

version 5/18/20

Existing facility Project/Proposed changes Totals after construction

tons CO2e	Existing facility			Project/Proposed changes			Totals after construction			Global Warming Potential (conversion to CO2e)		
CH ₄ - barn and manure storage	6,759.35			6,759.35			6,759.35			13,518.70	CH ₄	25
N ₂ O - barn and manure storage	1,859.36			1,859.36			1,859.36			3,678.72	N ₂ O	298
N ₂ O - manure land application				2,694.00			2,694.00			5,388.00		
Total CO2e	8,618.71			11,312.71			11,312.71			21,519.42		

	Existing facility			Project/Proposed changes			Totals after construction		
	Units	Layers	Total	Units	Layers	Total	Units	Layers	Total
A Total Head	330,000	330,000	660,000	330,000	330,000	660,000	660,000	660,000	1,320,000
Animal overhead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B Total animal units	990	990	1,980	990	990	1,980	990	1,980	3,960

CH ₄ - barn and manure storage				
D livestock (head)	330,000	330,000	330,000	330,000
E animal live weight (kg)	1.1	1.1	1.1	1.1
F volatile solids (vs) production rate (kg VS/kg animal live weight/yr)	3.7	3.7	3.7	3.7
G rate of CH ₄ production (potential) (m ³ CH ₄ /kg VS)	0.39	0.39	0.39	0.39
H convert from m ³ to kg (kg CH ₄ /m ³ CH ₄)	0.622	0.622	0.622	0.622
I methane potential CH ₄ production (kg/yr) (D*E*F*G*H)	533,142	533,142	533,142	533,142
J methane conversion factor (MCF) (% of potential CH ₄)	0.291	0.291	0.291	0.291
K CH ₄ (methic tons/yr) (T ³)	122.62	122.62	122.62	122.62
L convert to short tons	1,1023	1,1023	1,1023	1,1023
M CH ₄ (short tons/yr) (K*1)	135.17	135.17	270.33	270.33
N short tons/yr CO ₂ e	3,379.18	3,379.18	6,758.35	6,758.35

N ₂ O - barn and manure storage				
O livestock (head)	330,000	330,000	330,000	330,000
P animal live weight (kg)	1.8	1.8	1.8	1.8
Q excreted nitrogen (N) (kg N/kg animal live weight/yr)	0.6	0.6	0.6	0.6
R emission factor from manure storage (kg N/kg excreted N)	0.020	0.020	0.020	0.020
S convert to N ₂ O	1.57	1.57	1.57	1.57
T N ₂ O emissions (metric tons) (O*P*Q*R*S*1000)	2.80	2.80	5.60	5.60
U convert to short tons	1,1023	1,1023	1,1023	1,1023
V N ₂ O emissions (short tons) (U*1)	3.09	3.09	6.17	6.17
W short tons/yr CO ₂ e	919.68	919.68	1,839.36	1,839.36

N ₂ O - manure land application				
X N remaining in manure used as fertilizer ((O+P+Q)*1000S) (kg/yr)	354,618	354,618	354,618	354,618
Y fertilizer runoff/leaching rate (%)	0%	0%	0%	0%
Z fertilizer volatilization rate (%)	20%	20%	20%	20%
AA emission factor (%)	20%	20%	20%	20%
AB convert N to N ₂ O	1.571	1.571	1.571	1.571
AC N ₂ O emissions (metric tons) (X*(Y+Z)*AA*AB*1000)	4.52	4.52	9.04	9.04
AD convert to short tons	1,1023	1,1023	1,1023	1,1023
AE N ₂ O emissions (short tons) (AC*AD)	4.92	4.92	9.84	9.84
AF short tons/yr CO ₂ e	1,347.00	1,347.00	2,694.00	2,694.00

Global Warming Potential (conversion to CO2e)
 CH₄ 13,518.70
 N₂O 3,678.72
 N₂O 5,388.00
 GWP Source: International Panel on Climate Change Fourth Assessment Report.

CH₄ - barn and manure storage

Methane conversion factors (MCFs) by manure storage type	
Dairy Cows	0.290
long term below barn pit storage	0.290
outdoor liquid/slurry basin/tank	0.290
outdoor liquid/slurry	0.290
anaerobic lagoon	0.020
aerobic lagoon	-
slat floor accumulator/periodic removal	0.121
drylot	0.020
solid storage	0.020
daily haul and spread	0.020
pasture	0.020
composting	0.020

N₂O - barn and manure storage

kg N ₂ O/kg N produced in feedlot by manure storage type	
dry lot	0.005
anaerobic lagoon	0
anaerobic lagoon (natural aeration)	0
outdoor liquid/slurry basin/tank, no natural crust	0.005
long term below barn pit storage	0.002
drylot	0.02
solid storage	0.005
daily spread	0
pasture, range, pastlock	0
compost (static)	0.005
composting-entensive/passive	0.01
composting-intensive	0.1

N₂O - manure land application

N losses to feedlot or volatilization and leaching/run off (% of available N)	
use of fraction rate	volatilization rate
dairy cattle	0%
anaerobic lagoons	43%
outdoor liquid/slurry storage	29%
below barn pit storage	24%
solid storage	0%
drylot	1%
daily haul and spread	10%
pasture	0%
beef cattle	0%
outdoor liquid/slurry storage	26%
drylot	2%
pasture	0%
swine	0%
anaerobic lagoons	28%
outdoor liquid/slurry storage	26%
below barn pit storage	24%
solid storage	45%
pasture	0%
pen/poultry	0%
manure with bedding	26%
manure without bedding	34%
fat, manure (assumed value)	20%
outdoor liquid/slurry storage	26%

note: EPA does not have emission factors for all circumstances. For instance, for composting manure management the fat rate would have to be used because it's the best data available from EPA that we have.
 note: this is NOT an EPA quality emission factor. It is more correct to use the manure management method to derive these percentages than the animal type. This percentage was taken from EPA's factor by dairy cattle.

version 5/21/20	Existing facility				Project/Proposed changes				Totals after construction			
tons CO₂e												
CH ₄ - enteric fermentation	99.21				99.21				198.41			
CH ₄ - barn and manure storage	558.87				558.87				1,117.74			
N ₂ O - barn and manure storage	152.42				152.42				304.84			
N ₂ O - manure land application	223.24				223.24				446.48			
Total CO₂e	1,033.74				1,033.74				2,107.74			
A Total Head	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total
B Animal units/head	0.05	0.39	0.40	0.84	0.05	0.39	0.40	0.84	0.05	0.39	0.40	0.84
B Total animal units	0	720	0	720	0	720	0	720	0	1440	0	1,440.0
CH₄ - enteric fermentation	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total
A animal inventory (head)	-	2,400	-	2,400	-	2,400	-	2,400	1,500	4,800	-	6,300
B N ₂ O/F ₂ head/day (FPA)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.0011	1.50	0.0011	1.50
C conversion to tons/head/year	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
D tons CO ₂ e (MPC)	-	3.97	-	3.97	-	3.97	-	3.97	-	7.94	-	7.94
tons CO₂e	-	99.21	-	99.21	-	99.21	-	99.21	-	198.41	-	198.41
CH₄ - barn and manure storage	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total
D livestock (head)	-	2,400	-	2,400	-	2,400	-	2,400	1,500	4,800	-	6,300
E animal live weight (kg/head)	16	62	198	16	62	198	16	62	16	62	198	16
F volatile solids (vs) production rate (kg VS/kg animal live weight/day)	3.2	2	1	3.2	2	1	3.2	2	0.48	0.48	0.48	0.48
G rate of CH ₄ production (gramol/m ³ CH ₄ /kg VS)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.622	0.622	0.622	0.622
H convert from m ³ to kg (kg CH ₄ /m ³ CH ₄)	0.622	0.622	0.622	0.622	0.622	0.622	0.622	0.622	0.622	0.622	0.622	0.622
I maximum potential CH ₄ production (kg/day) (D*E*F*G*H)	-	88,176	-	88,176	-	88,176	-	88,176	170,360	170,360	170,360	340,720
J methane conversion factor (MCF) (E of potential CH ₄)	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236	0.236
K CH ₄ (metric tons/day) (F*J)	-	20.28	-	20.28	-	20.28	-	20.28	-	40.56	-	60.84
L convert to short tons	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023
M CH ₄ (short tons/day) (K*L)	-	22.35	-	22.35	-	22.35	-	22.35	-	44.71	-	67.07
N short tons/day CO ₂ e	-	598.87	-	598.87	-	598.87	-	598.87	-	1,197.74	-	1,796.68
N₂O - barn and manure storage	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total
D livestock (head)	-	2,400	-	2,400	-	2,400	-	2,400	1,500	4,800	-	6,300
E animal live weight (kg/head)	16	62	198	16	62	198	16	62	16	62	198	16
F excreted nitrogen (N) (kg N/kg animal live weight/day)	0.7	0.4	0.2	0.7	0.4	0.2	0.7	0.4	0.025	0.025	0.025	0.025
G emission factor from manure storage (kg N/kg excreted N)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
H convert to CO ₂ e	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
I N ₂ O emissions (metric tons) (F*G*H*1000)	-	0.48	-	0.48	-	0.48	-	0.48	-	0.93	-	1.41
J convert to short tons	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023
K N ₂ O emissions (short tons) (I*J)	-	0.51	-	0.51	-	0.51	-	0.51	-	1.02	-	1.52
L short tons/day CO ₂ e	-	152.42	-	152.42	-	152.42	-	152.42	-	304.84	-	457.26
N₂O - manure land application	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total	Swine < 55 lbs	Swine 55-330 lbs	Swine > 330 lbs	Total
X N remaining in manure used as fertilizer (D*(H+Q)*1.0000) (kg/day)	-	58,771	-	58,771	-	58,771	-	58,771	-	117,543	-	176,314
Y N ₂ O volatilization rate (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Z N ₂ O volatilization rate (%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
AA emission factor (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
AB convert to N ₂ O	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
AC N ₂ O emissions (metric tons) (X*Y*Z*AA*AB*1000)	-	0.88	-	0.88	-	0.88	-	0.88	-	1.36	-	2.24
AD convert to short tons	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023	1.1023
AE N ₂ O emissions (short tons) (AC*AD)	-	0.75	-	0.75	-	0.75	-	0.75	-	1.50	-	2.25
AF short tons/day CO ₂ e	-	223.24	-	223.24	-	223.24	-	223.24	-	446.48	-	670.72

Global Warming Potential (conversion to CO₂e)

CH₄ 1,117.74

N₂O 304.84

CO₂e 2,107.74

GW Source: International Panel on Climate Change Fourth Assessment Report.

CH₄ - barn and manure storage

Methane conversion factors (MCFs) by manure storage type

Dairy Cows	0.250
long-term below barn (pit storage)	0.250
outdoor liquid/slurry basin/tank	0.250
anaerobic lagoon	0.670
anaerobic lagoon	-
stall floor accumulation/periodic removal	0.21
drylot	0.020
solid storage	0.020
daily haul and spread	0.020
pasture	0.020
composting	0.020

N₂O - barn and manure storage

kg N₂O/kg N produced in feedlot by manure storage type

anaerobic lagoon	0
anaerobic lagoon (natural aeration)	0
outdoor liquid/slurry basin/tank, 90% N ₂ O	0.002
long-term below barn (pit storage)	0.02
drylot	0.005
solid storage	0
daily spread	0
pasture, range, paddock	0
compost (drain pit)	0.006
composting-anaerobic/pasture	0.01
composting intensive	0.1

N₂O - manure land application

N losses as feedlot to volatilization and leaching/run-off (% of available N)

	urea-off/leaching rate	volatilization rate
Dairy cattle	0%	43%
anaerobic lagoons	0%	26%
outdoor liquid/slurry storage	0%	24%
below barn pit storage	0%	0%
solid storage	1%	25%
drylot	0%	10%
daily haul and spread	0%	0%
pasture	0%	0%
beef cattle	0%	26%
outdoor liquid/slurry storage	0%	23%
below barn pit storage	0%	0%
solid storage	0%	58%
outdoor liquid/slurry storage	0%	26%
below barn pit storage	0%	34%
solid storage	0%	45%
pasture	0%	0%
poultry	0%	26%
manure with bedding	0%	26%
manure without bedding	0%	34%

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - US average basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - Minnesota specific

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - US average basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - US average basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - US average basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - regional basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - regional basis

US EPA, Inventory of U.S. Sources and Sinks of Greenhouse Gases (2010) - US average basis

version 5/21/20

	Existing facility			Project/Proposed	
	min	mean	max	min	mean
A Alfalfa crop (acres)	700	850	1,000	700	850
B CO ₂ e avoidance emission factor (tons/acre/yr)	1.21	1.21	1.21	1.21	1.21
TOTAL CO₂e avoided (tons/yr) (A*B)	847	1029	1210	847	1029

CO₂e avoidance data source: MPCA, Greenhouse Gas Reduction Potential of Agricultural Best Management Practices, p-gen4-19, <https://www.pca.state.mn.us/sites/default/files/p-gen4-19.pdf>

Note: For the EAW, round the total CO₂e to the nearest 100 ton.

changes	Totals after construction		
max	min	mean	max
1,000	1,400	1,700	2,000
1.21	1.21	1.21	1.21
1210	1694	2057	2420

October 2019, section K

Check applicability with 40 CFR 98, subp JJ

GHG reporting for ag & livestock sectors w/ >= 25,000 metric tons/yr, or 27,558 short tons/yr

Annual Emissions excluding enteric fermentation emissions

Total CO2e (tons/yr)	30,494.72
minus enteric fermentation (tons/yr)	15,596.40
compare with reporting threshold of 27,558 (tons/yr):	14,898.32

Global Warming Potential (conversion to CO2e)

CH4	25
N2O	298

IPCC AR4 GWP

CH4	25
N2O	298

ICPP AR5 GWP

CH4	28
N2O	265