverable reference	Deliverable Description in TC	Acceptance Criteria in TC
D1	<p>Following the initial 'kick-off' meeting, a detailed schedule of work will be provided. This will set out the list of feedstocks to be sampled; the type and number of samples to be collected and where they will be obtained from; a plan for gathering provenance data; and a planned schedule of laboratory preparation and testing to be carried out. Sampling location will consist of region combined with an initial shortlist of possible sampling sites within each region. This will be in either MS Word or PowerPoint format, as agreed with ETI. A detailed project plan incorporating a Gantt chart and showing linked tasks is to be supplied, preferably prepared using Microsoft Project – however, plans prepared using other software packages will be accepted.</p> <p>The extent and method of collection of cost and/or price data will be included.</p> <p>The provenance data to be collected will be designed to relate site geography, site management effects and other potential effects to supplied biomass properties.</p> <p>The plan for the design of the database will be completed in Month 1 (unless otherwise agreed) in consultation with the Project Manager (who may request the Prime Contractor liaise with the ETIs Techno-economic assessment of biomass pre-processing project).</p>	<ul style="list-style-type: none"> <li>• Satisfies the Deliverable Description, Deliverable Purpose(s) and Deliverable Objective, as described above.</li> <li>• Formal Deliverable prepared in accordance with the Generic Acceptance Criteria.</li> <li>• Comprises (at least): <ul style="list-style-type: none"> <li>○ A Gantt chart showing periods of sampling activity (showing biomass type, location, engagement with ETI, other features as appropriate)</li> <li>○ A plan of what provenance data is to be collected and a description of how these data will be related back to laboratory data.</li> <li>○ Details of sampling strategy and analytical tests to be performed. Details of potential suppliers of feedstock.</li> <li>○ Confirmed details of optimum suite of chemical and physical analyses; and sampling methodologies.</li> <li>○ Confirmation of internal roles and responsibilities</li> <li>○ A plan showing how and when the final design of the database will be achieved.</li> </ul> </li> </ul>

## Appendix 2. Example ANOVA table (for the sulphur content of SRF using hypothetical data)

Variate: sulphur					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr. (see below)
site stratum					
zone	1	0.28638	0.28638	2.64	0.143
soil	1	0.07804	0.07804	0.72	0.421
zone.soil	1	0.25714	0.25714	2.37	0.163
Residual	8	0.86932	0.10867	1.41	
site.*Units* stratum					
harvest	1	0.04304	0.04304	0.56	0.463
time	1	0.00109	0.00109	0.01	0.907
zone.harvest	1	0.00110	0.00110	0.01	0.906
soil.harvest	1	0.02774	0.02774	0.36	0.555
zone.time	1	0.06844	0.06844	0.89	0.356
soil.time	1	0.00488	0.00488	0.06	0.804
harvest.time	1	0.01751	0.01751	0.23	0.638
zone.soil.harvest	1	0.04971	0.04971	0.64	0.430
zone.soil.time	1	0.07616	0.07616	0.99	0.331
zone.harvest.time	1	0.00024	0.00024	0.00	0.956
soil.harvest.time	1	0.01786	0.01786	0.23	0.635
zone.soil.harvest.time	1	0.04030	0.04030	0.52	0.477
Residual	24	1.85432	0.07726		
Total	47	3.69328			

d.f. = degrees of freedom; s.s. = sum of squares; m.s. = mean sum of squares; v.r. = variance ratio; F pr. = the probability of the effect happening by chance alone



Appendix 3. *Miscanthus* sites showing general distribution of climate zones (shading) and of sampling sites by dot colour. Codes M1-M33 refer to unique site identifiers (see sample spreadsheet below)

## Miscanthus Sites (FR Climate Zone & Agent soil descriptions)



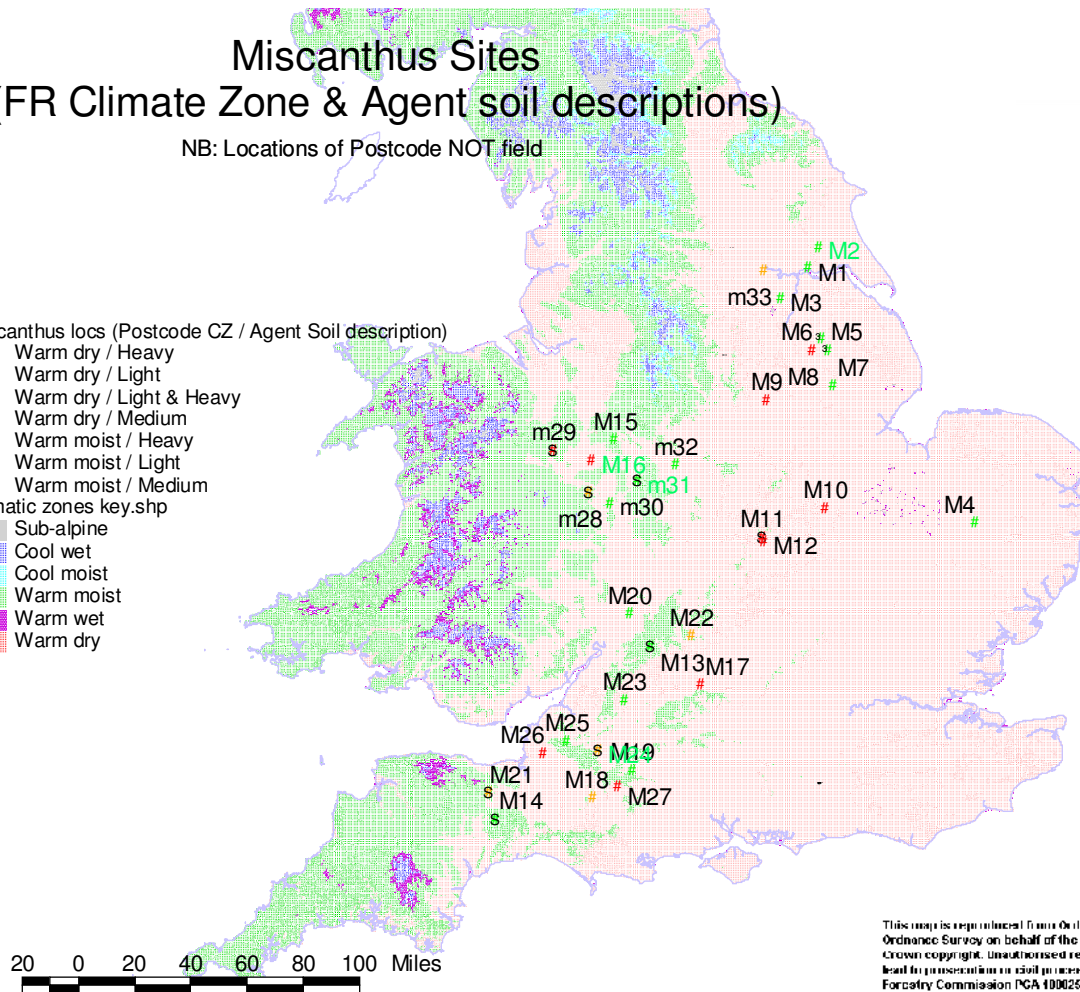
NB: Locations of Postcode NOT field

Miscanthus locs (Postcode CZ / Agent Soil description)

- # Warm dry / Heavy
- # Warm dry / Light
- # Warm dry / Light & Heavy
- # Warm dry / Medium
- \$ Warm moist / Heavy
- \$ Warm moist / Light
- s Warm moist / Medium

Climatic zones key.shp

- Sub-alpine
- Cool wet
- Cool moist
- Warm moist
- Warm wet
- Warm dry



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 Forestry Commission PGA 100025483 - 2005 MW, TD 020215

**Appendix 4. Sample spreadsheet of *Miscanthus* sites as at 2/3/15**

Sample of spreadsheet of Miscanthus sites as at 02/03/15

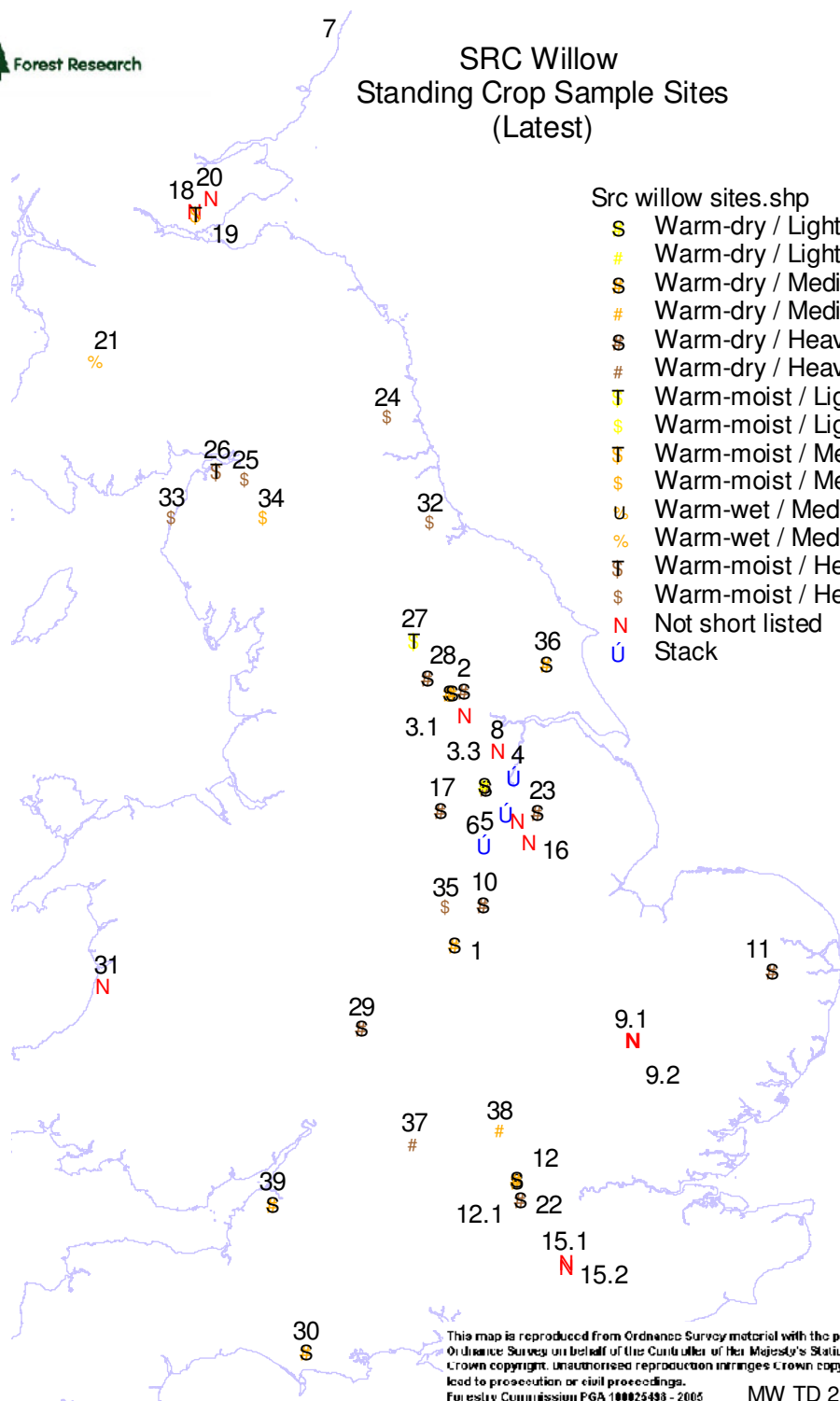
								Soil types			
Site refn	Site Name	Sample stage	Samples	Contact	County	Notes	Grid Ref. (of Postcode)	Dry Light	Dry Heavy	Wet Light	Wet Heavy
<i>Main sites</i>											
M1	Whinney Moor Farm (Eleker)	Sampled	11/02/2015	Chris Bradley	East Yorkshire	Harvested 3, 9, 10/02	SE 4/92415 4/28611	✓			
M2	Eastfield Farm	Dropped (Harve	n/a	Rodger Middleton	Yorkshire	Cut 25th/26th Feb. SE 9940 4903-GISd	SE 4/99045 4/39898	✓			
M3	Belton Grange			Peter Wilkinson	Lincolnshire	Any day now (19/02)	SE 4/77114 4/10071	✓			
M4	Nunnery Stud	Sampled	26/02/2015	M Wingrove	Norfolk	Any day now (19/02)	TL 5/88019 2/82230	✓			
M5	The Little Grange (Hackthorn)	Sampled	09/02/2015	Jim Beeden	Lincolnshire	Harvested 3/02	TF 5/04156 3/80856	✓	✓		
M6	J R Green & Sons	Dropped (Harve	n/a	Edward Green	Lincolnshire	1 Field cut 3/2/15. bal of 2 cut 25/2/15.	TF 5/00066 3/87881	✓	✓		
M7	Blankney			Michal Mos	Lincolnshire	About 2 weeks time (19/02)	TF 5/06748 3/60231	✓			
M8	Brattleby [House Farm]			J Wright	Lincolnshire	No answer (20/02)	SK 4/94941 3/80914		✓		
M9	Stubbins Farm			John Hanmer	Nottinghamshire	All cut last week	SK 4/68578 3/52531		✓		
M10	Manor Farm			Bruce Wilkinson	Northamptonshire	Expects to harvest late - even April. Bale	TL 5/02153 2/90531		✓		
M11	Coton Lodge			Peter Hicks	Northamptonshire	Left msg	SP 4/66056 2/73636		✓		
M12	Coton Manor			Ian Pasley-Tylor	Northamptonshire	2-4 wks	SP 4/67430 2/71649		✓		
M13	Shawswell			P St. Pier	Gloucester	Prob. Mid March	SP 4/02342 2/11309			✓	
M14	Miscanthus Nurseries Ltd			Mike Cooper	Devon	Left msg	ST 3/13314 1/13252			✓	
M15	Landmark Associates Ltd			R F Powell	Stafford	Prob 2-3 wks	SJ 3/81596 3/29858			✓	
M16	Buttery Farm			Colin Webb	Shropshire	Left msg	SJ 3/68469 3/17269				✓
M17	Common Farm			Tom Matthews	Oxfordshire	Probably March - wet	SU 4/30832 1/89800				✓
M18	Horsington Manor			Colebatch	Somerset	Spoke to land agent. Send info & he wil	ST 3/69248 1/24808				✓
M19	Downlands Church Farm			Victor Sidford	Wiltshire	Phone number wrong?	ST 3/91656 1/40840			✓	
M20	Rudgeway Farm			Richard Harvey	Gloucester	Phone switched off	SO 3/90363 2/30625			✓	
M21	Castle Farm			John Farrington	Somerset	Some time in March	ST 3/09606 1/28099				✓
M22	Simonsfield House			Richard Hartley	Oxfordshire	Left msg	SP 4/25937 2/17334				✓
M23	Roberts Berry Farm			Peter Cole	Wiltshire	In Switzerland - call back next week	ST 3/87562 1/80937	✓			
M24	The Sawmills			Tony Charlton, AJ	Somerset	Left msg	ST 3/72337 1/52016				✓
M25	Court Farm			Richard Curry	Bristol	Mike Cooper will arrange harvest	ST 3/54085 1/57191			✓	
M26	Manor Farm			Roger Duckett	Somerset	Left msg	ST 3/40825 1/50229				✓
M27	Pitching Piece Farm			Charlie White	Wiltshire	Probably not for at least a month	ST 3/83371 1/31849				✓
<i>Reserves</i>											
M28	Willey Estate, Broseley			Graham Cole	[Shropshire]						
M29	[Myddle]			J Mullock	[Shropshire]						
M30	[Claverley]			Richard Cotham	[Shropshire]						
M31	[Shareshill]			George Edwards	[Staffordshire]						
M32	[Alrewas]			Toby Williams	[Staffordshire]						
M33	[Drax]			Jim Beeden	North Yorkshire						

Appendix 5. Willow SRC sites showing climate of sampling sites by dot colour. Numbers 1-38 refer to unique site identifiers (see

sample spreadsheet below)



### SRC Willow Standing Crop Sample Sites (Latest)



- Src willow sites.shp
- S Warm-dry / Light
  - # Warm-dry / Light?
  - S Warm-dry / Medium
  - # Warm-dry / Medium?
  - S Warm-dry / Heavy
  - # Warm-dry / Heavy?
  - T Warm-moist / Light
  - \$ Warm-moist / Light?
  - T Warm-moist / Medium
  - \$ Warm-moist / Medium?
  - U Warm-wet / Medium
  - % Warm-wet / Medium?
  - T Warm-moist / Heavy
  - \$ Warm-moist / Heavy?
  - N Not short listed
  - U Stack

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Appendix 6. Sample spreadsheet of willow SRC sites as at 2/3/15; IFV represents the sites used to assess within-field variation

Climate	Soil	Willow SRC Site	Status	Action to confirm <input type="checkbox"/>	Sampling Phase	Local Contact
Warm dry	Heavy	14.1 South Mattersey	Preferred & IFV	Sample	Early & late	CRL Mark Paulson
Warm dry	Heavy	17. Renishaw Estate	Preferred & IFV	Sample	Early & late	Struan McDougall
Warm dry	Heavy	11. Wacton	Preferred & IFV	Sample	Early & late	William Easton
Warm dry	Heavy	22. Ryhurst Farm	Reserve	Confirm details	Unknown	Paul Proto
Warm dry	Heavy	23. South Carlton	Reserve	Confirm details	Unknown	via CRL Barbara Hilton
Warm dry	Heavy	10. Widmerpool	Reserve/drop	N/a	Unknown	Andrew Cunningham
Warm moist	Hvy-check	24. Molesden House	Preferred	Get site loc & details	Unknown	Simon Waugh
Warm moist	Hvy-check	25. Park Farm	Preferred	Confirm details	Unknown	Ronnie Wilkinson
Warm moist	Heavy	26. The Laythes	Preferred	Confirm details	Unknown	James Duff
Warm moist	Heavy		Reserve			
Warm moist	Heavy		Reserve			
Warm moist	Heavy		Reserve			
Warm dry	Medium	3.2 Towton [or 3.1 Towton Renshaw Wd]	Preferred	Sample	Early	Paul Saxon
Warm dry	Medium	12. Berkshire Coll.of Agric	Preferred	Sample	Early	Sam Armitage
Warm dry	Medium	1. Ratby	Preferred	N/a	Early & late	John Cawrey

Warm dry	Medium	36. Southburn	Preferred	Confirm details	Unknown	Philip Huxtable
Warm dry	Medium	30. Kings Marton College	Reserve	Confirm details		David Cotterell
Warm dry	Medium	39. Fenswood Farm	Reserve	Get site loc & details		Ian Shield
Warm moist	Medium	19. St Ninian's South	Reserve-sludge	Get site loc & details	Early & late	CRL Mark Paulson
Warm wet	Med-check	21. Rigghead (not OCCS)	Reserve	Get site loc & details	Early & late	CRL Mark Paulson
Warm moist	Medium		Preferred			
Warm moist	Med-check	32. Cotenook Farm	Reserve	Get site loc'n & details		Robin Twizell
Warm moist	Med-check	33. Iggesund	Reserve	Get site loc'n & details		Neil Watkins
Warm moist	Med-check	34. Newton Rigg College	Reserve	Get site loc'n & details		Owen Nevin
Warm dry	Light	14.1 South Mattersey Sand Pit	Preferred	Sample	Early & late	CRL Mark Paulson
Warm dry	Light		Preferred			
Warm dry	Light		Preferred			
Warm dry	Light		Reserve			
Warm dry	Light		Reserve			
Warm dry	Light		Reserve			
Warm moist	Lgt-check	7. [Hill of Banchory]	Preferred	Confirm with owner/agent	Early & late	Guy Milligan
Warm moist	Light	27. Ingerthorpe Hall	Preferred	Get site loc & details	Unknown	Murray Carter
Warm moist	Light		Preferred			
Warm moist	Light		Reserve			
Warm moist	Light		Reserve			
Warm moist	Light		Reserve			
□ NEED FIELD LOCATIONS TO CHECK SOILS □						

Warm dry	Unknown	35. East Midlands Airport	Reserve	Get site loc (check soil & CZ)	Paul Walker
Warm dry	Hvy-check	37. [Friar's Court] Clanfield	Reserve	Get site loc (check soil & CZ)	John Wilmer
Warm dry	Med-check	38. Haddenham	Reserve	Get site loc (check soil & CZ)	Thomas Bucknell
Warm moist	Unknown		Reserve		

**OTHERS - ADDITIONAL RESERVES**

Warm dry	Heavy	29. Dunstall Court	Reserve	N/a	Lionel Hill
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**OTHERS - HARVESTED?**

Warm dry	Hvy-check	28. Paddock House Farm		Confirm details	Gareth Gaunt
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IFV = In-field Variation

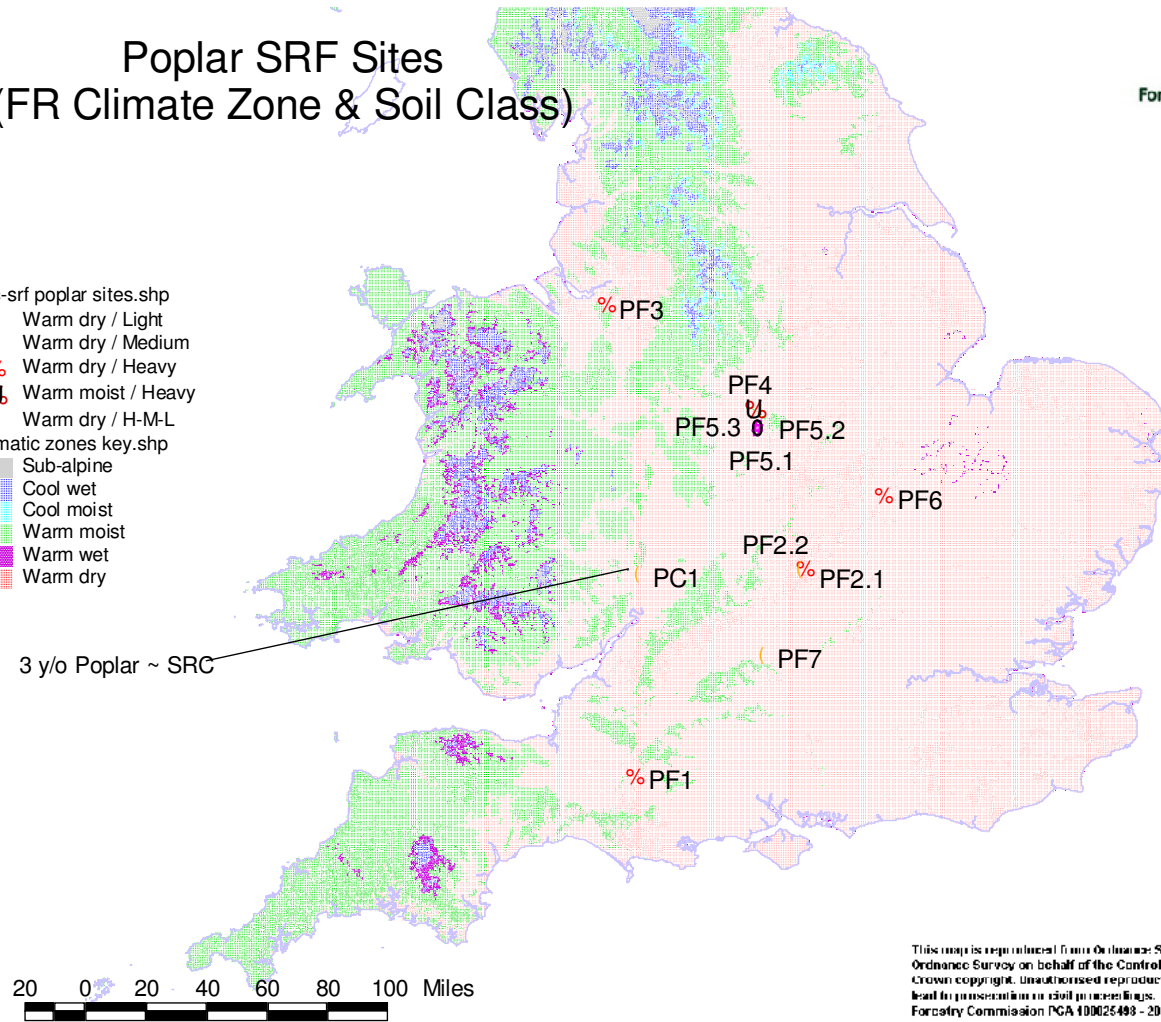
Appendix 7. Poplar SRF sites showing general distribution of climate zones (shading) and of sampling sites by dot colour. Codes M1-M33 refer to unique site identifiers

### Poplar SRF Sites (FR Climate Zone & Soil Class)



- Src-srf poplar sites.shp
- \$ Warm dry / Light
  - ( Warm dry / Medium
  - % Warm dry / Heavy
  - Ⓛ Warm moist / Heavy
  - Ⓛ Warm dry / H-M-L
- Climatic zones key.shp
- Sub-alpine
  - Cool wet
  - Cool moist
  - Warm moist
  - Warm wet
  - Warm dry

3 y/o Poplar ~ SRC

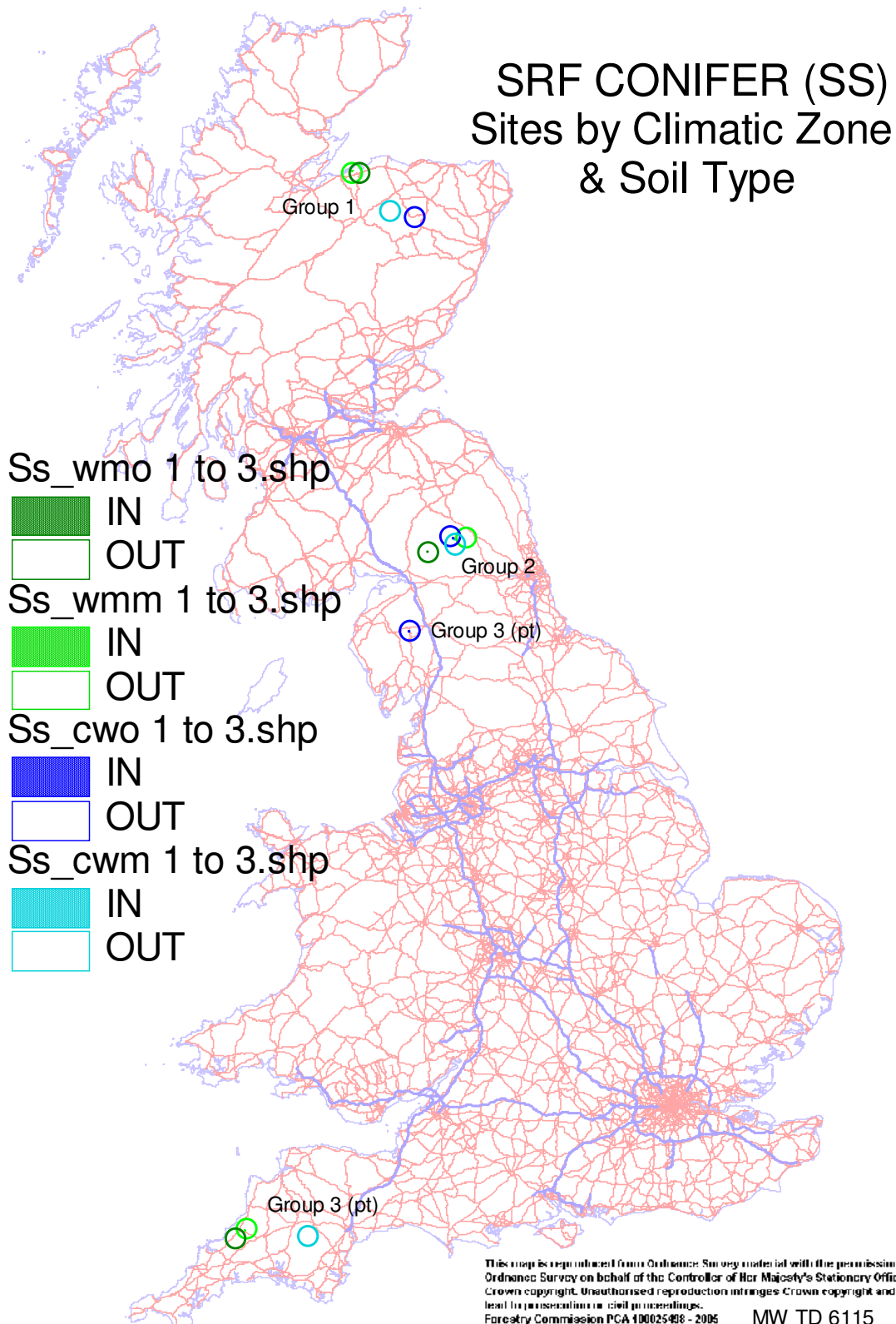


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**Appendix 8. Conifer SRF sites. Code follows the pattern: species\_temperature moisture soil where Ss =Sitka spruce; w=warm and c= cold; m=moist and w= wet; o=organic and**

m=mineral. IN means that the site has been selected for sampling



## Appendix 9. List of laboratory methods

Determination of the Inherent (Equilibrium) Moisture Content of Solid Fuel Samples	TOI_TSA_FT_001
Determination of Moisture Content of General Analysis Sample of Solid Fuel	TOI_TSA_FT_002
Determination of Ash Content of General Analysis Sample of Solid Fuel	TOI_TSA_FT_003
Determination of Volatile Matter Content of General Analysis Sample of Solid Fuel	TOI_TSA_FT_004
Determination of Calorific Value of Solid Fossil Fuels	TOI_TSA_FT_005
Determination of the Sulphur Content of Fuel Samples Using the LECO SC-432 High Temperature Analyser	TOI_TSA_FT_006
Determination of Chlorine in Solid Fuel using the SPECTRO TITAN Instrument	TOI_TSA_FT_007
Determination of Chlorine in Solid Fuel by Bomb Combustion and an Ion Specific Electrode	TOI_TSA_FT_008
Procedures for Operation of the Sample Preparation Centre	TOI_TSA_FT_009
Determination of Carbon, Hydrogen and Nitrogen in Biomass and Oil using the LECO CHN Instrument	TOI_TSA_FT_010
Determination of Ash composition SiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub> , Fe <sub>2</sub> O <sub>3</sub> , TiO <sub>2</sub> , CaO, MgO, NaO, K <sub>2</sub> O, Mn <sub>3</sub> O <sub>4</sub> , P <sub>2</sub> O <sub>5</sub> , BaO, SO <sub>3</sub>	TOI_TSA_AC_006* TOI_TSA_AC_062 TOI_TSA_AC_138*
Trace Elements Ba, Be, Cr, Co, Cu, Mo, Ni, V, Zn	TOI_TSA_AC_006 TOI_TSA_AC_062
Trace Elements As, Sb, Se	TOI_TSA_AC_106 TOI_TSA_AC_062
Trace Elements Cd, Pb	TOI_TSA_AC_012 TOI_TSA_AC_062
Trace Element Hg	TOI_TSA_AC_083 TOI_TSA_AC_034
Trace Element F	TOI_TSA_AC_014 TOI_TSA_AC_034
Trace Element Br	TOI_TSA_AC_013** TOI_TSA_AC_034

\* This analysis is not yet in UKAS scope, but currently in process of being signed off.

\*\* This analysis (bromine analysis by ion chromatography) is not in ETG UKAS scope

## Appendix 10. *Miscanthus* sampling protocols (working)

### **Miscanthus protocol to assess overall field condition**

#### **Site criteria:**

- Species – *Miscanthus*
- Age 1 year
- Site area – >1 ha with a minimum width of 25 m

#### **Office work:**

- Select 36 sites –
  - 6 warm, moist / light
  - 6 warm, moist / medium
  - 6 warm, moist / heavy
  - 6 warm, dry / light
  - 6 warm, dry / medium
  - 6 warm, dry / heavy

3 of the above sites will need to be identified for the additional in field variation sampling.

Produce 36 polygon maps with grids.

$$\text{Grid distance} = \frac{\sqrt{A} \times 100}{10}$$

Produce 3 in field variation polygon maps with grids.

$$\text{Grid distance} = \frac{\sqrt{A} \times 100}{20}$$

The 3 in field variation maps will have separate sampling grids that do not pick up the original 10 sample points.

Produce waypoint shape file to download to GPS.

#### **Phasing:**

- Phase 1, sampled within 24 hours after harvest (this includes the in-field variation sampling)
- Phase 2, sampled 3 weeks in field after harvest
- Phase 3, sampled 1 month after baling

Once notification of the harvest date is received from Terravesta, the site will be scheduled for sampling the day after harvest with liaison.

#### **Field work: sites 049 – 084, Phase 1**

Ensure there are sufficient robust sample bags for each site.

The sample bags should be labelled with the site number from the map issued, MISC and the phase

i.e. site 049 will have a bag marked as 049/Misc/1

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

A rain gauge made from a flat bottomed, straight sided water bottle with the top cut off, inverted and secured is to be dug into a place at each site on the phase 1 visit. It should be in or close to the sample field in the open, not overhung by trees and not to interfere with farm operations.

Locate waypoint position; there will be 10 per site.

Take a photo of the crop and a photo of the ground at each waypoint, the photos will be labelled site number/waypoint/C for crop or G for ground and sent to Field Station Manager, Fineshade when site is complete.

Visually assess if the site should be classed as stony or not and record on the site field form.

Collect 300 g of harvested material at each location point; this is likely to be in lengths. Ensure no material has been in contact with the ground and is not contaminated with soil. Cut each length up to fit into the sample bags, all material from each length will be included.

Take air temperature at 1.5 m height with a vertex at each waypoint and record on site field form.

Complete soil sample:

50 g of soil excluding any stones and plant material will be collected at each way point:

Scrape off the top humus / litter layer, if any.

Dig a spade width hole to 30 cm from the adjacent ground level.

Collect 25 g of soil from 5 – 15 cm and 15 – 30 cm layers and bag together.

Push soil temperature probe into ground horizontally at 10 cm depth. When display has settled and no longer changes, record temperature on site field form.

Do not fill in soil pit at this stage.

On a clean tarpaulin or in a clean bucket mix all 10 samples thoroughly and bulk a representative sample of 300 g in to a sample bag (double bag if necessary).

Label bag as follow: Site No i.e. 049/Soil

Soil samples should be sealed and stored in a cool dry and dark place until all team site samples are collected.

Proceed to next waypoint and repeat.

All Miscanthus samples from the same site can go in the same bag.

Visually assess and record recent weather conditions i.e. snow or frost present, recent heavy rain etc.

Record the site aspect on the site field form

Record the % slope for the site on the site record form

Miscanthus samples should be sealed when site is complete and dispatched to TSU, Thetford for next day delivery. Field Station Manager, Fineshade should be informed of dispatch

Soil samples should be sent when all team sites are complete to arrive before 12 noon of the following day to: Sample Reception (Stewart Bradley), E.ON Technologies (Ratcliffe) Ltd,

Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

### **48 hours before baling: Phase 2**

Regular contact with the land owner is required to ensure sampling happens as close to baling as possible.

Ensure there are sufficient robust sample bags for each site.

The sample bags should be labelled with the site number from the map issued, MISC and the phase

i.e. site 049 will have a bag marked as 049/MISC/2

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

Locate waypoint position; there will be 10 per site.

Collect 300 g of harvested material at each location point; this is likely to be in lengths.

Ensure no material has been in contact with the ground and is not contaminated with soil. Cut each length up to fit into the sample bags, all material from each length will be included.

Take air temperature at 1.5 m height with a vertex at each waypoint and record on site field form.

Locate soil pit.

Push soil temperature probe into ground horizontally at 10 cm depth. When display has settled and no longer changes, record temperature on site field form.

Fill in soil pit.

Proceed to next waypoint and repeat.

All Miscanthus samples from the same site can go in the same bag.

Visually assess and record recent weather conditions i.e. snow or frost present, recent heavy rain etc.

Locate rain gauge, remove and using a ruler measure in cm rainfall, record on the site field form.

Miscanthus samples should be sealed when site is complete and dispatched to TSU, Thetford for next day delivery. Field Station Manager, Fineshade should be informed of dispatch.

Once notification of the baling date is received from Terravesta, the confirmed date will be recorded on the site field form and the site will be scheduled for sampling 1 month later.

### **1 month after baling: Phase 3**

Ensure there are sufficient robust sample bags for each site.

The sample bags should be labelled with the site number from the map issued, MISC and the phase

i.e. site 049 will have a bag marked as 049/MISC/3

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

The landowner will need to make a telehandler available: The bales will be Heston bales.

Record on the site field form if the bales are stored in a barn or outside, if necessary take a photo and label: Site No/Misc/3

3 outer bales will be selected and 500 g of material will be picked from the outer edge of each bale, without breaking any strings. Ensure no material has been in contact with the ground and is not contaminated with soil.

An outer bale will be moved by telehandler giving access to 3 inner bales.

500 g of material will be picked from each of the 3 inner bales, if possible from areas that have not been exposed previously, without breaking any strings. Ensure no material has been in contact with the ground and is not contaminated with soil.

All Miscanthus samples from the same site can go in the same bag.

Miscanthus samples should be sealed when site is complete and dispatched to TSU, Thetford for next day delivery. Field Station Manager, Fineshade should be informed of dispatch.

The bale samples will not be able to be attributed to a specific field which would have been the original sample site.

**Field work: sites 082 - 084, in field variation sites. Phase 1**

These 3 sites will have an additional 20 sample point.

At all 20 points another sample will be done as follows

Ensure there are sufficient robust sample bags for each site. At least 20 will be required  
The sample bags should be labelled with the site number from the map issued, MISC, the waypoint number and IF

i.e. site 082 will have a bag marked as 082/MISC/ 1 to 20/IF

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

Locate waypoint position; there will be 20 per site.

Collect 3 kg of harvested material at each location point; this is likely to be in lengths. Ensure no material has been in contact with the ground and is not contaminated with soil. Cut each length up to fit into the sample bags, all material from each length will be included.

Each waypoint is to be sampled independently so 1 bag per waypoint, the bag should be sealed when a waypoint is complete and dispatched to TSU, Thetford for next day delivery. Field Station Manager, Fineshade should be informed of dispatch.



## **Processing protocol: TSU Thetford - week 0 and 3 and 1 month after baling**

A Qualcast SDS2810, 2800 W quiet garden shredder will be used for this process.

TSU Thetford will receive:

1 x 3 kg sample bag from 36 sites, week 0, sites 049 - 084

20 x 3 kg sample bags from 3 sites, week 0, sites 082 - 084

1 x 3 kg sample bag from 36 sites, week 3, sites 049 - 084

1 x 3 kg sample bag from 36 sites, 1 month post baling, sites 049 – 084

The bale samples will not be able to be attributed to a specific field which would have been the original sample site.

Each bag will be shredded separately:

The 3 kg week 0 bags, labelled Site No/MISC/1 from each site will be shredded into 1" (2.5 cm) pieces.

The shredded material will be bulked into a suitable container and mixed thoroughly.

A 2 kg or full bucket sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type and phase written on them i.e. 049/Misc/1. If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2...etc. for however many are used on the label.

The 20 x 3 kg week 0 bags, labelled Site No/MISC/Waypoint No/IF from each waypoint of each site will be shredded into 1" (2.5 cm) pieces.

The shredded material will be bulked into a suitable container and mixed thoroughly.

A 2 kg or full bucket sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type, waypoint number and IF written on them i.e. 084/MISC/1/IF. If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2...etc. for however many are used on the label.

The 3 kg week 3 bags, labelled Site No/MISC/2 from each site will be shredded into 1" (2.5 cm) pieces.

The shredded material will be bulked into a suitable container and mixed thoroughly.

A 2 kg or full bucket sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type and phase written on them i.e. 049/Misc/2. If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2...etc. for however many are used on the label.

The 3 kg 1 month after baling bags, labelled Site No/MISC/3 from each site will be shredded into 1" (2.5 cm) pieces.

The shredded material will be bulked into a suitable container and mixed thoroughly.

A 2 kg or full bucket sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type and phase written on

them i.e. 049/Misc/3. If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2...etc. for however many are used on the label.

Between different samples and different sites the shredder will be cleaned so no cross contamination occurs.

Samples will be dispatched for next day, before noon, delivery on the day of chipping to: Sample Reception (Stewart Bradley), E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

### **Miscanthus protocol to assess within field variation**

#### **Site criteria:**

Species – Miscanthus

Age 1 year

Site area – >1ha with a minimum width of 25 m

#### **Office work:**

Select 3 sites – 3 warm, dry / light

Produce 3 in field variation polygon maps with grids.

Grid distance =  $\sqrt{\frac{A}{20}} \times 100$

The 3 in field variation maps will have separate sampling grids that do not pick up the original 10 sample points.

#### **Field work: sites 082 - 084, in field variation sites. Phase 1**

These 3 sites will have an additional 20 sample point.

At all 20 points another sample will be done as follows

Ensure there are sufficient robust sample bags for each site. At least 20 will be required

The sample bags should be labelled with the site number from the map issued, MISC, the waypoint number and IF

i.e. site 082 will have a bag marked as 082/MISC/ 1 to 20/IF

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

Locate waypoint position; there will be 20 per site.

Collect 3 kg of harvested material at each location point; this is likely to be in lengths. Ensure no material has been in contact with the ground and is not contaminated with soil. Cut each length up to fit into the sample bags, all material from each length will be included.

Each waypoint is to be sampled independently so 1 bag per waypoint, the bag should be sealed when a waypoint is complete and dispatched to TSU, Thetford for next day delivery. Field Station Manager, Fineshade should be informed of dispatch.

### **Processing protocol: TSU Thetford - week 0 and 3 and 1 month after baling**

A Qualcast SDS2810, 2800 W quiet garden shredder will be used for this process.

TSU Thetford will receive:

20 x 3 kg sample bags from 3 sites, week 0, sites 082 - 084

Each bag will be shredded separately:

The 20 x 3 kg week 0 bags, labelled Site No/MISC/Waypoint No/IF from each waypoint of each site will be shredded into 1" (2.5 cm) pieces.

The shredded material will be bulked into a suitable container and mixed thoroughly.

A 2 kg or full bucket sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type, waypoint number and IF written on them i.e. 084/MISC/1/IF. If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2...etc. for however many are used on the label.

Between different samples and different sites the shredder will be cleaned so no cross contamination occurs.

Samples will be dispatched for next day, before noon, delivery on the day of chipping to: Sample Reception (Stewart Bradley), E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

## Appendix 11. Willow SRC sampling protocol (working)

### **SRC willow sampling of fresh chip stack to assess overall field condition**

#### **Site Criteria**

Species - willow or poplar

Harvesting method - chip or billet

Timing - within 24 hours of harvest

Stack size - minimum of c. 60 fresh tonnes (i.e. c 130 - 200 m<sup>3</sup>).<sup>1</sup>

#### **Office work**

Select 36 sites:

- 6 warm, moist / light
- 6 warm, moist / medium
- 6 warm, moist / heavy
- 6 warm, dry / light
- 6 warm, dry / medium
- 6 warm, dry / heavy.

*NB: Owing to a shortage of sites, some classes may have fewer than 6 sites*

#### **Field work**

For chip harvested sites take one Eon 10 litre bucket with lid to each site. Take two buckets for billet harvested sites. If buckets are not available, then take sufficient tough polythene bags.

A tough plastic sheet (minimum size 2 m \* 2 m), a large plastic bucket, a clean shovel, labels and a camera will also be required.

Use the same sampling procedure for chip stacks and billet stacks:

For sites harvested on two or more days, identify the stack (or part of any stack) which was harvested within one day i.e. harvested on the day of arrival or on the previous day. In the absence of local knowledge do this by eye.

Measure<sup>2</sup> the accessible circumference of the stack at c 1 m height. Divide the circumference figure by 40 to give the spacing between samples to be taken.

If there is more than one fresh stack (or part of a stack) at the site, then divide the sum of the circumferences by 40 to give the spacing between samples to be taken. NB: omit any stack if there is any doubt that it is newly harvested.

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<sup>1</sup> i.e. minimum of 1 ha of 20m<sup>3</sup> fresh / ha growth p.a. \* 3 yrs

<sup>2</sup> Pacing will be sufficient

Using a clean shovel, take 40 of c 1 litre samples, evenly spaced around the accessible perimeter of the fresh stack/s. For fresh chip, harvested within the period of a day, this will be all way round the stack/s. Take the samples from c 1 m above ground level, after first moving aside the outer 2" of surface chip at the sample point (which may have dried slightly)

Spread the large plastic sheet on firm level ground. Moving around the stack/s as sampling progresses, place each shovel-sample within the large plastic bucket, tipping it out when necessary into a conical pile at the centre of the plastic sheet.

When the 40 samples have been taken, mix the conical pile of chips thoroughly, and spread it out over the sheet. Do not spread within 6" of the edge of the sheet (to avoid possibility of ground contamination of chips at the edge of the sheet).

For chips, fill one Eon 10 litre bucket with c 20 of c 0.5 litre scoops distributed evenly from the surface of the mixed chips on the plastic sheet.

For chips, the bucket should be labelled on the lid and the side of the bucket with the date and site number from the map issued and SRC-W i.e. site 013 will be labelled as 013/SRC. A similar label will be placed in a sealed clear plastic bag on top of the chips inside each bucket and the bucket lid replaced and sealed securely.

For billets, fill two Eon 10 litre buckets with c 10 of c 1 litre scoops each, distributed evenly from the surface of the mixed chips on the plastic sheet.

For billets, the two buckets should be labelled on the lids and the sides of the buckets with the date and site number from the map issued and SRC-W i.e. site 013 will be labelled as -013/SRC.W, 1 of 2 and 013/SRC-W, 2 of 2. A similar label will be placed in a sealed clear plastic bag on top of the billets inside each bucket and the bucket lids replaced and sealed securely.

### **Despatch**

Chips: The 1 bucket from each site will be despatched for next day, before noon, delivery on the day of chipping to: E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

Billets: The 2 buckets from each site will be despatched for next day delivery to Colin Gordon at NRS. Colin, Alistair and Field Station Manager, Fineshade should be informed of dispatch.

### **Billet Processing protocol: Colin Gordon at NRS**

A suitable chipper or shredder will need to be hired for a short period if all sites can be done in the same week or fortnight.

Colin will receive:

2 x 10 litre buckets of billets from each billet harvested site (each bucket at least 2.5 kg).

The number of sites will depend on the number of sites harvested as billets.

Each site (of 2 buckets of billets) will be chipped separately to 1" chips. After chipping, the chips will be bulked into a suitable container and mixed thoroughly. A minimum of 3 Kg sample will be sealed in one of the buckets (already labelled) in which the sample was received. One of the within-bucket labels, in its sealed clear plastic bag, will be replaced on top of the chipped billets inside the bucket. The labels will have the site number and the sample type written on them i.e. 013/SRC – W.

The chipper will be cleaned between different samples so that no cross contamination occurs.

Samples will be dispatched for next day, before noon, delivery on the day of chipping to: E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

MW 16/2/15v18215

## Appendix 12. SRF sampling protocols (working)

### Conifer SRF protocol to assess overall field condition

#### Site criteria:

- Species – SS
- Age 12 - 16 years
- Site area - >1ha with a minimum width of 25 m

#### Office work:

- Select 12 sites –
  - 3 cold, wet / mineral
  - 3 cold, wet / organic
  - 3 warm, moist / mineral
  - 3 warm, moist / organic

Produce polygon map with grids.

$$\text{Grid distance} = \sqrt{\frac{A}{10} \times 100}$$

Produce waypoint shape file to download to GPS.

#### Phasing for each site:

10 fixed sample points;

Phase 1, trees 1 – 10, felled and sampled straight away

Phase 2, trees 1 - 10, Phase 1 tree sampled 3 months later (No bark)

Phase 3, trees 11 – 20, felled when phase 2 sampled and sampled straight away

Phase 4, trees 11 – 20, Phase 3 tree sampled 3 months later (No bark)

Plot 1 will contain trees 1 and 11

Plot 2 will contain trees 2 and 12

And so on.

#### Field work:

Ensure there are sufficient robust sample bags for each site a minimum of 3 will be required but more may be needed per site.

The sample bags should be labelled with the site number from the map issued, the material it will contain (Bark for phases 1 and 3 only, Stem or Top for all phases) and the sample phase 1.

i.e. site 001 will have 3 bags at phase 1, 001/Bark/1, 001/Stem/1, 001/Top/1

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

For phase 1:

Locate waypoint position; there will be 10 per site.

Take a photo of the crop and a photo of the ground at each waypoint, the photos will be labelled site number/waypoint/C for crop or G for ground and sent to Field Station Manager, Fineshade when site is complete.

Visually assess if the waypoint area should be classed as stony or not and record on the site field form.

Select the closest single stemmed SS tree to waypoint with a diameter at breast height (1.3 m) (dbh)  $>$  or  $=$  7 cm.

Measure and record dbh on the site assessment sheet.

At each waypoint fell one tree (i.e. tree numbers 1 – 10), measure tree length to tip and record on the site assessment sheet.

Cut top off at 7cm top diameter, measure stem length from butt to 7 cm top diameter and record on the site assessment sheet.

Cut the stem into 3 billets of equal length.

3 types of samples will be taken from this tree as follows:

- i. The top end of the bottom billet and the bottom end of the top billet will be peeled and 150 g of bark from each will be bagged in the site sample bag for bark only.
- ii. A disc of 500 g will be cut with a bow saw from the top end of the bottom billet and the bottom end of the top billet and will be bark free; these will be bagged in the site sample bag for stem only.
- iii. The top of the tree will be sampled; for every odd numbered tree, sampling will start from the 7 cm cut off point and for every even numbered tree, sampling will start from the top of the tree including the leader. Each whorl will be removed in turn, to no more than half the length of the top, 500 g of material is the aim of the collection, this can be cut up with secateurs or bill hook and will be bagged in the site sample bag for top only. If 500 g is not achieved stop at the half way point of the length of the top and collect no more at the way point.

Take air temperature at 1.5 m height with a vertex at each way point and record on site field form.

Visually assess and record recent weather conditions i.e. snow or frost present, recent heavy rain etc.

For phase 2:

The middle billet from phase 1 will have biodegradable tape tied round it to identify it in 3 months' time.

The 3 billets from phase 1 will be left in situ for 3 months, stacked with the 2 end billets side by side length ways on the floor and the middle billet lain on top of them.

The remaining top of the tree from phase 1 will be placed over the stack.

Complete soil sample:

50 g of soil excluding any stones and plant material will be collected at each way point:

Scrape off the top humus / litter layer, if any.

Dig a spade width hole to 30 cm from the adjacent ground level.

Collect 25 g of soil from 5 – 15 cm and 15 – 30 cm layers and bag together.

Push soil temperature probe into ground horizontally at 10 cm depth. When the display has settled and no longer changes, record temperature on site field form.

Do not fill in soil pit at this stage.

On a clean tarpaulin or in a clean bucket mix all 10 samples thoroughly and bulk a representative sample of 300 g in to a sample bag (double bag if necessary).



Label bag as follow: Site No i.e. 001/Soil

Soil samples should be sealed and stored in a cool dry and dark place until all team site samples are collected.

Proceed to next waypoint and repeat.

Record both aspect and % slope for the whole site on the site field form.

All bark samples from phase 1 of the same site can go in the same bag.

All stem samples from phase 1 of the same site can go in the same bag.

All top samples from phase 1 of the same site can go in the same bag.

Tree samples should be sealed when site is complete and dispatched to Colin Gordon at NRS for next day delivery. Colin, Alistair and Field Station Manager, Fineshade should be informed of dispatch

Soil samples should be sent when all team sites are complete to arrive before 12 noon of the following day to: Sample Reception (Stewart Bradley), E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.

**3 months after phase 1 sampling:** (Phase 2, 3 and 4)

Ensure there are sufficient robust sample bags for each site a minimum of 5 will be required but more may be needed per site.

The sample bags should be labelled with the site number from the map issued, the material it will contain (Bark for phase 3 only, Stem or Top for phases 1, 3 and 4) and the sample phase 2 or 3.

i.e. site 001 will have 5 bags, 001/Stem/2, 001/Top/2, 001/Bark/3,001/Stem/3, 001/Top/3

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

Locate waypoint position:

For phase 2:

Locate waypoint position

Locate the previously felled and stacked tree numbers 1 - 10: 2 types of samples will be taken from these trees as follows:

- i. A disc of 500 g will be cut with a bow saw from each end of the middle billet and will be bark free; these will be bagged in a sample bag for stem only.
- ii. The top of the tree will be sampled; for every even numbered tree, sampling will start from the cut off point and for every odd numbered tree, sampling will start from the top of the tree including the leader. Each whorl will be removed in turn until 500 g of material is collected, this can be cut up with secateurs or bill hook and will be bagged in a sample bag for top only. If 500 g is not achieved stop and collect no more at the way point.

Take air temperature at 1.5 m height with a vertex at each waypoint and record on site field form.

Locate soil pit.

Push soil temperature probe into ground horizontally at 10 cm depth. When display has settled and no longer changes, record temperature on site field form.  
Do not fill in soil pit at this stage.

Visually assess and record recent weather conditions i.e. snow or frost present, recent heavy rain etc.

For phase 3:

Select the next closest single stemmed SS tree to waypoint with a dbh  $>$  or  $=$  7 cm.

Measure and record dbh on the site assessment sheet.

At each waypoint fell one tree (i.e. tree numbers 11 – 20), measure tree length to tip and record on the site assessment sheet.

Cut top off at 7 cm top diameter, measure stem length from butt to 7cm top diameter and record on the site assessment sheet.

Cut the stem into 3 billets of equal length.

3 types of samples will be taken from this tree as follows:

- i. The top end of the bottom billet and the bottom end of the top billet will be peeled and 150 g of bark from each will be bagged in the site sample bag for bark only.
- ii. A disc of 500 g will be cut with a bow saw from the top end of the bottom billet and the bottom end of the top billet and will be bark free; these will be bagged in the site sample bag for stem only.
- iii. The top of the tree will be sampled; for every odd numbered tree, sampling will start from the 7 cm cut off point and for every even numbered tree, sampling will start from the top of the tree including the leader. Each whorl will be removed in turn, to no more than half the length of the top, 500 g of material is the aim of the collection, this can be cut up with secateurs or bill hook and will be bagged in the site sample bag for top only. If 500 g is not achieved stop at the half way point of the length of the top and collect no more at the way point.

For phase 4:

The middle billet from phase 3 will have biodegradable tape tied round it to identify it in 3 months' time.

The 3 billets from phase 3 will be left in situ for 3 months, stacked with the 2 end billets side by side length ways on the floor and the middle billet lain on top of them.

The remaining top of the tree from phase 3 will be placed over the stack.

Proceed to next waypoint and repeat.

All bark samples from phase 3 of the same site can go in the same bag

All stem samples from phase 2 of the same site can go in the same bag

All stem samples from phase 3 of the same site can go in the same bag

All top samples from phase 2 of the same site can go in the same bag

All top samples from phase 3 of the same site can go in the same bag

Tree samples should be sealed when site is complete and dispatched to Colin Gordon at NRS for next day delivery. Colin, Alistair and Field Station Manager, Fineshade should be informed of dispatch.

**6 months after phase 1 sampling:** (Phase 4)

Ensure there are sufficient robust sample bags for each site a minimum of 2 will be required but more may be needed per site.

The sample bags should be labelled with the site number from the map issued, the material it will contain (Stem or Top) and the sample phase 4.

i.e. site 001 will have 2 bags, 001/Stem/4, 001/Top/4

If more than 1 bag is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used.

Locate waypoint position:

For phase 4:

Locate the previously felled and stacked tree numbers 11 - 20: 2 types of samples will be taken from these trees as follows:

- i. A disc of 500 g will be cut with a bow saw from each end of the middle billet and will be bark free; these will be bagged in a sample bag for stem only.
- ii. The top of the tree will be sampled; for every even numbered tree, sampling will start from the cut-off point and for every odd numbered tree, sampling will start from the top of the tree including the leader. Each whorl will be removed in turn until 500 g of material is collected, this can be cut up with secateurs or bill hook and will be bagged in a sample bag for top only. If 500 g is not achieved collect no more at the way point.

Take air temperature at 1.5 m height with a vertex at each waypoint and record on site field form.

Locate soil pit.

Push soil temperature probe into ground horizontally at 10 cm depth. When display has settled and no longer changes, record temperature on site field form.

Fill in soil pit.

Visually assess and record recent weather conditions i.e. snow or frost present, recent heavy rain etc.

All stem samples from phase 4 of the same site can go in the same bag

All top samples from phase 4 of the same site can go in the same bag

Tree samples should be sealed when site is complete and dispatched to Colin Gordon at NRS for next day delivery. Colin, Alistair and Field Station Manager, Fineshade should be informed of dispatch.

## Processing protocol: Colin Gordon - months 0, 3 and 6

A suitable chipper will need to be hired for a short period if all sites can be done in the same week or fortnight.

Colin will receive

For phase 1, 1 sample each of stem, top and bark from 12 sites, month 0.

For phase 2, 1 sample each of stem and top from 12 sites, month 3

For phase 3, 1 sample each of stem, top and bark from 12 sites, month 3.

For phase 4, 1 sample each of stem and top from 12 sites, month 6.

Each phase, site and sample type will be dealt with individually.

The 20 x 500 g stem samples labelled Site No/Stem/(*Phase*) from each site will be chipped into 1" (2.5 cm) chip size.

The chips will be bulked into a suitable container and mixed thoroughly.

A 5 kg or 2 full bucket samples will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number and the sample type and phase clearly written on them i.e. 001/Stem/(*Phase*). If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used on the label.

The 5kg top samples labelled Site No/Top/(*Phase*) from each site will be chipped into 1" (2.5 cm) chip size.

The chips will be bulked into a suitable container and mixed thoroughly.

A 3 kg sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type and phase clearly written on them i.e. 001/Top/(*Phase*). If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used on the label.

The 3 kg bark samples labelled Site No/Bark/(*Phase*) from each site will be chipped into 1" (2.5 cm) chip size.

The chips will be bulked into a suitable container and mixed thoroughly.

A 2 kg sample will be sealed in buckets supplied by E.ON, a label will be placed in a sealed clear plastic bag on top of the chips inside the bucket and a label will be put on the lid and the side of the bucket. The labels will have the site number, the sample type and phase clearly written on them i.e. 001/Bark/(*Phase*). If more than 1 bucket is used for a sample type, write 1 of X, 1 of 2.... etc for however many are used on the label.

Between different samples and different sites the chipper will be cleaned so no cross contamination occurs.

Samples will be dispatched for next day, before noon, delivery on the day of chipping to: Sample Reception (Stewart Bradley), E.ON Technologies (Ratcliffe) Ltd, Technology Centre, Ratcliffe-on-Soar, Nottingham, NG11 0EE. Field Station Manager, Fineshade should be informed of dispatch.