SOUTH DAKOTA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

In re:
HEARING FOR RE-ISSUING THE STATE GENERAL WATER POLLUTION CONTROL PERMIT FOR CONCENTRATED ANIMAL FEEDING OPERATIONS

DENR CONTESTED CASE

CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

I hereby certify that on the 29th day of August, 2016, I served a copy of Exhibit List, Exhibits and Witness List by email on the following parties of record in this matter:

Ellie Bailey, AAG
DENR Feedlot Program
1303 East Highway 14, Suite 1
Pierre, SD 57501
Ellie.Bailey@state.sd.us

Dakota Rural Action
c/o Kelsea K. Sutton
Attorney at Law
Post Office Box 149
Gregory, SD 57533
kelsea@rosebudlaw.com

Anthony Helland
1013 West 20th Street
Sioux Falls, SD 57105
tony.helland@gmail.com

David and Lisa Nehring
27551 452nd Avenue
Parker, SD 57053
nehringd@crown.edu

George Bogenschutz
46135 222nd Street
Nunda, SD 57050
mtnmach@itctel.com

Catherine Duenwald
Office of Hearing Examiners
523 East Capitol Avenue
Pierre, SD 57501
Catherine.Duenwald@state.sd.us

Roger and Ann Loeschke
48464 155th Street
Milbank, SD 57252
arloe@tnics.com

South Dakota Cattlemen's Assn. &
South Dakota Dairy Producers
c/o Wilkinsopn & Wilkinson
Attorneys at Law
Post Office Box 29
DeSmet, SD 57231
todd@wslawfirm.net

William Powers
512 West Main Street
White, SD 57276
whp@swcp.com

Meghan Jarchow
2523 Princeton Avenue
Vermillion, SD 57069
Meghann.jarchow@usd.edu

Mr. Steven M. Pirner, Secretary
& Hearing Chairman
Department of Environment & Natural
Resources
523 East Capitol;
Pierre, SD 57501

Brian J. Donahoe

Brian J. Donahoe
Attorney for Sonstegard Foods Company

SOUTH DAKOTA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

In re:
HEARING FOR RE-ISSUING THE STATE GENERAL WATER POLLUTION CONTROL PERMIT FOR CONCENTRATED ANIMAL FEEDING OPERATIONS

DENR CONTESTED CASE

SONSTEGARD FOODS COMPANY'S EXHIBIT LIST

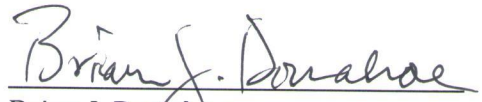
Sonstegard Foods Company, a South Dakota corporation, and through its undersigned attorney, as required by the Scheduling Order previously entered in the above referenced matter, provides the following list of exhibits that Sonstegard Foods Company may seek to introduce into evidence in its case.

EXHIBIT #	DESCRIPTION	Off.	Obj.	Rec.
Sonstegard 1	MN CAFO animal unit equivalencies webpage			
Sonstegard 2	Moody County SD Zoning Ordinance excerpts			
Sonstegard 3	Auburn Univ. manure production volume study			
Sonstegard 4	ASABE scientific standard – manure production			
Sonstegard 5	Steer v Layer Hen manure characteristics chart			
Sonstegard 6	Joffer et al. v Turner County Memorandum Opinion			

Sonstegard Foods Company reserves the right to propose additional exhibits at the hearing should the need arise, and further reserves the right to offer any exhibits identified by any other party. This includes additional rebuttal evidence or the use of any evidence in rebuttal when not offered in a case-in-chief.

Dated: AUGUST 29, 2016.

DONAHOE LAW FIRM, P.C.



Brian J. Donahoe
401 East 8th Street, Suite 215
Sioux Falls, SD 57103-7008
Telephone: (605) 367-3310
Facsimile: (866) 376-3310
brian@donahoelawfirm.com
Attorney for Sonstegard Foods Company

SOUTH DAKOTA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

In re: HEARING FOR RE-ISSUING THE STATE GENERAL WATER POLLUTION CONTROL PERMIT FOR CONCENTRATED ANIMAL FEEDING OPERATIONS	DENR CONTESTED CASE **SONSTEGARD FOODS COMPANY'S DISCLOSURE OF WITNESSES AND EXPERT WITNESSES**

COMES NOW Sonstegard Food Company, a South Dakota corporation, and through its undersigned attorney, hereby submits its Witness List as follows:

1. **Sonstegard Foods Company** is an organization of farmers and related industry members who are involved in or contribute to the raising or marketing of swine in the State of South Dakota. **Sonstegard Foods Company** stands in opposition to any proposed changes which adversely affect animal agricultural production. Therefore, it does not intend to call witnesses in favor of the proposed changes, but will call the following individuals as witnesses to rebut expected testimony from proponents of modifications to the subject permit:

WITNESSES

2. **Sonstegard Foods Company** may call two of its members to testify as to industry standards, requirements for approval under the General Permit for CAFOs and practical considerations as applied to the situation to be faced by pork producers under the current and proposed regulations, including

requested modifications by other interveners. **Sonstegard Foods Company** reserves the right to call these witnesses in rebuttal to any proposals or as to any issues that are developed at the hearing. SDPC intends to call:

a. Dave Uttech – Mr. Uttech is a member of the SDPPC from the Huron, SD area and may testify as to the issues set forth above.

b. Jim Quackenbusch – Mr. Quackenbush is a member of the SDPPC from the Watertown, SD area and may testify as to the issues set forth above.

EXPERT WITNESSES

c. Dr. Stephen Pohl, PhD. Dr. Pohl is a retired (emeritus) professor at South Dakota State University in Brookings, SD with significant experience in the swine industry, and Concentrated Animal Feeding Operations (CAFOs). He may be called upon to testify about the proposed changes in the General Permit, the scientific and engineering principles at issue which serve as the basis for approving the permit as recommended by DENR staff, and may rebut certain claims as to facts or the application of science to particular concerns governed by the proposed General Permit from those seeking modification of the recommendations of DENR staff.

    i. No written report is provided for this expert, as he is expecting to only rebut matters presented by others; this disclosure has been provided before expert reports were due from interveners and Dr. Pohl reserves the right to review and provide any testimony upon review of such reports.

    ii. A copy of Dr. Pohl's CV is attached hereto as Exhibit SDPPC 1.

d. Todd Van Maanen, P.E. Mr. Van Maanen is a registered Professional Engineer in SD with extensive experience in the design, approval and

permitting, construction, operation and regulations of CAFOs in the region. He may be called to rebut factual or other claims, or to address scientific or engineering principles in rebuttal to those parties who seek to modify the proposed permit as recommended by DENR staff.

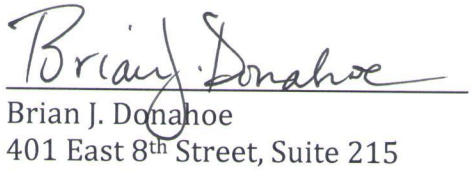
i. No written report is provided for this expert, as he is expecting to only rebut matters presented by others; this disclosure has been provided before expert reports were due from interveners and Dr. Pohl reserves the right to review and provide any testimony upon review of such reports.

ii. A copy of Mr. Van Maanen's CV is attached hereto as Exhibit SDPPC 2.

Sonstegard Foods Company further reserves the right to call other witnesses named by any other party and to name additional witnesses prior to or at the hearing as necessitated by the testimony and evidence presented during the hearing on the matter.

Dated: AUGUST 29, 2016.

DONAHOE LAW FIRM, P.C.



Brian J. Donahoe
401 East 8th Street, Suite 215
Sioux Falls, SD 57103-7008
Telephone: (605) 367-3310
Facsimile: (866) 376-3310
brian@donahoelawfirm.com
Attorney for Sonstegard Foods Company

Animal Unit Calculation Worksheet

Animal units (AU) are used in the permitting, registration, and the environmental review process because they allow equal standards for all animals based on size and manure production. An AU is calculated by multiplying the number of animals by an animal unit factor for the specific type of animal. When more than one type of animal is planned for a feedlot, the number of AUs is the sum of the AUs for each type of animal.

Use the worksheet to calculate the number of animal units your operation holds.

Instructions:

- Determine the total number of animals by type (column 1) and record that number in column 2.
- Multiply the number in column 2 by the "animal unit factor" in column 3 to give the number of animal units by animal type. Record this number in column 4.
- Add all the numbers from column 4 to get the total number of animal units for your facility
- Federal "animal unit factors" apply to CAFO's. More information is available online at the Environmental Protection Agency (PDF).

Animal Unit Calculation Table

1. Animal Type	2. Number of Animals	3. MN Animal Unit Factor	4. Number of Animal Units
A. Dairy Cattle			
1. Mature cow over 1,000 pounds		1.4	
2. Mature cow under 1,000 pounds		1.0	
3. Heifer		0.7	
4. Calf		0.2	
B. Beef Cattle			
1. Slaughter steer or stock cow		1.0	
2. Feeder cattle or heifer		0.7	
3. Cow and calf pair		1.2	
4. Calf		0.2	
C. Swine			

1. Over 300 pounds		0.4	
2. Between 55 and 300 pounds		0.3	
3. Under 55 pounds		0.05	
D. Horse		1.0	
E. Sheep and lambs		0.1	
F. Chickens			
1. Laying hen or broiler (liquid manure system)		0.033	
2. Chicken over 5 pounds (dry manure system)		0.005	
3. Chicken under 5 pounds (dry manure system)		0.003	
G. Turkeys			
1. Over 5 pounds		0.018	
2. Under 5 pounds		0.005	
H. Ducks		0.01	
I. Animal not listed in item A to H		Average weight of the animal in pounds divided by 1,000 pounds	
Total Number of Animal Units (Add up all the numbers in column 4)			Animal Units =

Accessibility | Affirmative action policy | Site terms of use | Privacy policy | Careers | Minnesota.gov

Minnesota Department of Agriculture (MDA), 625 Robert Street N, St. Paul, MN 55155-2538,
mda.info@state.mn.us

©2016 MDA

ORDINANCE 2013-02

ZONING ORDINANCE

FOR

MOODY COUNTY

PREPARED BY

THE MOODY COUNTY PLANNING COMMISSION

WITH ASSISTANCE FROM
THE FIRST DISTRICT ASSOCIATION OF LOCAL GOVERNMENTS

ORDINANCE 2013-02

ZONING ORDINANCE

OF

MOODY COUNTY

Notice of Planning Commission and County Commission Public Hearing Published: December 4, 2013
Public Hearing held by Planning Commission and Board of County Commissioners: December 19, 2013
Planning Commission Recommendation for Adoption: December 19, 2013
First Reading held by Board of County Commissioners: December 19, 2013
Second Reading held by Board of County Commissioners: February 18, 2014
Notice of Adoption Published: February 26, 2014 and March 5, 2014
Referendum Election: June 3, 2014
Referendum Canvas: June 5, 2014
Effective Date: June 5, 2014

TABLE OF CONTENTS

ARTICLE I General Provisions 1

Chapter 1.01. Title and Application 1

Section 1.01.01. Title 1
Section 1.01.02. Jurisdiction 1
Section 1.01.03. Purpose 1

Chapter 1.02. Ordinance Provisions 2

Section 1.02.01. Provisions of Ordinance Declared to be Minimum Requirements 2
Section 1.02.02. Purpose of Catch heads 2
Section 1.02.03. Enforcement, Violation & Penalty 2
Section 102.03.01 Enforcing Official 2
Section 102.03.02 2
Section 1.02.04. Separability Clause 3
Section 1.02.05. Repeal of Conflicting Ordinances 3
Section 1.02.06. Effective Date 3

Chapter 1.03. Official Zoning Map 3

Section 1.03.01. Provision for Official Zoning Map 4
Section 1.03.02. Interpretation of District Boundaries 4
Section 1.03.03. Disincorporation 5
Section 1.03.04. Changes and/or Replacement of Official Zoning Map 5

ARTICLE II District Regulations 6

Chapter 2.01. Application of District Regulations 6

Section 2.01.01. Application of District Regulations 6

Chapter 2.02. Non-Conforming Uses 6

Section 2.02.01. Purpose and Intent 6
Section 2.02.02. Continuation of Non-conforming Uses 6
Section 2.02.03. Use Becoming Non-conforming by Change of Law or Boundaries 6
Section 2.02.04. Extension or Enlargement 7
Section 2.02.05. Restoration After Damage 7
Section 2.02.06. Repairs and Maintenance 7
Section 2.02.07. Unsafe Non-conforming Lots 7
Section 2.02.08. Discontinuance of Nonconforming Use 7
Section 2.02.09. Effect on Use Which is Legal Under Prior Law 7
Section 2.02.10. Powers of the Planning Commission/Board of Adjustment 7
Section 2.02.11 Continuation of Nonstandard Uses 7
Section 2.02.12. Nonconforming Lots of Record 8

Chapter 2.03. District Regulations 8

Section 2.03.01. Districts 8
Section 2.03.02. Prohibited Uses 8

Chapter 2.04. "A" - Agricultural District 9

Section 2.04.01. Purpose 9
Section 2.04.02. Permitted Uses 9
Section 2.04.03. Permitted Accessory Uses 9
Section 2.04.04. Conditional Uses 10
Section 2.04.05. Area Regulations 11
Section 2.04.06. Easements/Waivers 13

Chapter 2.05. "CI" - Commercial/Industrial District 14

Section 2.05.01. Purpose 14
Section 2.05.02. Permitted Uses 14
Section 2.05.03. Conditional Uses 14
Section 2.05.04. Area Regulations 16
Section 2.05.05. Performance Standards 17

Chapter 2.06. "NR" - Natural Resources District 18

Section 2.06.01. Intent 18
Section 2.06.02. Area 18
Section 2.06.03. Permitted Uses 18
Section 2.06.04. Conditional Uses 18

Chapter 2.07. "LP - Lake Park District 19

Section 2.07.01. Purpose Uses 19
Section 2.07.02. Permitted Uses 19
Section 2.07.03. Conditional Uses 19
Section 2.07.04. Area Regulations 21
Section 2.07.05. Height Regulations 22
Section 2.07.06. Shoreline Alterations 22
Section 2.07.07. Filling, Grading, Lagooning and Dredging 22
Section 2.07.08. Easement/Covenant 22

Chapter 2.08. "PR" - Planned Residential District 23

Section 2.08.01. Intent 23
Section 2.08.02. Planned Residential District 23
Section 2.08.03. Procedure for Planned Residential District 24
Section 2.08.04. Subsequent Performance 25

Chapter 2.09. “AP” Aquifer Protection Overlay District 26

Section 2.09.01. Purpose and Intent 26
Section 2.09.02. Establishment/Delineation/Regulation of Aquifer Protection Overlay Zones 26

Section 2.09.03. Zone A – Aquifer Critical Impact Zones 26
Section 2.09.03.01. Permitted Uses in Zone A.....26
Section 2.09.03.02. Conditional Uses in Zone A 27
Section 2.09.03.03. Prohibited Uses in Zone A 29
Section 2.09.04. Zone B – Aquifer Secondary Impact Zones 29
Section 2.09.04.01. Permitted Uses in Zone B.....29
Section 2.09.04.02. Conditional Uses in Zone B 29
Section 2.09.04.03. Prohibited Uses in Zone B 30
Section 2.09.05. Performance Standards for Aquifer Protection Overlay Zones.....30
Section 2.09.06. Exceptions.....31
Section 2.09.07. Grant of Permit Alteration of Use 32
Section 2.09.08. Limitation of County Liability 32
Section 2.09.08. Underlying Zones 32

Chapter 2.10. "FP - Flood Damage Prevention Overlay District.....33

Section 2.10.01. Statutory Authorization.....33
Section 2.10.02. Findings of Fact.....33
Section 2.10.03. Statement of Purpose 33
Section 2.10.04. Methods of Reducing Flood Losses.....34
Section 2.10.05. Variance Procedures.....34
Section 2.10.06. General Provisions.....36
Section 2.10.06.01. Lands to which this Ordinance Applies.....35
Section 2.10.06.02. Basis for Establishing the Areas of Special Flood Hazard 36
Section 2.10.06.03. Compliance.....36
Section 2.10.06.04. Abrogation and Greater Restrictions 36
Section 2.10.06.05. Interpretation.....36
Section 2.10.06.06. Warning and Disclaimer of Liability 36
Section 2.10.07. Administration.....37
Section 2.10.07.01. Establishment of Development Permit 37
Section 2.10.07.02. Designation of the Administrative Official 37
Section 2.10.07.03. Duties and Responsibilities of the Administrative Official.....37
Section 2.10.08.Provisions for Flood Hazard Reduction.....39
Section 2.10.08.01. General Standards 39
Section 2.10.08.02. Specific Standard 40

Chapter 2.11. "CP - Corridor Protection Overlay District 43

Section 2.11.01. Purpose and Intent Statutory Authorization 43
Section 2.11.02. Boundaries of Corridor Preservation Zone 43
Section 2.11.03. Permitted Uses.....43
Section 2.11.04. Conditional Uses 43
Section 2.11.05. Area Regulations 43
Section 2.10.06. General Provisions.....43

ARTICLE III ADMINISTRATION 45

Chapter 3.01. General.....45
Section 3.01.01 Permits Required 45
Section 3.01.02 Applications.....45
Section 3.01.03 Fees 45
Section 3.01.04 Building/Use Permit.....46
Section 3.01.05 Building Permit Process 46

Chapter 3.02. Administrative Official....47

Section 3.02.01 Administrative Official....47
Section 3.02.02 Duties....47
Section 3.02.03. Right of Entry....48
Section 3.02.04. Stop Order....48
Section 3.02.05. Occupancy Violation....48

Chapter 3.03. Board of Adjustment....49

Section 3.03.01. Establishment....49
Section 3.03.02. Procedures for Meetings....49
Section 3.03.03. Powers and Duties of the Board....49
Section 3.03.04. Appeals, Record of Appeal, Hearing and Stays....50
Section 3.03.05. Board of Adjustment has Powers of Administrative Official on Appeals: Reversing Decision of Administrative Official....50
Section 3.03.06. Duties of Administrative Official, Board of Adjustment, and Courts on Matters of Appeal....51
Section 3.03.07. Appeals to a Court of Record....51

Chapter 3.04. Procedures for Conditional Uses, Variances and Zoning Amendments....51

Section 3.04.01. Powers and Jurisdiction Relating to Conditional Uses....51
Section 3.04.02. Powers and Jurisdiction Relating to Variances....53
Section 3.04.03. Zoning Amendments....54

ARTICLE IV Supplemental Requirements....56

Chapter 4.01. Visibility at Intersections....56

Chapter 4.02. Fences....56

Section 4.02.01. Fences in the “LP” Lake Park and “PR” Planned Residential District....56
Section 4.02.01.01. Purpose....56
Section 4.02.01.02. Permits Required....56
Section 4.02.01.03. Location/Construction Requirements....56

Chapter 4.03. Accessory Buildings....57

Chapter 4.04. Signs....58
Section 4.04.01. On and Off Premise Signs....58

Chapter 4.05. Structures to Have Access....60

Chapter 4.06. Yards....60

Section 4.06.01. Yards, General....60
Section 4.06.02. Yards, Reduction in Size....60
Section 4.06.03. Additional Yard Requirements....61
Section 4.06.04. Exceptions to Yard Requirements....61

Chapter 4.07. Erection of More Than One Principal Structure on a Lot....61

Chapter 4.08. Exception to Height Regulations 62

Chapter 4.09. Private Wastewater Treatment Systems (Septic Systems) 62

Chapter 4.10. Modular and Manufactured Home Regulations 62

Section 4.10.01. Modular Homes 62
Section 4.10.02. Type I and Type II Manufactured Homes 62

Chapter 4.11. Permanent Foundations Required for Dwellings 64

Chapter 4.12. Utility Easements 65

Chapter 4.13. Moved in Buildings 65

Chapter 4.14. Screening 65

Chapter 4.15. Refuse 66

Chapter 4.16. Unlicensed Vehicles 66

Chapter 4.17. Minimum Water and Sewer Requirements 66

Chapter 4.18. Shelterbelt Setback Requirements 66

Chapter 4.19. Extended Home Occupations 67

Chapter 4.20. Soil Erosion and Sedimentation Control 68

Chapter 4.21. Sand, Grave or Quarry Operation; Rock Crushers; Mineral Exploration and Development; and Concrete and Asphalt Mixing Plant Requirements 69

Section 4.21.01. Application 69
Section 4.21.02. State and Federal Requirements 69
Section 4.21.03. Setbacks 69
Section 4.21.04. General Provisions 70

Chapter 4.21. Wind Energy Systems (WES) Requirements 71

Section 4.22.01. Applicability 71
Section 4.22.02. Federal and State Requirements 71
Section 4.22.03. General Provisions 71

Chapter 4.23. Wireless Telecommunications Towers and Facilities 76

Section 4.23.01. Purpose 76
Section 4.23.02. Development of Towers 76
Section 4.23.03. Setbacks 78
Section 4.23.04. Structural Requirements 78
Section 4.23.05. Separation or Buffer Requirements 79
Section 4.23.06. Method of Determining Tower Height 79
Section 4.23.07. Illumination 79
Section 4.23.08. Exterior Finish 79

Section 4.23.09. Modification of Towers 79
Section 4.23.10. Certifications and Inspections 80
Section 4.23.11. Maintenance 80
Section 4.23.12. Criteria for Site Plan Development Modifications.....81
Section 4.23.13. Abandonment.....82
Section 4.23.14. Action of the Board of Adjustment 82

Chapter 4.24. Right to Farm Notice Easement.....83

Chapter 4.25. Concentrated Animal Feeding Operations.....85

Section 4.25.01. Intent 85
Section 4.25.02. Animal Units 85
Section 4.25.02. Classes of Concentrated Animal Feeding Operations.....87
Section 4.25.04. Concentrated Animal Feeding Operation Permit Requirements.....87
Section 4.25.05. Concentrated Animal Feeding Operation Control Requirements 88

Chapter 4.26. Adult Use Regulations.....96

Section 4.26.01. Setbacks.....96
Section 4.26.02. Required License 97
Section 4.26.02.01 Application; Standards for Issuance 97
Section 4.26.03. Conditions & Regulations Governing Operation; Violation; Penalty 99
Section 4.26.04. Suspension or Revocation 100

Chapter 4.27. Bed and Breakfast Establishments 101

Chapter 4.28. Home Occupations.....101

Chapter 4.29. Private Wind Energy Conversion Systems (PWECS) 102

Chapter 4.30 Sanitary Landfills, Rubble Sites, Composting Sites, Waste Tire Sites, and Restricted Use Sites Requirements 102

Chapter 4.31 Domestic Sanitary Sewer Treatment Plan/Facility Requirements 103

Chapter 4.32 Junkyards/Salvage Yards Requirements.....103

Chapter 4.33. Shoreline Alterations, Filling, Grading, Lagooning and Dredging 104

Chapter 4.34. Target Range Requirements.....105

Section 4.34.01. Conditional Use Permits.....105
Section 4.34.02. General Regulations for All Ranges.....105
Section 4.34.03. Special Regulations for Ranges.....106
Section 4.34.04. Application Regulations.....107
Section 4.34.05. Area Regulations.....107
Section 4.34.06. Miscellaneous Regulations 107

Chapter 4.35. Automotive Tow Businesses/Impound Lot Requirements 108

Chapter 4.36 Pipelines.....108

Chapter 4.37. Waiver of Setback from Existing Concentrated Animal Feeding Operation 108

Chapter 4.38. Private Campground 110

Section 4.38.01. Purpose 110
Section 4.38.02. Minimum Requirements 110
Section 4.38.02. Application Requirements 111

ARTICLE V DEFINITIONS 113

Ordinance 2013-02
An Ordinance Amending Moody County Ordinance 2002-1, An ordinance establishing zoning regulations for Moody County, and amendments thereto; and for the repeal of all ordinances in conflict therewith.

WHEREAS, the Moody County, South Dakota, Board of County Commissioners, hereinafter referred to as the Board of County Commissioners, deems it necessary, for the purpose of promoting the health, safety, and the general welfare of the County, to enact zoning regulations and to provide for its administration, and

WHEREAS, the Board of County Commissioners has appointed a County Planning Commission, hereinafter referred to as the Planning Commission, to recommend the district boundaries and to recommend appropriate regulations to be enforced therein, and

WHEREAS, the Planning Commission has divided Moody County into districts, and has established by reference to maps the boundaries of said districts for administration and interpretation; has provided for definitions and for amendments to this Ordinance; has provided for the enforcement; prescribed penalties for violation of provisions; has provided for building permits within the districts; has provided for invalidity of a part and for repeal of regulations in conflict herewith; and has prepared regulations pertaining to such districts in accordance with the county comprehensive plan and with the purpose to protect the tax base, to guide the physical development of the county, to encourage the distribution of population or mode of land utilization that will facilitate the economical and adequate provisions of transportation, roads, water supply, drainage, sanitation, education, recreation, or other public requirements, to conserve and develop natural resources, and

WHEREAS, the Planning Commission has given reasonable consideration, among other things, to the character of the districts and their peculiar suitability for particular uses, and

WHEREAS, the Planning Commission and Board of County Commissioners has given due public notice to a hearing relating to zoning districts, regulations, and restrictions, and has held such public hearings, and

WHEREAS, all requirements of SDCL 11-2, with regard to the preparation of these regulations and subsequent action of the Board of County Commissioners, has been met, and

WHEREAS, copies of said zoning regulations have been filed with the Moody County Auditor for public inspection and review during regular business hours, and

WHEREAS, all ordinances, or parts of regulations in conflict herewith are hereby expressly repealed;

THEREFORE BE IT ORDAINED that Ordinance 2013-02 is hereby adopted by the Board of County Commissioners, Moody County, South Dakota.

Adopted this 18th day of February, 2014. ATTEST:

_____ _____

Chairperson Moody County Board of County Commissioners

Moody County Auditor

j. Project-specific environmental concerns (e.g. native habitat, rare species, and migratory routes). This information shall be obtained by consulting with state and federal wildlife agencies. Evidence of such consultation shall be included in the application.

k. Final haul road agreements to be submitted sixty (60) days prior to construction.

CHAPTER 4.23 WIRELESS TELECOMMUNICATIONS TOWERS AND FACILITIES

Section 4.23.01 Purpose

The general purpose of this Section is to regulate the placement, construction, and modification of Towers and Telecommunications Facilities in order to protect the health, safety, and welfare of the public, while at the same time not unreasonably interfering with the development of the competitive wireless telecommunications marketplace in the County.

Specifically, the purposes of this Ordinance are:

1. To regulate the location of Towers and Telecommunications Facilities in the County;

2. To protect residential areas and land uses from potential adverse impact of Towers and Telecommunications Facilities;

3. To minimize adverse visual impact of Towers and Telecommunications Facilities through careful design, siting, landscaping, and innovative camouflaging techniques;

4. To promote and encourage shared use/co-location of Towers and Antenna Support Structures as a primary option rather than construction of additional single-use Towers;

5. To promote and encourage utilization of technological designs that will either eliminate or reduce the need for erection of new Tower structures to support antenna and Telecommunications Facilities;

6. To avoid potential damage to property caused by Towers and Telecommunications Facilities by ensuring such structures are soundly and carefully designed, constructed, modified, maintained, and removed when no longer used or are determined to be structurally unsound; and

7. To ensure that Towers and Telecommunications Facilities are compatible with surrounding land uses.

Section 4.23.02 Development of Towers

1. Towers are exempt from the maximum height restrictions of the districts where located. Towers shall be permitted to a height of one hundred and fifty (150) feet. Towers may be permitted in excess of one hundred and fifty (150) feet in accordance with "Criteria for Site Plan Development Modifications."

2. No new Tower shall be built, constructed, or erected in the County unless the Tower is capable of supporting three (3) other Persons' operating Tele-communications Facilities comparable in weight, size, and surface area to the Telecommunications Facilities installed by the Applicant on the Tower

within six (6) months of the completion of the Tower construction. No tower shall charge co-location fees in excess of commercially reasonable industry amounts. Each tower constructed shall upon the request of Moody County mount law-enforcement or public safety communications apparatus.

3. An Application to develop a Tower shall include:

   a. The name, address, and telephone number of the Owner and lessee of the parcel of land upon which the Tower is situated. If the Applicant is not the Owner of the parcel of land upon which the Tower is situated, the written consent of the Owner shall be evidenced in the Application.

   b. The legal description, folio number, and address of the parcel of land upon which the Tower is situated.

   c. The names, addresses, and telephone numbers of all owners of other Towers or usable Antenna Support Structures within a one-half (½) mile radius of the proposed new Tower site, including County-owned property.

   d. A description of the design plan proposed by the Applicant. Applicant must identify its utilization of the most recent technological design, including microcell design, as part of the design plan. The Applicant must demonstrate the need for Towers and why design alternatives, such as the use of microcell, cannot be utilized to accomplish the provision of the Applicant's telecommunications services.

   e. An affidavit attesting to the fact that the Applicant made diligent, but unsuccessful, efforts to install or co-locate the Applicant's Telecommunications Facilities on Towers or usable Antenna Support Structures owned by other Persons located within a one-half (½) mile radius of the proposed Tower site. In the event that one reason for the unsuccessful efforts to install or co-locate is that fees to be charged are not commercially reasonable, an explanation shall be provided why said charges are commercially unreasonable.

   f. Written technical evidence from an Engineer(s) that the proposed Tower or Telecommunications Facilities cannot be installed or co-located on another person’s Tower or usable Antenna Support Structures owned by other Persons located within one-half (½) mile radius of the proposed Tower site.

   g. A written statement from an Engineer(s) that the construction and placement of the Tower will not interfere with public safety communications and the usual and customary transmission or reception of radio, television, or other communications services enjoyed by adjacent residential and non-residential properties.

   h. Written, technical evidence from an Engineer(s) that the proposed structure meets the standards set forth in, "Structural Requirements," of this Ordinance.

   i. Written, technical evidence from a qualified Engineer(s) acceptable to the Fire Marshall and the building official that the proposed site of the Tower or Telecommunications Facilities does not pose a risk of explosion, fire, or other danger to life or property due to its proximity to volatile, flammable, explosive, or hazardous materials such as LP gas, propane, gasoline, natural gas, or corrosive or other dangerous chemicals.

j. The FCC has sole jurisdiction of the field of regulation of RF emissions and does not allow the County to condition or deny on the basis of RF impacts the approval of any Telecommunications Facilities (whether mounted on Towers or Antenna Support Structures) which meet FCC standards. In order to provide information to its citizens, the County shall make available upon request copies of ongoing FCC information and RF emission standards for Telecommunications Facilities transmitting from Towers or Antenna Support Structures. Applicants shall be required to submit information on the proposed power density of their proposed Telecommunications Facilities and demonstrate how this meets FCC standards.

k. No application shall be accepted from landowners or on property on which there are current or past unresolved violations outstanding.

4. The Board of Adjustment may require an Applicant to supplement any information that the Board considers inadequate or that the Applicant has failed to supply. The Board of Adjustment may deny an Application on the basis that the Applicant has not satisfactorily supplied the information required in this subsection. Applications shall be reviewed by the Board in a prompt manner and all decisions shall be supported in writing setting forth the reasons for approval or denial.

Section 4.23.03 Setbacks

1. All Towers up to one-hundred (100) feet in height shall be set back on all sides a distance equal to the underlying setback requirement in the applicable zoning district.

2. Towers in excess of one hundred (100) feet in height shall meet the following:

   a. Distance from existing off-site residences, business and public buildings shall be one thousand (1,000) feet. Distance from on-site or lessor's residence shall be five hundred (500) feet.

   b. Distance from public right-of-way shall be set back one (1) additional foot per each foot of tower height in excess of one hundred (100) feet.

   c. Distance from any property line shall be set back one (1) additional foot per each foot of tower height in excess of one hundred (100) feet.

3. Setback requirements for Towers shall be measured from the base of the Tower to the property line of the parcel of land on which it is located.

4. Setback requirements may be modified, as provided in, when placement of a Tower in a location which will reduce the visual impact can be accomplished. For example, adjacent to trees which may visually hide the Tower.

Section 4.23.04 Structural Requirements

All Towers must be designed and certified by an Engineer to be structurally sound and, at minimum, in conformance with applicable building codes, and any other standards outlined in this Ordinance. All Towers in operation shall be fixed to land.

Section 4.23.05 Separation or Buffer Requirements

For the purpose of this Section, the separation distances between Towers shall be measured by drawing or following a straight line between the base of the existing or approved structure and the proposed base, pursuant to a site plan of the proposed Tower.

Proposed Towers must meet the following minimum separation requirements from existing towers or towers which have a development permit but are not yet constructed at the time a development permit is granted pursuant to this Ordinance:

1. Monopole Tower structures shall be separated from all other Towers, whether monopole, self-supporting lattice, or guyed, by a minimum of seven hundred and fifty (750) feet.

2. Self-supporting lattice or guyed Tower structures shall be separated from all other self-supporting or guyed Towers by a minimum of fifteen hundred (1,500) feet.

3. Self-supporting lattice or guyed Tower structures shall be separated from all monopole Towers by a minimum of seven hundred and fifty (750) feet.

4. The separation requirements contained in 4.23.03 shall not be required of existing Towers or Towers which have a development permit but are not yet constructed at the time a development permit is granted pursuant to this Ordinance.

Section 4.23.06 Method of Determining Tower Height

Measurement of Tower height for the purpose of determining compliance with all requirements of this Section shall include the Tower structure itself, the base pad, and any other Telecommunications Facilities attached thereto which extend more than twenty (20) feet over the top of the Tower structure itself. Tower height shall be measured from grade.

Section 4.23.07 Illumination

Towers shall not be artificially lighted except as required by the Federal Aviation Administration (FAA). Upon commencement of construction of a Tower, in cases where there are residential uses located within a distance which is three hundred (300) percent of the height of the Tower from the Tower and when required by federal law, dual mode lighting shall be requested from the FAA. Beacon lighting, unless required by FAA, shall not be utilized.

Section 4.23.08 Exterior Finish

Towers not requiring FAA painting or marking shall have an exterior finish which enhances compatibility with adjacent land uses, as approved by the appropriate reviewing body.

Section 4.23.09 Modification of Towers

1. A Tower existing prior to the effective date of this Ordinance, which was in compliance with the County's zoning regulations immediately prior to the effective date of this Ordinance, may continue in existence as a nonconforming structure. Such non-conforming structures may be modified or demolished and rebuilt without complying with any of the additional requirements of this Section, except for Sections "Separation or Buffer Requirements", "Certification and Inspections", and "Maintenance," provided:

a. The Tower is being modified or demolished and rebuilt for the sole purpose of accommodating, within six (6) months of the completion of the modification or rebuild, additional Telecommunications Facilities comparable in weight, size, and surface area to the discrete operating Telecommunications Facilities of any Person currently installed on the Tower.

b. An Application for a development permit is made to the Board of Adjustment which shall have the authority to issue a development permit without further approval. The grant of a development permit pursuant to this Section allowing the modification or demolition and rebuild of an existing nonconforming Tower shall not be considered a determination that the modified or demolished and rebuilt Tower is conforming.

c. The height of the modified or rebuilt Tower and Telecommunications Facilities attached thereto do not exceed the maximum height allowed under this Ordinance.

Section 4.23.10 Certifications and Inspections

1. All Towers shall be certified by an Engineer to be structurally sound and in conformance with the requirements of this ordinance and all other construction standards set forth by federal and state law. For new monopole Towers, such certification shall be submitted with an Application pursuant to of this Ordinance and every five (5) years thereafter. For new lattice or guyed Towers, such certification shall be submitted with an Application pursuant to this Ordinance and every two (2) years thereafter. The Tower owner may be required by the County to submit more frequent certifications should there be reason to believe that the structural and electrical integrity of the Tower is jeopardized.

2. The County or its agents shall have authority to enter onto the property upon which a Tower is located, between the inspections and certifications required above, to inspect the Tower for the purpose of determining whether it complies with this ordinance and all other construction standards provided by federal and state law.

   The County reserves the right to conduct such inspections at any time, upon reasonable notice to the Tower owner. All expenses related to such inspections by the County shall be borne by the Tower owner.

Section 4.23.11 Maintenance

1. Tower owners shall at all times employ ordinary and reasonable care and shall install and maintain in use nothing less than commonly accepted methods and devices for preventing failures and accidents which are likely to cause damage, injuries, or nuisances to the public.

2. Tower owners shall install and maintain Towers, Telecommunications Facilities, wires, cables, fixtures, and other equipment in substantial compliance with the requirements of the National Electric Safety Code and all FCC, state, and local regulations, and in such manner that will not interfere with the use of other property.

3. All Towers, Telecommunications Facilities, and Antenna Support Structures shall at all times be kept and maintained in good condition, order, and repair so that the same shall not menace or endanger the life or property of any Person.

4. The property in which Towers, Telecommunications Facilities, and Antenna Support Structures are situated shall be maintained in a manner to control noxious weeds.

5. All maintenance or construction of Towers, Telecommunications Facilities, or Antenna Support Structures shall be performed by licensed maintenance and construction personnel.

6. All Towers shall maintain compliance with current RF emission standards of the FCC.

7. In the event that the use of a Tower is discontinued by the Tower owner, the Tower owner shall provide written notice to the County of its intent to discontinue use and the date when the use shall be discontinued.

Section 4.23.12 Criteria for Site Plan Development Modifications

1. Notwithstanding the Tower requirements provided in this Ordinance, a modification to the requirements may be approved by the Board of Adjustment as a conditional use in accordance with the following:

    a. In addition to the requirement for a Tower Application, the Application for modification shall include the following:

        i. A description of how the plan addresses any adverse impact that might occur as a result of approving the modification.

        ii. A description of off-site or on-site factors which mitigate any adverse impacts which might occur as a result of the modification.

        iii. A technical study that documents and supports the criteria submitted by the Applicant upon which the request for modification is based. The technical study shall be certified by an Engineer and shall document the existence of the facts related to the proposed modifications and its relationship to surrounding rights-of-way and properties.

        iv. For a modification of the setback requirement, the Application shall identify all parcels of land where the proposed Tower could be located, attempts by the Applicant to contract and negotiate an agreement for co-location, and the result of such attempts.

        v. The Board of Adjustment may require the Application to be reviewed by an independent Engineer under contract to the County to determine whether the antenna study supports the basis for the modification requested. The cost of review by the County's Engineer shall be reimbursed to the County by the Applicant.

2. The Board of Adjustment shall consider the Application for modification based on the following criteria:

    a. That the Tower as modified will be compatible with and not adversely impact the character and integrity of surrounding properties.

    b. Off-site or on-site conditions exist which mitigate the adverse impacts, if any, created by the modification.

c. In addition, the board may include conditions on the site where the Tower is to be located if such conditions are necessary to preserve the character and integrity of the neighborhoods affected by the proposed Tower and mitigate any adverse impacts which arise in connection with the approval of the modification.

3. In addition to the requirements of subparagraph (2) of this Section, in the following cases, the Applicant must also demonstrate, with written evidence, the following:

   a. In the case of a requested modification to the setback requirement, that the setback requirement cannot be met on the parcel of land upon which the Tower is proposed to be located and the alternative for the Person is to locate the Tower at another site which is closer in proximity to a residentially zoned land.

   b. In the case of a request for modification of the separation and buffer requirements from residential use of land of, if the Person provides written technical evidence from an Engineer(s) that the proposed Tower and Telecommunications Facilities must be located at the proposed site in order to meet the coverage requirements of the Applicant's wireless communications system and if the Person is willing to create approved landscaping and other buffers to screen the Tower from being visible to residentially used property.

   c. In the case of a request for modification of the height limit for Towers and Telecommunications Facilities or to the minimum height requirements for Antenna Support Structures, that the modification is necessary to:

      i. Facilitate co-location of Telecommunications Facilities in order to avoid construction of a new Tower; or

      ii. To meet the coverage requirements of the Applicant's wireless communications system, which requirements must be documented with written, technical evidence from an Engineer(s) that demonstrates that the height of the proposed Tower is the minimum height required to function satisfactorily, and no Tower that is taller than such minimum height shall be approved.

Section 4.23.13 Abandonment

1. If any Tower shall cease to be used for a period of three hundred sixty-five (365) consecutive days, the Board of Adjustment shall notify the Owner, with a copy to the Applicant, that the site will be subject to a determination by Board of Adjustment that such site has been abandoned. The Owner shall have thirty (30) days from receipt of said notice to show, by a preponderance of the evidence, that the Tower has been in use or under repair during the period. If the Owner fails to show that the Tower has been in use or under repair during the period, the Board of Adjustment shall issue a final determination of abandonment for the site. Upon issuance of the final determination of abandonment, the Owner shall, within seventy-five (75) days, dismantle and remove the Tower.

2. To secure the obligation set forth in this Section, the Applicant [and/or Owner] may be required to post a bond

Section 4.23.14. Action of the Board of Adjustment.

1. Moody County shall approve or deny an application for collocation within ninety (90) days of the submission date of a complete application. Failure to act by the Board of Adjustment within the prescribed time frame entitles the applicant the ability to file a court action. The court action is to be filed within thirty (30) days from the required date of action of the Board of Adjustment.

2. Moody County shall approve or deny an application for a new wireless telecommunications facility within one hundred fifty (150) days of the submission date of a complete application. Failure to act by the Board of Adjustment within the prescribed time frame entitles the applicant the ability to file a court action. The court action is to be filed within thirty (30) days from the required date of action of the Board of Adjustment.

3. The Board of Adjustment may not deny the application on the basis that a competing provider already provides coverage.

CHAPTER 4.24 RIGHT TO FARM EASEMENT

The following easement is to be utilized as required for farm and non-farm residential development within the Agricultural, Lake Park and Planned Residential Districts.

Prepared by:
Moody County Administrative Official (or by Grantor or Grantor's Attorney)
Administrative Official Address (or Grantor's or Grantor's Attorney's address)
Flandreau, SD 57028 (or Grantor's or Grantor's Attorney's city)

RIGHT TO FARM EASEMENT

1. Purpose. This easement is required in the Agricultural District, Lake Park District and Planned Residential District.

2. Easement.

   ("Grantors") are the owners of real property described as follows:
   _____

   In accordance with the conditions set forth in the decision of Moody County, dated _____ 20____, approving a permit for a dwelling on the above described property, and in consideration of such approval, Grantors grant to the owners of all property adjacent to the above described property, a perpetual nonexclusive easement as follows:

3. The Grantors, their heirs, successors, and assigns acknowledge:

   a. That the property for which they are applying for a Moody County residential building permit is located within or near agriculturally zoned land;

   b. That the Grantors may be subject to inconvenience or discomfort from lawful agricultural uses permitted by Moody County zoning regulations Agricultural uses permitted by Moody County may include, but are not limited to, the following:

      i. The cultivation, harvesting, and storage of crops and livestock production,

ii. Ground rig or aerial application of pesticides or herbicides; the application of fertilizer, including animal manure;

iii. The operation of machinery, the application of irrigation water, and other accepted and customary agricultural activities conducted in accordance with Federal, State, and County laws.

c. These activities ordinarily and necessarily produce discomforts and inconveniences which may include, but are not limited to: noise, odors, fumes, dust, smoke, burning, vibrations, insects, rodents, and/or the operation of machinery (including aircraft) during any 24-hour period and other conditions that may conflict with Grantors' use of Grantors' property for residential purposes.

d. That such inconveniences or discomforts are a normal and necessary aspect of living in an area with a strong rural character and an active agricultural sector.

e. That there is the potential for Moody County approved agricultural uses to expand.

f. That this Right to Farm Easement is a requirement for obtaining a Moody County building permit for residential development and may not be removed from the record title without consent of the Moody County Board of Adjustment.

g. This notice does not abdicate the grantor's rights as a landowner to object to illegal agricultural uses permitted by Moody County. Nor does this notice allow for agricultural uses permitted by Moody County to be conducted in an illegal manner

h. Grantors, their heirs, successors or assigns hereby waive all common law rights to object to normal and necessary agricultural management activities legally conducted on adjacent lands which may conflict with Grantors' use of Grantors' property for residential purposes, and Grantors hereby grant a Right to Farm easement to adjacent property owners for such activities.

i. Nothing in this Right to Farm easement shall grant a right to adjacent property owners for ingress or egress upon or across the described property. Nothing in this Right to Farm easement shall prohibit or otherwise restrict the Grantors, their heirs, successors or assigns from enforcing or seeking enforcement of statutes or regulations of governmental agencies for activities conducted on adjacent properties.

j. This Right to Farm easement is appurtenant to all property adjacent to the above described property and shall bind to the heirs, successors and assigns of Grantors and shall endure for the benefit of the adjoining landowners, their heirs, successors, and assigns. The adjacent landowners, their heirs, successors, and assigns are hereby expressly granted the right of third party enforcement of this easement.

IN WITNESS WHEREOF, the Grantors have executed this easement on _____, 20____.

_____
Signature, Grantor

STATE OF SOUTH DAKOTA
SS:
COUNTY OF MOODY

This instrument was acknowledged before me on _____, 20____ by _____ (Grantors).

_____Notary Public

My Commission Expires: _____

CHAPTER 4.25 CONCENTRATED ANIMAL FEEDING OPERATION REGULATIONS

Section 4.25.01 Intent

An adequate supply of healthy livestock, poultry and other animals is essential to the well-being of county citizens and the State of South Dakota. However, livestock, poultry, and other animals produce manure which may, where improperly stored, transported, or disposed, negatively affect the County's environment. Concentrated Animal Feeding Operations (CAFOs) and the manure generated from those facilities must be controlled where it may add to air, surface water, ground water, or land pollution. The following regulations have been adopted in order to provide minimum standards for the location of animal feeding operations and to provide protection against pollution caused by manure from domesticated animals. All Concentrated Animal Feeding Operations shall comply with the regulations as outlined herein.

Section 4.25.02 Animal Units

Table 4.25-1 denotes animal species and the number of a species required to equal 500, 1,000 and 2,000 animal units. Note that these figures relate to inventory rather than annual production. Other animal species equivalents which are not listed will be based on species' manure production.

TABLE 4.25-1
EQUIVALENT NUMBER OF A SPECIES TO EQUAL ANIMAL UNITS:

ANIMAL SPECIES	500 AU	1,000 AU	2,000 AU	ANIMAL UNIT EQUIVALENT SPECIES/AU
Feeder or Slaughter Cattle	500 hd	1,000 hd	2,000 hd	1.0
Cow/Calf Pair	417 hd	833 hd	1,666 hd	1.2
Mature Dairy Cattle	350 hd	700 hd	1,400 hd	1.43
Mature Dairy Cow under 1,000 pounds	500 hd	1,000 hd	2,000 hd	1.0
Heifer	714 hd	1,428 hd	2,856 hd	0.7
Dairy Calf	2,500 hd	5,000 hd	10,000 hd	0.2
Finisher Swine (over 300 lbs)	1,250 hd	2,500 hd	5,000 hd	0.4
Finisher Swine (55 to 300 lbs)	1,667 hd	3,333 hd	6,666 hd	0.3
Nursery Swine (less than 55 lbs)	5,000 hd	10,000 hd	20,000 hd	0.1
Farrow-to-Finish (sows)	135 hd	270 hd	540 hd	3.7
Swine Production Unit (Sows Breeding, Gestating & Farrowing)	1,064 hd	2,130 hd	4,260 hd	0.47
Horses	250 hd	500 hd	1,000 hd	2.0
Sheep and lambs	5,000 hd	10,000 hd	20,000 hd	0.1
Turkeys (over 5 lbs)	27,800 hd	55,000 hd	110,000 hd	0.018
Turkeys (under 5 lbs)	100,000 hd	200,000 hd	400,000 hd	0.005
Laying Hens and Broilers (continuous overflow watering in facility)	50,000 hd	100,000 hd	200,000 hd	0.01
Laying Hens and Broilers (liquid handling system in confinement facility)	15,150 hd	30,000 hd	60,000 hd	0.033
Chicken over 5 lbs (dry manure system)	100,000 hd	200,000 hd	400,000 hd	0.005
Chicken under 5 lbs (dry manure system)	166,667 hd	333,333 hd	666,666 hd	0.003
Ducks	2,500 hd	5,000 hd	10,000 hd	0.2

Numbers above represent actual “Head Count’ of animal species

Link to: Ex 3 - Auburn University - Manure Volume Study

ASAE D384.2 MAR2005 (R2014)
Manure Production and Characteristics

American Society of Agricultural and Biological Engineers

STANDARD

ASABE is a professional and technical organization, of members worldwide, who are dedicated to advancement of engineering applicable to agricultural, food, and biological systems. ASABE Standards are consensus documents developed and adopted by the American Society of Agricultural and Biological Engineers to meet standardization needs within the scope of the Society; principally agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environment, and waste management.

NOTE: ASABE Standards, Engineering Practices, and Data are informational and advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. The ASABE assumes no responsibility for results attributable to the application of ASABE Standards, Engineering Practices, and Data. Conformity does not ensure compliance with applicable ordinances, laws and regulations. Prospective users are responsible for protecting themselves against liability for infringement of patents.

ASABE Standards, Engineering Practices, and Data initially approved prior to the society name change in July of 2005 are designated as "ASAE", regardless of the revision approval date. Newly developed Standards, Engineering Practices and Data approved after July of 2005 are designated as "ASABE".

Standards designated as "ANSI" are American National Standards as are all ISO adoptions published by ASABE. Adoption as an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by ASABE.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

CAUTION NOTICE: ASABE and ANSI standards may be revised or withdrawn at any time. Additionally, procedures of ASABE require that action be taken periodically to reaffirm, revise, or withdraw each standard.

Copyright American Society of Agricultural and Biological Engineers. All rights reserved.

ASABE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA, phone 269-429-0300, fax 269-429-3852, hq@asabe.org

Manure Production and Characteristics

Developed by the Engineering Practices Subcommittee of the ASAE Agricultural Sanitation and Waste Management Committee; approved by the Structures and Environment Division Standards Committee; adopted by ASAE December 1976; reconfirmed December 1981, December 1982, December 1983, December 1984, December 1985, December 1986, December 1987; revised June 1988; revised editorially and reaffirmed December 1993; revised editorially March 1995; reaffirmed December 1998, December 1999, December 2001, February 2003; revised March 2005 by joint committee of ASAE and Federation of Animal Science Societies members; reaffirmed January 2010, December 2014.

Keywords: Livestock, Manure, Waste

1.0 Purpose

1.1 This standard provides three types of information for estimating characteristics of livestock and poultry manure:

- Typical characteristics for manure “as-excreted” by livestock and poultry based on typical diets and animal performance levels in 2002 (Section 3);
- Equations for estimating manure excretion characteristics based on animal performance and dietary feed and nutrient intake specific to an individual situation (Sections 4 through 9);
- Typical characteristics for manure “as-removed” from manure storage or animal housing (Section 10).

1.2 Typical or average estimates of manure excreted become obsolete due to changes in animal genetics, performance potential, feeding program strategies, and available feeds. To minimize future concerns, a set of equations for predicting nutrient excretion (primarily nitrogen and phosphorus), dry matter, and, depending upon species, other potential characteristics have been assembled for beef, dairy, swine, horses and poultry. The Equation Estimates sections (Sections 4 through 9) allow an estimate of manure characteristics that is relevant to a wide range of dietary options and animal performance levels commonly observed in commercial production.

1.3 It is more appropriate to use the equations in Sections 4 through 9for the following situations:

- When comprehensive nutrient management plans are being developed specific to an individual animal feeding operation (AFO);
- When farm specific data is available for an AFO’s feeding program and animal performance;
- When feed intake, feed nutrient concentration, feed digestibility, or animal performance varies from the assumptions used to estimate the typical values in Table 1.
- When Table 1 has not been updated to address industry trends.

1.4 It may be more appropriate to use the typical values found in Table 1 for the following situations:

- When planning estimates are being made on a scale larger than a single farm (e.g. county or regional estimate of nutrient excretion)
- When a rough approximation is needed for farm planning;
- When farm-specific information of animal performance and feed intake is not available.

 Copyright American Society of Agricultural and Biological Engineers

2.0 Caution

2.1 Section 3. Typical As-Excreted Manure Production and Characteristics. The user of these data should recognize that the reported typical values may become obsolete with time due to changes in animal genetics, feeding programs, alternative feeding technologies, and available feeds. In addition, users should also recognize that under current conditions, excretion of nutrients and other related characteristics will vary for individual situations from the currently listed values due to variations in animal feed nutrient intake, animal performance, and individual farm management. Sections 4–9 provide an alternative, and often more accurate, methodology for estimating nutrient excretion for individual production systems.

2.2 Sections 4 – 9. Equations for As-Excreted Manure Characteristics Estimates for Individual Species. These sections demonstrate the impact of dietary changes on nutrient excretion. However, this is not intended to be used as a ration-balancing tool, nor is this the appropriate tool for estimating the nutrient needs of the animal. Nutrient needs are best defined in the National Research Council's publication series or by using University recommendations. Both sources of information can provide estimates that reflect biological inefficiencies and digestibility limitations.

2.3 In using Sections 4 – 9 to evaluate the impact of alternative rations, it is important to recognize that these equations accurately estimate excretion only when animals are fed diets that meet or exceed the animal's minimum nutrient requirements. Estimates of excretion based on dietary options that do not meet an animal's minimum needs will not be accurate. Sections 4–9 are to be used following ration development by an animal nutrition professional.

2.4 New research data on excretion will be of value for confirming or improving the accuracy of the equations estimating excreting. The authors of this standard are very interested in comparing new research data with these equations. Authors can be contacted through the ASAE Standards staff.

2.5 Section 10. Typical As-Removed Manure Production and Characteristics. Many physical, chemical, and biological processes can alter manure characteristics from its original as-excreted form. The as-removed manure production and characteristics values reported in this table allow for common modifications to excreted manure (Section 3) resulting from water addition or removal, bedding addition, and/or treatment processes. These values represent typical values based on available data sources (see end of Section 10). These estimates may be helpful for individual farm long-term planning prior to any samples being available and for planning estimates addressing regional issues. Whenever possible, site-specific samples or other more localized estimates should be used in lieu of national tabular estimates. **This table should not be used to develop individual year nutrient management plans for defining field specific application rates, unless absolutely no site-specific manure analysis data are available.** However, where site-specific data are unavailable, this table may provide initial estimates for planning purposes until those site specific values are available.

3.0 Typical As-Excreted Manure Production and Characteristics

3.1 Two approaches were used for estimating typical characteristics summarized in Table 1.

1) Manure characteristics listed in **BOLD** are estimated for dietary intake and animal performance levels common for livestock and poultry management in 2003 using the equations listed in Sections 4 through 9. Beef, poultry and swine excretion characteristics are based on a calculation of dietary nutrient intake minus animal nutrient retention using dietary and performance measurements typical for the industry at the time these data were published. Nutrient retention estimates followed common industry methodologies used for recommending feeding programs. Dry matter excretion is estimated to be a function of dry matter intake minus dry matter digestibility (see equations in Sections 4 and 9).

   For estimating dairy and equine manure characteristics, existing research data and regression analysis were used to identify relationship between feeding programs, animal performance, and excretion.

   Total nitrogen, total phosphorus, and dry matter excretion were estimated by these methods for all species. Available research data or models allowed additional excretion estimates for some species. All data in Table 1 based upon animal dietary intake and performance measure is illustrated in **BOLD** with supporting assumptions for dietary intake and performance assumptions and references listed in Sections 4 through 9.

 Copyright American Society of Agricultural and Biological Engineers

2) Where dietary intake and animal performance level based excretion estimates could not be made, a review of current references including the USDA Agricultural Waste Management Field Handbook, previous ASAE D384 standard, and Manure Characteristics (MWPS-18, Section 1). Those values in Table 1 that are not bold are based upon these references.

3.2 Caution

3.2.1 Manure and nutrient production characteristics for meat producing animals are reported on a unit mass excreted per finished animal. Manure excretion by meat producing animals varies with stage of growth. This format was selected to minimize misuse of a daily average values to represent an entire production phase. Sizing of treatment systems based upon instantaneous loading rates should use the equations in Sections 4 through 9 with appropriate feeding program and performance inputs typical of the later stages of growth. Manure excretion rates for other animals are more constant and thus reported on a daily basis.

3.2.2 In addition, facilities for meat producing animals are rarely in full production 365 days per year due to uneven growth rates of animals, time required for facility cleaning after a group, and availability of animals for restocking a facility. Planning based on number of finished animals provides a more realistic planning estimate for annual manure volume and nutrient production.

3.2.3 It should also be noted that Table 1 estimates and predictive equations in Sections 4 through 9 provide an as-excreted estimate of manure production, excluding any additions of waste feed or dilution water, biochemical degradation of solids, or volatilization of nitrogen and carbon. Manure characteristics after storage and/or treatment of manures are better estimated by site-specific manure samples or, when farm specific information is not available, by the typical as-removed values listed in Section 10.

3.3 References

3.3.1 Fulhage, C. D., 2003. Proposed Revision to ASAE D384.1 for Representative Values of "As-Excreted" Manure Production. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 269-276.

Table 1 – Section 3 – Estimated typical manure (urine and feces combined) characteristics as excreted[1] by: Table 1.a – Meat-producing livestock and poultry. Diet based numbers are in BOLD. See footnotes 2 and 3 for source of non-bold values.

Animal Type and Production Grouping	Total Solids[3]	Volatile Solids[3]	COD[3, 4]	BOD[3, 4]	N	P	K	Ca	Total Manure[5]		Moisture[6]	Assumed Finishing Time Period (days)
	kg/ finished animal (f.a.)								kg/ f.a.	liter/ f.a.	% w.b.	
Beef: Finishing cattle	**360**	**290**	300	67	**25**	**3.3**	17.1	**7.7**	4,500	4,500	92	153
Poultry: Broiler	**1.3**	0.95	1.05	0.30	**0.053**	**0.016**	**0.031**		4.9	4.9	74	48
Poultry: Turkey, males	**9.2**	7.4	8.5	2.4	**0.55**	**0.16**	0.26		36	36	74	133
Poultry: Turkey, females	**4.4**	3.5	4.0	1.1	**0.26**	**0.074**	0.11		17	17	74	105
Poultry: Duck	**1.7**	1.0	1.4	0.28	**0.062**	**0.022**	0.031		6.5	6.5	74	39
Swine: Nursery pig,12.5 kg	4.8	4.0	4.4	1.5	**0.41**	**0.068**	0.16		48	48	90	36
Swine: Grow-finish, 70 kg	**56**	45	47	17	**4.7**	**0.76**	2.0		560	560	90	120
	lb/ finished animal (f.a.)									ft^3/ f.a.	% w.b.	
Beef: Finishing cattle	**780**	**640**	670	150	**55**	**7.3**	38	**17**	9,800	160	92	153
Poultry: Broiler	**2.8**	2.1	2.3	0.66	**0.12**	**0.035**	**0.068**		11	0.17	74	48
Poultry: Turkey, males	**20**	16	19	5.2	**1.2**	**0.36**	0.57		78	1.3	74	133
Poultry: Turkey, females	**9.8**	7.8	8.8	2.4	**0.57**	**0.16**	0.25		38	0.61	74	105
Poultry: Duck	**3.7**	2.2	3.0	0.61	**0.14**	**0.048**	0.068		14	0.23	74	39
Swine: Nursery pig, 27.5 lb	10	8.7	9.7	3.4	**0.91**	**0.15**	0.35		87	1.4	90	36
Swine: Grow-finish, 154 lb	**120**	99	104	38	**10**	**1.7**	4.4		1200	20	90	120

 Copyright American Society of Agricultural and Biological Engineers

Table 1.b – Section 3 — All other livestock and poultry. Diet based numbers are in BOLD. See footnotes 2 and 3 for source of non-bold values.

Animal Type and Production Grouping	Total Solids[3]	Volatile Solids[3]	COD[3, 4]	BOD[3, 4]	N	P	K	Ca	Mg	Total Manure[5]		Moisture[6]
	kg/ day-animal (d-a)									kg/ (d-a)	liter/ d-a.	% w.b.
Beef: Cow (confinement)[7,10]	**6.6**	**5.9**	6.2	1.4	**0.19**	**0.044**	0.14	**0.089**		-	-	88
Beef: Growing calf (confinement)	**2.7**	**2.3**	2.3	0.52	**0.13**	**0.025**	0.085	**0.040**		22	22	88
Dairy: Lactating cow	**8.9**	7.5	8.1	1.30	**0.45**	**0.078**	**0.103**			68	68	87
Dairy: Dry cow	**4.9**	4.2	4.4	0.626	**0.23**	0.03	0.148			38	3	87
Dairy: Milk fed calves					0.0079							
Dairy: Calf, 150 kg	1.4				0.063					8.5	8.5	83
Dairy: Heifer, 440 kg	3.7	3.2	3.4	0.54	**0.12**	**0.020**				22	22	83
Dairy: Veal, 118 kg	0.12				0.015	0.0045	0.0199			3.5	3.5	96
Horse: Sedentary, 500 kg[8]	**3.8**	3.0		0.48	**0.089**	**0.013**	**0.027**	**0.023**	**0.009**	25	25	85
Horse: Intense exercise, 500 kg[8]	**3.9**	3.1		0.49	**0.15**	**0.033**	**0.095**	**0.069**	**0.018**	26	26	85
Layer	**0.022**	0.016	0.018	0.0050	**0.0016**	**0.00048**	0.00058	**0.0022**		0.088	0.088	75
Swine: Gestating sow, 200 kg	0.50	0.45	0.47	0.17	**0.032**	**0.009**	0.022			5.0	5.0	90
Swine: Lactating sow,[9] 192 kg	1.2	1.0	1.1	0.38	**0.085**	**0.025**	.053			12	12	90
Swine: Boar, 200 kg	0.38	0.34	0.27	0.13	0.028	0.0097	.0176			3.8	3.8	90
	lb/ day-animal (d-a)									lb/ d-a.	ft^3/ d-a.	% w.b.
Beef: Cow (confinement)[7, 10]	**15**	**13**	14	3.0	**0.42**	**0.097**	0.30	**0.20**		-	-	88
Beef: Growing calf (confinement)	**6.0**	**5.0**	5.2	1.1	**0.29**	**0.055**	0.19	**0.088**		50	0.81	88
Dairy: Lactating cow	**20**	17	18	2.9	**0.99**	**0.17**	**0.23**			150	2.4	87
Dairy: Dry cow	**11**	9.2	9.7	1.4	**0.50**	**0.066**	0.33			83	1.3	87
Dairy: Milk fed calves					0.017							
Dairy: Calf, 330lb	3.2				0.14					19	0.30	83
Dairy: Heifer, 970 lb	8.2	7.1	7.5	1.2	**0.26**	**0.044**				48	0.78	83
Dairy: Veal, 260 lb	0.27				0.033	0.0099	0.044			7.8	0.12	96
Horse: Sedentary, 1,100 lb[8]	**8.4**	6.6		1.1	**0.20**	**0.029**	**0.060**	**0.051**	**0.020**	56	0.90	85
Horse: Intense exercise , 1,100 lb[8]	**8.6**	6.8		1.1	**0.34**	**0.073**	**0.21**	**0.15**	**0.040**	57	0.92	85
Layer	**0.049**	0.036	0.039	0.011	**0.0035**	**0.0011**	0.0013	0.0048		0.19	0.0031	75
Swine: Gestating sow, 440 lb	1.1	0.99	1.0	0.37	**0.071**	**0.020**	0.048			11	0.18	90
Swine: Lactating sow,[9] 423 lb	2.5	2.3	2.4	0.84	**0.19**	**0.055**	0.12			25	0.41	90
Swine: Boar, 440 lb	0.84	0.75	0.60	0.29	0.061	0.021	0.039			8.4	0.13	90

(continued)

Copyright American Society of Agricultural and Biological Engineers

Table 1.b – Section 3 (continued)

[1] Prior to any changes due to dilution water addition, drying, volatilization or other physical, chemical or biological processes.

[2] Non-bold table numbers indicate that predictive equations were not available from Sections 4 – 9 for estimating this characteristic. These numbers are average values taken from MWPS-18 Section 1, NRCS Agricultural Waste Management Field Handbook, and the previous version ASAE D384.1 or calculated based upon procedures used in footnote 3.

[3] Total Solids (TS) is estimated for most animal groups by equations in Sections 4 – 9. For beef cattle, volatile solids is also based upon equations. For all other species, volatile solids are calculated from TS and literature values of the ratio of VS to TS. Similarly, BOD and COD values are calculated using VS and the literature values of the ratio of BOD and COD to VS. Literature values are taken from MWPS-18 Section 1, NRCS Agricultural Waste Management Field Handbook, and the previous version ASAE D384.1.

[4] BOD: biochemical oxygen demand, 5-day, COD: chemical oxygen demand.

[5] Total manure is calculated from Total Solids and manure moisture content.

[6] As-excreted manure moisture contents range from 75 to 90 percent. At these moisture levels as-excreted manure has a density nearly equal to that of water, and a specific gravity of 1.0 was assumed in calculation of manure volume.

[7] Solids estimates (TS, VS, COD, and BOD) do not include solids in urine.

[8] These values apply to horses 18 months of age or older that are not pregnant or lactating. The representative number applies to 500 kg horses and the range represents horses from 400 to 600 kg. ‘‘Sedentary’’ would apply to horses not receiving any imposed exercise. Dietary inputs are based on minimum nutrient requirements specified in “Nutrient Requirements of Horses” (NRC, 1989). “Intense” represents horses used for competitive activities such as racing. Dietary inputs are based on a survey of race horse feeding practices (Gallagher et al, 1992) and typical feed compositions (forage = 50% alfalfa, 50% timothy; concentrate = 30% oats, 70% mixed performance horse concentrate).

[9] Bold values include contribution of nursing pigs.

[10] Beef cows’ values are representative of animals during non-lactating period and first six months of gestation.

Copyright American Society of Agricultural and Biological Engineers

4.0 Equations for As-Excreted Manure Characteristics Estimates for Beef

4.1 Fundamental Model

Nutrient Excretion = Feed Nutrient Intake – Nutrient Retention

*Dry Matter Excretion = Feed Dry Matter Intake × (1 – Dry Matter Digestibility)**

* Same relationship for organic matter or volatile solids excretion.

4.2 See 2.0 Caution

See Table 2, Definitions of variables — as excreted — beef.

Table 2 – Section 4 – Definition of variables — as excreted — beef

Variable	Description	Units
Animal Performance Characteristics Input		
BW_F	Live body weight at finish of feeding period (market weight) [2]	kg
BW_I	Live body weight at start of feeding period (purchase weight) [2]	kg
BW_{AVG}	Average live body weight for feeding period [2]	kg
SRW [3]	Standard reference weight for expected final body fat	478 kg for Choice (28% marbling) 462 kg for Select (26.8% marbling)
Feed Program Characteristics Inputs		
DMI	Dry matter intake	g dry feed/day
DMD	Dry matter digestibility of total ration	% of DMI
OMD	Organic matter digestibility of total ration	% of OMI
ASH	Ash concentration of total ration	% of DMI
C_{cp}	Concentration of crude protein of total ration	g of protein/g of dry feed
C_P	Concentration of phosphorus of total ration	g of phosphorus/g of dry feed
DOF	Days on feed for individual ration	days
x	Ration number	
n	Total number of rations fed	
Excretion Outputs		
N_{E-T}	Total nitrogen excretion per finished animal	g of nitrogen/finished animal
P_{E-T}	Total phosphorus excretion per finished animal	g of phosphorus/finished animal
Ca_{E-T}	Total calcium excretion per finished animal	g of calcium/finished animal
DM_E	Dry matter excretion per animal per day	g of dry matter/day/animal
DM_{E-T}	Total dry matter excretion per finished animal	g of dry matter/finished animal
OM_E	Organic matter (or volatile solids) excretion per animal per day	g of organic matter/day/animal
OM_{E-T}	Total organic matter (or volatile solids) excretion per finished animal	g of organic matter/finished animal

[1] Data specific to individual herd performance or feed analysis should be used when data is available. If situation specific information is not available, a default value from the Assumptions Table for Typical Manure Characteristics at the conclusion of this section may be the next best alternative.
[2] For beef cow/calf pairs (including pregnancy), assume $BW_F – BW_I$ equals weaning weight of calves. For beef cows on maintenance diet, assume the $BW_F – BW_I$ equals 0.
[3] If SRW is unknown, recommend using 478 kg as standard reference weight.

4.3 Equations for Estimating Excretions

Equations from the 1996 NRC Nutrient Requirements of Beef Cattle for retained protein and energy equations provide the basis for estimating nitrogen retention. Supplemental information referenced by this publication provides background information on validation of this approach for estimating retained nitrogen.

Retained phosphorus is generally recognized as 3.9 g of retained P per 100 g of retained protein. Retained calcium is generally recognized as 7.1 g per 100 g of retained protein. Therefore, P and Ca retention are calculated as a function of retained protein. Both assumptions originate from the 1996 NRC Nutrient Requirements of Beef Cattle. Additional supporting information is cited by this publication.

4.3.1 *Dry matter excretion equations for calves and finishers:* [1]

$$DM_E = [DMI * (1 - DMD/100)] + 20.3 * (0.06 * BW_{AVG}) \quad (1)$$

$$DM_{E-T} = \sum_{x=1}^{n} DMI_x * DOF_x * (1 - DMD_x/100) + \sum_{x=1}^{n} DOF_x * 20.3 * (0.06 * BW_{AVG}) \quad (2)$$

4.3.2 *Organic matter (or volatile solids) excretion equations:*

$$OM_E = [DMI * (1 - ASH/100)] * (1 - OMD/100) + 17 * (0.06 * BW_{AVG}) \quad (3)$$

$$\begin{aligned} OM_{E-T} = & \sum_{x=1}^{n} [DMI_x * DOF_X * (1 - ASH_x/100)] * (1 - OMD_x/100) \\ & + \sum_{x=1}^{n} DOF_X * 17 * (0.06 * BW_{AVG}) \end{aligned} \quad (4)$$

4.3.3 *Nitrogen excretion equation:*

$$\begin{aligned} N_{E-T} = & \sum_{x=1}^{n} (DMI_x * C_{cp-x} * DOF_x * /6.25) - [41.2 * (BW_F - BW_I)] \\ & + \left[0.243 * DOF_{Tt} * [(BW_F + BW_I)/2]^{0.75} * (SRW/(BW_F * 0.96))^{0.75} * [(BW_F - BW_I)/DOF_T]^{1.097}\right] \end{aligned} \quad (5)$$

4.3.4 *Phosphorus excretion equation:*

$$\begin{aligned} P_{E-T} = & \sum_{x=1}^{n} (DMI_x * C_{P-x} * DOF_x) - [10.0 * (BW_F - BW_I)] \\ & + \left\{5.92 * 10^{-2} * DOF_T * [(BW_F + BW_I)/2]^{0.75} * (SRW/BW_F * 0.96)^{0.75} * [(BW_F - BW_I)/DOF_T]^{1.097}\right\} \end{aligned} \quad (6)$$

4.3.5 *Calcium excretion equation:*

$$\begin{aligned} Ca_{E-T} = & \sum_{x=1}^{n} (DMI_x * C_{Ca-x} * DOF_x) - [18.33 * (BW_F - BW_I)] \\ & + 0.445 * \left\{0.243 * DOF_T * [(BW_F + BW_I)/2]^{0.75} * (SRW/(BW_F * 0.96))^{0.75} * [(BW_F - BW_I)/DOF_T]^{1.097}\right\} \end{aligned} \quad (7)$$

4.4 Manure Characteristics Based Upon Typical Performance and Diets — See Tables 3a and 3b.

Table 3a – Section 4 – Estimated manure (urine and feces combined) characteristics as excreted based upon equations and assumptions in Table 3b

Animal Type and Production Grouping	Total solids	Volatile Solids	Nitrogen	Phosphorus	Calcium	Total Manure[1]
Finishing cattle	kg/finished animal					
	360	290	25	3.3	7.7	3,400
	lb/finished animal					
	780	640	55	7.3	17	7,400

[1] Total manure is calculated from total solids and assumed moisture of 92%.

[1] Estimates dry matter for 1) feces based upon indigestibility of feed and for 2) urine based upon regression equation from 300 observations of urine excretion by beef cattle finishers ranging in weight from 100 to 620 kg and urine solids content of 6%.

Table 3b – Section 4 – Dietary and performance assumptions

Animal Type and Production Grouping	Live Weight (kg)		Average Daily Gain (kg/da)	Days on Feed	Feed Conversion (kg of feed per kg of gain)	Dietary Assumptions						
	In	Out				DMI (% of avg. body weight)	DMD	OMD	Crude Protein (g/day)	P (g/day)	Ca (g/day)	Ash
Finishing cattle	338	554	1.42	153	6.3	2.0%	80%	83%	1200	28	62	4%
Range: Only feed conversion efficiency and dietary nutrient content or digestibility were varied to determine range for N, P, and Ca.					5.8–6.8		70–85%	75–88%	1100–1300	22–45	53–80	

4.5 References

4.5.1 Anrique, R. G., M. L. Thonney, and H. J. Ayala. 1990. Dietary energy losses of cattle influenced by body type, size, sex, and intake. Anim. Prod. 50:467-474.

4.5.2 Danner, M. L., D. G. Fox, and J. R. Black. 1980. Effect of feeding system on performance and carcass characteristics of yearling steers, steer calves and heifer calves. J. Anim. Sci. 50:394-404.

4.5.3 Ellenberger, H. G., J. A. Newlander, and C. H. Jones. 1950. Composition of the bodies of dairy cattle. Vt. Agric. Exp. Sta. Bull. 558.

4.5.4 Erickson, G. E., B. Auvermann, R. Eigenberg, L.W. Greene, T. Klopfenstein, R. Koelsch. 2003. Proposed Beef Cattle Manure Excretion and Characteristics Standard for ASAE. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 269-276.

4.5.5 Fortin, A., S. Simpfendorfer, J. T. Reid, H. J. Ayala, R. Anrique, and A. F. Kertz. 1980. Effect of level of energy intake and influence of breed and sex on the chemical composition of cattle. J. Anim. Sci. 51:604-614.

4.5.6 Garrett, W. N. 1980. Energy utilization by growing cattle as determined in 72 comparative slaughter experiments. Energy Metab. Proc. Symp. 26:3-7.

4.5.7 Harpster, H. W. 1978. Energy requirements of cows and the effect of sex, selection, frame size, and energy level on performance of calves of four genetic types. Ph.D. dissertation. Michigan State University, East Lansing, MI.

4.5.8 Lomas, L. W., D. G. Fox, and J. R. Black. 1982. Ammonia treatment of corn silage. I. Feedlot performance of growing and finishing cattle. J. Anim. Sci. 55:909-923.

4.5.9 NRC. 1996 (2000 update). Nutrient Requirements for Beef Cattle. Seventh Revised Edition. National Academy Press. 242 pages.

4.5.10 Tylutki, T. P., D. G. Fox, and R. G. Anrique. 1994. Predicting net energy and protein requirements for growth of implanted and nonimplanted heifers and steers and nonimplanted bulls varying in body size. J. Anim. Sci. 72:1806-1813.

4.5.11 Woody, H. D., D. G. Fox, and J. R. Black. 1983. Effect of diet grain content on performance of growing and finishing cattle. J. Anim. Sci. 57:717-728.

5.0 Equations for As-Excreted Manure Characteristics Estimates for Dairy Cattle

5.1 Fundamental Model

5.1.1 The estimates for manure and nutrient excretion were derived from the combination of multiple data sets from Washington State University, University of California–Davis, The Ohio State University, and Pennsylvania State University. The data sets contain records from Holstein cattle and include a wide variety of animal ages, ranging from calves to multiparous lactating cows.

5.1.2 The data for the calves and heifers were divided according to animal body weight and includes four groups, milk fed calves, weaned calves weighing less than 204 kg, heifers weighing between 274 to 613 kg, and veal calves. Excretion estimates for veal calves were adapted from Sutton et al., 1989. Additional classifications of animals include non-lactating and lactating cows.

5.1.3 Lactating cow excretion estimates were derived from regression equations developed using lactating Holstein cows regardless of body weight or milk production. The data set for lactating cows was evaluated to compare the amount of metabolizable protein (MP) required to the MP supplied to the cow using the 2001 Dairy NRC Model. Only cows fed less than 112% of MP requirements were included in the data set. The average values reported for lactating cows were determined using the regression equation for a cow producing 40 kg of milk. The regression equations were developed using PROC MIXED of SAS, with study included as a random variable (St-Pierre, 2001).

5.2 See 2.0 Caution

See Table 4, Definitions of variables — as excreted — dairy cattle

Table 4 – Section 5 – Definition of variables — as excreted — dairy cattle

Variable	Description	Units
Animal Performance Characteristics Inputs		
Milk	Milk production	kg of milk/animal/day
MF	Milk fat	g/g milk/day
MTP	Milk true protein	g/g milk/day
DIM	Days in milk	days
DP	Dry period length	days
BW	Average live body weight	kg
Feed Program Characteristics Inputs		
DMI	Dry matter intake	kg dry feed/animal/day
DMD	Dry matter digestibility of total ration	% of DMI
OMD	Organic matter digestibility of total ration	% of OM intake
ASH	Ash concentration of total ration	% of DMI
C_{cp}	Concentration of crude protein of total ration	g crude protein/g dry feed
C_P	Concentration of phosphorus of total ration	g phosphorus/g dry feed
C_K	Concentration of potassium of total ration	g potassium/g dry feed
Excretion Outputs		
M_E	Total manure excretion per animal per day	kg/animal/day
N_E	Total nitrogen excretion per animal per day	g/animal/day
P_E	Total phosphorus excretion per animal per day	g/animal/day
K_E	Total potassium excretion per animal per day	g/animal/day
DM_E	Dry matter (solids) excretion per animal per day	kg/animal/day
OM_E	Organic matter (or volatile solids) excretion per animal per day	kg/animal/day
U_E	Urine excretion per animal per day	liters/animal/day

 Copyright American Society of Agricultural and Biological Engineers

5.3 Equations for Estimating Excretion

In many cases, multiple prediction equations are presented. Note, that while the more simplistic equation requires fewer inputs, the result could be less precise due to the influence of dietary intake of nutrients (more developed equation). Regression equations developed using the data set include both residual errors and errors from the variation between the research trials (inter-study errors). Equations with the lowest residual error should be used whenever the input variables are available.

Assumptions:

1) Urine dry matter, estimated at 4.5%, was used for total solids and moisture calculations. The urine volume was calculated by using a specific gravity of 1.038 g/ml.

2) Milk crude protein was converted to milk true protein using a conversion factor for the Holstein breed of 0.940 (http://www.aipl.arsusda.gov/reference/trueprot.htm).

5.3.1 *Total manure — lactating cow regression equations:*[2]

$$M_E = (Milk \times 0.172) + (DMI \times 2.207) + (MF \times 171.830) + (MTP \times 505.310) - 8.170 \quad (1)$$

Inter-study error = 8.50
Residual error = 7.00

$$M_E = (Milk \times 0.954) + (BW \times 0.037) + (DIM \times 0.017) + (MF \times 186.720) + (MTP \times 1141.480) - 33.06 \quad (2)$$

Inter-study error = 5.08
Residual error = 8.33

$$M_E = (Milk \times 0.647) + 43.212 \quad (3)$$

Inter-study error = 6.94
Residual error = 9.19

5.3.2 *Total manure — dry cow regression equation:* [2]

$$M_E = (BW \times 0.022) + 21.844 \quad (4)$$

Inter-study error = 5.93
Residual error = 5.71

5.3.3 *Total manure — heifer regression equations:* [2]

$$M_E = (DMI \times 3.886) - (BW \times 0.029) + 5.641 \quad (5)$$

Inter-study error = 5.34
residual error = 2.61

$$M_E = (BW \times 0.018) + 17.817 \quad (6)$$

Inter-study error = 4.02
Residual error = 3.55

[2] Total manure equals actual fecal excretion plus actual urine excretion from individual cows collected and weighted on a daily basis.

 Copyright American Society of Agricultural and Biological Engineers

5.3.4 *Total solids — lactating cow regression equations:* [3]

$$DM_E = (DMI \times 0.350) + 1.017 \tag{7}$$

Inter-study error = 1.13
Residual error = 0.76

$$DM_E = (Milk \times 0.135) + (BW \times 0.004) + (DIM \times 0.004) + (MTP \times 118.370) - 2.456 \tag{8}$$

Inter-study error = 0.63
Residual error = 1.03

$$DM_E = (Milk \times 0.096) + 5.073 \tag{9}$$

Inter-study error = 0.78
Residual error = 1.13

5.3.5 *Total solids — dry cow regression equation:* [3]

$$DM_E = (DMI \times 0.178) + 2.733 \tag{10}$$

Inter-study error = 0.74
Residual error = 0.45

$$DM_E = (BW \times 0.004) + 1.863 \tag{11}$$

Inter-study error = 0.42
Residual error = 0.59

5.3.6 *Urine volume — lactating cow regression equations:*

$$U_E = (Milk \times 0.114) + (BW \times 0.016) + (MF \times 97.709) + (MTP \times 353.280) + (C_{CP} \times 62.036) - 16.389 \tag{12}$$

Inter-study error = 3.87
Residual error = 5.56

$$U_E = (BW \times 0.017) + 11.704 \tag{13}$$

Inter-study error = 4.67
Residual error = 5.68

(Note: Urine volume could be considerably different, depending on ration mineral content. Insufficient data were available to derive regression equations based on intake of minerals)

[3] DM_E = actual fecal dry matter + urine dry matter.

 Copyright American Society of Agricultural and Biological Engineers

5.3.7 *Nitrogen excretion — lactating cow regression equation:* [4]

$$N_E = (Milk \times 2.303) + (DIM \times 0.159) + (DMI \times C_{CP} \times 70.138) + (BW \times 0.193) - 56.632 \quad (14)$$

Inter-study error = 53.07
Residual error = 102.71

$$N_E = (Milk \times 5.959) + (DIM \times 0.237) + (BW \times 0.347) + (MTP \times 4547.910) + (C_{CP} \times 1793.730) - 476.530 \quad (15)$$

Inter-study error = 42.48
Residual error = 107.01

$$N_E = (Milk \times 4.204) + 283.300 \quad (16)$$

Inter-study error = 57.8
Residual error = 110.8

5.3.8 *Nitrogen excretion — dry cow regression equation:* [4]

$$N_E = (DMI \times 12.747) + (C_{CP} \times 1606.290) - 117.500 \quad (17)$$

Residual error = 45.51

5.3.9 *Nitrogen excretion — heifer regression equations:* [4]

$$N_E = (DMI \times 1000) \times (C_{CP} / 6.25) \quad (18)$$

$$N_E = (DMI \times C_{CP} \times 78.390) + 51.350 \quad (19)$$

Inter-study error = 24.47
Residual error = 10.76

5.3.10 *Phosphorus excretion — lactating cow regression equations:* [5]

If diets contain less than 0.004 g P/g dry feed: [5]

$$P_E = [(DMI \times 1000) \times C_P] - (Milk \times 0.9) \quad (20)$$

If diets contain 0.004 g P/g dry feed or greater:

$$P_E = (Milk \times 0.565) + (MTP \times 816.260) + (DMI \times C_P \times 421.410) - 9.697 \quad (21)$$

Inter-study error = 10.81
Residual error = 11.47

$$P_E = (Milk \times 0.773) + 46.015 \quad (22)$$

Inter-study error = 10.83
Residual error = 14.48

[4] Nitrogen excretion = actual fecal N + actual urine N.
[5] Phosphorus excretion = actual fecal P + actual urine P.

 Copyright American Society of Agricultural and Biological Engineers

5.3.11 *Phosphorus excretion — dry cow regression equation:* [5,6]

$$P_E = \left\{ \left[(DMI \times 1000) \times C_P \times DP \right] - 264.386 \right\} / DP \tag{23}$$

5.3.12 *Phosphorus excretion — heifer regression equation:* [5]

$$P_E = (DMI \times 1000) \times C_P \tag{24}$$

5.3.13 *Potassium — lactating cow regression equations:* [7]

$$K_E = (Milk \times 1.822) + (MTP \times 2688.880) + (DMI \times C_K \times 156.930) - 91.755 \tag{25}$$

Inter-study error = 16.77
Residual error = 25.27

$$K_E = (Milk \times 1.800) + 31.154 \tag{26}$$

Inter-study error = 18.89
Residual error = 26.94

5.3.14 *Potassium — dry cow and heifer regression equation:* [7]

$$K_E = (DMI \times 1000) \times C_K \tag{27}$$

5.4 Manure Characteristics Based Upon Typical Performance and Diets — See Tables 5a, 5b and 5c.

Table 5a – Section 5 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon equations in Section 5 and assumptions in Table 5c.

Animal Type and Production Grouping	Total Solids	N	P	K	Total Manure[1]	Assumed Moisture
	kg/da-animal					% w.b.
Dairy: Lactating cow	8.9	0.45	0.078	0.10	69	87
Dairy: Dry cow	4.9	0.23			38	87
Dairy: Heifer, 440 kg	3.7	0.12	0.020		22	83
	lb/da-animal					% w.b.
Dairy: Lactating cow	20	0.99	0.17	0.23	150	87
Dairy: Dry cow	11	0.50			83	87
Dairy: Heifer, 440 kg	8.2	0.26	0.044		48	83
Equation Used for Excretion Estimate						
Dairy: Lactating cow	9	16	22	26	-	
Dairy: Dry cow	11	17	-	-	-	
Dairy: Heifer, 440 kg	No equation	19	24	-	-	

[1] Total manure is calculated from total solids and assumed moisture.

[6] The constant was derived from the 2001 Dairy NRC equation (p. 112) for absorbed phosphorus and assumes a 60 day dry period.
[7] Potassium excretion = actual fecal K + actual urine K.

 Copyright American Society of Agricultural and Biological Engineers

Table 5b – Section 5 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon sources cited in Table 5c

Animal Type and Production Grouping	Total solids	N	P	K	Total Manure[1]	Assumed Moisture
	kg/da-animal					% w.b.
Dairy: Milk-fed calves		0.0079				
Dairy: Calf, 150 kg	1.4	0.063			8.5	83
Dairy: Veal, 118 kg	0.12	0.015	0.0045	0.020	3.5	96.5
	lb/da-animal					% w.b.
Dairy: Milk-fed calves		0.017				
Dairy: Calf, 150 kg	3.2	0.14			19	83
Dairy: Veal, 118 kg	0.27	0.033	0.0099	0.044	7.8	96.5

Table 5c – Section 5 – Dietary and performance assumptions.

Animal Type and Production Grouping	Average Live Weight (kg)	Milk Production (kg)	Dietary Assumptions				Comments or Written Description of Assumptions
			Dry Matter Intake (% of average body weight)	Crude Protein (g/day)	P (g/day)	K (g/day)	
Lactating cow	624	40	3.4	3720	94.7	283	Averages based on 367 cows
range	437–810	9.8-86.1	1.1–4.9	1356–5250	40–144	168–443	
Dry cow	755	NA	1.4	1525			Averages based on 18 cows
range	413–934		0.7–2.2				
Milk-fed calves	57.1	NA	1.0	136			Averages based on 16 calves
Calf, 150 kg	153	NA	2.21	558			Averages based on 46 calves
range	86–204		1.56–3.37	275–880			
Dairy veal	40–85	NA	1.89	284	10		
range	85–150		2.09	491	18		
Heifer, 420 kg	437	NA	1.91	923			Averages based on 60 heifers
range	274–613		1.43–2.44	500–1688			

5.5 References

5.5.1 Nennich, T., J Harrison, D. Meyer, W. Weiss, A. Heinrichs, R. Kincaid, W. Powers, R. Koelsch, P. Wright. 2003. Development of Standards Method to Estimate Manure Production and Nutrient Characteristics from Dairy Cattle. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 263-268.

6.0 Equations for As-Excreted Manure Characteristics Estimates for Horses

6.1 Fundamental Model

Equations for as-excreted manure characteristics are based upon regression analysis from available data sets for N, P, K, Ca and Mg. Other estimates are based on survey data or dietary recommendations (NRC, 1989). The nitrogen data set contained 46 paired values (intake and excretion), with intakes ranging from 130 to 530 mg/kg *BW*/day (median = 250 g N/kg *BW*). For P, 128 paired values were used (range = 19–121 mg/kg *BW*/day; median = 42.8 mg P/kg *BW*). For K, 28 paired values were used (range 50–404 mg/kg *BW*/day; median = 193.3 mg K/kg *BW*). For Ca, 106 paired values were used (range 9.1–247 mg/kg *BW*/d; median 69.7 mg Ca/kg *BW*). For Mg, 50 paired values were used (range 18.6–131.6 mg Mg/kg *BW*/d; median 28.2 mg Mg/kg *BW*).

6.2 See 2.0 Caution

See Table 6, Definitions of Variables — As Excreted — Horses

Table 6 – Section 6 – Definition of Variables — As Excreted — Horses

Variable	Description	Units
Animal Performance Characteristics Input		
BW	Average live body weight	kg
Feed Program Characteristics Inputs		
DMI	Dry matter intake	g dry feed/day
DMD	Dry matter digestibility of total ration	%
OMD	Organic matter digestibility of total ration	%
ASH	Ash concentration of total ration	%
C_{cp}	Concentration of crude protein of total ration	g of protein/g of dry feed
C_P	Concentration of phosphorus of total ration	g of phosphorus/g of dry feed
C_K	Concentration of potassium of total ration	g of potassium/g of dry feed
C_{Ca}	Concentration of calcium of total ration	g of calcium/g of dry feed
C_{Mg}	Concentration of magnesium of total ration	g of magnesium/g of dry feed
Excretion Outputs		
N_E	Total nitrogen excretion per animal per day	g/animal/day
P_E	Total phosphorus excretion per animal per day	g/animal/day
K_E	Total potassium excretion per animal per day	g/animal/day
Ca_E	Total calcium excretion per animal per day	g/animal/day
Mg_E	Total magnesium excretion per animal per day	g/animal/day
DM_E	Dry matter excretion (feces + urine) per animal per day	g/animal/day
DM_F	Dry matter excretion (feces only) per animal per day	g/animal/day
F_E	Feces (wet weight) excretion per animal per day	g/animal/day
U_E	Urine excretion per animal per day	g/animal/day

6.3 Equations for Estimating Excretions

6.3.1 *Nitrogen excretion:*

$$\text{Sedentary horses: } N_E = (55.4 \times BW \times 10^{-3}) + (0.586 \times DMI \times C_{cp})/6.25$$

$$(R^2 = 0.76)$$

 Copyright American Society of Agricultural and Biological Engineers

Exercised horses: $N_E = (42.9 \times BW \times 10^{-3}) + (0.492 \times DMI \times C_{cp})/6.25$

$(R^2 = 0.94)$

6.3.2 *Phosphorus excretion:*

Sedentary or exercised horses: $P_E = (4.56 \times BW \times 10^{-3}) + (0.793 \times DMI \times C_p)$ (1)

$(R^2 = 0.85)$

6.3.3 *Potassium excretion:*

Sedentary or exercised horses: $K_E = (19.4 \times BW \times 10^{-3}) + (0.673 \times DMI \times C_k)$ (2)

$(R^2 = 0.62)$

6.3.4 *Calcium excretion:*

Sedentary horses: $Ca_E = (26.6 \times BW \times 10^{-3}) + (0.497 \times DMI \times C_{Ca})$ (3)

$(R^2 = 0.65)$

Exercised horses: $Ca_E = (-5.98 \times BW \times 10^{-3}) + (0.804 \times DMI \times C_{Ca})$ (4)

$(R^2 = 0.73)$

6.3.5 *Magnesium excretion:*

Sedentary or exercised horses: $Mg_E = (9.08 \times BW \times 10^{-3}) + (0.545 \times DMI \times C_{Mg})$ (5)

$(R^2 = 0.68)$

6.3.6 *Dry matter excretion (feces):*

Sedentary: $DM_F = [(0.03 \times BW + 1.4)/2.0] \times 425$ (6)

Exercised: $DM_F = \{[2.0 \times (0.03 \times BW + 1.4)]/2.85\} \times 310$ (7)

6.3.7 *Dry matter excretion (combined urine and feces):* [8]

Sedentary: $DM_E = 7.2 \times BW + 220$ (8)

Exercised: $DM_E = 7.3 \times BW + 230$ (9)

6.3.8 *Optional estimate of dry matter excretion (feces) for all horses:*

$DM_F = DMI \times (1 - DMD/100)$ (10)

6.3.9 *Optional estimate of dry matter excretion (combined urine and feces) for all horses:* [9]

$DM_E = [DMI \times (1 - DMD/100)] + 0.64 \times BW$ (11)

[8] Sum of total feces and total urine (equations 12 and 13) and multiplied by an assumed moisture content of 15%.
[9] Alternate approach: Sum of total urine (equation 13) multiplied by assumed urine solids content of 4% and dry matter excretion (equation 10).

6.3.10 *Total feces:*

$$\text{Sedentary or exercised horses: } F_E = DM_E/0.20 \quad (12)$$

6.3.11 *Total urine:*

$$\text{Sedentary or exercised horses: } U_E = 16 \times BW \quad (13)$$

6.4 Manure Characteristics Based Upon Typical Performance and Diets — See Tables 7a and 7b.

Table 7a – Section 6 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon equations in Section 6 and assumptions in Table 7b

Animal Type and Production Grouping	Total Solids	N	P	K	Ca	Mg
	g/da-animal					
Horse: Sedentary, 500 kg[1]	3800	89	13	27	23	9
Horse: Intense exercise, 500 kg[1]	3900	150	33	95	69	18
	lb/da- animal					
Horse: Sedentary, 1100 lb[1]	8.4	0.20	0.029	0.060	0.051	0.020
Horse: Intense exercise, 1100 lb[1]	8.6	0.34	0.073	0.21	0.15	0.040

[1] These values apply to horses 18 months of age or older that are not pregnant or lactating. The representative number applies to 500 kg horses. Under type of horse, classifications are made on amount of regular exercise imposed on horses.

Table 7b – Section 6 – Dietary and performance assumptions

Animal Type and Production Grouping[1]	Average Live Weight (kg)	Dietary Assumptions						
		Dry Matter Intake (% of average body weight)	Dry Matter Digestibility	Crude Protein (g/day)	P (g/day)	K (g/day)	Ca (g/day)	Mg (g/day)
Sedentary: Mature[2]	500	1.6	57.5%	656	14	25	20	7.5
Range	400–600	1.6–1.7	57.5%	536–776	11–17	20–30	16–24	6–9
Intense exercise (race horses)[3]	500	2.3	69%	1660	39	127	89	25.3
Range	400–600	2.3–2.4	69%	1328–1992	31–47	101–152	71–106	20–30

[1] These values apply to horses 18 months of age or older that are not pregnant or lactating. The representative number applies to 500 kg horses and the range represents horses from 400 to 600 kg.
[2] "Sedentary" would apply to horses not receiving any imposed exercise. Dietary inputs are based on minimum nutrient requirements specified in "Nutrient Requirements of Horses" (NRC, 1989).
[3] "Intense" represents horses used for competitive activities such as racing. Dietary inputs are based on a survey of race horse feeding practices (Gallagher et al, 1992) and typical feed compositions (forage = 50% alfalfa, 50% timothy; concentrate = 30% oats, 70% mixed performance horse concentrate).

6.5 References

6.5.1 Lawrence, L., J. Bicudo, E. Wheeler. 2003. Horse Manure Characteristics Literature and Database Review. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 277-284.

6.5.2 Gallagher, K., J. Leech and H. Stowe. 1992. Protein, energy and dry matter consumption by racing thoroughbreds: A field survey. J. Equine Vet. Sci. 12:43-48.

6.5.3 NRC. 1989. Nutrient Requirements of Horses. National Academy Press, Washington, D.C.

7.0 Equations for As-Excreted Manure Characteristics Estimates for Poultry (Broilers, Turkeys, and Ducks)

7.1 Fundamental Model

Nutrient Excretion = Feed Nutrient Intake – Nutrient Retention

7.2 See 2.0 Caution

See Table 8, Definitions of Input Variables — As Excreted — Poultry (Broilers, Turkeys, and Ducks)

Table 8 – Section 7 – Definition of Input Variables — As Excreted — Poultry (Broilers, Turkeys, and Ducks)

Variable	Description	Units
Feed Program Characteristics		
FI_{PH}	Feed intake per phase; dry matter intake assumed to be 88% of feed intake	g feed/phase (wet basis)
C_{cp}	Concentration of crude protein of total ration	g of protein/g of feed (wet basis)
C_P	concentration of phosphorus of total ration	g of phosphorus/g feed (wet basis)
x	Phase number (e.g. number assigned to starter, grower, finisher, withdrawal phase rations)	
n	Total number of phases fed	
DM_{RF}	Retention factor for dry matter	fraction
N_{RF}	Retention factor for nitrogen	fraction
P_{RF}	Retention factor for phosphorus	fraction
K_{RF}	Retention factor for potassium	fraction
Excretion Outputs		
$N_{E\text{-}PH}$	Nitrogen excretion per phase	g of nitrogen/phase
$N_{E\text{-}T}$	Total nitrogen excretion per finished animal	g of nitrogen/finished animal
$P_{E\text{-}PH}$	Phosphorus excretion per phase	g of phosphorus/per phase
$P_{E\text{-}T}$	Total phosphorus excretion per finished animal	g of phosphorus/finished animal
$K_{E\text{-}PH}$	Potassium excretion per phase	g of potassium/per phase
$K_{E\text{-}T}$	Total potassium excretion per finished animal	g of potassium/finished animal
$DM_{E\text{-}PH}$	Dry matter excretion per phase	g of dry matter/per phase
$DM_{E\text{-}T}$	Total dry matter excretion per finished animal	g of dry matter/finished animal

 Copyright American Society of Agricultural and Biological Engineers

7.3 Equations for Estimating Excretions — See Table 9 – Retention Factors for Broilers, Turkeys, and Ducks.

7.3.1 *Dry matter excretion equations:*

$$DM_{E-PH} = FI_{PH} \times 0.88 \times (1 - DM_{RF}) \quad (1)$$

$$DM_{E-T} = \sum_{x=1}^{n} FI_x \times 0.88 \times (1 - DM_{RF}) \quad (2)$$

7.3.2 *Nitrogen excretion equations:*

$$N_{E-PH} = \lfloor FI_{PH} \times (C_{cp} / 6.25) \rfloor \times (1 - N_{RF}) \quad (3)$$

$$N_{E-T} = \sum_{x=1}^{n} \left[FI_x \times (C_{cp-x} / 6.25) \right] \times (1 - N_{RF}) \quad (4)$$

7.3.3 *Phosphorus excretion equations:*

$$P_{E-PH} = (FI_{PH} \times C_p) \times (1 - P_{RF}) \quad (5)$$

$$P_{E-T} = \sum_{x=1}^{n} (F_x \times C_p) \times (1 - P_{RF}) \quad (6)$$

Note that P_{RF} varies for broilers less than and greater than 32 days of age.

7.3.4 *Potassium excretion equations:*

$$K_{E-PH} = (FI_{PH} \times C_K) \times (1 - K_{RF}) \quad (7)$$

$$K_{E-T} = \sum_{x=1}^{n} (F_x \times C_K) \times (1 - K_{RF}) \quad (8)$$

Table 9 – Section 7 – Retention Factors for Broilers, Turkeys, and Ducks

Species	Dry Matter (DM_{RF})	Nitrogen (N_{RF})	Phosphorus (P_{RF})	Potassium (K_{RF})
Broiler if < 32 days of age	0.6884	0.602	0.493	0.182
Broiler if ≥ 32 days of age			0.4102	0.182
Turkey toms and hens	0.7479	0.588	0.4798	
Ducks	0.6937	0.657	0.4635	

 Copyright American Society of Agricultural and Biological Engineers

7.4 Manure Characteristics Based Upon Typical Performance and Diets — See Tables 10a and 10b.

Table 10a – Section 7 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon equations in Section 7 and assumptions in Table 10b

Animal Type and Production Grouping	Total solids	Nitrogen	Phosphorus	Potassium	Total Manure[1]
	kg/finished animal				
Poultry: Broiler	1.3	0.053	0.016	0.031	4.9
Poultry: Turkey, males	9.2	0.55	0.16		36
Poultry: Turkey, females	4.4	0.26	0.074		17
Poultry: Duck	1.7	0.062	0.022		6.5
	lb/finished animal				
Poultry: Broiler	2.8	0.12	0.035	0.068	11
Poultry: Turkey, males	20	1.2	0.36		78
Poultry: Turkey, females	9.8	0.57	0.16		38
Poultry: Duck	3.7	0.14	0.048		14

[1] Total manure is calculated from total solids and assumed moisture of 74%.

Table 10b – Section 7 – Dietary and performance assumptions

Animal Type and Production Grouping	Live Weight (kg)		Days on Feed	Feed Conversion (kg of feed per kg of gain)	Dietary Assumptions			Comments, Assumptions, or References
	In	Out			Dry Matter Intake (kg per phase)	Crude Protein (kg per phase)	P (kg per phase)	
Broiler	n/a	2.36	47.7	1.95	4.05 kg to 47.7 d	0.835 kg to 47.7 d	0.0288 kg to 47.7 d	Represents 95.8% of broilers marketed July 2002 (662 million birds or 1.53 billion kg live weight) (Agristats, 2002). Four diet feeding program is assumed.
Turkey, males	n/a	15.45	133	2.70	36.7 kg to 133 d	8.37 kg to 133 d	0.309 kg to 133 d	Represents 45.5 million turkey toms (Ferket, 2001). Six diet feeding program is assumed
Turkey, females	n/a	6.82	105	2.34	17.6 kg to 105 d	3.94 kg to 105 d	0.143 kg to 105 d	Represents 59.5 million turkey hens (Ferket, 2001). Six diet feeding program is assumed.
Duck	n/a	3.182	39	1.97	5.51 kg to 39 d	1.12 kg to 39 d	0.0402 kg to 39 d	Represents 13 million ducks (Applegate et al., 2003). Assumes two diet feeding program.
Assumptions: Feed is 88% dry matter.								

7.5 References

7.5.1 Applegate, T., L. Potturi, R. Angel. 2003. Model for estimating poultry manure nutrient excretion: a mass balance approach. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 296-302.

7.5.2 Angel, R., T. Applegate, S. Bastyr. 2003. Comparison of two methods for estimating broiler manure nutrient excretion: Biological mass balance versus model based on mass balance approach. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 303-309.

8.0 Equations for As-Excreted Manure Characteristics Estimates for Poultry (Laying Hens)

8.1 Fundamental Model

Nutrient Excretion = Feed Nutrient Intake – Nutrient Retention

The laying hen model varies from other poultry specie to account for egg production. As such, the model assumes dry matter retention by the hen is equivalent to the sum of energy expenditure for maintenance, heat increment, and egg production as well as solids content within the egg, as is described below.

8.2 See 2.0 Caution

See Table 11, Definition of Input Variables — As Excreted — Poultry (Laying Hens)

Table 11 – Section 8 – Definition of Input Variables — As Excreted — Poultry (Laying Hens)

Variable	Description	Units
FI	Feed intake per day (wet weight). Dry matter intake assumed to be 88% of feed intake for poultry rations.	grams/day
$KCAL_i$	Kcal Intake Default: 270 kcal – Light layer strains Default: 292 kcal – Heavy layer strains default	kcal/day
$KCAL_m$	Kcal required for maintenance of body weight Default: 100 kcal	kcal/day
$KCAL_h$	Kcal required for heat increment in thermo-neutral environment Default: 40 kcal	kcal/day
$KCAL_e$	Kcal Required for egg production of one egg Default: 53 kcal	kcal/egg
Egg_{wt}	Egg weight Default: 60 g – Light layer strains Default: 63 g – Heavy layer strains	grams
Egg_{prod}	Fraction of eggs that are produced each day Default: 0.80	eggs/hen/day
C_{cp}	Concentration of crude protein of total ration	g of protein/g of feed (wet basis)
C_P	Concentration of phosphorus of total ration	g of phosphorus/g feed (wet basis)
C_{Ca}	Concentration of calcium of total ration	g of calcium/g feed (wet basis)
Excretion Outputs		
DM_E	Dry matter excretion per hen per day	g of dry matter/hen-day
N_E	Total nitrogen excretion per hen per day	g of nitrogen/hen-day
P_E	Total phosphorus excretion per hen per day	g of phosphorus/hen-day
Ca_E	Total calcium excretion per hen per day	g of phosphorus/hen-day

8.3 Equations for Estimating Excretions

8.3.1 *Dry matter excretion:*

$$DM_E = [FI \times 0.88] - \left\{ \begin{array}{l} (FI \times 0.88 \times 0.85) \times \left[1 - \left(\left\{ KCAL_i - \left[KCAL_m + KCAL_h + (KCAL_e \times Egg_{prod}) \right] \right\} \Big/ KCAL_i \right) \right] \\ + (0.3319 \times Egg_{wt} \times Egg_{prod}) \end{array} \right\} \quad (1)$$

or

 Copyright American Society of Agricultural and Biological Engineers

$$DM_E = [FI \times 0.88] - \left\{ \begin{array}{l} (FI \times 0.88 \times 0.85) \times \left[1 - \left(\left\{ KCAL_i - \left[140 + (53 \times Egg_{prod}) \right] \right\} \Big/ KCAL_i \right) \right] \\ + (0.3319 \times Egg_{wt} \times Egg_{prod}) \end{array} \right\}$$

8.3.2 *Nitrogen excretion:*

$$N_E = (FI \times C_{cp} / 6.25) - (0.0182 \times Egg_{wt} \times Egg_{prod}) \quad (2)$$

8.3.3 *Phosphorus excretion:*

$$P_E = (FI \times C_p) - (0.0024 \times Egg_{wt} \times Egg_{prod}) \quad (3)$$

8.3.4 *Calcium excretion:*

$$Ca_E = (FI \times C_{Ca}) - (0.00383 \times Egg_{wt} \times Egg_{prod}) \quad (4)$$

8.4 Assumptions: Diet contains 15% ash content and corrects diet energy retention to an ash-free, dry matter basis. Egg contains 33.19% solids, 1.82% N, 0.24% P, & 3.83% Ca. DM retention by hen is equivalent to energy expenditure for maintenance (100 kcal/hen, NRC, 1994; Lasiewski and Dawson, 1967), heat increment (40 kcal; NRC, 1994; MacLeod and Jewitt, 1988), and egg production (53 kcal/egg; NRC, 1994).

8.5 Manure Characteristics Based Upon Typical Performance and Diets – See Tables 12a and 12b.

Table 12a – Section 8 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon equations in Section 8 and assumptions in Table 12b

Animal Type and Production Grouping	Total Solids	Nitrogen	Phosphorus	Calcium	Total Manure[1]
	kg/da-animal				
Layer	0.022	0.0016	0.00048	0.0022	0.088
	lb/da- animal				
Layer	0.049	0.0035	0.0011	0.0048	0.19
[1] Total manure is calculated from total solids and assumed moisture of 75%.					

Table 12b – Section 8 – Dietary and performance assumptions

Animal Type and Production Grouping	Average Live Weight (kg)	Feed Conversion (kg of feed per kg of product)	Dietary Assumptions			Comments or Written Description of Assumptions Reference[1]
			Dry Matter Intake (g per phase)	Crude Protein (g per phase)	P (g per phase)	
Layer	1.3–1.45 at start	1.994	36.64 kg from 20–80 wk	6500.4 g from 20–80 wk	249.0 g from 20–80 wk	20-80 wk production cycle. Feed is 88% dry matter 64% and 36% of industry is light (1.28 kg) and heavy (1.45) weight strains, respectively. A weekly change in diet formulation, feed consumption, and egg production was assumed from average performance.

8.6 References

8.6.1 Applegate, T., L. Potturi, R. Angel. 2003. Model for estimating poultry manure nutrient excretion: A mass balance approach. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 296-302.

9.0 Equations for As-Excreted Manure Characteristics Estimates for Swine

9.1 Fundamental Model

Nutrient Excretion = Nutrient Feed Intake – Nutrient Retention

9.2 See 2.0 Caution

See Table 13, Definitions of Input Variables (using all swine groups).

Table 13 – Section 9 – Definition of Output Variables (used for all swine groups)

Variable	Description	Units
Nutrient Intake		
N_I	Daily nitrogen intake	g/day
N_{I-T}	Nitrogen intake per finished animal or period (e.g. lactation)	g/finished animal or g/period
P_I	Daily phosphorus intake	g/day
P_{I-T}	Phosphorus intake per finished animal or period (e.g. lactation)	g/finished animal or g/period
Nutrient Retention		
N_R	Daily nitrogen retained	g/day
N_{R-T}	Nitrogen retained per finished animal or period (e.g. lactation)	g/finished animal or g/period
WBN_F	Whole body nitrogen content at final body weight	g
WBN_I	Whole body nitrogen content at initial body weight	g
P_R	Daily phosphorus retained	g/day
P_{R-T}	Phosphorus retained per finished animal or period (e.g. lactation)	g/finished animal or g/period
Nutrient Excretion		
N_E	Daily nitrogen excretion	g/day
N_{E-T}	Total nitrogen excretion per finished animal or period (e.g. lactation)	g/finished animal or g/period
P_E	Daily phosphorus excretion	g/day
P_{E-T}	Total phosphorus excretion per finished animal or period (e.g. lactation)	g/finished animal or g/period
DM_E	Daily dry matter excretion	g/day
DM_{E-T}	Total dry matter excretion per finished animal or period (e.g. lactation)	g/finished animal or g/period

9.3 Equations for Estimating Excretions — See Table 14, Input Variables — Grow-finish Pigs (20 to 120 kg).

9.3.1 *Nutrient and Solids excretion — grow-finish Pigs (20 to 120 kg):*

$$N_{E-T} = N_{I-T} - N_{R-T} \tag{1}$$

$$P_{E-T} = P_{I-T} - P_{R-T} \tag{2}$$

$$DM_{E-T} = \left[C_{DM} \times FI_G \times (100 - DMD)/10{,}000\right] + \left[0.025 \times DOF_G \times (20 \times BW_{AVG} + 2{,}100)\right] \tag{3}$$

9.3.2 *Nutrient intake — grow-finish pigs (20 to 120 kg):*

$$N_{I-T} = ADFI_G \times C_{CP} \times DOF_G / 625 \quad \text{or} \quad FI_G \times C_{CP} / 625 \tag{4}$$

$$P_{I-T} = ADFI_G \times C_P \times DOF_G / 100 \quad \text{or} \quad FI_G \times C_P / 100 \tag{5}$$

 Copyright American Society of Agricultural and Biological Engineers

9.3.3 *Nutrient retention — grow-finish pigs (20 to 120 kg):* [10]

$$N_{R-T} = [(BW_F \times DP_F \times FFLP_F)/159.4] - \{BW_I \times [DP_F - 0.05 \times (BW_F - BW_I)] \times [FFLP_F + 0.07 \times (BW_F - BW_I)]\}/159.4 \quad (6)$$

$$P_{R-T} = (0.2256 \times N_{RT}) - [8.0 \times 10^{-6} \times N_{RT} \times (WBN_I + WBN_F)] \quad (7)$$

$$WBN_F = (BW_F \times DP_F \times FFLP_F)/159.4 \quad (8)$$

$$WBN_I = BW_I \times \{DP_F - [0.05 \times (BW_F - BW_I)]\} \times \{FFLP_F + [0.07 \times (BW_F - BW_I)]\}/159.4 \quad (9)$$

Daily excretion of solids, nitrogen and phosphorus can be estimated by dividing total excretion estimated above by days on feed for the grow-finish phase (DOF_G).

Table 14 – Section 9.3 – Input Variables — Grow-finish Pigs (20 to 120 kg)

Variable	Description	Units
Animal Performance Characteristics		
BW_I	Initial body weight	kg
BW_F	Final body weight (market weight)	kg
BW_{AVG}	Average of initial and final body weight	kg
DOF_G	Days on feed to finish animal (grow-finish phase)	days
DP_F	Average dressing percent (yield) at final weight, typically from packer kill sheet	%
$FFLP_F$	Average fat-free lean percentage at final weight, typically from packer kill sheet	%
Feed Program Characteristics		
$ADFI_G$	Average daily feed intake over finishing period (grow–finish phase); user provided or see NRC (1998)	g/d
FI_G	Feed Intake per finished animal (grow–finish phase)	g/finished animal
C_{CP}	Concentration of crude protein in total (wet) ration	%
C_P	Concentration of phosphorus in total (wet) ration	%
C_{DM}	Dry matter concentration of diet	%
DMD	Dry matter digestibility of total ration	%

9.4 Equations for Estimating Excretions — See Table 15, Definitions of Input Variables — Weanling Pigs (5 to 20kg).

9.4.1 *Nutrient and solids excretion — weanling pigs (5 to 20 kg):* [11]

$$N_{E-T} = N_{I-T} - N_{R-T} \quad (1)$$

$$P_{E-T} = P_{I-T} - P_{R-T} \quad (2)$$

$$DM_{E-T} = C_{DM} \times ADFI_N \times DOF_N \times (100 - DMD)/10{,}000 \quad (3)$$ [11]

[10] P retention based on relation to N (Jongbloed, 1987).
[11] Dry matter excretion in feces only.

 Copyright American Society of Agricultural and Biological Engineers

9.4.2 *Nutrient intake — weanling pigs (5 to 20 kg):*

$$N_{I-T} = ADFI_N \times C_{CP} \times DOF_N / 625 \quad \text{or} \quad FI_N \times C_{CP} / 625 \tag{4}$$

$$P_{I-T} = ADFI_N \times C_P \times DOF_N / 100 \quad \text{or} \quad FI_N \times C_P / 100 \tag{5}$$

9.4.3 *Nutrient retention — weanling pigs (5 to 20 kg):* [10]

$$N_{R-T} = DOF_N \times FFLG_G \times \{1 + [0.137 \times (BW_{F-N} + BW_{I-N})]\} / 125.8 \tag{6}$$

$$P_{R-T} = 4.7494 \times (BW_{F-N} - BW_{I-N}) \tag{7}$$

Daily excretion of solids, nitrogen and phosphorus can be estimated by dividing total excretion estimated above by days on feed for nursery phase (DOF_N).

Table 15 – Section 9.4 – Definition of Input Variables — Weanling Pigs (5 to 20 kg)

Variable	Description	Units
Animal Performance Characteristics		
BW_{I-N}	Initial body weight in nursery phase	kg
BW_{F-N}	Final body weight in nursery phase	kg
DOF_N	Days on feed to finish animal (nursery phase)	days
DP_{120}	Average dressing percent (yield) at 120 kg, typically from packer kill sheet	%
$FFLG_G$	Average fat-free lean gain from 20 to 120 kg Recommended values: 350 g/day High lean growth capacity pigs 325 g/day High-moderate lean growth capacity pigs 300 g/day Moderate lean growth capacity pigs Source: National Research Council. 1998. Nutrient Requirements of Swine. National Academy Press. Washington, D. C. 189 pages.	g/d
Feed Program Characteristics		
$ADFI_N$	Average daily feed intake over finishing period (nursery phase); user provided or see NRC (1998)	g/d
FI_N	Feed Intake per finished animal (nursery phase)	g/finished animal
C_{CP}	Concentration of crude protein in total (wet) ration	%
C_P	Concentration of phosphorus in total (wet) ration	%
C_{DM}	Dry matter concentration of diet	%
DMD	Dry matter digestibility of total ration	%

9.5 Equations for Estimating Excretions — See table 16, Input Variables — Gestating Sows.

9.5.1 *Nutrient and solids excretion — gestating sows:* [11]

$$N_{E-T} = N_{I-T} - N_{R-T} \tag{1}$$

$$P_{E-T} = P_{I-T} - P_{R-T} \tag{2}$$

$$\begin{aligned} DM_{E-T} &= C_{DM} \times ADFI_S \times GL \times (100 - DMD) / 10{,}000 \quad {}^{11} \\ &= C_{DM} \times ADFI_S \times 0.0115 \times (100 - DMD) \end{aligned} \tag{3}$$

 Copyright American Society of Agricultural and Biological Engineers

9.5.2 *Nutrient intake — gestating sows:* [11]

$$N_{I-T} = ADFI_S \times C_{CP} \times GL/625 = ADFI_S \times C_{CP} \times 0.184 \quad (4)$$

$$P_{I-T} = ADFI_S \times C_P \times GL/100 = ADFI_S \times C_P \times 1.15 \quad (5)$$

9.5.3 *Nitrogen retention — gestating sows:* [12]

$$N_{R-T} = (GLTG \times 36.8) + (LITTER \times 39.1) \quad (6)$$

$$P_{R-T} = 93.039 + \{3.9717 \times [(SW_{PF} - SW_B) - (2.277 \times LITTER)]\} + (LW_{Birth} \times 5.7) + \{[(2.277 \times LITTER) - LW_{Birth}] \times 0.80\} \quad (7)$$

Note: N_{R-T} accounts for nitrogen retention in maternal weight gain and the developing litter. P_{R-T} considers phosphorus retention in maternal weight gain, developing litter and placenta tissue.

Daily excretion of solids, nitrogen and phosphorus can be estimated by dividing total excretion estimated above by gestation length (*GL*) in days.

Table 16 – Section 9.5 – Input Variables — Gestating Sows

Variable	Description	Units
Animal Performance Characteristics		
GLTG	Gestation lean tissue gain; recommended value 19.205 kg	kg
GL	Gestation period length (assumed to be 115 days)	days
SW_{Breed}	Sow body weight at breeding	kg
SW_{PF}	Sow body weight post farrowing	kg
LW_{Birth}	Litter weight at birth	kg
LITTER	Number of pigs in litter	number of pigs
Feed Program Characteristics		
$ADFI_S$	Average daily feed intake during gestation	g/d
C_{CP}	Concentration of crude protein	%
C_P	Concentration of phosphorus	%
C_{DM}	Dry matter concentration of diet	%
DMD	Dry matter digestibility of total ration	%

9.6 Equations for Estimating Excretions – See Table 17, Input Variables — Lactating Sows.

9.6.1 *Nutrient and solids excretion — lactating sows*

$$N_{E-T} = N_{I-T} - N_{R-T} \quad (1)$$

$$P_{E-T} = P_{I-T} - P_{R-T} \quad (2)$$

$$DM_{E-T} = C_{DM} \times ADFI_L \times LL \times (100 - DMD)/10{,}000 \quad (3)$$ [11]

[12] Assumes gestation period length of 115 days.

 Copyright American Society of Agricultural and Biological Engineers

9.6.2 *Nutrient intake — lactating sows*

$$N_{I-T} = ADFI_{LACT} \times C_{CP} \times LL/625 \quad (4)$$

$$P_{I-T} = ADFI_{LACT} \times C_{P} \times LL/100 \quad (5)$$

9.6.3 *Nutrient retention — lactating sows*

$$N_{R-T} = [36.8 \times LLTG] + (LW_{WEAN} \times 32) - (LW_{BIRTH} \times 36.8) \quad (6)$$

$$P_{R-T} = [(SW_{WEAN} \times 4.84) - (SW_{PF} \times 5.28)] + [(LW_{WEAN} \times 6.4) - (LW_{BIRTH} \times 5.7)] \quad (7)$$

Daily excretion of solids, nitrogen and phosphorus can be estimated by dividing total excretion estimated above by lactation length (*LL*) in days.

Table 17 – Section 9.6 – Input Variables — Lactating Sows

Variable	Description	Units
Animal Performance Characteristics		
LLTG	Lactation lean tissue gain; recommended value: -4.20 kg	kg
LL	Lactation length (or time to weaning)	days
SW_{WEAN}	Sow body weight at litter weaning	kg
SW_{PF}	Sow body weight post farrowing	kg
LW_{WEAN}	Litter weight at weaning	kg
LW_{BIRTH}	Litter weight at birth	kg
Feed Program Characteristics		
$ADFI_{LACT}$	Average daily feed intake during lactation	g/d
C_{CP}	Concentration of crude protein	%
C_{P}	Concentration of phosphorus	%
C_{DM}	Dry matter concentration of diet	%
DMD	Dry matter digestibility of total ration	%

9.7 Manure Characteristics Based Upon Typical Performance and Diets – See Tables 18a, 18b, and 18c.

Table 18a – Section 9.7 – Estimated typical manure (urine and feces combined) characteristics as excreted based upon equations in Section 9 and assumptions in Table 18b

Animal Type and Production Grouping	Total solids	Nitrogen	Phosphorus	Total solids[1]	Nitrogen	Phosphorus
	kg/ finished animal			lb/ finished animal		
Swine: Nursery pig, 12.5 kg		0.41	0.068		0.91	0.15
Swine: Grow-finish, 70 kg	56	4.7	0.76	120	10	1.7
	kg/day animal			lb/day animal		
Swine: Gestating sow, 200 kg		0.032	0.009		0.071	0.020
Swine: Lactating sow, 192 kg		0.085	0.025		0.19	0.055

[1] Total solids include urine and feces.

 Copyright American Society of Agricultural and Biological Engineers

Table 18b – Section 9.7 – Dietary and performance assumptions[1,2]

Animal Type and Production Grouping	Live Weight (kg)		Average Daily Gain (kg/da)	Days on Feed	Feed Conversion (kg of feed per kg of gain)	Dietary Assumptions			
	In	Out				Dry Matter Intake (% of avg. body weight)	Dry Matter Digestibility	Crude Protein (g/day)	P (g/day)
Nursery pig, 12.5 kg[1,2]	5	20	0.412	36	1.50	5.0	80 %	137	3.88
Grow-finish, 70 kg[1,2]	20	120	0.84	120	2.80	3.4	82 %	371	10.3

[1] Feed is 88% dry matter. Corn-soybean meal-animal protein (weanling pig) or corn-soybean meal (grow-finish) diet meets the lysine requirement.
[2] N and P intake is based on NRC (1988). N and P retention are based in NRC (1988). P retention is based on Mahan and Newton (1995).

Table 18c – Section 9.7 – Dietary and performance assumptions of sows[1,2]

Animal Type and Production Grouping	Average Live Weight (kg)	Production	Dietary Assumptions				Comments or Written Description of Assumptions Reference[1]
			Dry Matter Intake (% of average body weight)	Dry Matter Digestibility	Crude Protein (g/day)	P (g/day)	
Gestating sow, 200 kg (start 175 kg, end 225 kg) [1,2], 115 day gestation period	200	12 pigs/litter	1.00	82%	259	12.4	Wt gain = 50 kg with 27 kg wt gain with litter and 23.0 kg wt gain for dam; gestation lean tissue gain = 17.6 kg
Lactating sow, 192 kg (start 198 kg, end 185 kg)[1,2], 20 day lactation period	192	10 pigs nursing	2.60	82%	967	34	Wt change = –13 kg; lactation lean tissue change = –5.3 kg

[1] Assumes corn-soy diet that is 88 % dry matter and meets the lysine requirement.
[2] N and P intake is based on NRC (1998). N retention is based on NRC (1998). P retention is based on Mahan and Newton (1995).

9.8 References

9.8.1 Carter, S., G. Cromwell, P. Westerman, J. Park, and L. Pettey. 2003. Prediction of Nitrogen, Phosphorus, and Dry Matter Excretion by Swine Based on Diet Chemical Composition, Feed Intake, and Nutrient Retention. Proceedings of the International Symposium for Animal, Agricultural, and Food Processing Wastes IX. ASAE. St. Joseph, MI. 285-295.

10.0 As-Removed Manure Production and Characteristics

10.1 Many physical, chemical, and biological processes can alter manure characteristics from its original as-excreted form. The as-removed manure production and characteristics values reported in this table allow for common modifications to excreted manure (Section 3) resulting from water addition or removal, bedding addition, and/or treatment processes. These values represent typical values based on available data sources (see end of Section 10). The variances on the data presented in Section 10, As-Removed Manure Production and Characteristics, are significantly high, and strongly correlated to the geographic location and the type of manure management system in use. These estimates may be helpful for individual farm long-term planning prior to any samples being available and for planning estimates addressing regional issues. Whenever possible, site-specific samples or other more localized estimates should be used in lieu of national tabular estimates. **This table should not be used to develop individual year nutrient management plans for defining field specific application rates, unless absolutely no site-specific manure analysis data are available**. Where site-specific data are unavailable, this table may provide initial estimates for planning purposes until site-specific values are available.

See Tables 19 and 20.

Table 19 – As-removed manure production characteristics. The numbers in parenthesis are coefficients of variation.

	Moisture (% wb)	TS (% wb)	VS (% TS)	Ash (% TS)	Heat (BTU/lb wb)	TKN (% wb)	NH_3-N (% wb)	P (% wb)	K (% wb)	Ca (% wb)	Na (ppm wb)	Mg (ppm wb)	Fe (ppm wb)	S (ppm wb)	Cl (ppm wb)	Zn (ppm wb)	Mn (ppm wb)	Cu (ppm wb)	Mass (kg/hd/d)
Beef																			
Earthen lot	33.1 (28)	67.2 (14)	30.2 (30)	69.9 (24)	1136 (15)	1.18 (33)	0.10 (102)	0.50 (36)	1.25 (25)	1.21 (46)	3012 (67)	3650 (27)	1305 (55)	2841 (37)	7396 (52)	85 (63)	393 (109)	14 (70)	7.5 (0.58)
Poultry																			
Leghorn pullets	65.20 (14)	40				2.13 (31)	0.85 (22)	1.00 (25)	1.10 (29)	1.49 (33)		2700 (26)							No data
Leghorn hen	59.27 (14)	40				1.85 (30)	0.88 (39)	1.21 (34)	1.31 (28)	6.40 (41)		4400 (32)							0.03
Broiler litter	31.00 (24)	70	70			3.73 (14)	0.75	0.60 (22)	1.37 (13)	1.82 (17)									0.02
Turkey litter	30.00					2.18		0.33	1.23	5.00									0.11
Dairy																			
Scraped earthen lots	54 (28)	46 (33)		43		0.70 (106)		0.25 (82)	0.67 (71)	0.45 (78)	311 (45)	100 (64)	4.6 (66)		86.0	1.2 (42)	1.4	0.2 (21)	35
Scraped concrete lots	72	25				0.53		0.13	0.40	0.31	32	9	1.3			0.4	0.7	0.1	40
Lagoon effluent	98	2	52			0.073	0.08	0.016	0.11	0.04	7	3	2.5		1.7	0.9	1.4	2	106
Slurry (liquid)	92 (1)	8 (16)	66			0.30	0.14	0.13	0.40	0.40	905	1535	735	625		25	40	75	67
Equine																			
Solid manure	43.4 (16.1)	64.9 (19.7)	26.3 (10.3)			0.76 (0.36)		0.24 (0.11)	0.99 (0.58)	1.13 (0.72)		0.3 (0.18)	3614 (4722)			51.7 (33.66)	135 (60)	12.70 (6.02)	32.2 (residential) 46 (commercial)
Swine																			
Finisher-Slurry, wet-dry feeders	91.00	9.00				0.70	0.50	0.21	0.24	0.25	380			400		85.0		50	3-4

(continued)

Copyright American Society of Agricultural and Biological Engineers

Table 19 (continued)

	Moisture (% wb)	TS (% wb)	VS (% TS)	Ash (% TS)	Heat (BTU/lb wb)	TKN (% wb)	NH_3-N (% wb)	P (% wb)	K (% wb)	Ca (% wb)	Na (ppm wb)	Mg (ppm wb)	Fe (ppm wb)	S (ppm wb)	Cl (ppm wb)	Zn (ppm wb)	Mn (ppm wb)	Cu (ppm wb)	Mass (kg/hd/d)
Flush building	98.00	2.00				0.20	0.14	0.07	0.17	0.04	300	290		155		33.6	14.4	31.2	16
Agitated solids and water	97.80	2.20				0.10	0.05	0.06	0.06	0.08	215	300		180		44.4	15.6	19.2	
Lagoon surface water	99.6	0.40				0.06	0.04	0.02	0.07	0.01	215	55		37		3.6	1.2	2.4	
Lagoon sludge	90.0	10.0				0.26	0.07	0.25	0.07	0.04	191	132		79		22	80	90	

Copyright American Society of Agricultural and Biological Engineers

Table 20 – References

The numbers in the table are rounded averages gathered from across the U.S. They are best-estimate interpretations based on the research data collected.

Beef			
Earthen Lots		**Concrete Lots**	
Nebraska unpub. (12 lots, 96 hd ea) NC State (n~30) Texas AM University (n~4) Oklahoma State University (n = 72) Ward lab (n = 1026) ∑ = 1144		Iowa unpublished data (N~ 6) NC State (n~27) NOTE: Not enough data to publish estimates for concrete lots	
Dairy			
Scraped Earthen Lots	**Scraped Concrete Lots**	**Lagoon Effluent**	**Liquid Slurry**
Jones (Texas, n~17) TAMU (n~5) Dairyland (n~77) Agsource (n~367) ∑ = 476	N.C. State data (n~ 187) TAMU (n~ 3) ISU (n~18) KSU (n~9) ∑ = 190	N.C. State data (~160) Meyer (n~ 518) NY (n~57) TAMU (n~18) ∑ = 753	N.C. State data (n~400) Minn (n~21) NY (n~39) Kansas (n~18, Stram et al.) Wisc (n~746) Dairyland (n~216) Agsource (n~514) NRAES-31, 1989, Collins et al.) ∑ = 1954
Swine			
Deep Pit Slurry	**Flush Water**	**Lagoon Surface Water**	**Agitated Liquid & Solids**
ISU Jaranilla (n = 24) ISU NIR data (n = 268) (1999 & 2000 data) ∑ = 292	SE US data (Chastain)	SE US data (Chastain) Mo. Data ISU NIR data (n= 189) ∑ = 189+	SE US data (Chastain)
Poultry			
Pullets	**Layer Hens**	**Broiler Litter**	**Turkey Litter**
Patterson	Patterson ISU (Lorimor & Xin, n = 48)	ISU (Mo. & Okla samples, n = 95)	

10.2 References (continued)

10.2.1 Barker, J. C., J. P. Zublena, C. R. Campbell. 1994. Unpublished compilation of manure samples of all species and facilities. North Carolina State Univ. Raleigh, N.C.

10.2.2 Stram, T. D., J. P. Harner, D. V. Key, and J. P. Murphy. 2000. Nutrients available from dairy lagoons and sand-laden manure. ASAE paper MC00-120. Presented at Mid Central Meeting of ASAE.

10.2.3 Collins, E. R., T. A. Dillaha, and H. W. Roller. 1989. Dairy manure management. NRAES-31.

10.2.4 Lorimor, J. C., and H. Xin. 1999. Manure production and nutrient concentrations from high-rise layer houses. ASAE Trans. 15(4): 337-340.

10.2.5 Patterson, P. H., and E. S. Lorenz. 1996. Manure nutrient production from commercial white leghorn hens. Applied Poultry Science Research report.

10.2.6 Lorimor, J. C., W. Powers, A. Sutton. 2000. Manure characteristics. MWPS18-Section 1. Midwest Plan Service. Ames, IA.

10.2.7 Lorimor, J. C. 1999. Managing manure nutrients for crop production. ISU Extension publication PM-1811. Ames, IA.

10.2.8 Chastain, J. P. 2002. Nutrient content of swine manure as removed. Unpublished data compiled by the author.

10.2.9 Erickson, G. A., T. Klopfensteein, D. Walters, and G. Lesoing. 1998. Nutrient balance of nitrogen, organic matter, phosphorus and sulfur in the feedlot. Nebraska Beef Report, Univ. of Nebraska, Lincoln, NB.

10.2.10 Ward Lab. 2003 Data accumulated from commercial lab (603 samples).

10.2.11 Lorimor, J. C. 2003. Unpublished data compiled by author on earthen beef feedlots in Iowa.

10.2.12 Jaranilla-Sanchez, P. A., J. C. Lorimor, and J. Boeding. 2003. Manure Accumulation in a Deep Pit Finishing Building. ASAE paper MC03-403. Presented at Mid Central Meeting of ASAE.

10.2.13 Bicudo, J. 2003. Compilation of unpublished data. Numbers were based on analyses of stall waste made in KY, TX, CO, Alberta (Canada), OK, and WA.

10.2.14 Ye, W. 2003. Application of near-infrared spectroscopy for determination of nutrient contents in manure. PhD dissertation, Iowa State University.

Manure Characteristics MWPS-18 Section 1, Second Edition

Table 6. Daily manure production and characteristics, as-excreted (per head per day)

		Total Manure			Nutrient Content		
	Size (lbs)	(lbs)	(cu ft)	(gal)	(lbs N)	(lbs P_2O_5)	(K_2O)
Finishing Steer	1,100	54	0.86	6.46	0.4	0.12	0.25
Layer Hen	3	0.15	0.002	0.017	0.0026	0.0008	0.0012
Ratio	0.0027273	0.0027778	0.0023256	0.0026316	0.0065	0.0066667	0.0048

Average Ratio 0.0025783

FILED

SEP 29 2015

Turner County Clerk of Courts
First Judicial Circuit Court of SD

STATE OF SOUTH DAKOTA) IN CIRCUIT COURT
: SS
COUNTY OF TURNER) FIRST JUDICIAL CIRCUIT

MARK JOFFER, LISA JOFFER, KATIE OVERVAAG, BRYAN OVERVAAG, KATHERINE LUTTER, and STEVEN LUTTER, Plaintiffs, v. TURNER COUNTY, SOUTH DAKOTA, TURNER COUNTY BOARD OF COMMISSIONERS, PETER SONSTEGARD, and SONSTEGARD FOODS COMPAY, Defendants.	CIV. 15 - 18 MEMORANDUM DECISION AND ORDER ON CROSS-MOTIONS FOR SUMMARY JUDGMENT

This matter came before the Court on the parties' competing motions for summary judgment, on August 27, 2015. Turner County and Turner County Board of Commissioners [collectively the Board] appeared through its attorney, James E. Moore of Sioux Falls. Peter Sonstegard and Sonstegard Foods Company [Sonstegard] appeared through their attorney, Brian J. Donahoe of Sioux Falls. Plaintiffs, Mark Joffer, Lisa Joffer, Katie Overvaag, Bryan Overvaag, Katherine Lutter, and Steven Lutter [Plaintiffs] appeared through their attorney, Michael J. Schaffer of Sioux Falls. The Court, having read the parties' briefs, heard the oral arguments, reviewed the exhibits, and further considered the matter, now issues the following Memorandum Decision and Order.

FACTS

In 2014, the Board proposed revisions to Turner County's 2008 Revised Zoning Ordinance [2008 Ordinance]. The Turner County Planning Commission [the Planning Commission] published a "Notice of Public Hearing" on July 24, 2014 and July 31, 2014 giving notice of the time, place, and purpose of a hearing to be held on August 5, 2014 on the proposed revision. At the August 5 meeting the Planning Commission recommended adoption of the proposed 2014 Revised Zoning Ordinance [2014 Revised Ordinance] and submitted it to the Board.

Notice of Public Hearing on the proposed revised ordinance before the Board was set for September 9, 2014. At the September 9 hearing the Board held the first reading of the proposed 2014 Revised Ordinance and voted to approve it in its revised form. It held the second reading on September 23.

On September 22, 2014, the day before the second reading, Sonstegard sent a fax to Commissioner Lyle Van Hove at his worksite, which Van Hove brought to the hearing the next day. This fax contained a portion of what appeared to be the Moody County Zoning Regulations relating to animal unit equivalencies that varied from the proposed revisions the Planning Commission had approved and which the Board had approved at its first reading.

The Board had caused no additional notice to be published indicating it would consider the proposed Sonstegard fax changes. Indeed, prior to the September 23 hearing, apparently only Van Hove and Sonstegard knew of the contents of the Sonstegard fax. Nonetheless, the Board addressed the changes contained in the

Sonstegard fax at the September 23 hearing and adopted 2014 Revised Ordinance, "with the additions discussed."[1] It thereafter published notice of the adoption on October 2, and October 9.

Thereafter, on February 5, 2015, Sonstegard submitted a conditional use permit application to the Turner County Zoning Administrator, Faye Dubblede. In it, Sonstegard sought a permit to operate a CAFO consisting of six million layer chickens, accompanying layer barns, manure sheds, a processing facility, and a feed mill, all to be located about two and one half miles from the City of Parker and approximately three miles from the City of Marion. The plaintiffs own property within the range of roughly one to three miles of the proposed site.

The Plaintiffs sued the Board and Sonstegard, seeking a judgment declaring the 2014 Revised Ordinance void, invalid, and unenforceable because the manner of the ordinance's adoption failed to comply with statutory due process requirements. Thereafter, the parties each served motions for summary judgment, asserting that there exist no material issues of fact.

ANALYSIS

A. Summary Judgment Principles

[1] The imprecise nature of the language, "with the additions discussed," was the source of additional controversy. At depositions of the commissioners who voted in favor of the 2014 Revised Ordinance, they expressed contradictory understandings of what exactly they had voted upon in adopting the such additions. When the Board finally published the 2014 Revised Ordinance in printed form in late 2014, some of the language contained in the Sonstegard fax was adopted and other portions were not. The issue of whether such imprecise language constitutes an improper legislative adoption was not raised, either in briefing or argument and thus, the court does not reach the issue.

Summary judgment must be entered "if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to a judgment as a matter of law." SDCL 15-6-56(c). The Court's duty in ruling on a summary judgment motion is to "probe the record for material facts, resolve disputed facts in favor of the non-moving party, and decide whether the moving party is entitled to a judgment as a matter of law." *Fisher v. Kahler*, 2002 S.D. 30, ¶ 5 (citing *Sorrels v. Queen of Peace Hosp.*, 1999 S.D. 133, ¶ 5).

Summary judgment is not a substitute for trial:

> A belief that the non-moving party will not prevail at trial is not an appropriate basis for granting the motion on issues not shown to be a sham, frivolous or unsubstantiated; summary judgment is an extreme remedy and should be awarded only when the truth is clear . . . .

Toben v. Jeske, 2006 S.D. 57, ¶ 16 (quoting *Keyston Plaza Condominiums Ass'n v. Eastep*, 2004 S.D. 28, ¶ 15). On the other hand, summary judgment should not "be viewed as a disfavored procedural shortcut, but rather as an integral part of [our laws] as a whole, which are designed to secure the just, speedy, and inexpensive determination of every action." *Accounts Management v. Litchfield*, 1998 S.D. 24, ¶ 4.

B. The County's Authority to Enact Zoning Ordinances

Counties are creatures of statue with no inherent authority, possessing only such powers the Legislature expressly confers upon them by statute or which may reasonably be implied from those expressly granted powers. The South Dakota

Legislature has expressly delegated to the Board the power to regulate zoning, pursuant to SDCL Chapter 11-2. That legislative authority to enact a zoning ordinance is rooted in the county's police power to protect the public's health, safety, and welfare. *Schafer v. Deuel County Board of Commissioners*, 2006 S.D. 106, ¶ 12.

As an exercise of the county's police power, the Board's implementation of a zoning ordinance requires strict adherence to the rules of law. *Pennington County v. Moore*, 525 N.W.2d 257, 258 (S.D. 1994) (quoting *State v. Hansen*, 68 N.W.2d 480, 481 (S.D. 1955)).

There is no dispute that the matter before the court constitutes the county's effort to *amend* an existing ordinance. That authority derives from SDCL 11-2-28, which provides that a zoning ordinance may be:

> Amended, supplemented, changed, modified, or repealed by action of the board. Any such modification or repeal shall be proposed in a resolution or ordinance, as appropriate, presented to the board for adoption in the same manner and upon the same notice as required for the adoption of the original resolution or ordinance.

The statutory requirements to adopt the original ordinance require a two-step process, intended to insure due process, by serving "several important functions including: safeguarding against the arbitrary exercise of power, informing decision makers, affording the affected landowners with the opportunity to formally voice their concerns and present evidence in opposition to proposed measures, and providing an avenue for expression of public opinion." *Schafer*, at ¶ 13. *See also*, 1 Rathkopf's The Law of Zoning and Planning § 12:6 (4th ed.)

In the first step, set out in SDCL 11-2-18, the Planning Commission must hold at least one public hearing on the proposed ordinance, after providing notice of its time and place in a legal county newspaper at least ten days prior to the hearing. If the Planning Commission recommends adoption of the proposal, the process moves to the second step.

The second step, set out in SDCL 11-2-19, requires that the Board hold a hearing on the recommended proposal, again following ten days published notice. SDCL 11-2-20 provides, in part: "Based on the results of the hearing or hearings, the action upon the zoning regulations . . . shall be by ordinance carried by the affirmative votes of not less than a majority of all the members of the board."

Where, as here, a Board seeks to amend its zoning ordinance, SDCL 11-2-29 requires that the Planning Commission hold at least one public hearing on any proposed change, after giving the statutorily required ten-day published notice to allow any person to appear and "request or protest the requested change."

C. The Parties' Arguments

The Plaintiffs assert that the Board possessed no authority to enact the revised ordinance that included language from the Sonstegard fax because that proposed change had not been submitted to the Planning Commission, nor had the Board caused notice to the public that it would consider it.

It is uncontroverted that the Board published no notice that it intended to review the contents of the Sonstegard fax at the September 23 meeting. Moreover, there was no notice that the Commission would review the Sonstegard proposal

because it was never presented to the Commission. The Board's attempt to amend the 2014 Revised Ordinance as earlier proposed violated the due process requirements of SDCL 11-2-29 and 11-2-18.

The Board and Sonstegard, although acknowledging the provisions of South Dakota law above addressed, nonetheless contend, as counsel for the Board orally argued, that "no clear South Dakota law" requires that the Board be limited to either adopting or rejecting the ordinance as proposed to it. To so limit the Board, Sonstegard argued in briefing, would place unreasonable limitations on the Board's authority, and that in any event, while a matter of first impression in this state, the law of other jurisdictions permits a board to make "unsubstantial changes" in a proposal without invoking publishing requirements.

There are several problems with these arguments. The most prominent among them is that, contrary to the Board's assertion at oral argument, there *is* a law that limits a board's action to either adopting or rejecting the proposed ordinance change. That law is SDCL 11-2-30, which states:

> After the hearing, the board shall by resolution or ordinance, as appropriate, *either adopt or reject* the amendment, supplement, change, modification, or repeal. If adopted, the board shall publish a notice of the fact of adoption once in a legal newspaper of such county and [sic] take effect on the twentieth day after its publication." [emphasis supplied][2]

Thus, SDCL 11-2-30 limits a board's range of lawful actions to either accepting the proposal as written or rejecting it.

D. Defendants' Assertions that SDCL 11-2-30 Conflicts with other Statutes

[2] None of the parties addressed this statute in their briefings, for reasons that are not entirely clear.

The Board and Sonstegard at oral argument, asserted that SDCL 11-2-30 conflicts with other statutes, specifically SDCL 11-2-18, 19, 28 and 29, as the Board urges, and SDCL 11-2-20 as urged by Sonstegard. The Board and Sonstegard argue these purported conflicts in statutory language make it impossible to look at the plain meaning and give effect to the language of all the statutes. They reason that since SDCL 11-2-28 dictates that the process to amend is the same as the process to enact a zoning ordinance and since SDCL 11-2-18-20 do not restrict the Board to either adopting or rejecting a proposed zoning enactment, SDCL 11-2-30's language so limiting the Board in the case of an amendment conflicts with the other statutes. They also contend a conflict exists because it does not make sense to restrict the Board's powers when considering amendments, changes, or modifications and not when considering adoption of a new ordinance.

A court's analysis of a claimed conflict between two statutes is governed by canons of statutory construction. The South Dakota Supreme Court has stated:

> [W]e adhere to two primary rules of statutory construction. The first rule is that the language expressed in the statute is the paramount consideration. The second rule is that if the words and phrases in the statute have plain meaning and effect, we should simply declare their meaning and not resort to statutory construction.

Goetz v. State, 2001 S.D. 138, ¶ 15. Additionally, the Court has set out that:

> When engaging in statutory interpretation, we . . . read statutes as a whole, as well as enactments relating to the same subject. When the language in a statute is clear, certain and unambiguous, there is no reason for construction, and this Court's only function is to declare the meaning of the statute as clearly expressed.

State v. Hatchett, 2014 S.D. 13, ¶ 11 (quoting *AEG Processing Ctr. No. 58, Inc. v. S.D. Dep't of Revenue & Regulation*, 2013 S.D. 75, ¶ 17). The Court has also stated that, "[s]ince statutes must be construed according to their intent, the intent must be determined from the statute as a whole, as well as enactments relating to the same subject." *Argus Leader v. Hagen*, 2007 S.D. 96, ¶ 25 (citing *Moss v. Guttormson,* 1996 S.D. 76, ¶ 10).

The first step in that analysis is to attempt to harmonize the two statutes: "Where statutes appear to conflict, it is our responsibility to give reasonable construction to both, and if possible, to give effect to all provisions under consideration, construing them together to make them harmonious and workable." *Argus Leader*, at ¶ 25 (quoting *Wiersma v. Maple Leaf Farms*, 1996 S.D. 16, ¶ 4) (internal quotations omitted).

Here, the plain meaning of the respective statutes is clear. The language of SDCL 11-2- 30 applies to situations where an existing zoning ordinance is being modified, changed, or repealed. SDCL 11-2-28 requires the Board to follow the requirements of SDCL 11-2-19 when considering an amendment, supplement, change, modification, or repeal of an existing zoning ordinance. SDCL 11-2-20 requires a majority vote of the Board in order to enact the ordinance. In plain, unambiguous words, SDCL 11-2-30 grants board authority only to adopt or reject a proposal. It is difficult to conceive of a clearer legislative pronouncement. Moreover,

none of the statutes empowers a board considering an amendment to a zoning ordinance to change the proposal's language without first submitting to the notice process and to the planning commission for its review and approval.

While it is true that the other statutory provisions do not restrict the board from making changes to an original proposed zoning enactment without resubmitting to the planning commission, neither do they authorize the board to do so. They are simply silent in that regard. The statutes do not, in the court's view, conflict with one another.

If a conflict had existed, however, the result would be the same. "When the question is which of two enactments the legislature intended to apply to a particular situation, terms of a statute relating to a particular subject will prevail over the general terms of another statute." *Argus Leader*, 2007 S.D. 96, ¶ 21 (quoting *Benson v. State*, 2006 S.D. 8, ¶ 71). SDCL 11-2-19 and 11-2-20 govern the requirements the Board must follow when adopting zoning ordinances generally. SDCL 11-2-30, however, applies to the specific situation at issue here, since the Board was presented with proposed changes to an already-enacted zoning ordinance. The Legislature's enactments are unequivocal that, when a Board addresses a proposed amendment, it must follow the dictates of SDCL 11-2-30. No generally applicable statute elsewhere in SDCL chapter 11-2 can relieve the Board of those requirements. Thus, even if a conflict had existed between the terms of SDCL 11-2-30 and one or more other statutes, the provisions of SDCL 11-2-30 would govern.

a. Defendants' Assertions that the Sonstegard Fax Constituted Permissible Unsubstantial Changes allowed under South Dakota's Zoning Laws

The Board and Sonstegard contend that there is no authority in South Dakota to guide this Court's decision despite the statutes addressed above. They suggest that the Court look to the laws of other states to resolve the case, in particular, *Grant v. Board of County Commissioners of Mesa County*, 432 P.2d 762 (Colo. 1967). There, the Colorado Supreme Court held that the board of commissioners' change of a proposal previously recommended by the planning commission did not constitute a substantial change, since it and the planning commission had contemplated it throughout the process. Thus, it upheld the board's amendment of the proposal. *Grant*, 432 P.2d at 77-78.

The Board and Sonstegard urge this Court to adopt Colorado Court's holding in *Grant* and arrive at the conclusion that the addition of the Sonstegard fax equivalency units was not a substantial change and thus, not required to be first heard and recommended by the Commission before the Board considered it. The *Grant* case, however, was decided based upon a specific Colorado statute not enacted in this state. That Colorado statute provided:

> No *substantial* change in or departure from the text or map so certified by the county planning commission shall be made unless such change or departure be first submitted to the certifying county planning commission for its approval, disapproval or suggestions, and if disapproved, shall receive the favorable vote of not less than a majority of the entire membership of the board of county commissioners.

Id. at 77 (quoting C.R.S. '53, 106-2-11)(emphasis added). That statute in effect, permitted *unsubstantial* changes, thus leaving the court there to decide whether the change at issue was a substantial one. South Dakota law contains no such statutory language. To the contrary, as already stated, SDCL 11-2-30 authorizes the Board only to either adopt or reject a proposed ordinance amendment.

Even if the *Grant* case reflected South Dakota law, the facts it address vary dramatically from those before the court here. This is because Board's adoption of the Sonstegard fax's equivalency units is far from an unsubstantial change. The magnitude of adopting a 0.003 equivalency unit is evidenced by the setback requirements that result by a comparison of the table of equivalencies contained in the 2014 Ordinance before the second reading and that after the adoption of the 2014 Ordinance "with the additions discussed." [3]

---

[3] In order to gauge the significance of the change posed by the Sonstegard fax, some further background is necessary. Both the 2008 Ordinance and the 2014 Revised Ordinance contain setback requirements for CAFOs. The 2008 Ordinance considered any operation housing 82,000 or more chickens and utilizing any manure system other than a liquid manure handling system to constitute a large CAFO. For a large CAFO the 2008 Ordinance had a required setback of 3/8th of a mile plus 100 feet for each additional 500 animal units from any dwellings, churches, schools, businesses, and designated State or County parks. In addition, under the 2008 Ordinance, large CAFOs were required to be located at least one mile plus 400 feet for each additional 1,000 animal units, from any incorporated municipalities. The Plaintiffs contend that the animal equivalency unit of 0.01 for "Laying Hens and Broilers (continuous overflow watering)" should be used to calculate the setback distance of Sonstegard's proposed CAFO. However, the Board and Sonstegard contend that the use of the 0.01 equivalency unit is inappropriate because that unit is for a CAFO operating a manure system wholly dissimilar to the one proposed by Sonstegard. The Board and Sonstegard, however, have not offered an equivalency unit they deem to be appropriate.

The 2008 Ordinance contained a table of animal equivalency units to allow one to determine the number of animal units in order to calculate the appropriate setback distance. The setback required under the 2008 Ordinance as follows:[33]

6,000,000 x 0.01 = 60,000 animal units
1,980 feet (3/8 of a mile) + 100 feet x 118 (59,000 animal units divided by 500) = 11,800 feet
1,980 feet + 11,800 feet = 13,780 feet divided by 5,280 feet (1 mile) = 2.6 mile setback from any dwellings, churches, schools, businesses, and designated State or County parks.

6,000,000 x 0.01 = 60,000 animal units
5,280 feet + 400 feet x 59 (59,000 animal units divided by 1,000) = 23,600 feet
5,280 feet + 23,600 feet = 28,880 feet divided by 5,280 feet = 5.469 mile setback from any incorporated municipalities.

The required setback for Sonstegard's proposed CAFO using the 0.01 unit equivalent, for example, would be 2.6 miles from any dwellings, churches, schools, businesses, and designated State or County parks.[4] The required setback from a municipality would be 5.469 miles. Using, however, the required setback arrived at by employing the 0.003 units contained in the Sonstegard fax — the required setback from any dwellings, churches, schools, businesses and the like would be only 0.96 miles. The setback required from a municipality would be only 2.174.

These stark differences demonstrate that the attempted adoption of the 0.003 animal equivalency figure constituted a substantial change from what the Planning Commission had approved. In this case, even had South Dakota law permitted a board to make unsubstantial amendments without re-noticing, the change contained in the Sonstegard fax *was* substantial.

The 2014 Revised Ordinance defines a large CAFO as in the 2008 Ordinance. Under the 2014 Revised Ordinance, the large CAFO setback is 1,980 feet plus 100 feet for each additional 500 animal units over 2,500 animal units from any dwellings, churches, schools, businesses, and designated State or County parks. Also, the 2014 Revised Ordinance requires a facility to be no closer than 5,280 feet plus 400 feet for each additional 1,000 animal units over 2,500 animal units from any incorporated municipality.

The 2014 Revised Ordinance calculates animal units as in the 2008 Ordinance. The 2014 Ordinance retained the 0.01 equivalency mentioned above, but adds the 0.003 equivalency unit from the Sonstegard fax. Sonstegard's proposed CAFO's setback are calculated using the 0.003 equivalency. The Plaintiffs compute the setback required under the 2014 Ordinance applying equivalency in the Sonstegard fax as follows[3]:

6,000,000 x 0.003 = 18,000 animal units
1,980 feet + 100 feet x 31 (15,500 animal units divided by 500) = 3,100 feet
1,980 feet + 3,100 feet = 5,080 feet divided by 5,280 feet = 0.96 mile setback from any dwellings, churches, schools, businesses, and designated State or County parks.

6,000,000 x 0.003 = 18,000 animal units
5,280 feet + 400 feet x 15.5 (15,500 animal units divided by 1,000) = 6,200 feet
5,280 feet + 6,200 feet = 11,480 feet divided by 5,280 feet = 2.174 mile setback from any incorporated municipalities.

[4] Since the 2014 Ordinance, before the addition of the 0.003 equivalency, contained an equivalency unit for chickens that was less restrictive than the DENR regulation it appears reasonable to calculate the setback requirements using the 0.01 equivalency.

The Board and Sonstegard argue that Sonstegard fax equivalency of 0.0003 did not change anything in the earlier proposal or the 2008 Zoning Ordinance because the system Sonstegard planned did not fit into either of the categories for laying hens and broilers, at issue here. They posit that Zoning Administrator, Faye Dubblede, could have simply looked to other counties' regulations for guidance to adopt an appropriate animal equivalent. Their argument, however, is untethered to any legal authority and the ordinance's plain meaning fails to support it.[5] The 2008 Zoning Ordinance, and the proposed 2014 Revised Ordinance, before it was changed by the Sonstegard fax, both contained two categories for laying hens and broilers. The first was a category for continuous overflow watering systems, which the Ordinance assigned an animal unit equivalent of 0.01; the second was a category for separate liquid handling systems, which the Ordinance assigned an animal unit equivalent of 0.033.

While the Ordinance provided that "other animal species equivalent which are not listed will be based on species' waste production," nothing in the ordinance allowed the Zoning Administrator – or anyone else – to adopt a different animal unit equivalent for chickens apart from one of the two categories the ordinance provided.

Defendants' argument overlooks the crucial role due process must occupy in every such proposed zoning change. The legislature's zoning statutes aim, as

[5] The 2008 Ordinance and the 2014 Ordinance before the addition of the 0.003 equivalency contained a requirement almost identical to the South Dakota Department of Environment and Natural Resources [DENR] regulations. The DENR regulation set an animal equivalency of 0.012 for CAFO's housing chickens and utilizing a manure system other than a liquid handling system.

previously addressed, to insure that area landowners and the public have adequate notice and an opportunity to be heard concerning potential zoning changes. In this case, it would have been entirely reasonable for any landowner in the affected community to look to the animal equivalency units in both the 2008 Ordinance and the 2014 Revised Ordinance before further it was modified by the Sonstegard fax, and conclude that the required setbacks contained in those documents were satisfactory, only to be unfairly surprised when learning of the unnoticed change shortly made prior to adoption. Thus, whether the Sonstegard fax changed the 2014 Revised Ordinance as previously approved or simply supplemented it, the outcome is the same: it constituted a change the Planning Commission had not previously approved and about which the public had not been given notice and a meaningful opportunity to be heard.

CONCLUSION

The Board's actions, in adopting the contents of the Sonstegard fax, without first submitting them to the Planning Commission and without giving the community an opportunity for notice and a hearing, contravened basic notions of due process and the specific dictates of South Dakota law by depriving property owners and the public of a meaningful opportunity to be heard as to the business its government was considering.

The South Dakota Supreme Court has made clear that "improperly adopted zoning regulations are invalid and will not be enforced." *Pennington County v. Moore*, 525 N.W.2d 257, 59; see also *Brookings v. Martinson*, 246 N.W. 916 (S.D.

1933). Because the zoning statutes here set forth express the procedural requirements with which the Board failed to comply, there exists no legal basis for the 2014 Revised Ordinance's enforcement. *Pennington County v. Moore*, 525 N.W.2d 257, 258-59.

Thus, the Plaintiffs' Motion for Summary Judgment is granted and the Defendants' Motion for Summary Judgment is denied. The 2014 Revised Ordinance is void, invalid and therefore is unenforceable.

Dated this 28th day of September, 2015.

BY THE COURT:

Timothy W. Bjorkman
First Circuit Judge