New Zealand Greenhouse Gas Inventory
Approval for change to emission factor, parameter or methodology

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[1]	Agriculture
Name of EF, variable or category	Nitrogen excretion (Nex) broilers and layers.
Current value of emission factor, variable or methodology Tier	Poultry 0.6 kgN/head/year
Suggested value of emission factor, variable or methodology Tier	layers 0.416 kgN/head/year broilers 0.390 kgN/head/year (default of 0.6 kg N animal-1 year-1 remains for ducks and turkeys)
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	Yes, based on …….

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	Comprehensive review of NZ and Overseas literature. Justification on basis of feed regimes for poultry.
Is the proposed change scientifically defensible?	Yes	Analysis of Nitrogen from excreta and on using different feeding regimes sourced from NZ experiments and survey of international literature.
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	There is no change to the methodology only the emissions value for nitrogen excreta is changing to a country specific emissions factor based on this research. Parties are encouraged to use country specific emissions factors when they become available.
Is any new EF, variable or methodology comparable with any other countries?	Yes	Most parties report between 0.21 and 0.78. Japan appears as an outlier 1.02.
Is the level of uncertainty reported?	Yes	Emissions factors are provided with an uncertainty range.

[1] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	The values proposed are compared against IPCC2006 and IPCC1996 defaults and ranges.

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[2]	Agriculture
Name of EF, variable or category	Volatile Solids (VS) for broilers and layers.
Current value of volatile solids value, variable or methodology Tier	Poultry 0.1 kg VS day-1
Suggested value for volatile solids, variable or methodology Tier	layers 0.014 kg VS day-1 broilers 0.019 kg VS day-1 ducks 0.023 kg VS day-1 turkeys 0.11 kg VS day-1
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	Yes based on overestimation of default values under NZ conditions, specific to poultry sub-classes

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	Comprehensive review of NZ and Overseas literature. Justification on basis of specific for poultry.
Is the proposed change scientifically defensible?	Yes	Analysis of excreta volumes per head related to overall efficiency of management and on different feed regimes taken from NZ experiments and survey of international literature.
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	There is no change to the methodology only the emissions value for volatile solids is changing to a country and poultry class specific emissions factor based on this research. Parties are encouraged to use country specific emissions factors when they become available.
Is any new EF, variable or methodology comparable with any other countries?	Yes	Most parties report between 0.21 and 0.78. Japan appears as an outlier 1.02.
Is the level of uncertainty reported?	Yes	Emissions factors are provided with an uncertainty range.

[2] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	The values proposed are compared against IPCC2006 and IPCC1996 defaults and ranges.

Bo Review

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[3]	Agriculture
Name of EF, variable or category	Bo for layers, broilers, turkeys and ducks
Current value of Bo value, variable or methodology Tier	No recommendation in review Current Bo literature values (Table 5.1. Page 61) Mean Range Bo Layers 0.39 (0.332-0.496) Bo Broilers 0.375 (0.306-0.414) Bo Turkeys 0.36 (+/-15%) Bo Ducks 0.36 (+/- 15%)
Suggested value for Bo, variable or methodology Tier	**Lower range suggested values:** Bo Layers 0.33 (min of range) Bo Broilers 0.31 (-18%) Bo Turkeys 0.31 (-15%) Bo Ducks 0.36 (no change)
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	Yes based on: NZ Temperatures are cool not temperate Higher aeration, ventilation rates and practices Manure is removed quickly and in a dry state for layers and broilers (reducing the likelihood of high Methane emissions) 1. High analysis formulations based on true amino acid/N digestibility (not total amino acids, crude protein) used in NZ 2. High health status, low gut enteric loadings and low disease/pathogens levels versus Other International countries. 3. High quality ingredients and quality assurance systems 4. Gut digestibility modifiers/enhancers as enzymes used routinely in all 4 poultry sub-classes above 5. Biological, mechanistic models used to enhance performance efficiency and nutrient utilization. 6. Other species having lower Bo values in

[3] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

	more recent literature compared to poultry classes (Reindeer 0.19, Rabbits 0.32, Fur-bearing animals 0.25, Ostrich 0.25)

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	Comment
Is the need for a change well documented?	Yes	Comprehensive review of Overseas literature and NZ ration formulations, management and health status
Is the proposed change scientifically defensible?	Yes	Bo recommendations are line with survey data of international literature for other species.
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	There is no change to the methodology only the emissions value for Bo is changing to a country and poultry class specific emissions factor based on this research and practical conditions under which poultry and manure is managed in this country. Parties are encouraged to use country specific emissions factors when they become available.

EF3 Review

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[4]	Agriculture
Name of EF, variable or category	EF3 for poultry
Current value of EF3 value, variable or methodology Tier	Non-poultry-specific EF3, 0.005 kg N2O-N/kg for litter category birds
Suggested value for EF3, variable or methodology Tier	Reduce poultry-specific EF3 value to 0.001 kg N2)-N/kg N (from IPCC 1996, 2006 and AWMS)
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	Yes, based on three international data reference sources (above) Value should be species specific and litter category dependent

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	Comprehensive review of Overseas literature
Is the proposed change scientifically defensible?	Yes	EF3 recommendations are line with survey data of international literature for other species.
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	There is no change to the methodology only the emissions value for EF3 is changing to species and litter specific emissions factor based on this research. Parties are encouraged to use country specific emissions factors when they become available.

[4] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[5]	Agriculture
Name of EF, variable or category	**Flock Size Calculations for Broilers and Layers**
Current values	Assumptions, equations and calculations used are sound and acceptable
Suggested values, variable or methodology Tier	No change suggested other than to review poultry sectors which have experienced considerable historic growth since inception i.e. broiler industry. A 5-10 year review to update total emissions outputs and efficiency effects on outputs is recommended at least for the meat chicken industry. Model data output be used and compared to other research data to set up base N excretion numbers for broilers.
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	Growth estimates can be ratified through Stats NZ trends analysis and PIANZ, hatchery levy and placement data.
Is the proposed change scientifically defensible?	Yes	Based on historic growth trends of the broiler industry Models sufficiently accurate in calculating N excretion outputs.
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	For population size calculations, the equations, assumptions and algorithms Used are consistent and acceptable

[5] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

7.0 Methodology Used to Calculate Flock Sizes

(Section 7 Page 66)

The overestimation of broiler flock size in equation 13 due to lack of consideration of downtime has been addressed by adopting equation 14. Agree, that downtime is considerable and variable especially in the outbreak of disease when sheds can be extensively rested. Growing cycles can be affected and while 6.1 is used, lower numbers could be appropriate i.e. 5.5-5.8. In respect of not underestimating total emissions, the higher number of batches/cycles per year should be used.

All mortality contribution areas have been covered in the equation 14 (Page 67). Mortality estimates are realistic with knowledge that most of the broiler industry is less than 3.5-4%. (3.19% indicated on P68). Equation 14 calculates numbers that are generally considered correct when compared with other industry personnel (hatchery operators).

The shed removal schedules in table 7.1-7.3 are acceptable estimates according to days grown.

As rightly discussed and asserted, the average days to same slaughter weights will continue to decrease. In respect of this trend, all emissions documents should have an automatic review period to readjust for improvements coming from in genetic performance, management, nutrition/feeding, digestive modifiers, health status and environmental mental changes.

Table 7.2 (Pg 69) Algorithms used for Meat Chicken Breeding stock are acceptable. Stats New Zealand ,2011 data will be perfectly adequate to estimate size of the current breeding flock. The size of this flock is likely to change to most of all poultry breeding flocks based on the considerable growth in chicken meat consumption. This should be reviewed every 5 years in conjunction with the chicken meat consumption increases observed annually in New Zealand (and overseas).

Table 7.3. Turkey and Duck breeding stock numbers are very small and relatively static. PIANZ data will be as close to the real numbers as is possible to find. There is no other data set or source to improve on over this.

Table 7.4 Laying Hens for Commercial Egg Production. This national flock is relatively static and consumption of eggs per person has reached a relatively stable plateau. Forced moulting of layers does not occur in this country like many others however, even with this practice there is still no extra “hen places per annum” that are available which may lead to under or overestimation of the national flock size if based on placements data alone.
The number of flocks or birds not picked up by RMP or NZFSA or EPFNZ statistics is negligible. Flock numbers quoted are within generally accepted industry and hatchery company/personnel placement “talk/quotes”.

Table 7.5 Replacement Stock Numbers for Egg Production. Given the typical layer cycle of 75-80 weeks, the number of rearing birds according to Statistics New Zealand 2009-2010 is in accord with this production period. Notably, the layer cycle is getting longer due to better management, shedding/environment, mortality/health status, genetic improvements made to egg quality (internal and shell) and egg production. The optimum economic replacement age has increased from 62 weeks of age to 75-82 weeks of age from the 1980s to 2010.

(Simon I wrote this originally with specific names mentioned but thought this maybe too specific afterwards-have left it in as background but can be deleted as covered similar data in another way above-your call or cut and paste sections that are helpful)

Methodology Used for Calculating Flock Sizes for Broilers and Layers

4) Survey Information

The broiler industry and market is predominately owned and supplied respectively by 2 major and 2 minor companies. These include major parties Tegel and Inghams and minor parties Van den Brinks and Turks Poultry. Being all PIANZ members historically and currently, information supplied should be considered close to 95-100% correct. Levies are paid to PIANZ from the breeder hatchery section of these companies or hatchery supplying non hatchery integrated broiler producers. Data from PIANZ on size and growth of the broiler market should be considered the most accurate source of data available to MAF. The growth of the broiler/chicken market is high and rolling estimates of 4-7% per annum have been made. Growth estimates should be included in any projective calculations for at least the broiler industry section.

Layer industry is more static than the broiler industry and inside numbers quoted within integrators and hatchery companies has the industry size at about 3,500,000 million layers. The backyard, free range industry is growing faster than the housed tiered cage market and there is less canvassing and membership for producers, being more a cottage industry at this point. The largest free range producers are still those with large integrated cage produced operations also hence bird numbers by system would be captured by PIANZ membership and Hatchery company levies (source of population statistics) paid to PIANZ etc.

The free range, back yard, non auditable layer market should be considered to be no more than 4-500,000 birds or 10% of the surveyed and estimated size of this industry. However a growth estimate of 5-10% per annum could reasonably be included for the free range, back yard, non-PIANZ membership section of the egg producing industry.

The duck market is small (far smaller than in Australasia for instance), however it is growing. Again PIANZ membership allows for the most accurate estimate of the size of this market being mainly drive and supplied by two main companies as the report correctly states. Backyard and organic duck producers are growing

but are very minor players in terms of volumes or contributions made to emissions factors of any description.

The turkey market is indeed small and is still driven by seasonal Christmas demand rather than regular monthly consumption. There are no known smaller non registered producers of turkeys and the report rightly asserts that there are 2 main companies (Tegels and Croziers) and that this would represent 95-100% of that industry. Inghams do not have a turkey operation, only one for broilers.

Table 7.6 Determination of Cumulative Nitrogen Excretion from meat chicken in relation to average number of days alive.

The modeling methodology used to calculate cumulative N excretion on day 36 is sound.

8.1 Methane Emissions

Recalculate Methane emissions based on recommended changes to VS submission sheet above.

Additional research, investigative or literature based needs to be done to more widely ascertain whether the assumption of 1 kg of Methane is accurately equivalent to 21 kg of Carbon Dioxide. More accurate actual measurements need to be devised/undertaken to determine how correct this assumption is.

8.2-8.3 Nitrous Oxide Emissions.

Calculations could be considerably incorrect based on the very large % uncertainties indicated in both international and non-poultry specific data. Given that Nitrous Oxide is exceptionally more “warming” than Carbon Dioxide *per se*, it seems necessary to request that more research be undertaken to reduce the uncertainties in the overall poultry inventory to something well less than a guesstimate, albeit a best educated one, given the variation in algorithms available to date.

8.5 N Volatilisation Losses

While the conservative estimate of 40% “average” N volatilization loss has been selected, values specific to layer manure without bedding and broiler manure with bedding need to be selected and used. Layer litter without manure will have higher volatilization loss (bedding N loss component will be slow and small compared to the manure fraction N Loss)

A Need for More Specific NZ Research Based around Relative Industry/Country Efficiency Standards and Performance

The considerably high performance standards/efficiency of the NZ industry when compared internationally, indicate that NZ poultry specific numbers are likely to be better/lower than international “averages” within data sets. I contend that NZ “emissions calculations” will be overestimated in NZ by use of current poultry

specific or international/IPCC default values for broiler and layer industries at least.

Further collaborative research with science providers and industry, PIANZ, Massey University (Dr R Ravindran) or Lincoln, is required in this area to be more accurate, definitive and country specific with respect to emissions value selected.

As this report indicates, there is considerable practical variation in manure and N output based on multiple parameter inputs and efficiency levels. This can be personally vouched for based on measurement of litter outputs with layers, replacement stock and literature reviews conducted at Monogastric Research Centre (Masses University) for and on behalf of an industry funded Environmental Taskforce, literature reviews and as also supported by noted researchers quoted in this review. Where variations can be as much as 15-30% (not just 0-10%) then a request for more specific industry research survey/monitoring data is warranted. The obvious point is who requests, funds and interprets such research.

The Proposed Future Use of Performance Predicting Models

Use and acceptable of growth models that mechanistically and biological model excretion and emissions outputs are the best way forward. This approach is proposed in table 8.1 (page 75) which indicates the effect of efficiency improvement over time for broiler predictive excretions of N. There is a 35% reduction in N excretion from 1970 to 2011 (0.143 to 0.097 kg/bird). It is recommended this approach be used to adjust the GHG inventory for New Zealand. The layer industry may also have a similar model to predict N excretion.

Reviewer	Grant Richards
Date of review	1 September 2011

Inventory sector[6]	Agriculture
Name of EF, variable or category	Litter management %
Current values tabulated in Table 4.15 page 56	
Suggested values, variable or methodology Tier	Accept values in table 4.15 Pg59 Entirely, no changes required
Use from year (start year)	**1990-2010**
Recommend that a change to the new value or methodology is approved	No change is required to above Table reference in review

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	No	Comprehensive review of NZ numbers and sub class populations in each Manure system are accurate
Is the proposed change scientifically defensible?		
Has any documentation been peer-reviewed or published?	Yes	Report was internally reviewed by Dr Tate at Landcare research, Dr Whitehead approved release, Grant Richards has peer reviewed.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	

[6] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

Meat Chicken Litter Management

Broiler mortality is very low in this country (average less than 4%) hence composting of dead broilers is very small.

The report rightly asserts that 95-100% of broiler litter is spread on pasture immediately if possible, the only exceptions being during rainy conditions and/or when paddocks are wet.

Broiler growing placements per year are also correct, being a range of 5.5-6.1 cycles per year depending on turnaround times devised, market demand for broilers, disease pressure and stand down time and as a positive bio-security disease prevention and policy practice.

There should be very minor N volatilization issues caused through prolonged storage over long periods of time. Due to cool conditions, good ventilation, aeration equipment and management, the extremely high performance/productivity of broilers in this country, as a result of top genetics, low disease/high health status, very high feed conversion efficiency standards (by international standards), diets and feed programmes modeled around optimum economic dose, DM/amino acid based on true digestibility, digestive modifiers (enzyme use is standard), minimum crude/non protein nitrogen levels with excellent quality materials and minimum manure/emissions production and loss, **default or selected EF parameters are more likely to be on the low side than average or higher**. There is little comparative research data on which to select relative numbers, other than from known first principles that all the above factors tend to raise productive efficiency Key Performance Indicators (KPIs) and minimize gaseous losses and manure wastage outputs.
The quantity of bedding material present in broiler litter means there is negligible N volatilization for this component, additionally waste organic material from broilers is usually very dry also. In respect of this, the lowest default or lower default numbers within the published literature range would be appropriate and still adequately conservative. There is no further published research literature available at this time specifically from this country or internationally from which more definitive default numbers can be selected.

More research is required to support this assertion however.

For the layer industry, 90% or more of the industry numbers are derived from caged birds with automatic manure collection and removal mechanisms under cages. Litter is removed weekly with producers adopting “best practice” type manure management policies. This means minimal storage time so reducing the chance or time over which N volatilisation and ammonia production can occur. Furthermore, most of the top operators (75% of the total industry) blow air over the manure daily (often at night when electricity is diurnally cheaper), this helps dry the manure quickly hence stabilizing Nitrogenous components within the manure and minimizing ammonia emissions. Wet litter is also minimized by improving health status, creating a healthy gut environment, improving water quality, adding digestive modifiers i.e. enzymes, using diatomaeous earths (Zeolite, Bentonite etc), correctly balancing diruretic type minerals in water and feed (i.e. Sodium, Chloride, Magnesium), optimizing shed temperature and humidity via tunnel ventilation, side fan/pad ventilation and air cooling and

minimizing bird activity through light/dark cycles and lowering shed light intensity (lux) and avoiding or minimising all direct sources of outside light into the sheds. Litter production from sheds has been reduced by 25% for the same number of birds in farm field exercise of applying the above best practice management techniques (pers comm. Grant Richards). Furthermore, additional literature surveys have indicated that nitrogen/crude protein intakes can be reduced by 20-25% without loss of performance, by formulating diets based on digestible amino acids and ignoring minimum crude protein/ non essential amino acid levels while improving availability and digestibility of key essential amino acids by use of adding digestive enzymes to feed, which are now routinely used in commercial layer (and all poultry) diets. (Source: Monogastric Research Centre, Massey University Environmental Taskforce-literature survey, producer seminars, 1995)

Feed digestibility improvements of 5-10% or more have been noted in the literature.

Given the modern management and manure management techniques used by the majority of the layer industry, and despite the fact that there is low/slow N/Ammonia release bedding materials (except for 10% of free range/barn section), N volatilization and ammonia production numbers should and could be selected in the lower ranges or low side of average and the low side uncertainty limits provided in the literature. Further research is required to ensure this is the case but from first principle, and from the fact the layer industry is very efficient by international standards, these assertions and suggestions have a strong foundation in support of lower selected numbers from the suggested current defaults used.

Layer litter is spread virtually immediately following mechanical emptying from the shed. There is negligible storage post shed removal, before it is applied and drier land is used for application when conditions can be wetter i.e. winter. There is no bedding material in caged systems (unlike broiler, broiler breeder and barn egg laying systems). There is likely to be more N volatilization and ammonia release risk from spread layer litter than broiler litter, hence there is a case to separate N loss/volatilisation figures for Layers compared to broiler litter. One default value for general poultry is too broad in this regard. However, there is no research or literature to help define the relative difference other than what is likely to be occurring from first principle argument. Where more definitive research is required to have separate numbers, then using an average poultry number for N loss is the best that can be proposed at this point in time. This over penalizes the broiler industry and under penalizes the layer industry calculations respectively from an expert review perspective.

Provisional acceptance where further research is deemed required to separate numbers by poultry sub classes or industries. Where MAF are prepared to except “expert opinion” then the following change is recommended:

Broilers : N loss……..
Layers: N loss……

Broiler Feeding Programmes

Most broilers are phase feed with four main feeding stages, this is correctly asserted depending on average kill ages and proportion slaughtered for the smaller broiler bird market or where there is split sex feeding. Feed change over points can vary which will later volumes of each feed used but this only varies by 2-3 days given all company feeding programmes I have designed, worked with and observed. Phase feeding minimizes excess manure/NPN-nitrogen excretion and ammonia emissions from not over-formulating and supplying excess N as birds become older and demands are less than with younger birds.

The diets, ranges and specifications provided are acceptable industry norms in all cases with variations being minor and natural variation being small whatever ingredients inputs maybe used. In New Zealand good quality ingredients are used, and availability and inclusion of cheaper lower quality by-products is rare compared to many other countries especially developing countries.

Accept entirely

Layer Feeding Programmes

Layer feeding programmes involve 2-4 main phase feeds where there are single age sheds and single silos available for those sheds. This represents 80-90% of the caged industry and only 10-20% of the industry, have mixed aged sheds with single silos whereby on one single compromised ration can be fed on those farms. The industry is operating at 80-90% maximum efficiency in this respect whereby manure volumes are minimized, manure dryness is maximized and N content and quantity and potential ammonia release are minimized, because diets are not over-formulated, this definitely leads to reduced manure excretion and gaseous emissions.

Layer indicator diets, ranges, specifications are all within industry normal ranges and breeder manual specifications.

Accept Entirely

Turkey and Ducks

All data presented are in line with breeder specifications, typical industry diets, feeding programmes, ranges and general specifications used. Further, data lines up against international data used and recommended from which the author is also familiar with.

These industries combined, speak for less than 2% of the total poultry industry hence don’t warrant further comment or debate on presented data.

Accept entirely.

Summary of Production and Manure Management Systems (Table 4,15, pg 59)

Summary table (4.15) on page 59 of original report is a fair representation of manure management systems in NZ and proportion of industry represented by poultry sub-class, and is also a fair representation given statistics available to reviewers. There is no further data available to recommend altering Methane Conversion Factors (MCF) presented by poultry sub-class. It is fair to use default or IPCC 1996 guideline numbers where indicated by astrix in this table.