final report

Project code: B.CCH.1037

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Date published: April 2012

PUBLISHED BY
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NORTH SYDNEY NSW 2059

Managing carbon in livestock systems: modelling options for net carbon balance (CSIRO)

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

A model was developed for estimating methane emissions in northern Australia. Modelling work conducted in this project build on existing modelling the research group had been associated with as part of the National Carbon Accounting Toolkit. Funding for this program was terminated before the work was completed. The current project developed a standalone animal model that predicted herd methane emissions based on the characteristics of the animal and the pasture. The model was run using data from the Lansdown Research Station. These data included herd and pasture characteristics including a comprehensive dataset of pasture quality over the season. Results demonstrated that methane values were within the expected range and that daily emissions were insensitive to changes in management but emissions intensity was highly sensitive to changes in management. In addition the same data was forwarded to Hutton Oddy for inclusion in a data fusion exercise involving a number of demonstration sites across Australia.

Executive Summary

The Lansdown Research Station is the only demonstration site in the rangelands of northern Australia. The site is 638 ha of native and improved pastures. Average annual rainfall (1975-2008) is 809 mm. Soils are predominantly alluvial over grey clays. The property is the site for intensive and pasture-based methane mitigation research. As a demonstration site it has hosted a field day as well as numerous visitors and interest groups.

Within the context of this project, we used datasets generated on the property to populate a mechanistic exel-based model. This model was brought into the project partially completed and the first part of the project was to complete the model development. Once completed the model was tested on a database of pasture and animal performance characteristics generated at Lansdown using field data. These data comprised of repeated measures of animal LW and estimates of diet quality, intake and proportion of non-grass in the diet, based on faecal NIRS measurements taken over an entire grazing season. The model is designed to run of readily available datasets anf for the purposes of this study we use initial LW, and F.NIRS estimates of DM digestibility. The model showed that base line results for methane emissions were lower than those obtained using open path laser at Lansdown from similar animals and pastures (127 versus 226 g methane/d). The reasons for this difference are not well understood, but the model data is more in line with results obtained using methane chambers (40 to 160 g/d; Kennedy and Charmley, 2012) and previous modelling exercises (Charmley et al 2008).

To test the sensitivity of the model to changes in input parameters, diet quality was arbitrarily increased (as could be achieved by the inclusion of a legume into the diet). The results are interesting in that daily methane output was hardly affected but since animal growth performance was increased, emissions intensity (emissions per kg LW gain) was more than halved.

The data used in the Lansdown modelling exercise has been forwarded to Hutton Oddy for a meta-analysis of data from all demonstration sites.

Contents

1. Background

The rangelands of northern Australia encompass vast and diverse grazing environments. No single property can encompass the variability in land type, seasonality and production system. Lansdown Research Station is located approximately 45 km south of Townsville in the Burdekin Catchment. The site is 638 ha of native and improved pastures (Figure 1). Average annual rainfall (1975-2008) is 809 mm. Soils are predominantly alluvial over grey clays. The property has principally been used to conduct conventional animal production/tropical pastures research and has been chosen because of its proximity to a large number of Queensland commercial cattle producers and road and air links. Because of its modest size it is well suited to demonstration of measurable impacts of various mitigation strategies. The site is the base for a range of ruminant methane research including measurement techniques, mitigation strategies, and state of the art monitoring systems.

Figure 1. Arial view of Lansdown research Station

In 2009/10, four national demonstration sites were commissioned by RELRP. The main aims of these sites were to demonstrate and communicate new research on options to mitigate methane emissions from ruminant livestock. This is a critical activity of the Program as it integrates individual projects, industry groups, state DPIs, local farmer and/or regional groups with the RELRP project consortium to ensure that there is a pathway from research outcomes and technology development towards commercial applications. This activity promotes a consistent message on methane mitigation and evaluation for adoption by producers. Furthermore, the demonstration sites, where appropriate, combine with demonstration for the livestock adaptation programs under Australia's Farming Future Climate Change Research Program and with information from the nitrous oxide program (e.g. in mixed livestock and grain enterprises) and soil carbon programs. The second objective of the site network was to establish limited baseline data to help demonstrate impacts of abatement measures. These measurements provide an opportunity to engage with producers already associated with these sites in extension activities related to methane abatement strategies. The aim will be to both complement and enhance the impact of the trials established for their own particular purpose with considerations, awareness and information delivery related to emissions abatement outputs from the RELRP.

One strategy to achieve this is to demonstrate a number of mitigation or abatement options using modelling protocols that have taken their biophysical and economic inputs from actual farm sites. In all cases, the existing demonstration sites at CSIRO Lansdown (Townsville), UNE Trevenna (Armidale), VDPI-DemoDAIRY (Terang) and UWA Future Farm (Pingelly) can provide the biophysical and economic inputs required to successfully model net carbon balance. Further, each of these sites may have the opportunity to develop scenario to consider climate variability and abatement strategies. Lansdown is the only site in the tropical rangelands.

2. Project Objectives

This work was conducted at CSIRO Lansdown demonstration site (BCCH 1032) and focussed on northern extensive beef production systems. The aim is to discriminate the reasons why differences may result in yield and composition of emissions, and emissions intensities from enterprises. It is acknowledged that each stakeholder involved in, or affected by, the development of the CFI will have different information needs. There is however a need for work to be undertaken to determine applicability of analysis, the key points for discrimination between models, and the use of the modelling approach in the development of CFI methodologies. These outcomes are important to reduce the risk of 'conflict' during CFI method development where a range of model approaches may be taken to determine the impact of mitigation strategies. By using the RELRP demonstration sites as the benchmark farming systems (or components of farming systems) for the modelling exercise, a range of models can be examined under conditions where real-time measurements of methane emissions from livestock were undertaken. This approach provides a degree of realism to the evaluation processes. The report to the Commonwealth will focus analysis and synthesis of modelling used over a range of livestock production systems in different environments. It will aim to provide confidence in the ability of a range of different approaches to identify the likely magnitude of CO2e abatement from various potential CFI methodologies.

The objective of this work was to develop a tropical livestock methane model and test it on data generated at the Lansdown research Station to (a) identify current methane emissions and (b) to demonstrate a range of abatement options to reduce methane emissions.

3. Development of a livestock methane model

There are currently few models specifically developed with northern beef production systems in mind for estimating methane emissions from extensively grazed livestock in these systems. Charmley *et al.* (2008) describe the use of a property level model developed specifically for the north and uses it to evaluate animal and property herd methane emissions for several northern Australia bioregions. This model is based on ARC (1980) and SCA (1990). This modelling approach was significantly extended with funding from DCCEE as part of their national carbon Accounting Toolbox (NCAT) FullCAM modelling framework. Unfortunately funding for this project was pulled before the modelling exercise was completed. Following discussions with the project leader, Jeff Baldock, it was agreed that this modelling basis could be further developed and used in the context of modelling methane emissions for Lansdown Research Station.

For the purposes of context, a brief overview of the modelling progress previous to this project is given. The objective for this module of the model was to develop a model that accurately estimate the methane (CH_4) production of beef cattle in northern Australia for accounting purposes. With this in mind, the following assumptions were made:

- methane production at the SLA by land type scale
- The model runs on a daily time step
- Model data requirements are minimal and any data required readily available

The approach being used was complex, but it was felt that this level of detail was required to meet the brief. The animal methane module was driven by a pasture module which was built as part of the NCAT. In B.CCH.1037, the livestock model was adapted to run as a standalone using inputs specific to a particular paddock, property or region.

A spreadsheet (Microsoft Excel) based model predicts methane emissions for grazing cattle from a range of inputs:

Animal breed, class, weight and physiological condition

Pasture yield and quality

Stocking density / utilization rate.

The model is based on the metabolisable energy (ME) system as described in Nutrient Requirements of Domesticated Ruminants (SCA, 2007). The model iterates on a daily time step. Dry matter intake is driven by live weight (LW) and LW gain, diet quality and availability and grazing pressure and consumed energy is partitioned to maintenance and production, with the level of production related to the surplus/deficit of energy after accounting for essential processes (maintenance, pregnancy, etc). The LW data estimated on one day is then used to estimate intake on the following day and so forth. There is provision for the inclusion of supplements. Total daily or annual methane production is estimated for each animal in a class and the classed summed to provide herd methane emissions (Figure 2).

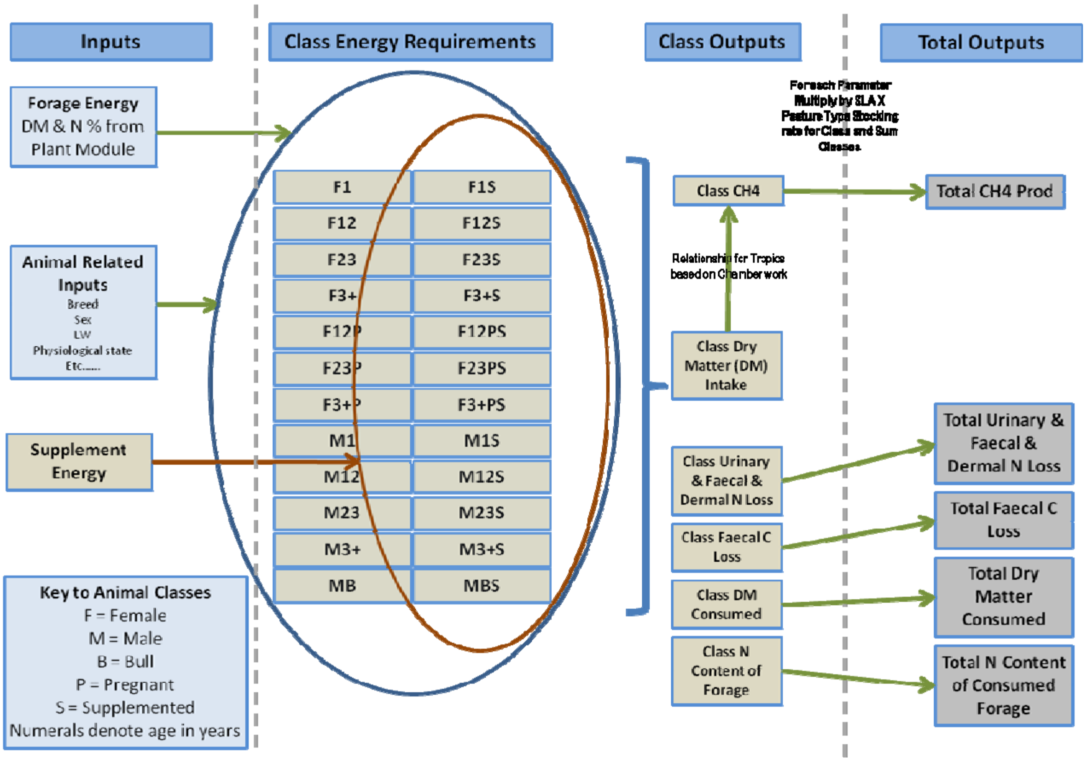

Figure 2: Overview of animal module showing inputs, outputs and feedbacks

Running the Lansdown data.

Data for the Lansdown herd (which consists entirely of growing steers) was used to examine the model. Firstly the average pasture data for Lansdown (Table 1, Figure 2)was used to estimate herd emissions over 12 months. Figure 3 shows the marked contrast in diet quantity and quality between wet and dry seasons. This marked seasonality is characteristic of northern grazing systems and necessitates a different modelling approach to that used in southern systems.

Figure 3. Typical wet and dry season grazing conditions at Lansdown

Table 1. Lansdown input parameters for NCAT modelling scenario	
Cattle breed	Brahman and Tropical composite
Number	200
Average LW (kg)	385
Average LW gain (kg/yr)	predicted
Stocking rate (Adult equivalents/Ha)	0.28
Grazing area	600
Pasture	Midgrass pastures under eucalypt woodland (Aristida-Bothriochloa)
Pasture quality	Polynomial relationship based on FNIRS data collected on8 occasions
Pasture yield	Visual estimates based on “Botanal” methodology

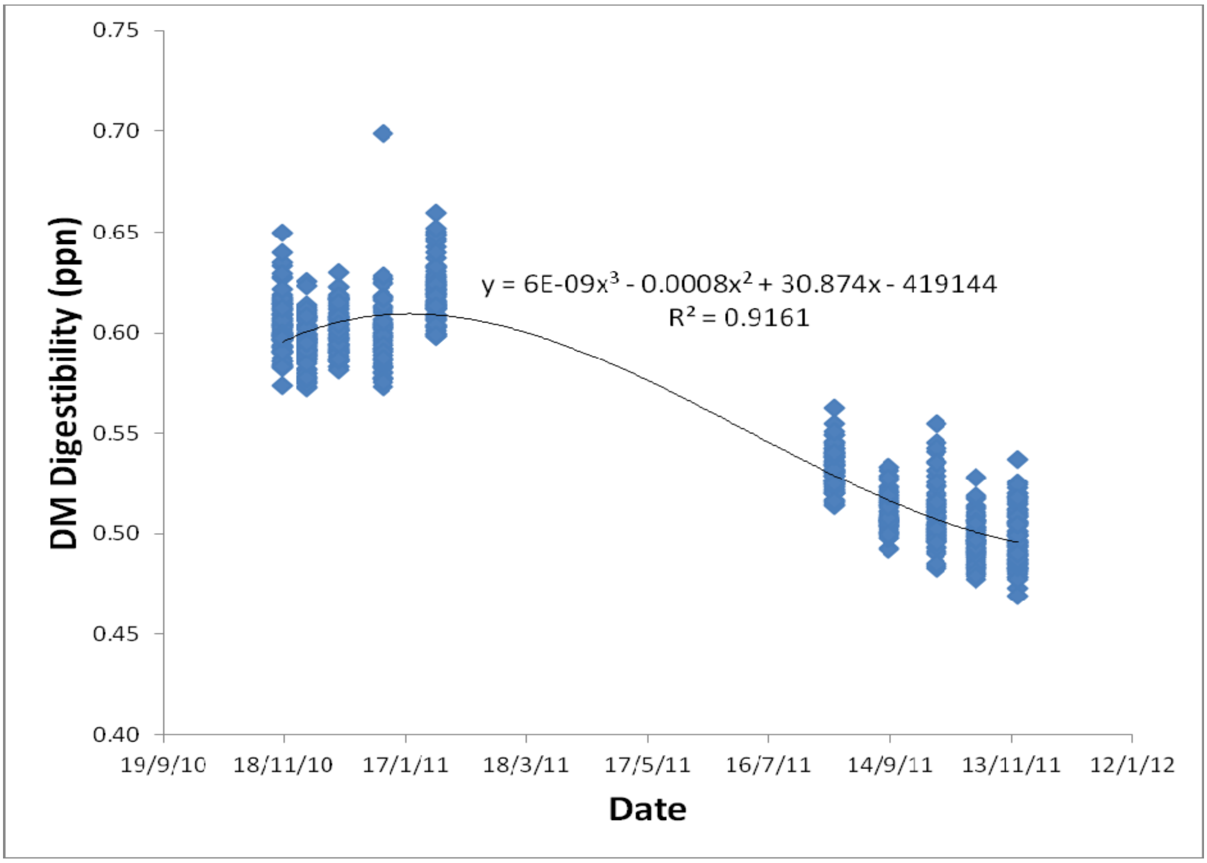

Figure 4. Estimated change in DM digestibility over time based on a polynomial relationship derived from 800 FNIRS data points collected on 10 occasions from the same 100 cattle.

Figure 4 demonstrated that the faecal NIRS data gave a highly plausible “digestibility curve” for the forage class. Owing to the late wet season in 2011/12 all data points from August to December 2011 were “dry season” data. The season broke in January 2012.

The animal growth performance in Figure 5 showed that cattle increased in average LW from 251 to 414 kg over the season (159 kg). The model did not use this data as an input but did assume an initial LW of 300 kg (as opposed to 250kg). Predicted growth rates in Figure 5 were markedly lower that observed (13 kg versus 159 kg). We have observed this phenomenon previously when using SCA algorithms under tropical conditions. Currently we believe the SCA (1990) model over-estimates the energy requirements for activity, particularly when we have observed Brahman cattle walking in excess of 20 km per day. Alternatively, voluntary intake under grazing conditions may be considerably higher than many models predict based on pen feeding trials.

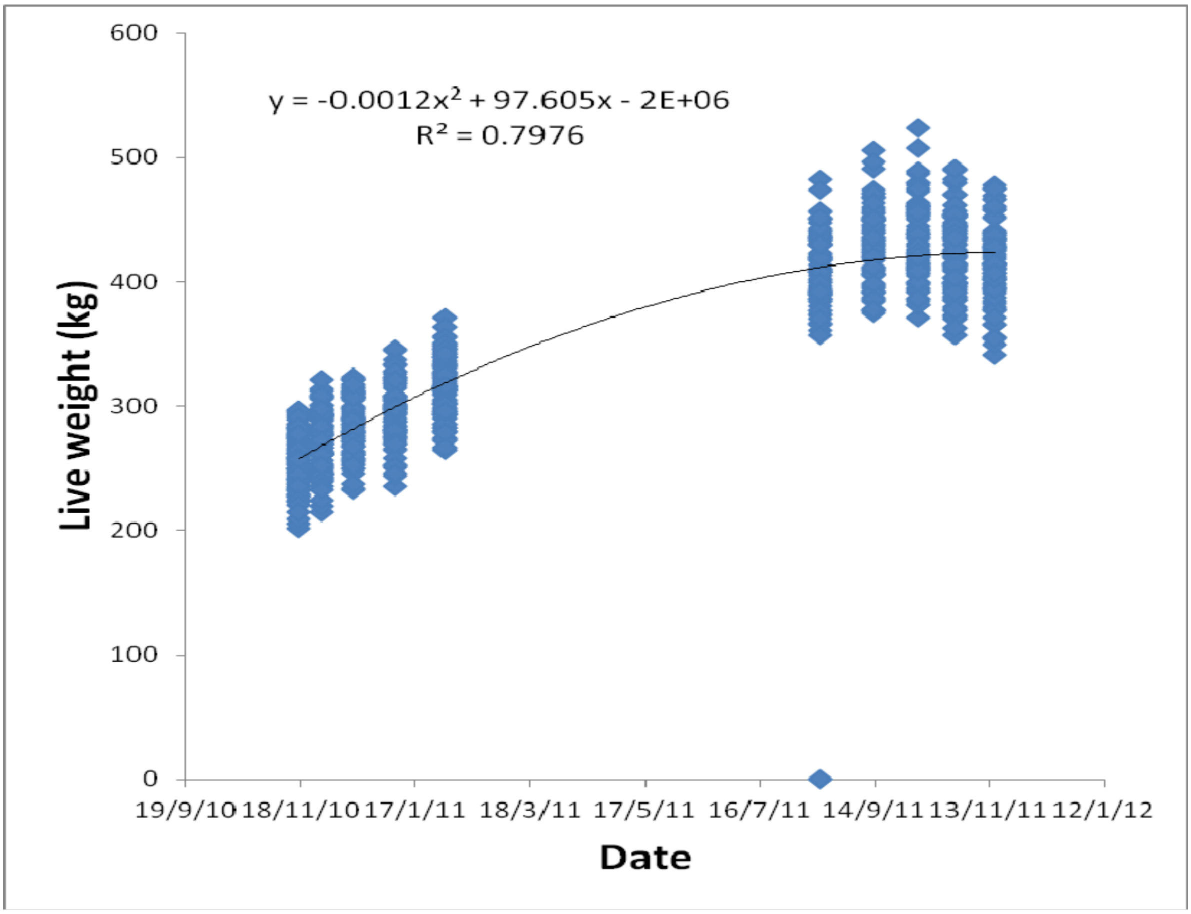

Figure 5. Observed LW data for 100 cattle over time based onweights collected on 10 occasions over the season.

Seasonal methane emissions based on data presented in table 1 and figure 4 are given in Figure 6. Emissions increased in the early part of the season in response to the increasing LW of cattle and the increasing diet quality. However, as the season advanced and diet quality declined, then daily emissions fell as DM intake declined. Figure 6 also shows the sensitivity of the method to changes in diet quality. In this scenario, diet quality was arbitrarily increased by 5% units in the wet season and by 8% units in the dry season as a result of introducing *Stylosanthes* (seca stylo). Although there was an increase in LW and LW gain in response to improved diet quality, methane emissions over the season were little affected. This can be attributed to fact that DM intake was not markedly altered due to the stocking rate and biomass on offer limiting potential intake.

As the current model under-predicted LW gain we have to assume it also under-predicted DM intake. Since methane emissions are related to DM intake, the model may be under-predicting methane emissions (see Page 12).

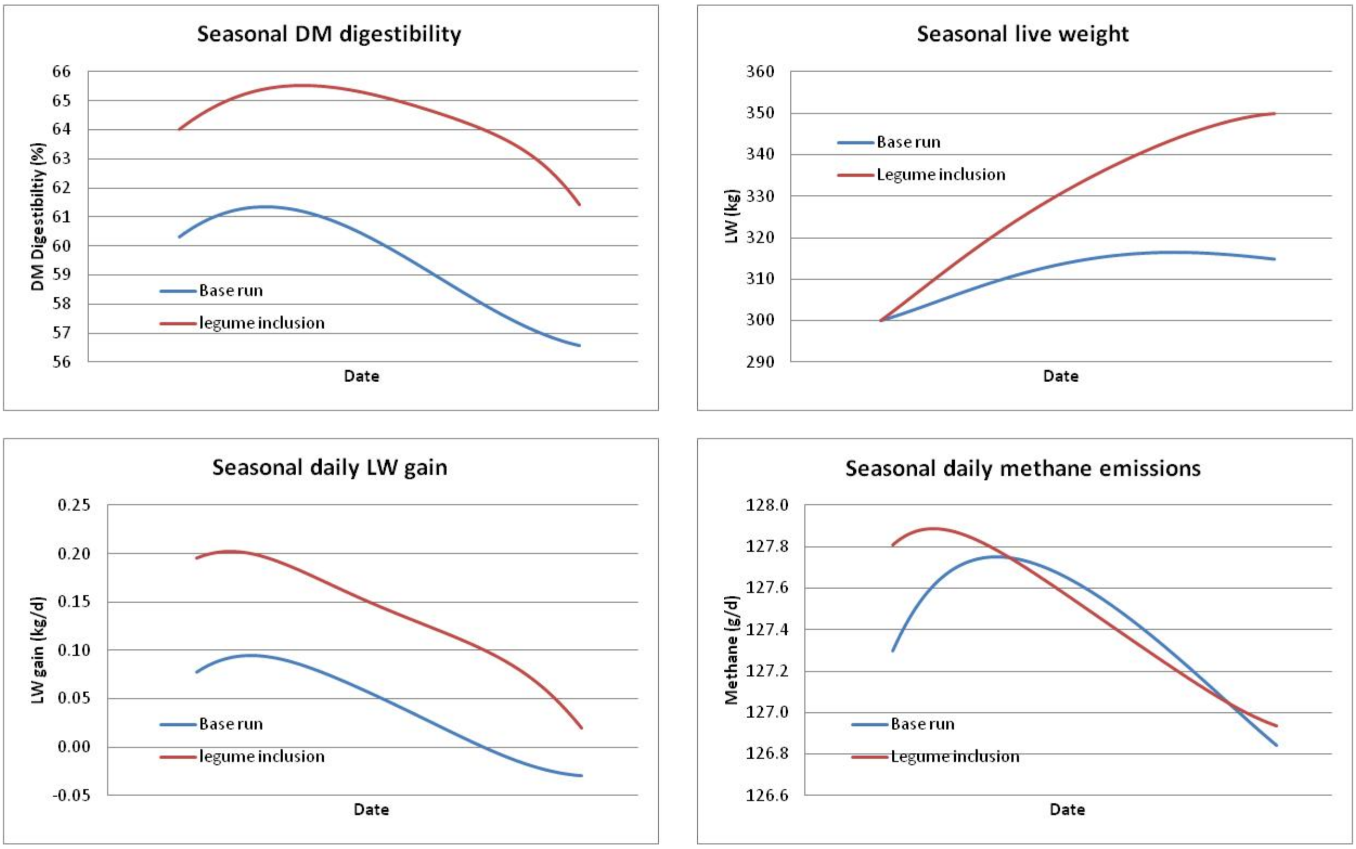

Figure 6. Model results for the Lansdown data and the sensitivity of teh model to increasing diet quality through the introduction of a legume.

When the cumulative seasonal emissions per unit of LW gain are considered, then increasing diet quality has a dramatic effect on emissions intensity (Table 2). This modelling scenario highlights the vulnerability of a northern industry in which annual rates of LW gain are often very low. It also demonstrates that any practice that can increase productivity will have a profound and positive effect on emissions intensity.

Table 2. Annual performance and methane emissions for the Lansdown scenario and the effect of inclusion of a legume to increase diet quality.

	Base line	Legume inclusion
Initial LW (kg)	300	300
Final LW (kg)	311.92	330.28
Annual LW gain	11.92	30.28
Annual methane emissions (kg/yr)	46.52	46.53
Methane emissions per kg LW gain (kg/kg)	3.90	1.54

Modelling the baseline data produced methane emissions data lower than that obtained using open path laser at Lansdown from similar animals and pastures (136 versus 281 g methane/d). The reasons for this difference are several-fold. However the model data are more in line with results obtained using methane chambers (40 to 160 g/d; Kennedy and Charmley, 2012) and previous modelling exercises (Charmley et al 2008). Methane emissions based on laser data has been collected across several properties across northern Australia and range between 136 and 281 g/d (See Final report B.CCH 1004). Currently the laser method only collects methane emissions for several hours around mid-morning to mid-afternoon. This coincides with a concerted bout of rumination following the early morning grazing bout. From 24 hour laser measurements we know that this corresponds to a peak in methane output (McGinn et al 2011), so it should be expected that there are differences between the two methods. We are currently refining the laser method to overcome this bias in laser results. An alternative reason for the discrepancy between the two methods may be associated with the underestimation of DM intake and LW change by the model, compared with observed results (Figure 5). As discussed previously this is a serious concern for any modelling approach that relies on the estimation of intake.

The modelling results show the sensitivity of the model to changes in diet quality. This confirms findings of earlier work (Charmley et al. 2008) that showed that the most significant means of reducing methane emissions intensity in northern Australia is to improve individual animal performance, through changed management practice, in this case altering diet quality by introduction of a legume.

3. Provision of data for Hutton Oddy

At the Perth RELRP meeting in October 2011 it was reported that Hutton Oddy would be conducting a data synthesis approach to compare and contrast models in use at the demonstration sites across the country. It was requested that early in the new year he will have received a summary of the data collected, the modelling conducted and perhaps a draft of our reports. Unfortunately at that stage we were still only mid way through our modelling exercise. Nevertheless, the data used in Section 2 above was sent to Hutton in February 2012.

This process did not develop according to plan for a number of reasons:

1. This exercise was not developed at the time we were preparing our modelling project for Lansdown and was not part of our original plan or milestones
2. There was a lack of clarity about the expectation for this work at the Perth meeting
3. I was unable to make the key Melbourne meeting in December 2011 due to conflicting engagements.
4. Our data was not ready in time for Hutton Oddy to conduct his analysis.

4. Appendices

Data for models

Animal	Month	Sesaon	LW	NIRS_kg_DMI	NIRS_non-grass (%)_DMI	NIRS_N (g/kg DM)	NIRS_*Invivo*_DMD	NIRS_*Invivo*_OMD
100007	17/11/2010	Spring	296	8.36	7.8	17.10	0.5985	0.6110
100014	17/11/2010	Spring	293	7.80	3.5	18.00	0.6092	0.6242
100018	17/11/2010	Spring	283	7.40	9.6	17.20	0.5990	0.6133
100020	17/11/2010	Spring	271	7.09	6.1	18.10	0.6090	0.6229
100023	17/11/2010	Spring	283	6.69	1.3	17.40	0.6041	0.6186
100025	17/11/2010	Spring	269	7.60	9.2	21.30	0.6189	0.6296
100027	17/11/2010	Spring	277	6.76	4.8	15.40	0.5842	0.5975
100033	17/11/2010	Spring	282	7.69	5.4	20.60	0.6329	0.6454
100037	17/11/2010	Spring	289	8.06	5.0	18.90	0.6269	0.6389
100041	17/11/2010	Spring	295	6.97	3.6	16.10	0.5966	0.6100
100052	17/11/2010	Spring	250	6.62	3.4	18.40	0.6145	0.6269
100061	17/11/2010	Spring	274	6.65	6.5	17.00	0.6036	0.6175
100063	17/11/2010	Spring	297	7.08	1.6	17.30	0.6032	0.6168
100064	17/11/2010	Spring	258	7.07	6.4	18.20	0.6041	0.6156
100070	17/11/2010	Spring	286	7.45	4.8	17.50	0.5962	0.6083
100071	17/11/2010	Spring	258	6.85	8.2	18.10	0.6142	0.6290
100077	17/11/2010	Spring	275	6.77	4.6	18.90	0.6044	0.6152
100083	17/11/2010	Spring	277	7.22	7.0	14.90	0.5905	0.6042
100084	17/11/2010	Spring	279	6.82	7.7	14.70	0.5932	0.6062
100105	17/11/2010	Spring	232	5.94	3.9	15.40	0.5941	0.6084
100110	17/11/2010	Spring	281	7.56	1.9	16.80	0.5999	0.6139
100122	17/11/2010	Spring	238	5.59	5.9	15.20	0.5906	0.6057
100125	17/11/2010	Spring	227	3.66	5.1	17.50	0.5967	0.6124
100130	17/11/2010	Spring	257	6.17	-0.3	17.90	0.5966	0.6055
100132	17/11/2010	Spring	283	6.40	8.2	16.40	0.5930	0.6081
100156	17/11/2010	Spring	262	7.60	15.4	19.40	0.6346	0.6511
100168	17/11/2010	Spring	247	6.92	5.6	19.00	0.6130	0.6280
100174	17/11/2010	Spring	264	7.43	1.9	18.90	0.5988	0.6149
100178	17/11/2010	Spring	250	6.74	5.3	19.00	0.6119	0.6241
100183	17/11/2010	Spring	286	7.61	3.9	16.90	0.5934	0.6083
100185	17/11/2010	Spring	235	5.46	.	15.10	0.5871	0.6022
100197	17/11/2010	Spring	274	7.16	6.6	19.90	0.6109	0.6243
100198	17/11/2010	Spring	273	7.24	8.4	15.20	0.5902	0.6037
100203	17/11/2010	Spring	247	5.80	5.8	14.60	0.5996	0.6090
100224	17/11/2010	Spring	291	7.32	7.8	15.10	0.5909	0.6035
100225	17/11/2010	Spring	234	5.81	1.5	16.80	0.5982	0.6112
100227	17/11/2010	Spring	239	6.39	5.6	17.90	0.6276	0.6411
100231	17/11/2010	Spring	253	6.93	8.8	18.40	0.6062	0.6197

100272	17/11/2010	Spring	229	6.10	7.4	18.40	0.6074	0.6194
100276	17/11/2010	Spring	241	6.52	7.9	17.40	0.6145	0.6301
100278	17/11/2010	Spring	255	6.35	4.1	14.20	0.5910	0.6036
100283	17/11/2010	Spring	241	6.68	5.7	17.80	0.5996	0.6125
100287	17/11/2010	Spring	223	5.98	7.9	18.50	0.6115	0.6246
100292	17/11/2010	Spring	243	6.41	8.9	17.50	0.6145	0.6269
100296	17/11/2010	Spring	250	6.48	4.5	17.80	0.6154	0.6283
100310	17/11/2010	Spring	254	6.58	2.1	16.60	0.6015	0.6169
100312	17/11/2010	Spring	262	6.62	10.3	18.70	0.5987	0.6131
100320	17/11/2010	Spring	262	6.31	0.9	14.70	0.5971	0.6119
100328	17/11/2010	Spring	270	7.16	10.6	18.10	0.6166	0.6269
100339	17/11/2010	Spring	250	6.02	2.1	15.50	0.5828	0.5982
100355	17/11/2010	Spring	259	7.03	3.4	15.80	0.6003	0.6103
100361	17/11/2010	Spring	267	7.49	4.6	17.80	0.6048	0.6159
100373	17/11/2010	Spring	284	7.55	6.4	17.60	0.6174	0.6316
100382	17/11/2010	Spring	255	5.64	0.1	14.10	0.5823	0.5925
100394	17/11/2010	Spring	254	7.34	4.7	20.80	0.6399	0.6509
100395	17/11/2010	Spring	276	7.05	3.1	15.40	0.5832	0.5959
100398	17/11/2010	Spring	275	6.62	7.1	15.30	0.5930	0.6067
100402	17/11/2010	Spring	228	5.48	10.6	17.70	0.6089	0.6213
100404	17/11/2010	Spring	266	6.33	0.9	15.10	0.5854	0.5957
100411	17/11/2010	Spring	249	6.35	2.3	16.60	0.6096	0.6208
100412	17/11/2010	Spring	233	6.00	4.1	16.30	0.5856	0.6020
100417	17/11/2010	Spring	265	7.14	5.2	17.10	0.6072	0.6165
100421	17/11/2010	Spring	259	6.97	10.9	18.60	0.6292	0.6444
100427	17/11/2010	Spring	227	5.85	4.9	15.50	0.5965	0.6094
100434	17/11/2010	Spring	278	.	.	.		.
100439	17/11/2010	Spring	202	4.52	7.9	15.50	0.5827	0.5940
100457	17/11/2010	Spring	233	6.16	12.6	20.70	0.6161	0.6303
100460	17/11/2010	Spring	257	6.32	-2.0	15.40	0.6030	0.6139
100466	17/11/2010	Spring	238	6.15	6.3	17.40	0.6025	0.6139
100469	17/11/2010	Spring	223	5.76	4.9	15.50	0.5991	0.6089
100475	17/11/2010	Spring	241	6.86	3.1	19.20	0.6062	0.6194
100495	17/11/2010	Spring	229	5.30	7.9	16.60	0.5907	0.6008
100496	17/11/2010	Spring	241	6.96	8.9	21.40	0.6172	0.6289
100502	17/11/2010	Spring	245	6.03	15.5	17.60	0.6001	0.6100
100504	17/11/2010	Spring	236	6.06	6.4	19.50	0.5986	0.6094
100506	17/11/2010	Spring	224	5.63	5.8	16.00	0.5971	0.6073
100509	17/11/2010	Spring	206	4.93	5.1	13.50	0.5734	0.5885
100513	17/11/2010	Spring	221	6.10	9.1	17.70	0.6218	0.6335
100527	17/11/2010	Spring	209	5.95	12.8	22.80	0.6497	0.6651
100539	17/11/2010	Spring	215	6.04	7.5	17.90	0.6122	0.6263
100007	29/11/2010	Spring	312	6.96	15.3	17.00	0.5888	0.5960
100014	29/11/2010	Spring	307	7.65	13.9	16.90	0.5972	0.6092
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100020	29/11/2010	Spring	280	6.31	22.7	15.80	0.5982	0.6063

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100064	29/11/2010	Spring	272	5.86	20.3	16.00	0.5812	0.5911
100070	29/11/2010	Spring	297	6.37	24.0	17.40	0.5996	0.6083
100071	29/11/2010	Spring	276	6.54	21.3	18.70	0.5994	0.6086
100077	29/11/2010	Spring	291	7.96	20.3	19.20	0.6033	0.6200
100083	29/11/2010	Spring	293	6.83	22.0	19.10	0.5886	0.6010
100084	29/11/2010	Spring	289	7.39	15.8	17.50	0.5937	0.6055
100105	29/11/2010	Spring	250	5.11	22.9	16.00	0.5760	0.5857
100110	29/11/2010	Spring	309	7.60	10.8	17.00	0.5968	0.6074
100122	29/11/2010	Spring	261	6.08	18.6	17.40	0.5912	0.6007
100125	29/11/2010	Spring	290	6.97	19.8	19.20	0.6069	0.6162
100130	29/11/2010	Spring	283	6.87	10.0	20.10	0.6020	0.6096
100132	29/11/2010	Spring	301	7.27	21.5	18.30	0.5919	0.6048
100156	29/11/2010	Spring	279	5.79	25.8	16.00	0.5724	0.5840
100168	29/11/2010	Spring	262	5.73	20.9	16.50	0.6016	0.6087
100174	29/11/2010	Spring	277	6.55	23.0	17.10	0.5781	0.5903
100178	29/11/2010	Spring	271	5.45	18.1	18.30	0.5916	0.6020
100183	29/11/2010	Spring	293	6.18	17.8	16.10	0.5868	0.5963
100185	29/11/2010	Spring	245	5.27	17.9	17.00	0.5745	0.5853
100197	29/11/2010	Spring	285	5.74	10.6	16.70	0.5993	0.6058
100198	29/11/2010	Spring	292	6.40	15.3	16.20	0.5796	0.5905
100203	29/11/2010	Spring	261	5.25	21.8	17.20	0.5970	0.6054
100224	29/11/2010	Spring	308	7.75	18.6	16.80	0.5956	0.6103
100225	29/11/2010	Spring	252	6.17	12.7	17.40	0.6041	0.6143
100227	29/11/2010	Spring	254	5.97	19.6	15.10	0.5899	0.6017
100231	29/11/2010	Spring	272	6.83	20.4	17.70	0.5969	0.6115
100272	29/11/2010	Spring	242	6.21	19.2	18.90	0.6035	0.6137
100276	29/11/2010	Spring	251	6.42	22.8	16.20	0.5916	0.6054
100278	29/11/2010	Spring	272	6.01	15.3	16.70	0.5880	0.6007
100283	29/11/2010	Spring	256	5.37	18.7	17.50	0.5869	0.5957
100287	29/11/2010	Spring	240	6.18	21.3	18.80	0.5965	0.6094
100292	29/11/2010	Spring	263	6.15	24.6	18.40	0.5906	0.5994
100296	29/11/2010	Spring	263	6.18	17.6	15.70	0.5797	0.5899
100310	29/11/2010	Spring	270	6.59	14.2	17.00	0.5919	0.6038
100312	29/11/2010	Spring	277	.	.	.		.
100320	29/11/2010	Spring	272	6.33	19.6	16.60	0.5975	0.6083
100328	29/11/2010	Spring	288	8.13	19.0	19.70	0.6024	0.6172
100339	29/11/2010	Spring	267	6.24	22.4	18.70	0.6129	0.6239

100355	29/11/2010	Spring	278	7.35	19.7	16.40	0.5769	0.5868
100361	29/11/2010	Spring	292	6.84	16.9	18.10	0.5958	0.6051
100373	29/11/2010	Spring	285	7.54	13.1	19.10	0.5986	0.6113
100382	29/11/2010	Spring	270	6.32	16.0	20.60	0.5990	0.6046
100394	29/11/2010	Spring	264	5.92	15.8	17.00	0.5855	0.5950
100395	29/11/2010	Spring	294	7.25	17.4	18.40	0.6075	0.6170
100398	29/11/2010	Spring	294	7.84	19.1	19.90	0.6255	0.6384
100402	29/11/2010	Spring	241	5.63	22.3	19.40	0.6102	0.6211
100404	29/11/2010	Spring	272	5.50	15.1	18.00	0.5776	0.5896
100411	29/11/2010	Spring	270	5.54	13.9	15.70	0.5870	0.5956
100412	29/11/2010	Spring	246	5.44	15.2	15.70	0.5896	0.5977
100417	29/11/2010	Spring	284	5.88	17.4	16.20	0.5960	0.6047
100421	29/11/2010	Spring	272	6.96	23.6	18.00	0.6113	0.6216
100427	29/11/2010	Spring	243	6.11	17.1	17.70	0.5973	0.6077
100434	29/11/2010	Spring	298	6.91	17.8	19.20	0.5931	0.6072
100439	29/11/2010	Spring	215	4.40	24.3	19.60	0.6073	0.6130
100457	29/11/2010	Spring	246	6.28	21.1	19.20	0.6140	0.6284
100460	29/11/2010	Spring	267	6.66	16.9	19.00	0.6059	0.6152
100466	29/11/2010	Spring	248	6.28	16.7	20.20	0.5944	0.6059
100469	29/11/2010	Spring	246	6.27	12.9	20.00	0.6023	0.6131
100475	29/11/2010	Spring	272	7.16	11.4	19.80	0.6116	0.6237
100495	29/11/2010	Spring	245	5.37	26.4	18.70	0.6081	0.6167
100496	29/11/2010	Spring	262	6.78	14.1	18.30	0.5955	0.6070
100502	29/11/2010	Spring	261	6.28	23.5	19.80	0.5891	0.5992
100504	29/11/2010	Spring	253	6.51	19.8	18.70	0.5913	0.6040
100506	29/11/2010	Spring	239	4.96	23.2	16.30	0.5847	0.5941
100509	29/11/2010	Spring	220	5.19	20.7	16.90	0.5952	0.6074
100513	29/11/2010	Spring	236	.	.	.		.
100527	29/11/2010	Spring	224	.	.	.		.
100539	29/11/2010	Spring	233	6.29	15.1	18.60	0.6232	0.6341
100007	15/12/2010	Wet summer	322	9.33	11.6	22.10	0.6167	0.6279
100014	15/12/2010	Wet summer	312	8.12	18.1	17.80	0.5858	0.5956
100018	15/12/2010	Wet summer	313	7.83	10.4	17.50	0.5910	0.5988
100020	15/12/2010	Wet summer	300	7.76	18.6	19.50	0.6166	0.6247
100023	15/12/2010	Wet summer	312	7.44	12.0	17.40	0.5970	0.6054
100025	15/12/2010	Wet summer	294	6.52	14.4	17.40	0.5904	0.5955
100027	15/12/2010	Wet summer	311	8.35	12.1	18.90	0.6139	0.6204
100033	15/12/2010	Wet summer	323	.	.	.		.
100037	15/12/2010	Wet summer	310	8.78	12.5	18.30	0.6169	0.6225
100041	15/12/2010	Wet summer	321	9.29	20.8	20.00	0.6080	0.6212
100052	15/12/2010	Wet summer	279	7.00	19.1	17.70	0.5920	0.5993
100061	15/12/2010	Wet summer	308	8.52	14.4	22.30	0.6227	0.6343
100063	15/12/2010	Wet summer	321	7.17	5.4	17.20	0.6026	0.6094
100064	15/12/2010	Wet summer	291	7.84	17.4	16.60	0.6073	0.6129
100070	15/12/2010	Wet summer	307	8.31	8.1	18.30	0.6117	0.6196
100071	15/12/2010	Wet summer	288	6.96	15.7	17.90	0.6160	0.6270

100077	15/12/2010	Wet summer	311	7.09	12.7	16.70	0.5883	0.5975
100083	15/12/2010	Wet summer	307	7.76	12.6	18.10	0.6163	0.6254
100084	15/12/2010	Wet summer	307	7.10	12.3	16.00	0.5867	0.5969
100105	15/12/2010	Wet summer	264	6.70	14.8	20.00	0.6068	0.6155
100110	15/12/2010	Wet summer	315	7.28	7.1	17.60	0.6082	0.6172
100122	15/12/2010	Wet summer	274	6.16	11.7	16.80	0.5980	0.6067
100125	15/12/2010	Wet summer	298	8.25	17.2	18.60	0.5900	0.6013
100130	15/12/2010	Wet summer	286	6.93	9.7	20.60	0.6022	0.6117
100132	15/12/2010	Wet summer	315	6.48	9.9	17.20	0.5873	0.5950
100156	15/12/2010	Wet summer	290	8.12	12.8	18.30	0.6096	0.6181
100168	15/12/2010	Wet summer	276	7.30	12.7	17.50	0.6010	0.6131
100174	15/12/2010	Wet summer	292	7.94	10.6	20.50	0.6078	0.6199
100178	15/12/2010	Wet summer	290	8.21	10.1	19.10	0.6042	0.6157
100183	15/12/2010	Wet summer	317	8.10	15.5	17.30	0.5970	0.6045
100185	15/12/2010	Wet summer	254	6.64	15.5	18.10	0.6014	0.6134
100197	15/12/2010	Wet summer	310	8.27	13.1	20.00	0.6010	0.6125
100198	15/12/2010	Wet summer	309	8.73	12.7	22.00	0.6122	0.6232
100203	15/12/2010	Wet summer	272	7.01	13.9	18.60	0.6173	0.6269
100224	15/12/2010	Wet summer	321	7.44	14.4	17.50	0.6102	0.6199
100225	15/12/2010	Wet summer	257	6.05	6.6	16.50	0.5940	0.6034
100227	15/12/2010	Wet summer	261	6.05	10.5	16.70	0.6043	0.6153
100231	15/12/2010	Wet summer	284	6.32	9.3	17.20	0.5856	0.5960
100272	15/12/2010	Wet summer	256	6.85	10.0	19.30	0.5960	0.6072
100276	15/12/2010	Wet summer	261	5.93	20.6	17.30	0.5831	0.5942
100278	15/12/2010	Wet summer	286	6.26	8.0	16.40	0.5967	0.6057
100283	15/12/2010	Wet summer	269	7.41	12.0	21.70	0.6189	0.6323
100287	15/12/2010	Wet summer	250	5.79	11.9	18.50	0.6083	0.6151
100292	15/12/2010	Wet summer	274	7.67	16.1	19.30	0.5931	0.6028
100296	15/12/2010	Wet summer	271	6.50	9.7	16.70	0.5909	0.6026
100310	15/12/2010	Wet summer	279	6.74	11.6	18.20	0.5904	0.5991
100312	15/12/2010	Wet summer	278	6.85	18.6	20.50	0.6067	0.6121
100320	15/12/2010	Wet summer	283	6.58	11.5	20.50	0.6225	0.6349
100328	15/12/2010	Wet summer	296	7.39	8.8	18.60	0.5944	0.6045
100339	15/12/2010	Wet summer	280	7.19	12.8	18.90	0.5980	0.6093
100355	15/12/2010	Wet summer	289	7.00	7.8	17.50	0.5923	0.6036
100361	15/12/2010	Wet summer	299	8.24	9.9	19.70	0.6133	0.6275
100373	15/12/2010	Wet summer	305	7.30	6.3	18.30	0.5993	0.6080
100382	15/12/2010	Wet summer	276	5.94	5.4	17.90	0.5943	0.5973
100394	15/12/2010	Wet summer	289	7.79	16.4	19.00	0.6175	0.6241
100395	15/12/2010	Wet summer	306	7.04	6.0	17.10	0.5831	0.5940
100398	15/12/2010	Wet summer	298	6.71	12.2	18.40	0.5935	0.6025
100402	15/12/2010	Wet summer	255	5.40	13.1	16.80	0.5855	0.5953
100404	15/12/2010	Wet summer	290	8.05	18.2	18.30	0.5916	0.6018
100411	15/12/2010	Wet summer	286	8.06	14.5	18.90	0.6171	0.6272
100412	15/12/2010	Wet summer	263	7.10	19.9	20.80	0.6182	0.6271
100417	15/12/2010	Wet summer	307	7.99	19.7	17.30	0.5900	0.5980

100421	15/12/2010	Wet summer	280	7.00	15.6	18.50	0.6061	0.6157
100427	15/12/2010	Wet summer	246	6.23	12.7	19.00	0.6151	0.6235
100434	15/12/2010	Wet summer	318	9.36	15.2	22.10	0.6297	0.6406
100439	15/12/2010	Wet summer	233	5.62	14.4	20.50	0.6016	0.6103
100457	15/12/2010	Wet summer	258	5.92	17.3	17.10	0.5937	0.6059
100460	15/12/2010	Wet summer	288	7.12	8.4	17.00	0.5946	0.6038
100466	15/12/2010	Wet summer	268	6.38	13.5	18.90	0.5814	0.5911
100469	15/12/2010	Wet summer	263	6.29	12.1	21.80	0.6064	0.6126
100475	15/12/2010	Wet summer	281	6.98	10.0	19.50	0.5989	0.6084
100495	15/12/2010	Wet summer	261	7.18	16.7	19.90	0.6078	0.6197
100496	15/12/2010	Wet summer	271	6.69	8.9	18.60	0.5863	0.5996
100502	15/12/2010	Wet summer	272	6.26	15.6	18.30	0.5870	0.5946
100504	15/12/2010	Wet summer	268	6.70	11.2	18.50	0.6041	0.6105
100506	15/12/2010	Wet summer	250	6.57	16.9	17.40	0.6010	0.6107
100509	15/12/2010	Wet summer	234	5.91	19.3	18.60	0.6046	0.6120
100513	15/12/2010	Wet summer	253	.	.	.		.
100527	15/12/2010	Wet summer	238	6.60	23.6	17.90	0.5870	0.6004
100007	6/01/2011	Wet summer	345	.	.	.		.
100014	6/01/2011	Wet summer	337	8.97	53.0	20.40	0.5968	0.6115
100018	6/01/2011	Wet summer	323	9.27	19.7	19.10	0.6178	0.7193
100020	6/01/2011	Wet summer	306	7.77	49.8	19.00	0.5771	0.6031
100023	6/01/2011	Wet summer	315	8.07	35.7	21.20	0.6048	0.6288
100025	6/01/2011	Wet summer	294	7.69	21.6	20.60	0.6026	0.5869
100027	6/01/2011	Wet summer	305	7.68	45.8	19.50	0.5731	0.6137
100033	6/01/2011	Wet summer	320	8.91	16.7	21.60	0.6181	0.6072
100037	6/01/2011	Wet summer	319	8.81	39.0	19.90	0.6037	0.5807
100041	6/01/2011	Wet summer	328	7.92	48.3	19.80	0.5828	0.6283
100052	6/01/2011	Wet summer	284	7.50	54.5	19.50	0.5768	0.6090
100061	6/01/2011	Wet summer	326	7.89	51.3	21.90	0.5998	0.5896
100063	6/01/2011	Wet summer	346	9.38	7.0	18.50	0.5978	0.5844
100064	6/01/2011	Wet summer	297	8.18	46.4	19.20	0.5837	0.6061
100070	6/01/2011	Wet summer	334	8.81	47.8	19.10	0.5794	0.6084
100071	6/01/2011	Wet summer	298	.	.	.		.
100077	6/01/2011	Wet summer	302	8.00	20.1	18.70	0.5938	0.5909
100083	6/01/2011	Wet summer	307	7.64	40.7	21.00	0.5979	0.5903
100084	6/01/2011	Wet summer	285	6.79	17.9	14.80	0.5873	0.6014
100105	6/01/2011	Wet summer	280	7.02	54.3	19.40	0.5826	0.6026
100110	6/01/2011	Wet summer	334	8.45	16.4	17.20	0.6017	0.6000
100122	6/01/2011	Wet summer	281	6.67	18.7	15.50	0.5773	0.5891
100125	6/01/2011	Wet summer	306	8.44	47.4	20.30	0.5827	0.6096
100130	6/01/2011	Wet summer	293	7.80	7.7	23.60	0.6251	0.5943
100132	6/01/2011	Wet summer	323	7.97	13.6	18.30	0.5989	0.5951
100156	6/01/2011	Wet summer	300	7.81	43.6	20.10	0.5824	0.6353
100168	6/01/2011	Wet summer	288	.	.	.		.
100174	6/01/2011	Wet summer	319	8.28	41.5	17.40	0.5772	0.6080
100178	6/01/2011	Wet summer	295	.	.	.		.

100183	6/01/2011	Wet summer	323	8.12	51.0	18.40	0.5799	0.5923
100185	6/01/2011	Wet summer	270	7.15	42.3	19.90	0.5961	0.5895
100197	6/01/2011	Wet summer	317	7.79	33.8	21.30	0.5910	0.5848
100198	6/01/2011	Wet summer	321	8.60	48.6	19.40	0.5803	0.6063
100203	6/01/2011	Wet summer	278	7.00	42.0	20.70	0.5925	0.5985
100224	6/01/2011	Wet summer	333	8.96	10.0	18.50	0.5999	0.5896
100225	6/01/2011	Wet summer	275	6.93	17.0	17.30	0.5918	0.6004
100227	6/01/2011	Wet summer	253	5.95	15.2	22.80	0.6987	0.6103
100231	6/01/2011	Wet summer	302	8.02	13.6	19.20	0.5953	0.6024
100272	6/01/2011	Wet summer	281	7.77	14.9	19.50	0.6067	0.6885
100276	6/01/2011	Wet summer	276	7.02	15.1	16.30	0.5986	0.6035
100278	6/01/2011	Wet summer	304	7.93	6.1	17.60	0.6037	0.6121
100283	6/01/2011	Wet summer	282	7.07	42.2	20.80	0.5831	0.6097
100287	6/01/2011	Wet summer	265	6.63	19.7	17.70	0.6044	0.6160
100292	6/01/2011	Wet summer	273	7.03	52.7	20.80	0.5766	0.5940
100296	6/01/2011	Wet summer	281	7.14	13.4	16.20	0.5866	0.6113
100310	6/01/2011	Wet summer	287	7.72	15.1	18.80	0.5924	0.5868
100312	6/01/2011	Wet summer	301	7.99	15.6	22.00	0.6265	0.5978
100320	6/01/2011	Wet summer	298	7.71	12.3	19.30	0.6263	0.6044
100328	6/01/2011	Wet summer	304	8.84	15.1	21.50	0.6162	0.6375
100339	6/01/2011	Wet summer	287	7.66	51.9	21.80	0.6022	0.6359
100355	6/01/2011	Wet summer	290	8.54	8.6	21.30	0.6166	0.6265
100361	6/01/2011	Wet summer	308	8.44	44.8	20.30	0.5752	0.6084
100373	6/01/2011	Wet summer	328	9.06	13.0	20.90	0.6127	0.6294
100382	6/01/2011	Wet summer	298	7.73	7.5	21.10	0.6122	0.5842
100394	6/01/2011	Wet summer	294	7.90	45.8	20.90	0.6100	0.6220
100395	6/01/2011	Wet summer	295	.	.	.		.
100398	6/01/2011	Wet summer	308	7.98	23.8	18.80	0.6029	0.6218
100402	6/01/2011	Wet summer	251	6.02	20.9	16.60	0.6042	0.6149
100404	6/01/2011	Wet summer	300	7.92	48.4	20.40	0.5889	0.7995
100411	6/01/2011	Wet summer	296	7.62	43.1	19.90	0.5863	0.8198
100412	6/01/2011	Wet summer	279	7.50	45.6	19.20	0.5889	0.6108
100417	6/01/2011	Wet summer	308	8.29	42.6	21.00	0.5907	0.6169
100421	6/01/2011	Wet summer	299	8.21	51.3	22.20	0.6033	0.5984
100427	6/01/2011	Wet summer	266	6.95	13.9	18.80	0.6025	0.5936
100434	6/01/2011	Wet summer	321	8.32	57.6	20.00	0.5846	0.5988
100439	6/01/2011	Wet summer	236	5.94	43.6	19.30	0.5925	0.5960
100457	6/01/2011	Wet summer	274	7.37	12.9	21.00	0.6271	0.6112
100460	6/01/2011	Wet summer	308	8.47	9.7	20.00	0.6111	0.6135
100466	6/01/2011	Wet summer	284	7.06	10.8	20.10	0.6069	0.5913
100469	6/01/2011	Wet summer	275	7.06	16.5	19.30	0.6243	0.6029
100475	6/01/2011	Wet summer	301	8.33	14.0	20.60	0.5991	0.6370
100495	6/01/2011	Wet summer	279	7.33	54.5	20.50	0.5939	0.6196
100496	6/01/2011	Wet summer	281	7.47	12.8	20.70	0.6177	0.6184
100502	6/01/2011	Wet summer	299	7.57	17.0	20.40	0.6134	0.6339
100504	6/01/2011	Wet summer	271	.	.	.		.

100506	6/01/2011	Wet summer	258	6.90	44.8	20.50	0.5908	0.6104
100509	6/01/2011	Wet summer	253	6.46	50.5	18.30	0.5863	0.6021
100513	6/01/2011	Wet summer	270	7.73	50.1	23.50	0.6055	0.6347
100527	6/01/2011	Wet summer	252	7.38	46.6	24.40	0.6281	0.6206
100539	6/01/2011	Wet summer	244	5.92	11.3	18.70	0.5873	0.5947
100539	6/01/2011	Wet summer	246	6.02	20.6	18.10	0.6170	0.6030
100007	1/02/2011	Wet summer	371	9.82	14.6	18.60	0.6141	0.6271
100014	1/02/2011	Wet summer	323	8.49	18.1	18.90	0.6123	0.6242
100018	1/02/2011	Wet summer	349	10.30	34.6	21.60	0.6206	0.6302
100020	1/02/2011	Wet summer	335	8.85	18.1	18.40	0.6071	0.6170
100023	1/02/2011	Wet summer	344	8.74	13.4	18.90	0.6068	0.6205
100025	1/02/2011	Wet summer	316	8.76	38.2	22.40	0.6253	0.6322
100027	1/02/2011	Wet summer	319	8.61	17.3	20.60	0.6264	0.6388
100033	1/02/2011	Wet summer	334	.	.	.		.
100037	1/02/2011	Wet summer	313	7.21	19.1	18.70	0.6120	0.6182
100041	1/02/2011	Wet summer	347	9.57	22.7	19.70	0.6251	0.6420
100052	1/02/2011	Wet summer	310	8.27	18.7	18.30	0.6010	0.6128
100061	1/02/2011	Wet summer	356	9.57	17.4	20.40	0.6224	0.6329
100063	1/02/2011	Wet summer	364	10.14	34.2	21.60	0.6287	0.6435
100064	1/02/2011	Wet summer	313	8.37	22.0	19.50	0.6035	0.6153
100070	1/02/2011	Wet summer	346	9.07	21.1	20.10	0.6029	0.6132
100071	1/02/2011	Wet summer	315	9.20	33.1	19.50	0.5981	0.6140
100077	1/02/2011	Wet summer	332	9.39	32.4	20.00	0.6124	0.6236
100083	1/02/2011	Wet summer	327	8.23	23.6	20.20	0.5993	0.6096
100084	1/02/2011	Wet summer	326	8.85	28.6	22.20	0.6423	0.6530
100105	1/02/2011	Wet summer	299	7.86	21.1	19.60	0.6139	0.6233
100110	1/02/2011	Wet summer	340	9.91	32.6	23.80	0.6333	0.6455
100122	1/02/2011	Wet summer	305	8.79	34.3	21.50	0.6322	0.6456
100125	1/02/2011	Wet summer	333	8.60	14.6	19.80	0.6119	0.6222
100130	1/02/2011	Wet summer	312	8.48	29.1	24.90	0.6451	0.6618
100132	1/02/2011	Wet summer	342	9.16	41.2	19.40	0.5984	0.6079
100156	1/02/2011	Wet summer	325	8.85	20.9	19.00	0.6161	0.6271
100168	1/02/2011	Wet summer	314	9.02	23.4	22.40	0.6461	0.6586
100174	1/02/2011	Wet summer	336	9.90	20.1	22.00	0.6230	0.6380
100178	1/02/2011	Wet summer	313	8.50	14.7	19.70	0.6176	0.6300
100183	1/02/2011	Wet summer	339	9.33	11.1	19.60	0.6237	0.6286
100185	1/02/2011	Wet summer	290	7.99	9.9	18.40	0.6083	0.6178
100197	1/02/2011	Wet summer	349	10.53	34.4	24.10	0.6502	.
100198	1/02/2011	Wet summer	351	9.40	23.3	19.50	0.6086	0.6192
100203	1/02/2011	Wet summer	294	7.76	13.7	20.90	0.6302	0.6375
100224	1/02/2011	Wet summer	355	9.97	33.3	21.30	0.6150	0.6229
100225	1/02/2011	Wet summer	280	8.47	31.2	19.70	0.6154	0.6301
100227	1/02/2011	Wet summer	293	8.86	36.8	22.00	0.6493	0.6580
100231	1/02/2011	Wet summer	309	9.28	34.4	20.60	0.6324	0.6414
100272	1/02/2011	Wet summer	303	9.12	26.8	19.60	0.5996	0.6127
100276	1/02/2011	Wet summer	280	7.86	40.8	20.10	0.6033	0.6126

100278	1/02/2011	Wet summer	316	8.58	35.9	20.50	0.6216	0.6320
100283	1/02/2011	Wet summer	304	8.20	16.6	19.30	0.6191	0.6351
100287	1/02/2011	Wet summer	283	8.28	37.5	22.00	0.6276	0.6379
100292	1/02/2011	Wet summer	298	7.80	6.6	21.30	0.6274	0.6372
100296	1/02/2011	Wet summer	293	8.19	32.6	18.10	0.6368	0.6451
100310	1/02/2011	Wet summer	316	8.90	28.7	21.80	0.6217	0.6355
100312	1/02/2011	Wet summer	323	9.20	32.4	21.90	0.6192	0.6320
100320	1/02/2011	Wet summer	314	9.15	32.5	22.60	0.6327	0.6409
100328	1/02/2011	Wet summer	333	9.87	28.8	21.80	0.6594	0.6712
100339	1/02/2011	Wet summer	313	8.41	10.3	18.60	0.6076	0.6203
100355	1/02/2011	Wet summer	322	9.00	23.1	20.10	0.6039	0.6165
100361	1/02/2011	Wet summer	327	9.04	10.5	18.80	0.6142	0.6265
100373	1/02/2011	Wet summer	351	9.95	25.5	20.00	0.5992	0.6127
100382	1/02/2011	Wet summer	316	8.13	27.4	20.60	0.6063	0.6218
100394	1/02/2011	Wet summer	317	8.65	18.4	23.40	0.6488	0.6581
100395	1/02/2011	Wet summer	339	9.78	43.5	23.80	0.6207	0.6331
100398	1/02/2011	Wet summer	339	9.34	41.6	21.40	0.6194	0.6338
100402	1/02/2011	Wet summer	273	7.32	39.8	21.50	0.6114	0.6205
100404	1/02/2011	Wet summer	331	9.04	16.5	22.20	0.6218	0.6333
100411	1/02/2011	Wet summer	320	8.94	18.3	20.70	0.6064	0.6158
100412	1/02/2011	Wet summer	296	8.17	18.2	21.80	0.6025	0.6127
100417	1/02/2011	Wet summer	346	9.31	17.2	20.10	0.6131	0.6215
100421	1/02/2011	Wet summer	328	8.54	17.9	19.40	0.6137	0.6251
100427	1/02/2011	Wet summer	283	8.35	35.3	21.60	0.6087	0.6207
100434	1/02/2011	Wet summer	342	.	.	.		.
100439	1/02/2011	Wet summer	265	7.08	20.0	21.70	0.6255	.
100457	1/02/2011	Wet summer	286	8.26	34.1	20.90	0.6090	0.6175
100460	1/02/2011	Wet summer	325	8.72	34.1	20.80	0.6040	0.6178
100466	1/02/2011	Wet summer	295	8.05	35.0	21.60	0.6241	0.6361
100469	1/02/2011	Wet summer	293	8.73	18.7	21.60	0.6156	.
100475	1/02/2011	Wet summer	317	9.43	40.6	23.00	0.6400	.
100495	1/02/2011	Wet summer	303	8.01	9.5	21.80	0.6133	0.6231
100496	1/02/2011	Wet summer	302	8.88	31.6	20.20	0.6240	0.6377
100502	1/02/2011	Wet summer	302	8.49	29.8	22.00	0.6189	0.6308
100504	1/02/2011	Wet summer	286	7.56	41.3	22.70	0.6182	0.6270
100506	1/02/2011	Wet summer	274	7.25	13.8	21.20	0.6119	0.6247
100509	1/02/2011	Wet summer	272	7.28	16.9	19.70	0.6130	0.6227
100513	1/02/2011	Wet summer	296	.	.	.		.
100527	1/02/2011	Wet summer	267	7.14	26.8	17.50	0.5987	0.6102
100539	1/02/2011	Wet summer	279	8.44	31.7	20.50	0.6521	0.6660
100007	17/08/2011	Dry winter	482	7.79	36.0	11.60	0.5140	0.5374
100014	17/08/2011	Dry winter	436	8.15	43.8	13.40	0.5341	0.5509
100018	17/08/2011	Dry winter	431	7.42	52.1	12.40	0.5262	0.5408
100020	17/08/2011	Dry winter	434	8.09	47.1	12.50	0.5243	0.5436
100023	17/08/2011	Dry winter	437	8.34	46.0	12.20	0.5263	0.5430
100025	17/08/2011	Dry winter	402	7.04	42.7	12.50	0.5308	0.5496

100027	17/08/2011	Dry winter	419	6.60	35.3	11.80	0.5247	0.5450
100033	17/08/2011	Dry winter	431	9.43	46.6	13.80	0.5407	0.5607
100037	17/08/2011	Dry winter	431	.	.	.		.
100041	17/08/2011	Dry winter	433	.	.	.		.
100052	17/08/2011	Dry winter	400	6.78	47.3	12.80	0.5403	0.5563
100061	17/08/2011	Dry winter	435	8.74	51.1	13.30	0.5235	0.5408
100063	17/08/2011	Dry winter	456	9.65	50.9	14.10	0.5384	0.5581
100064	17/08/2011	Dry winter	408	.	.	.		.
100070	17/08/2011	Dry winter	450	8.48	42.0	11.70	0.5266	0.5425
100071	17/08/2011	Dry winter	401	7.19	46.3	11.40	0.5167	0.5363
100077	17/08/2011	Dry winter	418	7.57	46.0	14.60	0.5458	0.5642
100083	17/08/2011	Dry winter	420	8.38	41.9	12.30	0.5427	0.5577
100084	17/08/2011	Dry winter	414	7.80	38.6	12.20	0.5415	0.5561
100105	17/08/2011	Dry winter	395	8.18	34.9	12.10	0.5367	0.5580
100110	17/08/2011	Dry winter	439	8.06	42.7	11.80	0.5292	0.5468
100122	17/08/2011	Dry winter	405	7.49	49.8	13.80	0.5405	0.5585
100125	17/08/2011	Dry winter	433	8.06	51.6	13.80	0.5427	0.5628
100130	17/08/2011	Dry winter	390	6.22	34.6	11.40	0.5315	0.5525
100132	17/08/2011	Dry winter	441	7.33	48.7	13.10	0.5220	0.5447
100156	17/08/2011	Dry winter	435	9.31	48.7	13.70	0.5362	0.5565
100168	17/08/2011	Dry winter	386	.	.	.		.
100174	17/08/2011	Dry winter	450	8.24	46.3	12.30	0.5322	0.5474
100178	17/08/2011	Dry winter	408	7.09	44.6	12.00	0.5199	0.5397
100183	17/08/2011	Dry winter	448	9.90	46.6	12.00	0.5143	0.5304
100185	17/08/2011	Dry winter	384	6.13	38.4	15.10	0.5383	0.5492
100197	17/08/2011	Dry winter	457	8.36	40.6	11.80	0.5255	0.5474
100198	17/08/2011	Dry winter	474	.	.	.		.
100203	17/08/2011	Dry winter	366	6.16	49.0	13.40	0.5266	0.5418
100224	17/08/2011	Dry winter	451	8.42	42.2	11.60	0.5198	0.5429
100225	17/08/2011	Dry winter	373	7.86	60.0	15.20	0.5454	0.5611
100227	17/08/2011	Dry winter	397	8.47	51.3	13.70	0.5494	0.5667
100231	17/08/2011	Dry winter	393	6.90	45.8	11.80	0.5362	0.5536
100272	17/08/2011	Dry winter	377	7.96	37.0	11.40	0.5311	0.5444
100276	17/08/2011	Dry winter	381	6.64	50.6	12.90	0.5306	0.5467
100278	17/08/2011	Dry winter	410	7.21	45.2	12.90	0.5397	0.5573
100283	17/08/2011	Dry winter	.	.	42.1	12.10	0.5267	0.5449
100287	17/08/2011	Dry winter	384	7.81	56.5	15.10	0.5494	0.5647
100292	17/08/2011	Dry winter	408	7.96	43.8	12.40	0.5318	0.5461
100296	17/08/2011	Dry winter	394	7.58	39.5	10.70	0.5216	0.5432
100310	17/08/2011	Dry winter	410	7.51	39.1	14.90	0.5624	0.5755
100312	17/08/2011	Dry winter	422	.	.	.		.
100320	17/08/2011	Dry winter	411	8.68	44.8	13.60	0.5346	0.5505
100328	17/08/2011	Dry winter	418	7.41	36.6	11.40	0.5348	0.5536
100339	17/08/2011	Dry winter	430	7.49	48.8	12.50	0.5290	0.5460
100355	17/08/2011	Dry winter	420	7.72	42.8	10.60	0.5259	0.5401
100361	17/08/2011	Dry winter	417	7.96	44.4	12.90	0.5424	0.5554

100373	17/08/2011	Dry winter	423	9.47	42.8	12.90	0.5307	0.5515
100382	17/08/2011	Dry winter	390	6.48	31.9	12.20	0.5442	0.5591
100394	17/08/2011	Dry winter	408	8.65	40.1	14.10	0.5549	0.5725
100395	17/08/2011	Dry winter	441	8.51	41.6	11.60	0.5211	0.5395
100398	17/08/2011	Dry winter	435	7.38	61.5	14.70	0.5204	0.5250
100402	17/08/2011	Dry winter	361	6.73	46.1	11.80	0.5251	0.5437
100404	17/08/2011	Dry winter	417	7.28	47.6	12.50	0.5342	0.5492
100411	17/08/2011	Dry winter	430	7.94	40.2	11.40	0.5291	0.5472
100412	17/08/2011	Dry winter	389	6.23	46.1	11.20	0.5198	0.5365
100417	17/08/2011	Dry winter	443	7.75	47.3	12.10	0.5286	0.5449
100421	17/08/2011	Dry winter	419	.	.	.		.
100427	17/08/2011	Dry winter	367	6.25	41.5	12.20	0.5287	0.5449
100434	17/08/2011	Dry winter	451	.	.	.		.
100439	17/08/2011	Dry winter	367	5.82	44.9	13.00	0.5382	0.5535
100457	17/08/2011	Dry winter	374	6.25	42.4	11.90	0.5232	0.5410
100460	17/08/2011	Dry winter	430	8.28	52.4	13.60	0.5455	0.5599
100466	17/08/2011	Dry winter	386	6.49	35.7	11.60	0.5339	0.5519
100469	17/08/2011	Dry winter	391	6.57	53.9	14.10	0.5391	0.5540
100475	17/08/2011	Dry winter	.	.	40.6	12.30	0.5388	0.5551
100495	17/08/2011	Dry winter	386	6.73	44.5	12.00	0.5252	0.5407
100496	17/08/2011	Dry winter	392	7.29	44.9	11.70	0.5347	0.5483
100502	17/08/2011	Dry winter	390	7.21	46.6	12.70	0.5324	0.5498
100504	17/08/2011	Dry winter	377	7.09	45.4	12.90	0.5389	0.5542
100506	17/08/2011	Dry winter	400	6.42	41.4	10.20	0.5158	0.5328
100509	17/08/2011	Dry winter	370	5.93	41.1	11.40	0.5162	0.5340
100513	17/08/2011	Dry winter	392	.	.	.		.
100527	17/08/2011	Dry winter	357	6.86	53.5	14.20	0.5511	0.5629
100539	17/08/2011	Dry winter	392	8.11	40.9	11.90	0.5403	0.5556
100007	13/09/2011	Spring	506	7.92	31.1	9.10	0.5082	0.5311
100014	13/09/2011	Spring	450	9.01	24.5	9.30	0.5236	0.5350
100018	13/09/2011	Spring	456	7.84	21.2	7.40	0.5154	0.5323
100020	13/09/2011	Spring	451	7.85	21.8	9.60	0.5054	0.5320
100023	13/09/2011	Spring	455	7.19	24.4	9.70	0.5268	0.5486
100025	13/09/2011	Spring	406	6.88	13.6	7.40	0.5179	0.5375
100027	13/09/2011	Spring	.	6.95	16.5	7.80	0.5106	0.5342
100033	13/09/2011	Spring	429	7.53	14.1	8.20	0.5207	0.5388
100037	13/09/2011	Spring	449	8.31	16.2	7.70	0.5038	0.5298
100041	13/09/2011	Spring	460	.	.	.		.
100052	13/09/2011	Spring	412	7.38	27.0	9.30	0.5112	0.5354
100061	13/09/2011	Spring	452	6.68	9.7	8.10	0.5066	0.5360
100063	13/09/2011	Spring	474	8.39	20.3	8.00	0.5068	0.5276
100064	13/09/2011	Spring	433	8.24	33.6	10.00	0.5063	0.5301
100070	13/09/2011	Spring	468	8.88	27.4	9.00	0.5157	0.5353
100071	13/09/2011	Spring	398	6.65	13.9	8.10	0.5236	0.5438
100077	13/09/2011	Spring	439	8.21	15.7	8.50	0.5291	0.5480
100083	13/09/2011	Spring	433	7.59	21.0	8.70	0.5066	0.5340

100084	13/09/2011	Spring	417	7.79	15.6	8.50	0.5230	0.5436
100105	13/09/2011	Spring	424	7.05	26.3	8.30	0.5001	0.5262
100110	13/09/2011	Spring	444	8.24	21.3	8.60	0.5290	0.5476
100122	13/09/2011	Spring	426	7.33	32.6	9.10	0.5057	0.5281
100125	13/09/2011	Spring	449	6.68	24.8	9.00	0.5139	0.5374
100130	13/09/2011	Spring	392	6.81	15.4	8.10	0.5331	0.5496
100132	13/09/2011	Spring	442	8.06	20.5	8.10	0.5079	0.5290
100156	13/09/2011	Spring	.	.	37.0	9.20	0.5009	0.5235
100168	13/09/2011	Spring	.	3.92	16.4	8.20	0.5035	0.5191
100174	13/09/2011	Spring	471	9.62	33.8	9.80	0.5092	0.5286
100178	13/09/2011	Spring	430	7.74	20.3	9.20	0.5065	0.5331
100183	13/09/2011	Spring	468	8.42	25.6	9.70	0.5075	0.5337
100185	13/09/2011	Spring	392	6.66	26.6	7.20	0.5111	0.5282
100197	13/09/2011	Spring	491	7.92	20.6	8.10	0.5146	0.5372
100198	13/09/2011	Spring	497	8.97	23.1	8.90	0.5078	0.5360
100203	13/09/2011	Spring	377	5.61	28.0	8.30	0.5138	0.5351
100224	13/09/2011	Spring	458	7.81	22.1	7.20	0.5067	0.5315
100225	13/09/2011	Spring	395	7.48	20.6	6.40	0.5036	0.5258
100227	13/09/2011	Spring	409	6.75	20.3	7.60	0.5126	0.5348
100231	13/09/2011	Spring	419	7.01	11.5	7.60	0.5317	0.5486
100272	13/09/2011	Spring	384	8.07	23.3	8.10	0.5189	0.5401
100276	13/09/2011	Spring	385	6.92	20.9	7.10	0.5021	0.5273
100278	13/09/2011	Spring	422	9.76	11.6	10.30	0.5070	0.5532
100283	13/09/2011	Spring	.	.		.		.
100287	13/09/2011	Spring	392	6.88	20.4	9.10	0.5195	0.5445
100292	13/09/2011	Spring	420	7.51	22.0	6.70	0.5001	0.5279
100296	13/09/2011	Spring	405	7.46	21.4	7.00	0.5046	0.5314
100310	13/09/2011	Spring	424	.	.	.		.
100312	13/09/2011	Spring	431	7.72	23.3	7.40	0.5217	0.5388
100320	13/09/2011	Spring	411	7.83	19.9	6.50	0.5047	0.5294
100328	13/09/2011	Spring	441	8.62	23.8	8.10	0.5206	0.5394
100339	13/09/2011	Spring	446	6.96	31.5	8.60	0.5042	0.5301
100355	13/09/2011	Spring	451	8.90	20.3	8.50	0.5166	0.5352
100361	13/09/2011	Spring	435	8.07	33.5	8.90	0.5064	0.5280
100373	13/09/2011	Spring	432	8.27	17.1	6.70	0.5007	0.5254
100382	13/09/2011	Spring	396	6.99	11.8	7.30	0.5155	0.5386
100394	13/09/2011	Spring	427	7.48	28.6	8.70	0.5038	0.5260
100395	13/09/2011	Spring	467	8.53	15.0	8.10	0.5276	0.5447
100398	13/09/2011	Spring	449	7.09	18.2	7.00	0.5010	0.5262
100402	13/09/2011	Spring	377	6.95	21.5	8.00	0.5179	0.5432
100404	13/09/2011	Spring	439	.	.	.		.
100411	13/09/2011	Spring	446	8.38	25.6	7.70	0.4931	0.5217
100412	13/09/2011	Spring	.	.	27.1	7.50	0.4977	0.5226
100417	13/09/2011	Spring	471	8.54	29.2	8.80	0.5098	0.5337
100421	13/09/2011	Spring	450	7.38	22.6	7.20	0.4989	0.5255
100427	13/09/2011	Spring	375	7.44	22.1	8.10	0.5168	0.5366

100434	13/09/2011	Spring	464	8.64	28.5	8.10	0.4927	0.5181
100439	13/09/2011	Spring	377	6.43	33.3	8.90	0.5052	0.5248
100457	13/09/2011	Spring	387	6.98	20.5	7.90	0.5207	0.5408
100460	13/09/2011	Spring	435	8.05	21.9	7.40	0.5064	0.5290
100466	13/09/2011	Spring	397	7.20	23.2	8.00	0.5335	0.5469
100469	13/09/2011	Spring	406	7.26	24.3	7.90	0.4978	0.5219
100475	13/09/2011	Spring	.			.		.
100495	13/09/2011	Spring	407	7.08	26.5	9.50	0.5059	0.5284
100496	13/09/2011	Spring	410	.	.	.		.
100502	13/09/2011	Spring	406	7.19	23.0	9.30	0.5146	0.5377
100504	13/09/2011	Spring	391	6.86	12.9	8.00	0.5280	0.5471
100506	13/09/2011	Spring	420	7.05	25.8	8.70	0.5079	0.5340
100509	13/09/2011	Spring	386	5.40	15.3	7.20	0.4995	0.5249
100513	13/09/2011	Spring	399	6.62	24.1	9.00	0.5135	0.5401
100527	13/09/2011	Spring	378	.	.	.		.
100539	13/09/2011	Spring	412	7.00	15.7	8.00	0.5188	0.5388
100007	7/10/2011	Spring	524	8.86	18.9	7.46	0.5187	0.5442
100014	7/10/2011	Spring	455	6.89	19.3	6.42	0.5071	0.5328
100018	7/10/2011	Spring	454	8.20	54.1	8.60	0.4832	0.5053
100020	7/10/2011	Spring	451	8.99	29.7	9.83	0.5455	0.5581
100023	7/10/2011	Spring	456	6.42	20.7	9.08	0.5412	0.5559
100025	7/10/2011	Spring	410	.	.	.		.
100027	7/10/2011	Spring	415	7.57	28.8	7.81	0.5107	0.5330
100033	7/10/2011	Spring	445	7.19	31.6	6.55	0.5134	0.5332
100037	7/10/2011	Spring	458	8.11	24.9	6.71	0.5169	0.5388
100041	7/10/2011	Spring	453	.	.	.		.
100052	7/10/2011	Spring	407	7.19	37.9	8.59	0.5287	0.5381
100061	7/10/2011	Spring	460	8.67	50.6	10.23	0.5169	0.5324
100063	7/10/2011	Spring	480	8.22	33.8	7.60	0.4961	0.5187
100064	7/10/2011	Spring	434	8.45	33.8	8.62	0.5238	0.5396
100070	7/10/2011	Spring	438	7.09	38.8	8.39	0.4931	0.5172
100071	7/10/2011	Spring	417	7.56	45.7	9.64	0.5318	0.5372
100077	7/10/2011	Spring	461	7.58	23.1	7.08	0.5147	0.5358
100083	7/10/2011	Spring	440	7.94	27.5	8.62	0.5104	0.5307
100084	7/10/2011	Spring	423	7.34	39.0	7.85	0.5047	0.5219
100105	7/10/2011	Spring	416	7.11	27.8	6.30	0.4912	0.5193
100110	7/10/2011	Spring	458	7.82	37.8	7.80	0.5020	0.5202
100122	7/10/2011	Spring	431	7.67	46.2	8.70	0.5014	0.5200
100125	7/10/2011	Spring	453	7.70	23.1	5.75	0.5083	0.5333
100130	7/10/2011	Spring	392	6.14	35.7	8.18	0.4991	0.5233
100132	7/10/2011	Spring	462	7.36	36.2	7.88	0.5078	0.5269
100156	7/10/2011	Spring	480	8.07	27.9	7.79	0.5150	0.5413
100168	7/10/2011	Spring	392	6.74	28.8	7.25	0.4986	0.5228
100174	7/10/2011	Spring	478	8.38	22.0	6.76	0.4978	0.5237
100178	7/10/2011	Spring	442	7.50	30.3	6.99	0.5045	0.5262
100183	7/10/2011	Spring	487	7.89	28.6	7.33	0.5201	0.5397

100185	7/10/2011	Spring	395	5.98	22.6	7.57	0.5147	0.5356
100197	7/10/2011	Spring	473	8.17	25.4	6.86	0.5117	0.5316
100198	7/10/2011	Spring	508	10.65	28.9	8.14	0.5425	0.5473
100203	7/10/2011	Spring	371	6.61	26.8	6.52	0.5009	0.5251
100224	7/10/2011	Spring	464	8.49	34.4	8.82	0.4967	0.5171
100225	7/10/2011	Spring	412	7.06	53.6	9.52	0.5088	0.5248
100227	7/10/2011	Spring	414	7.60	43.4	8.91	0.5080	0.5288
100231	7/10/2011	Spring	419	7.34	51.4	9.53	0.4961	0.5148
100272	7/10/2011	Spring	399	7.32	27.3	6.24	0.4843	0.5112
100276	7/10/2011	Spring	394	7.17	41.9	7.57	0.4961	0.5142
100278	7/10/2011	Spring	436	7.63	38.0	7.58	0.4998	0.5179
100283	7/10/2011	Spring	.	.	.	.		.
100287	7/10/2011	Spring	410	7.32	41.1	9.16	0.5235	0.5343
100292	7/10/2011	Spring	420	7.73	26.0	6.61	0.4992	0.5234
100296	7/10/2011	Spring	407	7.25	39.0	7.52	0.4963	0.5172
100310	7/10/2011	Spring	426	7.84	42.6	8.83	0.4972	0.5171
100312	7/10/2011	Spring	461	.	.	.		.
100320	7/10/2011	Spring	422	7.41	28.4	7.51	0.5057	0.5265
100328	7/10/2011	Spring	438	7.84	40.7	9.00	0.5104	0.5319
100339	7/10/2011	Spring	450	7.89	26.4	7.20	0.5021	0.5257
100355	7/10/2011	Spring	463	8.30	50.4	8.70	0.5037	0.5160
100361	7/10/2011	Spring	435	7.94	22.1	6.00	0.5004	0.5282
100373	7/10/2011	Spring	461	8.45	37.1	7.40	0.5047	0.5241
100382	7/10/2011	Spring	413	5.41	24.2	7.60	0.5040	0.5296
100394	7/10/2011	Spring	420	7.26	20.1	7.10	0.5126	0.5410
100395	7/10/2011	Spring	461	7.00	40.1	8.80	0.4904	0.5094
100398	7/10/2011	Spring	.	.	44.8	8.80	0.4854	0.5110
100402	7/10/2011	Spring	382	6.28	37.9	7.50	0.4996	0.5194
100404	7/10/2011	Spring	438	7.81	24.0	8.50	0.5359	0.5545
100411	7/10/2011	Spring	459	8.30	29.1	8.60	0.5352	0.5486
100412	7/10/2011	Spring	405	7.30	24.2	6.60	0.4934	0.5212
100417	7/10/2011	Spring	489	.	30.5	.		.
100421	7/10/2011	Spring	455	9.05	29.6	10.40	0.5549	0.5627
100427	7/10/2011	Spring	386	7.24	36.8	8.10	0.5015	0.5210
100434	7/10/2011	Spring	475	8.35	25.1	7.00	0.5022	0.5276
100439	7/10/2011	Spring	384	6.22	23.8	7.40	0.5164	0.5373
100457	7/10/2011	Spring	398	6.78	36.3	8.60	0.5114	0.5335
100460	7/10/2011	Spring	456	7.55	43.7	7.60	0.5007	0.5206
100466	7/10/2011	Spring	411	.	.	.		.
100469	7/10/2011	Spring	415	6.99	50.7	8.70	0.4976	0.5149
100475	7/10/2011	Spring	.	.	.	.		.
100495	7/10/2011	Spring	400	7.59	31.1	7.70	0.4981	0.5222
100496	7/10/2011	Spring	429	8.06	51.8	9.80	0.5091	0.5228
100502	7/10/2011	Spring	412	6.94	41.8	9.10	0.5029	0.5201
100504	7/10/2011	Spring	400	6.88	43.7	9.90	0.5136	0.5325
100506	7/10/2011	Spring	424	7.47	28.3	7.50	0.5021	0.5282

100509	7/10/2011	Spring	382	6.71	30.6	7.00	0.4955	0.5192
100513	7/10/2011	Spring	409	7.05	25.4	7.80	0.5156	0.5401
100527	7/10/2011	Spring	386	.	.	.		.
100539	7/10/2011	Spring	420	7.47	39.9	9.70	0.5253	0.5380
100007	26/10/2011	Spring	490	7.60	35.3	7.50	0.4909	0.5048
100014	26/10/2011	Spring	453	6.88	26.8	7.90	0.5088	0.5200
100018	26/10/2011	Spring	453	8.18	32.2	8.90	0.4954	0.5120
100020	26/10/2011	Spring	435	6.26	27.1	8.00	0.4803	0.5008
100023	26/10/2011	Spring	448	7.77	43.6	9.30	0.4897	0.5048
100025	26/10/2011	Spring	403	6.70	29.6	7.00	0.4865	0.5024
100027	26/10/2011	Spring	415	6.81	33.8	8.80	0.485	0.5026
100033	26/10/2011	Spring	421	6.61	18.1	8.00	0.5129	0.5327
100037	26/10/2011	Spring	.	.	24.6	7.40	0.4887	0.5093
100041	26/10/2011	Spring	452	7.89	33.7	8.20	0.5005	0.5146
100052	26/10/2011	Spring	415	7.26	33.5	8.40	0.5002	0.5142
100061	26/10/2011	Spring	441	6.86	26.0	7.60	0.4874	0.5035
100063	26/10/2011	Spring	457	9.14	33.0	10.40	0.5142	0.5241
100064	26/10/2011	Spring	421	7.11	41.2	9.20	0.4953	0.5107
100070	26/10/2011	Spring	454	8.43	29.8	8.20	0.4885	0.5088
100071	26/10/2011	Spring	399	7.05	24.4	7.50	0.5055	0.5215
100077	26/10/2011	Spring	441	7.69	26.5	9.30	0.5173	0.5276
100083	26/10/2011	Spring	446	6.19	38.6	8.10	0.4776	0.4990
100084	26/10/2011	Spring	399	7.10	22.6	8.10	0.5135	0.5298
100105	26/10/2011	Spring	414	6.05	35.0	7.30	0.4907	0.5073
100110	26/10/2011	Spring	434	7.94	25.2	8.00	0.5016	0.5206
100122	26/10/2011	Spring	420	7.12	32.1	7.50	0.5029	0.5182
100125	26/10/2011	Spring	431	7.16	28.4	6.60	0.4845	0.5077
100130	26/10/2011	Spring	380	7.80	26.1	8.80	0.5176	0.5332
100132	26/10/2011	Spring	424	6.89	26.3	8.60	0.5016	0.5195
100156	26/10/2011	Spring	454	7.66	35.1	6.80	0.4823	0.4979
100168	26/10/2011	Spring	391	7.21	31.1	7.90	0.5066	0.5204
100174	26/10/2011	Spring	470	.	.	.		.
100178	26/10/2011	Spring	424	7.46	31.7	7.00	0.4932	0.5072
100183	26/10/2011	Spring	470	8.30	44.1	8.40	0.4804	0.4955
100185	26/10/2011	Spring	385	6.75	38.3	7.30	0.49	0.5041
100197	26/10/2011	Spring	480	7.60	34.4	7.20	0.4834	0.5030
100198	26/10/2011	Spring	482	7.83	30.8	7.30	0.4914	0.5092
100203	26/10/2011	Spring	373	6.61	35.4	8.10	0.4996	0.5120
100224	26/10/2011	Spring	433	7.12	25.9	6.80	0.4829	0.5059
100225	26/10/2011	Spring	410	7.84	28.6	8.00	0.5034	0.52
100227	26/10/2011	Spring	403	7.55	29.1	9.10	0.5065	0.52
100231	26/10/2011	Spring	409	7.51	32.4	7.80	0.5124	0.53
100272	26/10/2011	Spring	385	6.98	23.3	7.80	0.4962	0.52
100276	26/10/2011	Spring	370	7.38	30.0	6.50	0.4969	0.51
100278	26/10/2011	Spring	419	8.12	30.0	7.30	0.4956	0.51
100283	26/10/2011	Spring	.	.	.	.		.

100287	26/10/2011	Spring	387	6.36	51.6	9.30	0.4838	0.50
100292	26/10/2011	Spring	413	7.45	28.3	8.50	0.4985	0.51
100296	26/10/2011	Spring	394	7.70	25.4	8.30	0.5105	0.52
100310	26/10/2011	Spring	411	7.87	24.0	7.90	0.5083	0.53
100312	26/10/2011	Spring	452	6.53	35.1	9.50	0.5065	0.52
100320	26/10/2011	Spring	412	8.63	26.1	7.20	0.5095	0.52
100328	26/10/2011	Spring	426	6.72	23.6	7.40	0.5064	0.52
100339	26/10/2011	Spring	444	7.48	31.1	7.90	0.5062	0.52
100355	26/10/2011	Spring	445	7.32	40.3	9.30	0.4991	0.51
100361	26/10/2011	Spring	423	6.84	41.3	8.10	0.5028	0.51
100373	26/10/2011	Spring	430	7.65	25.8	6.60	0.4964	0.51
100382	26/10/2011	Spring	400	6.37	16.9	8.00	0.528	0.53
100394	26/10/2011	Spring	438	7.64	36.9	7.80	0.4914	0.51
100395	26/10/2011	Spring	462	8.43	31.6	9.50	0.4986	0.51
100398	26/10/2011	Spring	454	6.84	24.0	8.20	0.4849	0.51
100402	26/10/2011	Spring	372	5.84	25.9	8.20	0.5019	0.52
100404	26/10/2011	Spring	446	7.99	32.1	7.60	0.5035	0.51
100411	26/10/2011	Spring	443	7.47	36.1	7.40	0.4816	0.50
100412	26/10/2011	Spring	397	.	.	.		.
100417	26/10/2011	Spring	491	7.89	32.6	7.50	0.4894	0.51
100421	26/10/2011	Spring	436	7.31	29.1	8.00	0.4963	0.52
100427	26/10/2011	Spring	357	7.14	34.6	8.50	0.4974	0.51
100434	26/10/2011	Spring	445	7.17	30.8	7.70	0.4936	0.51
100439	26/10/2011	Spring	363	6.27	31.4	7.80	0.4923	0.51
100457	26/10/2011	Spring	396	6.86	31.8	7.70	0.4948	0.51
100460	26/10/2011	Spring	439	7.91	30.1	8.70	0.4918	0.51
100466	26/10/2011	Spring	399	7.63	26.0	9.00	0.5181	0.53
100469	26/10/2011	Spring	414	5.95	42.1	9.40	0.4952	0.50
100475	26/10/2011	Spring	.	.	.	.		.
100495	26/10/2011	Spring	399	6.96	34.8	8.70	0.4966	0.52
100496	26/10/2011	Spring	425	7.30	30.6	8.80	0.4929	0.51
100502	26/10/2011	Spring	400	6.70	22.6	10.20	0.5281	0.53
100504	26/10/2011	Spring	388	6.70	23.4	8.70	0.519	0.53
100506	26/10/2011	Spring	435	.	.	.		.
100509	26/10/2011	Spring	377	6.77	34.3	7.40	0.4791	0.4957
100513	26/10/2011	Spring	392	6.73	30.0	8.80	0.4967	0.5197
100527	26/10/2011	Spring	378	6.50	38.5	7.90	0.4968	0.5138
100539	26/10/2011	Spring	403	7.80	29.6	8.00	0.5053	0.5190
100007	16/11/2011	Spring	475	7.82	27.9	6.10	0.4992	0.5218
100014	16/11/2011	Spring	425	6.97	26.3	6.90	0.5255	0.5403
100018	16/11/2011	Spring	434	6.41	33.1	7.60	0.4847	0.5084
100020	16/11/2011	Spring	415	6.30	28.0	6.50	0.5121	0.5293
100023	16/11/2011	Spring	429	7.30	37.1	8.80	0.5201	0.5362
100025	16/11/2011	Spring	414	6.28	40.6	6.70	0.4893	0.5036
100027	16/11/2011	Spring	393	7.63	41.4	9.20	0.5119	0.5344
100033	16/11/2011	Spring	418	6.20	35.8	7.80	0.4854	0.5056

100037	16/11/2011	Spring	458	8.32	26.4	6.40	0.5099	0.5281
100041	16/11/2011	Spring	420	7.46	31.7	7.40	0.5171	0.5374
100052	16/11/2011	Spring	399	6.80	35.7	7.80	0.5226	0.5375
100061	16/11/2011	Spring	427	7.86	36.6	8.90	0.5105	0.5282
100063	16/11/2011	Spring	466	6.95	44.3	9.30	0.4876	0.5105
100064	16/11/2011	Spring	402	6.41	38.2	8.40	0.4964	0.5220
100070	16/11/2011	Spring	415	7.12	33.4	8.20	0.5182	0.5394
100071	16/11/2011	Spring	407	6.32	29.1	7.70	0.4802	0.5068
100077	16/11/2011	Spring	433	7.06	33.1	7.40	0.4989	0.5108
100083	16/11/2011	Spring	415	6.80	39.6	7.70	0.5003	0.5198
100084	16/11/2011	Spring	411	6.61	35.3	8.10	0.4912	0.5077
100105	16/11/2011	Spring	398	6.05	36.8	8.50	0.5095	0.5283
100110	16/11/2011	Spring	439	7.22	39.7	8.90	0.4900	0.5048
100122	16/11/2011	Spring	439	7.42	43.0	8.50	0.4828	0.4994
100125	16/11/2011	Spring	429	8.42	31.0	9.10	0.5370	0.5460
100130	16/11/2011	Spring	377	6.15	32.8	7.40	0.4943	0.5107
100132	16/11/2011	Spring	437	5.93	33.6	9.60	0.5053	0.5200
100156	16/11/2011	Spring	434	7.46	37.8	7.90	0.5088	0.5268
100168	16/11/2011	Spring	355	5.87	38.6	8.60	0.5010	0.5267
100174	16/11/2011	Spring	433	7.79	36.8	7.70	0.5059	0.5289
100178	16/11/2011	Spring	422	7.32	31.2	8.40	0.5199	0.5352
100183	16/11/2011	Spring	441	7.71	33.7	7.80	0.5116	0.5300
100185	16/11/2011	Spring	378	6.75	30.0	6.60	0.5061	0.5261
100197	16/11/2011	Spring	460	9.58	37.4	8.30	0.5149	0.5258
100198	16/11/2011	Spring	469	7.32	30.4	6.40	0.4937	0.5161
100203	16/11/2011	Spring	341	6.71	45.1	8.40	0.5051	0.5270
100224	16/11/2011	Spring	458	7.02	45.6	9.10	0.4785	0.5004
100225	16/11/2011	Spring	395	5.98	38.1	8.30	0.4918	0.5123
100227	16/11/2011	Spring	428	6.60	48.8	7.60	0.4828	0.4995
100231	16/11/2011	Spring	412	.	.	.		.
100272	16/11/2011	Spring	391	6.36	35.6	7.90	0.4729	0.4977
100276	16/11/2011	Spring	383	5.73	38.6	7.20	0.4818	0.5033
100278	16/11/2011	Spring	435	6.20	35.3	8.10	0.4830	0.5040
100283	16/11/2011	Spring	.	.	.	.		.
100287	16/11/2011	Spring	395	6.13	44.5	7.90	0.4825	0.5024
100292	16/11/2011	Spring	380	8.34	37.1	8.00	0.4956	0.5214
100296	16/11/2011	Spring	401	6.09	40.6	7.80	0.4695	0.4905
100310	16/11/2011	Spring	407	6.96	44.5	9.30	0.4789	0.5026
100312	16/11/2011	Spring	452	6.37	36.2	8.00	0.4897	0.5092
100320	16/11/2011	Spring	414	6.09	36.4	8.40	0.4814	0.5017
100328	16/11/2011	Spring	431	7.22	42.1	7.70	0.4776	0.4986
100339	16/11/2011	Spring	404	8.74	44.6	8.70	0.5055	0.5267
100355	16/11/2011	Spring	439	6.57	42.5	8.90	0.4960	0.5131
100361	16/11/2011	Spring	396	7.95	35.0	6.60	0.5082	0.5309
100373	16/11/2011	Spring	451	6.52	29.2	6.20	0.4859	0.5125
100382	16/11/2011	Spring	410	.	.	.		.

100394	16/11/2011	Spring	404	7.09	31.8	7.30	0.4969	0.5270
100395	16/11/2011	Spring	478	.	.	.		.
100398	16/11/2011	Spring	466	5.61	48.9	9.90	0.4890	0.5046
100402	16/11/2011	Spring	366	.	.	.		.
100404	16/11/2011	Spring	411	6.73	32.6	8.60	0.5186	0.5384
100411	16/11/2011	Spring	426	6.39	29.4	7.00	0.4867	0.5099
100412	16/11/2011	Spring	384	5.71	31.2	7.90	0.5041	0.5235
100417	16/11/2011	Spring	475	8.61	27.8	7.90	0.5146	0.5287
100421	16/11/2011	Spring	414	6.91	36.8	8.40	0.4933	0.5186
100427	16/11/2011	Spring	378	6.03	37.8	9.70	0.4837	0.5015
100434	16/11/2011	Spring	437	7.66	29.5	6.90	0.5014	0.5211
100439	16/11/2011	Spring	350	5.90	30.6	8.20	0.5163	0.5302
100457	16/11/2011	Spring	387	5.49	.	9.10	0.4850	0.5044
100460	16/11/2011	Spring	461	7.59	49.9	7.80	0.4862	0.5022
100466	16/11/2011	Spring	394	5.79	34.9	8.70	0.4995	0.5138
100469	16/11/2011	Spring	415	6.46	38.8	9.50	0.4873	0.5052
100475	16/11/2011	Spring	.	.	48.0	.		.
100495	16/11/2011	Spring	366	7.19	45.3	12.40	0.5243	0.5433
100496	16/11/2011	Spring	428	6.67	40.6	8.90	0.4944	0.5092
100502	16/11/2011	Spring	415	5.57	31.2	8.90	0.4945	0.5130
100504	16/11/2011	Spring	402	5.83	35.0	8.40	0.4956	0.5106
100506	16/11/2011	Spring	402	7.29	32.9	7.00	0.4988	0.5182
100509	16/11/2011	Spring	355	6.55	31.2	9.10	0.5177	0.5323
100513	16/11/2011	Spring	371	6.02	36.7	9.30	0.5087	0.5332
100527	16/11/2011	Spring	354	5.70	34.9	7.90	0.5044	0.5263
100539	16/11/2011	Spring	407	6.77	36.3	8.00	0.4900	0.5047

5. Bibliography

ARC (1980) 'The nutrient requirements of ruminant livestock.' Agricultural Research Council. (CAB International: Wallingford UK).

Charmley, E., Stephens, M.L., Kennedy, P.M., 2008. Predicting livestock productivity and methane emissions in northern Australia: development of a bio-economic modelling approach. *Aust. J. Expt. Agric*. **48**, 109-113.

Kennedy, P.M. and Charmley, E. (2012). Methane yields from Brahman cattle fed tropical grasses and legumes. Animal Production science **52**, 225-239

McGinn, S.M., Turner, D., Tomkins, N., Charmley, E., Bishop-Hurley, G. And Chen, D. (2011). Methane emissions from grazing cattle using point-source dispersion. Journal of environmental Quality **40**,22-27.

SCA 1990. 'Feeding standards for Australian livestock, ruminants.' Standing Committee on Agriculture. (CSIRO Publications: Melbourne)

Tomkins, N.W., McGinn, S.M., Turner, D.A. and Charmley, E. 2011. Comparison of open-circuit respiration chambers with a micrometeorological method for determining methane emissions from beef cattle grazing a tropical pasture. *Anim. Feed Sci. Tech*. **166-167**, 240-247.