***a. Source Category Description***

Fertilizer in this category refers to any nitrogen-based compound, or mixture containing such a compound, that is applied to land to improve plant fitness.

The approach to calculating emissions for the assigned SCCs consisted of three general steps, as follows:

* Calculating the percent change in county-level fertilizer quantities applied between 2002 and 2010.
* Using the percent change in applied fertilizer quantity to grow the fertilizer activity files provided with the CMU Ammonia Model v.3.6.1
* Running the CMU Ammonia Model to calculate ammonia emissions based on the updated county-level fertilizer quantities.

For this source category, the following SCCs were assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **Descriptor 2** | **Descriptor 4** | **Descriptor 5** | **Descriptor 10** |
| 2801700001 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Anhydrous Ammonia |
| 2801700002 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Aqueous Ammonia |
| 2801700003 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Nitrogen Solutions |
| 2801700004 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Urea |
| 2801700005 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Ammonium Nitrate |
| 2801700006 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Ammonium Sulfate |
| 2801700007 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Ammonium Thiosulfate |
| 2801700010 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | N-P-K (multi-grade nutrient fertilizers) |
| 2801700011 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Calcium Ammonium Nitrate |
| 2801700012 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Potassium Nitrate |
| 2801700013 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Diammonium Phosphate |
| 2801700014 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Monoammonium Phosphate |
| 2801700015 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Liquid Ammonium Polyphosphate |
| 2801700099 | Miscellaneous Area Sources | Agriculture Production - Crops | Fertilizer Application | Miscellaneous Fertilizers |

***b. Activity Data***

County-level fertilizer consumption data for 2002 and 2010 was obtained from the Fertilizer Institute’s Commercial Fertilizers 2002 and 2010 reports.2 The consumption data includes total fertilizer sales or shipments for farm and non-farm use and is reported semi-annually for the fiscal year. To make the fertilizer types listed in the Commercial Fertilizers reports match the activity input files from the CMU Ammonia Model, the fertilizer types were grouped according to Table 1 below. For any state in 2002 reporting fertilizer quantities from unknown counties, the quantities were apportioned to every county in the state based on cropland area obtained from the U.S. Department of Agriculture’s 2002 Census of Agriculture.3 Similarly for 2007, fertilizer quantities from unknown counties were apportioned based on cropland area reported in the 2007 Census of Agriculture.4 For each fertilizer group, the percent difference in fertilizer consumption between 2002 and 2007 was calculated for each county. These percentages were used to grow the 2002 county-level nitrogen quantities from the fertilizer activity files provided with the CMU Ammonia Model v.3.6.

The average nitrogen content for each fertilizer group, reported in Table 2, was calculated by summing the county-level fertilizer quantities for all counties from the CMU Ammonia Model activity files to generate total nitrogen applied. For each fertilizer group, the total nitrogen applied was then divided by the 2002 fertilizer consumption data from the 2002 Commercial Fertilizers report to obtain the percent nitrogen content for each fertilizer group. For any county with fertilizer consumption in 2007, but not in 2002, the fertilizer quantity obtained from the 2007 Commercial Fertilizer’s report was multiplied by the percent nitrogen content of each fertilizer group to determine tons of nitrogen. The tons of nitrogen were then converted to kilograms and allocated temporally by month according to the state-level percentage of total fertilizer in that group applied each month. The state-level percentage was calculated using data in the CMU Ammonia Model input files.

***c. Emission Factors***

Emission factors for each fertilizer group were provided with the CMU Ammonia Model and are reported in Table 3 below.3

***d. Emissions***

The fertilizer activity files provided with the CMU Ammonia Model v.3.6 were replaced with the updated county-level fertilizer files. County-level ammonia emissions were then calculated by running the model. The model corrects for the difference in mass between nitrogen and ammonia.

N applied x % N volatilized as NH3 x 17 g /14 g = NH3 emissions

***e. Sample Calculations***

*Allocation of Fertilizer Quantities from Unknown Counties*

From the 2007 Commercial Fertilizers report, Colorado reported 4,774,000 kg of ammonium nitrate from unknown counties for January through June of 2007. This quantity was distributed to counties based on the percent of cropland in the state located in each county. For example, Colorado has 11,484,000 acres of cropland. Adams County, Colorado has 547,000 acres of cropland.

Percent of cropland in CO located in Adams County = (547,000 / 11,484,000) x 100 = 4.76

Ammonium nitrate allocated to Adams County = 4,774,000 kg x .0476 = 227,240 kg

*Growing the CMU Ammonia Model Input Files*

After allocating fertilizer data from unknown counties for 2002 and 2007, the county-level percent difference between fertilizer quantity applied in 2002 and 2007 was used to grow the data in the activity files provided with the CMU Ammonia Model. For example, Autauga County, Alabama applied 473,180 kg of ammonium nitrate from July 2001 through December 2001 and 516,240 kg from July 2006 through December 2006.

Percent change in ammonium nitrate applied = (516,240 kg / 473,180 kg) x 100 = 109

The quantity of nitrogen, in the form of ammonium nitrate, applied per month from July through December 2002 in Autauga County was extracted from the CMU Ammonia Model activity files and multiplied by the percent change.

July: 3,250 kg x 1.09 = 3,543 kg N

August: 3,210 kg x 1.09 = 3,499 kg N

September: 9,640 kg x 1.09 = 10,508 kg N

October: 6,320 kg x 1.09 = 6,889 kg N

November: 2,600 kg x 1.09 = 2,834 kg N

December: 1,380 kg x 1.09 = 1,504 kg N

*Calculation of Nitrogen Content in a Fertilizer Group*

The sum of all nitrogen applied in the form of ammonium nitrate from the CMU Ammonia Model ammonium nitrate activity file was 508,000,000 kg. From the 2002 Commercial Fertilizers report, the total quantity of ammonium nitrate applied in 2002 was 1,420,000,000 kg.

N content of ammonium nitrate = (508,000,000 kg / 1,420,000,000 kg) x 100 = 36 %

*County Where Fertilizer was Applied in 2007, but not in 2002*

In Meade County, Kentucky, there was no ammonium nitrate applied from January to June of 2002, but there were 356,705 kg applied from January to June of 2007. To convert to kg of nitrogen, the quantity of ammonium nitrate applied in 2007 was multiplied by the nitrogen content of ammonium nitrate.

N applied = 356,705 kg x 0.36 = 128,414 kg

The quantity of nitrogen was then allocated temporally by month from January to June based on the state-level distribution of nitrogen applied in the form of ammonium nitrate from the CMU Ammonia Model ammonium nitrate activity file. Total nitrogen in the form of ammonium nitrate applied in Kentucky from January through June of 2002 was 17,000,000 kg. The total for January was 289,000 kg. The total for February was 745,000 kg.

January: (289,000 kg / 17,000,000 kg) x 128,414 kg = 2,183 kg N applied in Meade County

February: (745,000 kg / 17,000,000 kg) x 128,414 kg = 5,600 kg N applied in Meade County

March – June: calculated same as above.

***f. References***

1. Cliff Davidson, Peter Adams, Ross Strader, Rob Pinder, Natalie Anderson, Marian Goebes, and Josh Ayers. The Environmental Institute, Carnegie Mellon University, *CMU Ammonia Model v.3.6*., 2004.
2. Association of American Plant Food Control Officials in partnership with The Fertilizer Institute, [*Commercial Fertilizers 2002* and *Commercial Fertilizers 2007*](http://www.aapfco.org), accessed 21 May 2019.
3. U.S. Department of Agriculture, [*2002 Census of Agriculture*](https://www.nass.usda.gov/AgCensus/), accessed 21 May 2019.
4. 4. U.S. Department of Agriculture, [*2007 Census of Agriculture*](https://www.nass.usda.gov/AgCensus/), accessed 21 May 2019.

**Table 1. Fertilizers Assigned to Fertilizer Groups**

|  |  |  |  |
| --- | --- | --- | --- |
| **CMU Ammonia Model Fertilizer Group** | **Commercial Fertilizers Report - Fertilizer Code** | **Description 1** | **Description 2** |
| Ammonium Nitrate | 10 | Ammonium Nitrate | Ammoniumnitrate |
| Ammonium Sulfate | 24 | Ammonium Sulfate | Ammoniumsulfate |
| Ammonium Thiosulfate | 31 | Ammonium Thiosulfate | Ammoniumthiosul |
| Anhydrous Ammonia | 2 | Anhydrous Ammonia | Anhy Ammonia |
| Aqueous Ammonia | 6 | Aqua Ammonia | Aqua Ammonia |
| Calcium Ammonium Nitrate | 35 | Calcium Ammonium Nit | Calcium Amm Nit |
| Diammonium Phosphate | 203 | Diammonium Phosphate | DAP |
| Liquid Ammonium Polyphosphate | 249 | Liquid Ammonium Poly | Liq Amm Poly |
| Miscellaneous | 12 | Ammonium Nitrate Sol | Amm Nit Solution |
|  | 13 | Ammonium Nitrate-Lim | Amm Nit Lime Mix |
|  | 16 | Ammonium Nitrate-Sul | Ammoniumnit-Sul |
|  | 20 | Ammonium Polysulfide | Ammoniumpolysulf |
|  | 25 | Ammonium Sulfate Sol | Amm Sul Solution |
|  | 27 | Ammonium Sulfate-Nit | Ammoniumsul-Nit |
|  | 29 | Ammonium Sulfate-Ure | Ammoniumsul-Urea |
|  | 46 | Calcium Nitrate-Urea | Calcium Nit-Urea |
|  | 52 | Magnesium Nitrate | Magnesium Nit |
|  | 54 | Nitric Acid | Nitric Acid |
|  | 62 | Sodium Nitrate | Sodium Nitrate |
|  | 64 | Sulfur Coated Urea | Sul Ctd Urea |
|  | 67 | Urea Solution | Urea Solution |
|  | 68 | Urea-Formaldehyde | Urea-Form |
|  | 97 | Nitrogen Product - C | Nitrogen No Code |
|  | 98 | Nitrogen Product - C | Nitrogen No Id |
|  | 201 | Ammonium Metaphospha | Ammoniummetaphos |
|  | 202 | Ammonium Phosphate | Ammoniumphos |
|  | 204 | Ammonium Polyphospha | Ammoniumpoly |
|  | 206 | Ammonium Phosphate N | Amm Phosnitrate |
|  | 207 | Ammonium Phosphate S | Amm Phossulfate |
|  | 241 | Nitric Phosphate | Nitric Phos |
|  | 413 | Manure Salts | Manure Salts |
|  | 458 | Potassium-Sodium Nit | Pot-Sod Nitrate |
|  | 617 | Fish Scrap | Fish Scrap |
|  | 629 | Guano | Guano |
|  | 649 | Manure | Manure |
|  | 652 | Peat | Peat |
|  | 661 | Sewage Sludge, Activ | Act Sew Sludge |
|  | 663 | Sewage Sludge, Diges | Dig Sew Sludge |
|  | 665 | Sewage Sludge, Heat | Ht Driedsew Slge |
|  | 667 | Sewage Sludge, Other | Oth Sew Sludge |
|  | 671 | Soybean Meal | Soybean Meal |
|  | 673 | Tankage, Animal | Animal Tankage |
|  | 675 | Tankage, Process | Process Tankage |
|  | 697 | Natural Organic Prod | Nat Org No Code |
|  | 698 | Nat Organic Product | Nat Org No Id |
|  | 764 | Soil Amendment | Soil Amendmnt |
|  | 766 | Soil Conditioner | Soil Cond |
|  | 767 | Potting Soil | Potting Soil |
|  | 797 | Sec./Micronut. - Cod | Sec/Mic No Code |
|  | 798 | Sec./Micronut. - Cod | Sec/Mic No Id |
|  | 978 | Fertilizer Product - | Fert No Id |
|  | 988 | Single Nutrient - Co | Sgle-Nu No Id |
| Mix | 0 | Identified By Grade | Ident. By Grade |
|  | 998 | Multiple Nutrient - | Mult-Nut No Grade |
| Monoammonium Phosphate | 209 | Monoammonium Phosphate | Monoamm Phos |
| Nitrogen Solutions | 56 | Nitrogen Solution <28% | Nitrogensol <28% |
|  | 58 | Nitrogen Solution 28% | Nitrogensol 28% |
|  | 59 | Nitrogen Solution 30% | Nitrogensol 30% |
|  | 60 | Nitrogen Solution 32% | Nitrogensol 32% |
|  | 61 | Nitrogen Solution >32% | Nitrogensol >32% |
| Potassium Nitrate | 453 | Potassium Nitrate | Pot Nitrate |
| Urea | 66 | Urea | Urea |

**Table 2. Fertilizer Nitrogen Content**

|  |  |
| --- | --- |
| **Fertilizer** | **Nitrogen Content (percent)** |
| Ammonium Nitrate | 36 |
| Ammonium Sulfate | 22 |
| Ammonium Thiosulfate | 12 |
| Anhydrous Ammonia | 82 |
| Aqueous Ammonia | 21 |
| Calcium Ammonium Nitrate | 17 |
| Diammonium Phosphate | 18 |
| Liquid Ammonium Polyphosphate | 10 |
| Miscellaneous | 8 |
| Mix | 12 |
| Monoammonium Phosphate | 11 |
| Nitrogen Solutions | 29 |
| Potassium Nitrate | 14 |
| Urea | 46 |

**Table 3. Fertilizer Emission Factors**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Fertilizer Description** | **Pollutant Code** | **Emission Factor**  **(varies by county for some fertilizers)** | | | **Emission Factor Unit** | **Emission Factor Reference** |
| **Min** | **Max** | **Average** |
| Ammonium Nitrate | NH3 | 1.0 | 3.0 | 1.91 | % N volatilized as NH3 | 1 |
| Ammonium Sulfate | NH3 | 5.0 | 15.0 | 9.53 | % N volatilized as NH3 | 1 |
| Ammonium Thiosulfate | NH3 | 2.5 | 2.5 | 2.5 | % N volatilized as NH3 | 1 |
| Anhydrous Ammonia | NH3 | 4.0 | 4.0 | 4.0 | % N volatilized as NH3 | 1 |
| Aqueous Ammonia | NH3 | 4.0 | 4.0 | 4.0 | % N volatilized as NH3 | 1 |
| Calcium Ammonium Nitrate | NH3 | 1.0 | 3.0 | 1.91 | % N volatilized as NH3 | 1 |
| Diammonium Phosphate | NH3 | 5.0 | 5.0 | 5.0 | % N volatilized as NH3 | 1 |
| Liquid Ammonium Polyphosphate | NH3 | 5.0 | 5.0 | 5.0 | % N volatilized as NH3 | 1 |
| Miscellaneous Fertilizers | NH3 | 6.0 | 8.0 | 6.59 | % N volatilized as NH3 | 1 |
| Monoammonium Phosphate | NH3 | 5.0 | 5.0 | 5.0 | % N volatilized as NH3 | 1 |
| Nitrogen Solutions | NH3 | 8.0 | 8.0 | 8.0 | % N volatilized as NH3 | 1 |
| N-P-K (multi-grade nutrient fertilizers) | NH3 | 1.0 | 3.0 | 1.91 | % N volatilized as NH3 | 1 |
| Potassium Nitrate | NH3 | 2.0 | 2.0 | 2.0 | % N volatilized as NH3 | 1 |
| Urea | NH3 | 15.0 | 20.0 | 15.8 | % N volatilized as NH3 | 1 |