The Fertilizer Boom

America's Rapidly Growing Nitrogen Fertilizer Industry and its Impact on the Environment and Public Safety

ENVIRONMENTAL INTEGRITY PROJECT

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THE ENVIRONMENTAL INTEGRITY PROJECT

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The Fertilizer Boom:

America's Rapidly Growing Nitrogen Fertilizer Industry and Its Impact on the Environment and Public Safety

Executive Summary

On April 17, 2013, the small town of West, Texas, just north of Waco, was the site of one of the most destructive industrial accidents in U.S. history. A fire broke out at a nitrogen fertilizer storage depot that held up to 120,000 pounds of ammonium nitrate – a commonly used farm fertilizer derived from natural gas. The material exploded, killing 15, injuring 260, and levelling more than 120 buildings.

Ten years later, the U.S. is experiencing a boom in the nitrogen fertilizer industry, including the production of ammonium nitrate. This rise is driven largely by cheap natural gas produced by hydraulic fracturing. Also contributing is the war in Ukraine, which has triggered natural gas sanctions on Russia, the world's leading exporter of nitrogen fertilizer. In the U.S., there are currently 30 plants producing ammonia, the building block of synthetic nitrogen fertilizers. That number could grow by a third within a few years, with

An ammonium nitrate storage depot at the West Fertilizer Company (at top right of picture) exploded on April 17, 2013, destroying an apartment complex (center) and 120 other buildings and killing 15.

nine proposals to build new ammonia fertilizer plants across the U.S., and another three existing plants planning to expand their production, according to a review of public records and company announcements.[1] If built, these proposed projects could increase U.S. ammonia production capacity for fertilizer by more than half, from nearly 20 million metric tons per year to about 31 million metric tons per year.[6]

This does not include the growing number of projects that plan to make ammonia to use as a fuel and as a chemical ingredient in non-fertilizer products, which could add an additional 14 ammonia plants. Based on the capacity of these new plants and expansions announced to date, when taken together, the total proposed production capacity in the U.S. of ammonia for both fertilizer and non-fertilizer could nearly triple, from 20 million metric tons to 57 million metric tons per year. This expansion could produce more than 54 million tons of greenhouse gases per year – as much as from 13 coal-fired power plants. This report focuses on nitrogen fertilizer, but a brief discussion of ammonia fuel projects is on page 11.

The production of nitrogen fertilizers, including the ammonium nitrate pellets shown here, takes a heavy toll on the environment.

There is no question that nitrogen fertilizer provides a tremendous benefit to society by boosting the production of food to feed billions of people around the world, including in developing nations. Chemical fertilizer empowers farmers to grow more corn, soybeans, and many other crops that are a staple of the global diet. But the over-application of chemical fertilizers also carries a cost for the environment, and that harm increases when the manufacture of the chemicals is poorly regulated. The impacts of the industry include water, air, and greenhouse gas pollution, and these costs can grow as the industry expands. Nitrogen fertilizer is a product that is routinely over applied to farm fields and lawns, running off into waterways, feeding algal blooms and low-oxygen "dead zones."

In nearly four decades, the U.S. Environmental Protection Agency (EPA) has not updated its technology-based standards for water pollution control systems at fertilizer manufacturing plants, even though the agency is required by law to do so regularly. The outdated and weak 1980s-era standards in place today contributed to an estimated 7.7 million pounds of nitrogen pollution – including 3.9 million pounds of toxic ammonia – that fertilizer plants piped into U.S. waterways in 2021. That's as much nitrogen pollution as from 62 municipal sewage treatment plants.[2] An expansion of the industry could add significant pollution to local waterways. For example, if the proposed ammonia fertilizer plants for which capacity or permit information is available are built, they could pipe an additional 3.1 million pounds of ammonia into local waterways every year, based on permit documents or the rates allowed under outdated federal rules.

Even with the antiquated and weak water pollution control standards in place today for the fertilizer industry, fertilizer plants have a poor record of environmental compliance. Two-thirds (20 of 30) of nitrogen fertilizer plants in the U.S. violated their permitted water pollution limits at least once over a five year period, from March 2018 to March 2023, according to EPA Enforcement and Compliance History Online (ECHO) data.[3] But only 25 percent of the plants with violations (5 of 20) were subject to a formal enforcement action, and only 15 percent (3 of 20) were penalized for their water pollution violations, according to EPA data.

In terms of air pollution and climate impacts, nitrogen fertilizer plants also have a heavy footprint that could get heavier with the growth of the industry. The 30 fertilizer plants operating in the U.S. today reported releasing 16,146 tons of nitrogen oxide air pollution in the most recent available year (2021),[4] as well as 12,491 tons of ammonia, 5,227 tons of sulfur dioxide and 3,981 tons of volatile organic compounds, all of which contribute to smog. In addition, these fertilizer plants released 1,929 tons per year of soot-like particulate matter (which can trigger asthma and heart attacks) and 12 tons of benzene (a known carcinogen). The nitrogen fertilizer plants operating in the U.S. today released a total of 46.8 million tons of greenhouse gases in 2021.[5] That's as much as about nine million passenger vehicles driving for a year. The proposed new and expanded fertilizer plants could greatly increase these emissions, adding up to 19 million tons of greenhouse gases a year, as well as additional health-damaging air pollutants, such as benzene.

Safety risks from ammonia-based fertilizers are not limited to the plants that produce them. The rapid growth in the U.S. ammonia fertilizer industry also raises concerns about the adequacy of safety regulations meant to protect people from the dangers of ammonia fertilizer storage. Many of these safety regulations remain inadequate. The most recent nearly catastrophic accident involving improperly stored fertilizer happened on January 31, 2022. A fire erupted at a farm retail site in Winston-Salem, North Carolina, that held up to 1.2 million pounds of ammonium nitrate fertilizer surrounded by a residential neighborhood. That was ten times as much of the chemical as in West, Texas. Thankfully, in the North Carolina fire, the ammonium nitrate did not explode.

However, over the decade since the Texas disaster, ammonium nitrate has been involved in at least 106 spills or accidental releases across the U.S., seven of which involved fires, five of which required evacuations, nine of which resulted in 13 injuries, and two of which resulted in deaths, according to a review of federal records by the Environmental Integrity Project.[6] Accidents involving another form of ammonia – anhydrous ammonia – resulted in an additional 12 deaths and 316 injuries over this period, although some of these incidents may have been linked to the use of anhydrous ammonia as a coolant instead of as a fertilizer.[7] Going back further, over the past hundred years, forms of ammonia fertilizer have been involved in at least 11 explosions at manufacturing, storage, and transport facilities in the U.S., causing 641 deaths.[8] Globally, at least 1,237 people have been killed in nine explosions involving ammonia fertilizer over the last century.[9]

According to the U.S. Chemical Safety Board, the U.S. has more than 1,300 facilities that store ammonium nitrate.[10] Following the Texas disaster, federal authorities offered multiple proposed rules and recommendations meant to improve safe handling of ammonium nitrate. While many of these recommendations were adopted, EPA has avoided enacting a central proposal that would require better disaster preparedness at fertilizer storage and production facilities, as well as more transparency and sharing of information.

Finally, end-users of nitrogen fertilizers – from farmers to homeowners – often overapply these chemicals on their crops, lawns, and fields. Farm runoff of fertilizer is one of the largest sources of water pollution in the U.S.[11] Roughly half of the nitrogen applied in agriculture – by far the largest user – is not absorbed by crops but is lost through runoff or leaching into groundwater.[12] Heavy loads of nitrogen in waterways cause algal blooms that choke aquatic life, threaten drinking water supplies, and destroy recreational and fishing opportunities.[13] Runoff of nitrogen fertilizer has created a vast "dead zone" in the Gulf of Mexico that is the second largest in the world.[14] The leaching of fertilizer underground also increases nitrogen pollution in private drinking water wells of rural families, sometimes at levels exceeding those the EPA recommends as safe for public health.[15]

Policy Recommendations:

- The EPA should update and strengthen its water pollution control standards – called effluent limitation guidelines – for nitrogen fertilizer manufacturers to reflect current technologies. On April 11, a coalition of 13 environmental groups, led by the Environmental Integrity Project, filed a federal lawsuit against EPA asking for the agency to update its standards for fertilizer plants and other industries.[16]
- After tightening up these guidelines, state and federal regulators should strictly enforce permit limits for water and air pollution from the industry and impose penalties for violations.
- The EPA should add ammonium nitrate to the list of more than 140 hazardous chemicals that require facility owners to plan for disasters and share information about chemical hazards with local emergency planners.
- The Occupational Safety and Health Administration (OSHA) should ensure that retailers of nitrogen fertilizers are regulated under its Process Safety Management standards and inspect these facilities regularly to make sure explosive fertilizers are stored correctly and protected from fires that could cause explosions.
- The EPA should remove an exemption for fertilizer retailers from its Emergency Planning and Community Right-to-Know Act, thereby making it easier for first responders and the public to understand whether explosive nitrogen fertilizers are located near communities.

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History and Growth of the U.S. Ammonia Fertilizer Industry

Over the past century, nitrogen fertilizers have become the backbone of global agriculture and a driver of the ability to grow enough food to feed a rising population of eight billion. Prior to the invention of a chemical process to synthesize nitrogen fertilizer using natural gas, bacteria on the roots of certain plants were the only method of taking nitrogen from the atmosphere and putting it into the soil, making it available to plants to help them grow.

Ammonia-based nitrogen fertilizers, shown here being sprayed on crops, revolutionized global agriculture and allowed for dramatic population increases during the 20th century.

Nitrogen gas, made up of two nitrogen atoms strongly bound together, is the most abundant gas on Earth, making up 78 percent of the planet's atmosphere.[17] Plants in the legume family, such as beans, lentils, clover, alfalfa, and peanuts, have symbiotic bacteria known as Rhizobia clustered in nodules within their roots.[18] The bacteria fix nitrogen in the soil not only for the benefit of their host plant, but for plants that grow after the host plant dies, releasing their nitrogen into the soil. Prior to synthetic fertilizers, farmers could avoid depleting their soils by rotating nitrogen-fixing legumes like clover into their crop cycles. This allowed the farmers to also grow other major crops that deplete nitrogen, such as corn, wheat, oats, and rice. Farmers also relied on natural sources of nitrogen, such as manure, compost, and guano from birds and bats. The use of chemical fertilizers, combined with more effective pesticides and herbicides, allowed more food to be grown per acre of available land, which allowed populations to increase and provided more food for the poor, particularly in developing nations. However, this agricultural change, often called the "green revolution," also came with a significant cost to the environment.[19]

A new method of fertilizing crops emerged in the early 1900s when German chemists Fritz Haber and Carl Bosch discovered an efficient method for pulling nitrogen from the air. Under high temperature and pressure, along with the presence of a metal catalyst, the scientists found they could synthesize ammonia – a compound made up of one nitrogen atom bound to three hydrogen atoms. Haber, a controversial figure who helped Germany develop chlorine gas as a chemical weapon during World War I, received the Nobel Prize in Chemistry in 1918 for discovering the method, which became known as the Haber-Bosch

process.[20] The discovery in 1909 had an immediate dark side as well, providing Germany with a source of explosive material that prolonged the war.

Following the war, use of nitrogen fertilizer on farms drastically boosted crop yields, allowing the global population to rise from less than two billion to more than six billion throughout the 1900s.[21] The price of this raw material has also become a main influence on global food prices, with fertilizer often forming one of the most significant overhead costs to farmers. Since 1994, global ammonia fertilizer production has risen by 50 percent,[22] with most production concentrated in five countries/regions: China, Europe, the U.S., India, and Russia. Of these, China is by far the world's largest producer of ammonia fertilizer, making up roughly 55 percent of the global total as of 2020. [23]

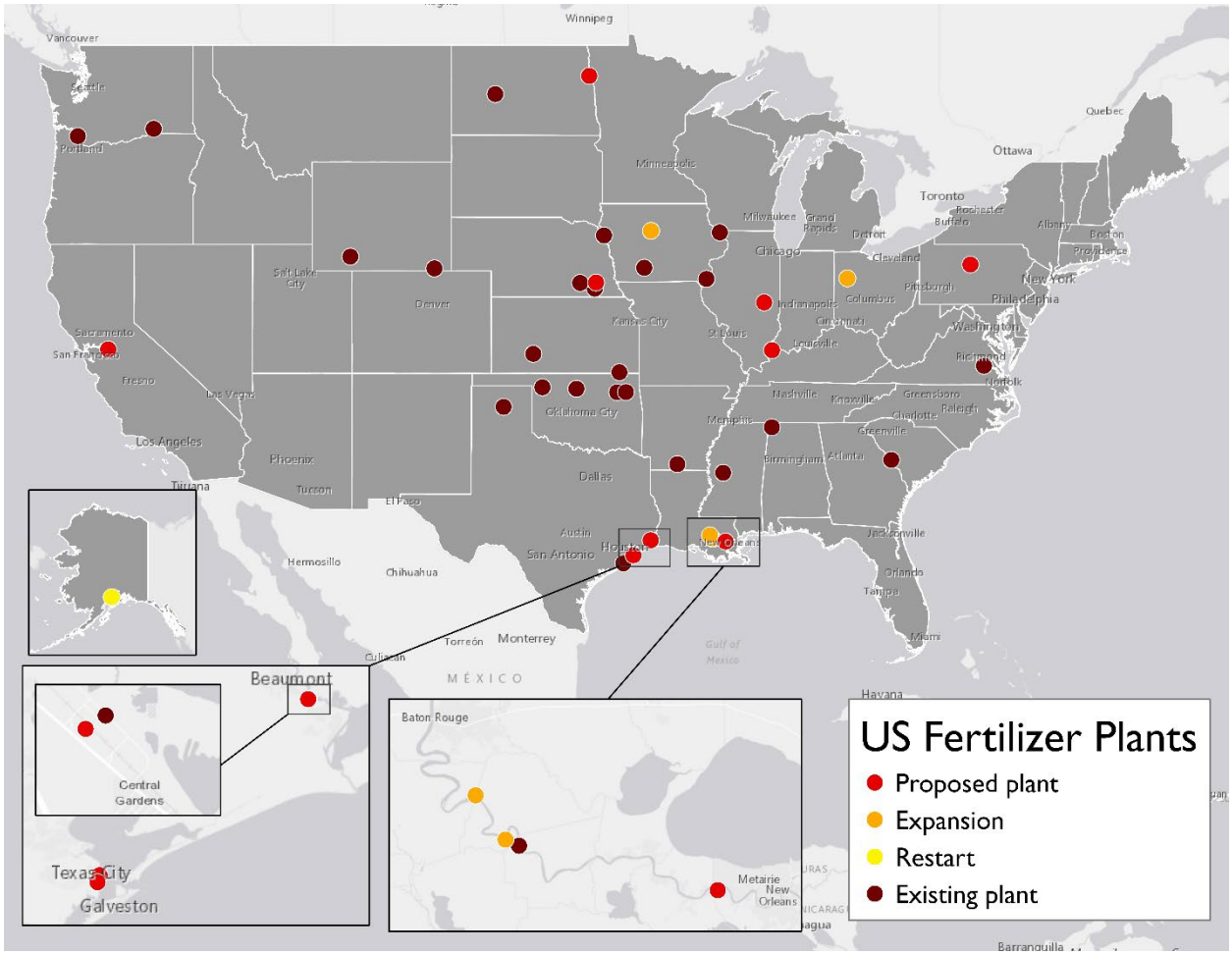
In the U.S., ammonia production first ramped up to supply explosive material needed for World War II, with many of these plants converting to fertilizer production after the war's end. But in the later part of the 20th Century, domestic ammonia fertilizer production declined significantly, from 113 plants in 1976 to 39 in 2000, to only 22 in 2008.[24] The industry's decline in the U.S. was driven by the rise of the price for natural gas in the U.S., which soared from $0.58 per 1,000 cubic feet at the wellhead in 1976 to $7.97 in 2008, according to the Energy Information Administration.[25] Many plants closed due to high gas prices and never re-opened. After about 2008, however, natural gas prices fell as the spread of newer drilling techniques – hydraulic fracturing and horizonal drilling – produced more gas at lower prices. This made fertilizer production in the U.S. more competitive with production in Russia, China, and other countries. The U.S. Renewable Fuel Standard, which required the use of biofuels in transportation fuel, first enacted in 2005 and expanded in 2007, also increased domestic fertilizer use by as much as 3 to 8 percent by increasing U.S. corn production to supply ethanol added to vehicle fuels such as gasoline.[26]

The number of U.S. ammonia fertilizer production facilities increased from 22 in 2008 to 30 plants in 2021, with approximately 88 percent of the ammonia produced used in fertilizer. The rest is used in manufacturing explosives, plastics, synthetic fibers and resins, and other chemicals. About 60 percent of these facilities are in Louisiana, Oklahoma, and Texas because of those states' large reserves of natural gas, the key ingredient for ammonia production.[27] Ammonia manufacturing plants today are also much larger than they were in the 1970s and are able to produce about the same amount of ammonia from a third as many facilities. This means that their local pollution impacts are much higher than they were decades ago.

The largest three existing plants are owned by Illinois-based CF Holdings Inc., which owns a total of five plants across the country. These include the biggest in the U.S., the CF Industries Donaldsonville Complex,[28] which sprawls across 1,400 acres beside the Mississippi River in Louisiana and produces 4.6 million metric tons of ammonia per year. Louisiana, Iowa, and Oklahoma each have four nitrogen fertilizer plants; Texas has three; Kansas, Nebraska, and Wyoming each have two; with the remainder in Georgia, Ohio, Mississippi, Virginia, Arkansas, Illinois, Alabama, Oregon, and North Dakota. (Appendix A lists the existing ammonia manufacturing plants).

According to public records available on EIP's Oil & Gas Watch Database,[29] as of April 1, 2023, companies are proposing to build nine new ammonia nitrogen fertilizer plants across the U.S. Another three existing plants are proposing to expand their production.[30] If built, these 12 proposed projects could increase current U.S. ammonia production capacity for fertilizer by 58 percent, from 20 million metric tons a year to 31 million metric tons per year. (Appendix C lists these proposed projects). Three additional projects are being proposed that do not plan to make ammonia- based nitrogen fertilizers, but would make other kinds of fertilizers, such as urea.[31]

FIGURE 1: EXISTING AND PLANNED AMMONIA FERTILIZER PLANTS IN U.S.



Sources: EPA's Enforcement and Compliance History Online (ECHO) database, Oil & Gas Watch, publicly available permit records. Some locations are approximate. Data current as of April 1, 2023. This map includes three projects that will not make ammonia but will make other ammonia-based synthetic fertilizers.

TABLE 1: TYPES OF NITROGEN FERTILIZER MADE FROM NATURAL GAS

Type	State	Percent nitrogen
Anhydrous ammonia	Liquid (stored under high pressure), gas (at atmospheric pressure)	82
Urea	Solid	46
Ammonia solutions	Liquid	28 - 32
Ammonium nitrate	Solid	34

Source: Michigan State University Extension

The U.S. Geological Survey estimates that U.S. ammonia production from existing plants ticked up slightly in 2022 – from 15.49 million metric tons to 15.85 million metric tons.[32] But that is just current production, in contrast to proposals for future production capacity – which are growing more substantially. The war in Ukraine, which began in February 2022, has become a significant catalyst for higher nitrogen fertilizer prices,[33] which have made the proposed development of more fertilizer plants in the U.S. more economically attractive. Russia is the second-largest producer and largest exporter of ammonia fertilizer in the world, accounting for 23 percent of the global market as of March 2022.[34] Initial concern about how a ban on Russian fertilizer would affect fertilizer prices and, therefore, global food prices, may have played a significant role in a decision by U.S. officials not to impose sanctions on Russian fertilizer exports, despite an import ban on Russian oil, natural gas, and coal.[35]

Still, the curtailment of Russian natural gas supplies to Europe caused a decline in European ammonia fertilizer production, contributing to an increase in global fertilizer prices, which have risen rapidly since late 2020. Chinese fertilizer exports also dropped significantly between 2021 and 2022, with urea exports decreasing 60 percent during that time.[36] All of these factors make the production of fertilizer in the U.S. more economically competitive.

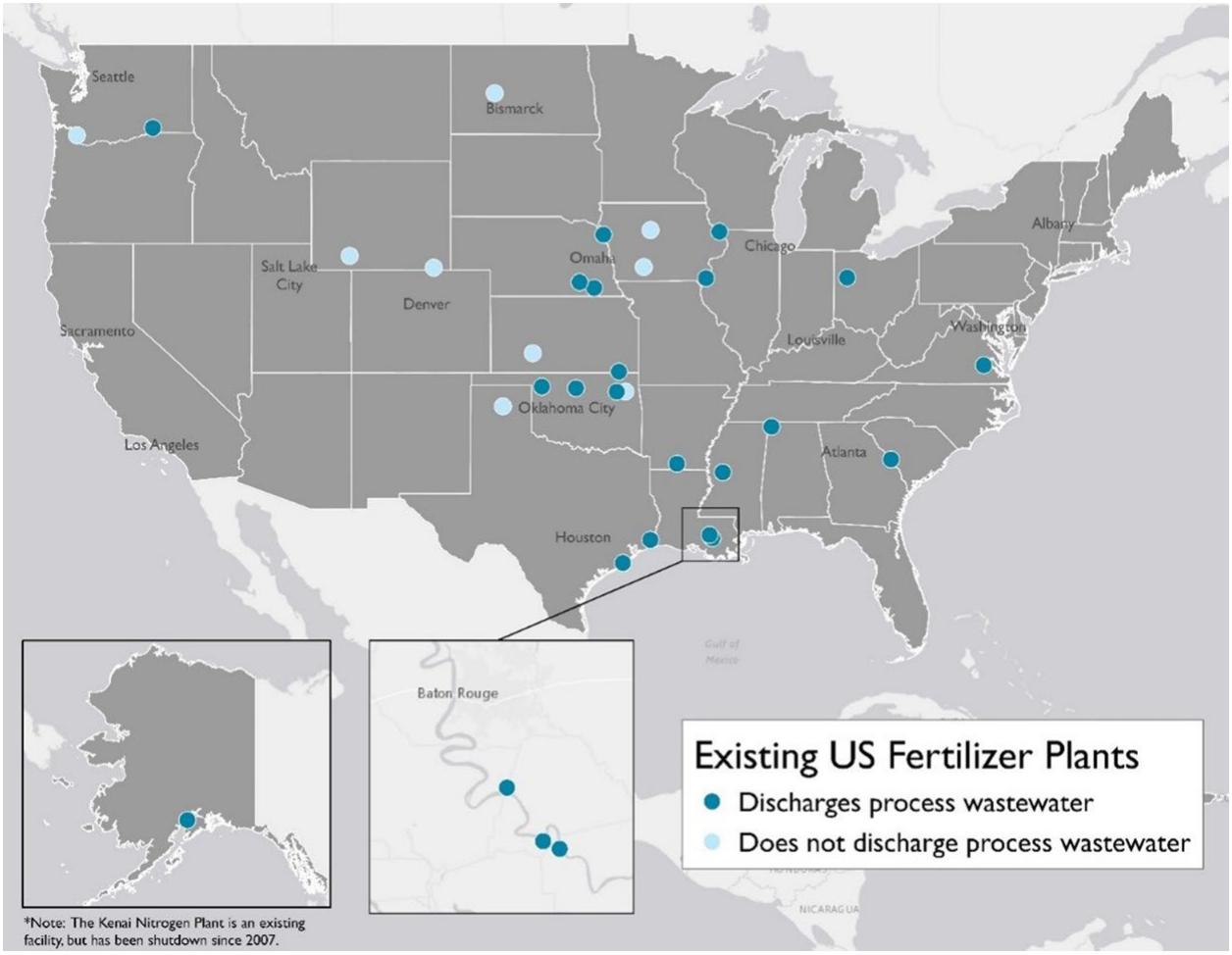
Although the predominant use of ammonia is for fertilizer, a growing number of facilities have also been proposed in the U.S. to make ammonia for use as fuel or to enable the transportation and storage of hydrogen fuel (ammonia contains three hydrogen atoms). In addition to the 12 projects to build or expand fertilizer plants discussed earlier, public records available on the Oil & Gas Watch database identify 14 proposed projects in Texas, Louisiana, and Alaska that would produce ammonia for fuel or in the production of hydrogen fuel.[37] These projects are in early planning stages. None have started construction and only six have announced the amount of ammonia they plan to produce. These six projects aim to make up to nearly 24 million metric tons of ammonia per year. (For additional information about these projects, see Appendix C2). Some of the proposed fuel projects[38] propose to use clean energy subsidies through the federal Inflation Reduction Act for the capture and sequestration of carbon dioxide, although this is a largely untested technology and its impact on the climate is unknown.

The growing size and number of ammonia plants should raise concerns about wastewater discharges, air emissions, spills, leaks, explosions, and whether current federal standards can adequately protect nearby communities from pollution resulting from fertilizer and ammonia manufacturing and downstream uses of these products.

Water and Air Pollution Impacts of Fertilizer Plants:

EIP obtained and reviewed water pollution control permits and other public records and data for 30 ammonia fertilizer manufacturing sites across the U.S. to estimate the amount of ammonia, total nitrogen, sulfates, and zinc each plant discharged in 2021. Of these, about two thirds (21 of 30) discharge wastewater to a waterway.[39] Below is a map that shows the locations of the fertilizer plants that discharge into waterways. Several plants that make ammonia for fertilizer do not discharge process wastewater directly to waterways. For example, at least four plants inject their wastewater into underground injection wells.[40] Another plant, Dyno Nobel's in St. Helens, Oregon, recycles all of its process wastewater.

U.S. NITROGEN FERTILIZER PLANTS THAT DISCHARGE WASTEWATER



Note: "process wastewater" is wastewater from fertilizer plants and does not include stormwater or cooling water from a plant.

The kind of wastewater discussed here – process wastewater – is water that comes into contact with natural gas and chemical ingredients used to make fertilizers. It does not include stormwater or cooling water that does not come into contact with industrial chemicals, unless plants mix these types of wastewater with their process wastewater. Process wastewater is regulated under current federal technology-based EPA regulations and, therefore, has the most amount of monitoring data available. (For a discussion of our methodology, see Appendix B).

In the U.S., ammonia discharges from fertilizer plants and other industries are regulated at the national level by water pollution control technology standards set by EPA under the federal Clean Water Act, called effluent limitation guidelines (ELGs). Under the law, EPA is supposed to review these technology standards on a regular basis and update them at least every five years as evidence shows that pollution control technology has advanced. But EPA has failed to keep up with this responsibility for the nitrogen fertilizer industry and several other sectors. The effluent guidelines for nitrogen fertilizer plants, for example, were first promulgated almost a half century ago – in 1974 and 1975 – and were last amended in 1986. The numeric pollution limits in the guidelines have not been revised since they were first promulgated and are now badly out of date and too weak, compared to the more modern pollution control technology now available. For example, there are currently no federal limits on the amount or concentration of total nitrogen[41] discharged to waterways from fertilizer plants, even though technologies are readily available to reduce total nitrogen concentrations to very low levels.[42] Sulfate and zinc discharges are also not regulated under EPA's current effluent guidelines for fertilizer manufacturers.

To push EPA to update and strengthen these standards for fertilizer manufacturers and six other industries, EIP and several allies on April 11, 2023, filed a lawsuit against EPA, demanding that the agency fulfill its obligations under the federal Clean Water Act.[43]

Ammonia Water Pollution

Ammonia is a form of nitrogen pollution that is a common cause of fish kills.[44] The U.S. EPA recommends keeping average monthly levels in freshwater below 1.9 mg/L to avoid chronic toxic effects on aquatic life, though toxic effects on sensitive fish have been observed at concentrations as low as 0.02 mg/L.[45] That's as little as about a quarter cup in an Olympic swimming pool.[46] Ammonia also adds to nitrogen levels in waterways, and nitrogen, a nutrient, feeds excessive algae growth that then dies, consuming oxygen through decomposition and causing "dead zones." EPA established technology-based pollution control limits on ammonia discharges from fertilizer plants in the 1970s, but has not updated their regulations since 1986.

In total, 21 nitrogen fertilizer plants across the U.S. discharged an estimated 3.9 million pounds of ammonia in 2021 from process wastewater outfalls. The largest discharges came from: the CF Industries fertilizer plant in Donaldsonville, Louisiana, which discharged 1.6 million pounds in 2021; Mosaic's Faustina Plant, which discharged 691,585 pounds and is also in Donaldsonville; and CF Industries' Port Neal plant in Iowa, which discharged 368,814 pounds. Eighty-six percent of the ammonia discharged by fertilizer plants in the U.S. was piped into waterways near communities where more than 30 percent of people are considered low income or more than 40 percent are people of color.[47]

Planned new ammonia production plants could add a considerable amount of pollution to waterways. If the proposed plants for which information is available are built, the proposed fertilizer plants could pipe an additional 3.1 million pounds of ammonia to local waterways, based on permit documents or capacity announcements and rates allowed under current federal rules.[48] Just four of the fuel-related projects could add an estimated 2.6 million pounds, based on limited data available.

A stockpile of ammonia fertilizer in solid form at a manufacturing site.

Nitrogen, Sulfate and Zinc Water Pollution

EPA has not established technology-based limits on total nitrogen from fertilizer plants. Total nitrogen is a combination of ammonia nitrogen, organic nitrogen, and nitrate-nitrite nitrogen. In total, 21 ammonia manufacturing plants in the U.S. discharged an estimated 7.7 million pounds of total nitrogen in 2021 from wastewater outfalls, based on monitoring data and permit records.

Current treatment technology to remove total nitrogen can treat wastewater very effectively, so it contains no more than 2 to 8 milligrams per liter (mg/L) of total nitrogen. In contrast, on a concentration basis, nitrogen fertilizer plants discharge a monthly median average of about 25 mg/L – roughly three to 12 times the achievable concentration using modern technology. Those plants that discharged the highest concentrations (in the top 25 percent) exceeded 50 mg/L on average, or more than six to 25 times the achievable concentration.

Nitrogen fertilizer plants in 2021 also discharged a large quantity of sulfates to waterways. Sulfates are mineral salts containing sulfur. They can derive from natural sources but are also found in many consumer products such as shampoos and soaps and are a byproduct of some heavy industries, including fertilizer manufacturing. In high enough concentrations, they can cause diarrhea and corrode plumbing. Sixteen fertilizer plants for which data were available discharged an estimated 115 million pounds of sulfates in 2021, based on a review of monitoring data and permit applications, with close to half coming from a single plant, the CF Industries Donaldsonville plant in Louisiana (52.4 million pounds).

TABLE 2: TOP 10 LARGEST DISCHARGERS OF TOTAL NITROGEN WATER POLLUTION IN 2021

Company	City, State	2021 Pollution Total (Total Nitrogen, lbs)	Average Daily Load (lb/day)
CF Industries Holdings, Inc.	Donaldsonville, LA	3,145,664	8,642
Mosaic Company	Donaldsonville, LA	814,799	2,230
CF Industries Holdings, Inc.	Port Neal, IA	609,883	1,675
Yara Freeport LLC (via BASF Freeport)	Freeport, TX	320,563	887
Dyno Nobel Louisiana Ammonia, LLC (via Cornerstone Chemical)	Waggaman, LA	276,015	756
Koch Fertilizer, LLC	Enid, OK	263,652	721
CF Industries Holdings, Inc.	Yazoo City, MS	225,741	617
LSB Industries, Inc.	El Dorado, AR	205,538	564
Nutrien Ltd.	Geismar, LA	173,942	477
East Dubuque Nitrogen Fertilizers, LLC	East Dubuque, IL	145,237	399

Source: Discharge monitoring reports available through EPA's Enforcement and Compliance History Online and permit records.

Zinc, a metal that is also found in natural deposits but often ends up in high concentrations in industrial wastewater, is highly toxic to fish and other aquatic life. Eighteen nitrogen fertilizer plants discharged an estimated 13,663 pounds of zinc, based on discharge monitoring data and permit documents.

Discharges of Wastewater to Impaired Waterways

Twelve of the 21 ammonia manufacturing plants examined for this report discharged to a waterway listed as impaired for failing to meet water quality standards.[49] Of those that discharge to impaired waterways, three discharge to waterways where listed impairments are connected to nitrogen and other nutrients (including algal growth and specific nutrient parameters). These plants are CF Industries Yazoo City Plant in Mississippi, which discharges to the Yazoo River; Nutrien's plant in Lima, Ohio, which discharges to the Ottawa River; and the AdvanSix plant in Hopewell, Virginia, which discharges to the James River. Other causes of impairment include mercury, PCBs, metals, pathogens, and pesticides.[50]

Stormwater

While not all fertilizer plants discharge process wastewater directly to a waterway, almost all discharge some amount of stormwater. EPA's current effluent guidelines (ELGs) do not establish limits for polluted stormwater, even though monitoring data and information in permit applications demonstrate that stormwater runoff from many ammonia and nitrogen fertilizer plants can be heavily contaminated.

For example, four stormwater outfalls at the AdvanSix facility in Hopewell, Virginia, had maximum concentrations of ammonia nitrogen greater than 1,000 mg/L in 2021. Across the U.S., seven of nine facilities with available ammonia stormwater monitoring data reported discharging ammonia (as nitrogen) at concentrations greater than 10 mg/L at least once that year.[51] Concentrations of other contaminants can be extremely high in stormwater runoff from nitrogen fertilizer plants. Stormwater from Nutrien's Geismar, Louisiana plant contained fluoride concentrations as high as 7,460 mg/L and sulfate as high as 7,660 mg/L, according to monitoring data from 2021.

Air Pollution and Greenhouse Gases

Nitrogen fertilizer production plants also release a significant amount of air pollution. In total, 30 plants reported releasing 10,176 tons of carbon monoxide, 16,146 tons of nitrogen oxides, 12,491 tons of ammonia, and 12 tons of benzene in 2021, according to state emission inventories. For a detailed listing of reported air emissions from the 30 fertilizer plants operating across the U.S., see Appendix D.

According to EPA's Greenhouse Gas Reporting Program,[52] the 30 nitrogen fertilizer plants discussed in this study reported emitting 46.8 million tons of greenhouse gases in 2021. Put into context, they emitted nearly as much as about 9.4 million gas-powered cars running for a year, or as much as 11 coal-fired power plants operating at full capacity for a year. Since 2012, reported emissions increased by 9.6 million tons (26 percent) as plants added capacity and new plants became operational.

Alone, proposed fertilizer-related projects could add up to 19 million tons of greenhouse gases per year, if built, with additional emissions possible from production of other products on site. On top of this, the proposed fuel-related ammonia projects could produce up to an additional 35 million tons of greenhouse gases per year. Together, the fertilizer and fuel-related ammonia projects could mean up to an additional 54 million tons of greenhouse gases per year to the atmosphere. That's the equivalent of about 13 coal-fired power plants.[53] Emissions are likely to be higher because seven of the proposed fuel projects have not announced how much ammonia they plan to make, nor have they applied for permits that reveal the amount of greenhouse gases they could emit. This information is needed to estimate their potential emissions.

The ammonia fertilizer industry has been under significant pressure to decarbonize in recent years, given its outsized greenhouse gas footprint and some potential for using ammonia as a "low carbon" fuel or as a carrier for hydrogen (another low-carbon fuel). As a result, several existing plants have announced plans to install carbon capture equipment, and new plants have been announced that would build carbon capture into the facility design. Eighteen projects, including fertilizer and fuel plants, have announced plans to capture and use or permanently sequester carbon to reduce their potential carbon emissions by 60-98 percent. However, it is unclear how much of this is realistic because federal and state agencies have yet to hold these companies accountable for their carbon reduction commitments by including carbon capture and sequestration as legal requirements in their Clean Air Act permits. Carbon capture and sequestration is also a largely untested

technology that is being met with significant community opposition in some areas due to health and environmental risks.[54]

Environmental Compliance History of Fertilizer Plants

Despite the reality that the fertilizer industry today has outdated and weak federal standards for controlling pollution, fertilizer plants often fail even to meet even the low bar of current regulations and permit requirements. Twenty fertilizer plants (67 percent) violated their water pollution limits at least once over a five-year period, from March 2018 to March 2023, according to EPA's Enforcement and Compliance History Online (ECHO) data. But only 25 percent (5 total) of the plants with violations faced a formal enforcement action, and only 15 percent (3 total) were penalized for their water pollution violations, according to EPA data.[55] The plant with the most violations, in El Dorado, Arkansas, reported discharging an average of 1,464 pounds of ammonia nitrogen in February 2023 from its process outfall, exceeding its permit limit by 452 percent.[56]

TABLE 3: TOP 10 FERTILIZER PLANTS FOR MOST WATER POLLUTION VIOLATIONS, (March 2018 to March 2023)

Plant Name	City, State	Effluent Violations	Formal Enforcement Actions	Penalties
LSB Industries, Inc.	El Dorado, AR	74	1	$124,000
Green Valley Chemical Corp.	Creston, IA	35	0	$0
Koch Fertilizer, LLC	Enid, OK	28	1	$0
Dakota Gasification Co	Beulah, ND	24	0	$0
The Mosaic Company	Donaldsonville, LA	21	1	$0
Yara Freeport LLC	Freeport, TX	19	0	$0
Koch Fertilizer, LLC	Fort Dodge, IA	13	0	$0
OCI Partners LP	Beaumont, TX	11	0	$0
Nutrien Ltd.	Lima, OH	10	0	$0
CF Industries Holdings, Inc.	Donaldsonville, LA	9	0	$0

Source: EPA Enforcement and Compliance History Online (ECHO) database, discharge monitoring data. Violations of permitted effluent limits listed above do not necessarily mean they have been decided by a court or legal action but are what EPA's database describes as exceedances of permit limits.

Environmental enforcement actions and penalties against fertilizer plants are much more common for air pollution permit violations. EPA data show that between March 2020 and March 2023, 43 percent (13 of 30) of facilities spent at least one quarter in violation of their Clean Air Act permits.

Almost 77 percent of those facilities (10 of 13) faced a formal enforcement action for air violations within the last three years, and 69 percent of these violators (9 of 13) were fined for air pollution violations.

The air permit violations for the 10 facilities listed below included exceeding legal limits for nitrogen dioxide, carbon monoxide, sulfuric acid, sulfur dioxide, particulate matter, and other pollutants. As of March 2023, six of these 10 facilities were listed as still being in "high priority violation" of the Clean Air Act, despite the numerous enforcement actions taken against them by state and federal regulators.

TABLE 4: TOP 10 FERTILIZER PLANTS FOR MOST QUARTERS WITH SIGNIFICANT AIR POLLUTION VIOLATIONS (March 2020 to March 2023)

Plant Name	City, State	Quarters With Significant Air Violations (Over 3 Years)	Formal Enforcement Actions (Over 3 Years)	Total Penalties (Over 3Years)
Yara Freeport LLC	Freeport, TX	12	8	$286,666
Dyno Nobel Louisiana Ammonia, LLC	Waggaman, LA	12	6	$112,886
OCI Partners LP	Beaumont, TX	12	4 (1 Unsettled)	$90,187
The Mosaic Company	Donaldsonville, LA	12	3	$0
AdvanSix Inc.	Hopewell, VA	12	2	$123,082
CF Industries Holdings, Inc.	Port Neal, IA	12	0	$0
LSB Industries, Inc.	El Dorado, AR	5	2	$11,840
Nutrien Ltd.	Borger, TX	2	3 (1 Unsettled)	$269,713
LSB Industries, Inc.	Pryor, OK	2	2	$38,000
Coffeyville Resources Nitrogen Fertilizers, LLC	Coffeyville, KS	1	0	$0

Source: EPA Enforcement and Compliance History Online (ECHO) database. ECHO only provides three years of compliance information for air violations.

Safety Risks Associated with Ammonia Fertilizers

Beyond the issue of poor compliance with air and water permits, fertilizer factories also have a history of safety risks – including deadly explosions.

Over the last century, more than 600 people in the U.S. have been killed in major explosions and fires fueled in part by nitrogen fertilizer in the form of ammonium nitrate. Before the disaster in West, Texas, in 2013, the deadliest was also in Texas – on the Gulf Coast, southeast of Houston, in Texas City, where 581 people died in a massive explosion on April 16, 1947.

The tally of deaths below does not include the use of ammonium nitrate as an explosive in terrorist actions, such as the 1995 Oklahoma City bombing, in which a truck packed with

the fertilizer was detonated outside the Alfred P. Murrah Federal Building, killing 168 people.[57] Globally, at least 2,200 people have been killed in 29 accidents involving ammonium nitrate fertilizer over the last century.[58]

TABLE 5: MAJOR INCIDENTS RELATED TO AMMONIA FERTILIZER

City, State	Date	Deaths	Tons of Ammonium Nitrate
West, Texas	April 17, 2013	15	54
Port Neal, Iowa	December 13, 1994	4	Unknown
Kansas City, Missouri	November 29, 1988	6	11.3 (ammonium nitrate and fuel oil)
Pryor, Oklahoma	January 17, 1973	0	14,000
Mt. Vernon, Missouri	November 9, 1966	0	50
Traskwood, Arkansas	December 17, 1960	0	40-50
Roseburg, Oregon	August 7, 1959	14	4.1
Presque Isle, Maine	August 26, 1947	0	Unknown
Texas City	April 16, 1947	581	2,000-5,500
Nixon, New Jersey	March 1, 1924	20	Unknown
Gibbstown, New Jersey	January 14, 1916	1	2

Note: Table does not include use of ammonium nitrate in terrorist acts or accidents where a facility or transport containing ammonium nitrate caught fire but did not explode. Source: U.S. Chemical Safety Board, Bureau of Alcohol, Tobacco, Firearms, and Explosives.[59]

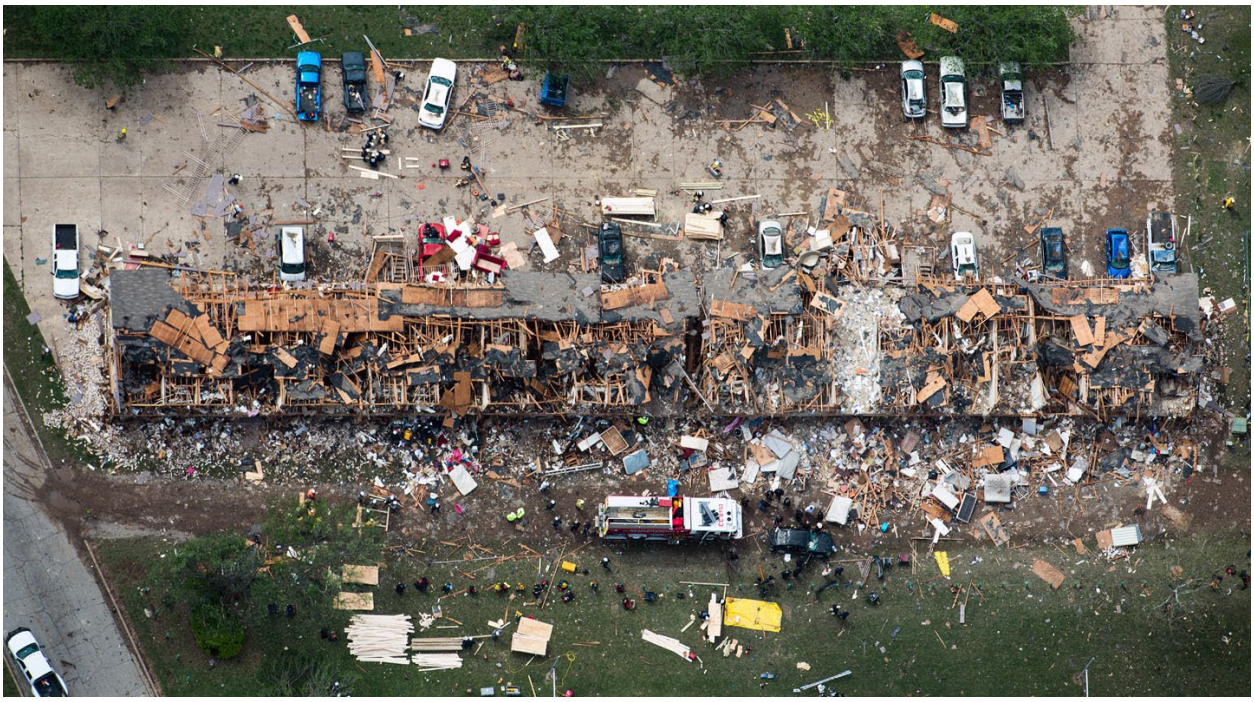
The Explosion in West, Texas, 2013

The West Fertilizer Company served as a retail supply depot to farmers growing crops on fields near the town of West, Texas. Built in 1961 when the area was made up of open fields, the town had grown to a population of around 2,600 by the time of the 2013 explosion. Homes, apartments, and schools had expanded into the fields that formerly surrounded the 12,000-square-foot building, which was made of mostly wood. A middle school and nursing home were only 1,000 feet away; a nearby apartment complex was only about 500 feet from the site.

A little before 7:30 p.m. on April 17, 2013, volunteer firefighters received a call that the fertilizer plant was on fire. They responded with two fire engines, two brush trucks, and a water tanker truck.[60] Ten years later, investigators still don't know the exact cause of the fire or where it started in the building.

Inside the facility, various fertilizers, seeds, and other products were stored in wooden bins. This included 40 to 60 tons of ammonium nitrate pellets, with 30 tons in a main ammonium nitrate storage bin. As the fire spread, soot began falling on the pile of ammonium nitrate, a source of contamination that increased the reactivity of the chemical and turned it into a ticking time bomb.

At 7:51 p.m., the pile exploded. The blast left a crater nearly 100 feet wide and 10 feet deep, blew out windows in homes five miles away, and registered with the force of a 2.1 magnitude earthquake. It killed 15 people – 12 first responders and three nearby residents – and injured more than 260 people.[61]



The ammonium nitrate fertilizer in the West Fertilizer plant exploded with the force of an earthquake, destroying this nearby apartment complex and more than 100 other buildings.

Following the explosion, federal lawmakers took up the issue of strengthening EPA rules that would prevent similar disasters. The U.S. Government Accountability Office as well as the independent U.S. Chemical Safety and Hazard Investigation Board recommended 27 separate measures to prevent similar incidents in the future. While EPA, other government agencies and lawmakers implemented some of the recommendations, they rejected others. A decade later, many of the safety measures inspired by the West, Texas, disaster have not yet been incorporated into laws and regulations surrounding ammonium nitrate manufacture, storage, and transport.

Government Response to the West Disaster

The West incident led to a nationwide push for a review of the network of U.S. chemical safety and disaster prevention rules. Officials focused especially on the Occupational Safety and Health Administration's (OSHA) rules for safe handling of dangerous materials, as well as EPA's risk management and information-sharing regulations. The EPA is currently working on a revision of its Risk Management Program (RMP) rules, which the agency initiated in mid-2022.[62] As of the publication of this report, the agency has not said it plans to incorporate ammonium nitrate into its RMP rule.

In June 2013, the Senate's Environment and Public Works Committee held hearings on the West disaster and corresponding regulations. Among those testifying were Rafael Moure-Eraso, chair of the U.S. Chemical Safety Board, and Barry Breen, EPA deputy administrator in charge of the Office of Solid Waste and Emergency Response. During the hearing, the committee's chair, former Democratic California Sen. Barbara Boxer, questioned Breen about a 2002 recommendation from the Chemical Safety Board to incorporate reactive chemicals such as ammonium nitrate into the list of chemicals that trigger a requirement to enroll a facility in the EPA's Risk Management Program.

The RMP rule is the EPA's main tool to prevent industrial and chemical disasters and requires facility owners to share information with first responders who are most at risk when responding to fires at fertilizer sites. The rule originated in amendments to the 1970 Clean Air Act that were passed in 1990. Under the rule, facilities that store hazardous substances must submit formal risk management plans to the EPA and update them every five years. The EPA inspects these facilities to ensure they comply with their own risk management plans. The rule applies to any facility that contains certain quantities, typically 10,000 to 20,000 pounds, of at least one chemical on a list of 140 toxic and flammable substances.[63] This list has never included ammonium nitrate. However, it does include both pressurized liquid ammonia (known as anhydrous ammonia) with a threshold of 10,000 pounds, and liquid ammonia (also called aqua ammonia) solution with concentration of 20 percent or greater, with a threshold of 20,000 pounds.

When asked why the EPA has avoided following the Chemical Safety Board's recommendation to add ammonium nitrate to that list of 140 chemicals, Breen responded by describing the recommendation as an "inadequate approach."[64] Breen told the committee, "we need to understand the issue better, and that's what we're doing now."

Boxer was not satisfied with the response, telling Breen that she did not "sense in your voice any type of shock or desire to use your authorities to move forward."

"I am sympathetic to the fact that there's work to be done," Boxer said. "I am unsympathetic to the attitude that I hear, which is a lack of urgency, because lives are being lost and recommendations were made a long time ago, and nothing's happening."

The EPA had an opportunity to add ammonium nitrate to the list during the Obama Administration, which specifically proposed revising the rule as a response to the West

disaster. In an executive order issued Aug. 1, 2013, the administration wrote that the "Secretary of Homeland Security, the Secretary of Labor, and the Secretary of Agriculture shall develop a list of potential regulatory and legislative proposals to improve the safe and secure storage, handling, and sale of ammonium nitrate and identify ways in which ammonium nitrate safety and security can be enhanced under existing authorities."[65]

Following its investigation in West, the Chemical Safety Board in 2016 issued its own set of 19 recommendations for federal, state, and local authorities and the private sector to avert a similar crisis in the future.[66] Its recommendations were targeted at the Department of Homeland Security and Federal Emergency Management Agency, the El Dorado Chemical Company, EPA, International Code Council, OSHA, State Firefighters and Fire Marshal's Association of Texas, Texas A&M University's Engineering Extension Service, Texas Commission on Fire Protection, Texas Department of Insurance, and West Volunteer Fire Department. The recommendations focused on tightening the regulations and inspection of facilities that store ammonium nitrate, as well as helping better prepare first responders for fires at storage sites.

Over the past decade, most of these entities acted on the Chemical Safety Board's recommendations –with four exceptions:

- The EPA told the board that it would not follow its recommendation to include fertilizer-grade ammonium nitrate to its list of chemicals that trigger its RMP rule.
- The International Code Committee has not adopted the board's recommended changes to the International Fire Code to include more strict requirements for ammonium nitrate storage and handling, including automatic fire detection and suppression systems in flammable buildings, proper ventilation, smoke and heat vents, minimum safe distances between ammonium nitrate and combustible materials, and prohibiting the use of flammable materials in building construction.
- The West Volunteer Fire Department stopped responding to the board in 2016, making it unclear whether the department followed the recommendation to develop "standard operating procedures for pre-incident planning for facilities that store or handle materials such as fertilizer grade ammonium nitrate."
- The Texas Department of Insurance told the board that it would not adopt its recommendations to add ammonium nitrate facility guidelines for underwriting risk and annual loss control surveys. This included guidance on considering whether ammonium nitrate was stored safely, with proper ventilation and automatic sprinklers and smoke detectors, at a safe distance from nearby residences, hospitals, and schools.
- OSHA also did not adopt CSB-recommended changes to its process safety management rules for ammonium nitrate. In 2018, following a victory in the D.C. Circuit Court of Appeals by a trade group representing fertilizer retailers, OSHA issued a memo clarifying that it would not cite "retail" facilities for violation of its process safety management rules. These retail facilities include wholesalers of field beans, grains, and other farm products.[67]

In May 2014, a little more than one year after the West explosion, the U.S. Government Accountability Office released its own report with eight recommendations for federal agencies to improve the way they track and inspect ammonium nitrate storage sites, along with better educating the fertilizer industry on how to avoid explosions.[68] The recommendations targeted the Department of Homeland Security, EPA, and OSHA. Six of these recommendations were fully implemented, with another two partially implemented. For a detailed breakdown, see Appendix E.

As stated above, both the EPA and OSHA, in collaboration with the Department of Homeland Security, have issued voluntary guidance to the industry on better ways to handle ammonium nitrate. The EPA's 2015 advisory states that operators of fertilizer storage facilities with ammonium nitrate "should develop an emergency response plan that includes: coordination and joint training with emergency responders; employee training; outreach to the community and local emergency planners; analysis of what may be at risk in a serious accident and appropriate planning, including explosion, exposure to toxic gases, and exposure to local populations; signs that clearly mark high hazard areas, safe areas, emergency contact numbers, firefighting equipment, and other essential areas during an emergency response; and site and area evacuation plan." [69]

"Owners and operators of facilities holding [ammonium nitrate] should ensure that emergency responders are aware of the hazards," the advisory continues. "Reliance on a report may not always be sufficient. It is recommended that owners and operators should take a proactive approach to reach out to their local emergency response officials and ensure that the hazards of [ammonium nitrate] and relevant characteristics of the facility are understood by responders." [70]

Strangely, the EPA has avoided subjecting fertilizer facilities to the RMP rule, even though this rule would require a proactive approach to reach out to local emergency response officials. In fact, the Chemical Safety Board found during its investigation that the West Fertilizer Company was subject to the RMP rules for anhydrous ammonia, stored as liquid under pressure in tanks at the site. A 2016 video detailing the results of the investigation stated that "company employees and emergency responders demonstrated a far greater awareness of the hazards of anhydrous ammonia than those of ammonium nitrate.

"Members of the West Volunteer Fire Department were well aware that anhydrous ammonia could potentially take the form of a toxic cloud able to drift into nearby homes," CSB investigator Dr. Samuel Oyewole said in the video. "But the firefighters did not anticipate the potential for an explosion of the fertilizer-grade ammonium nitrate."[71]

Experts outside the Chemical Safety Board have also urged the EPA to add ammonium nitrate to its RMP list during the agency's past two attempts to revise that rule. In an April 2016 comment letter to the EPA, Iclal Atay, chief of the Bureau of Release Prevention at the New Jersey Department of Environmental Protection, wrote that his department agrees with the Chemical Safety Board's recommendation to add ammonium nitrate to the RMP rule.[72] A March 2016 comment letter from Jeff Ruch, executive director of Public

Employees for Environmental Responsibility, states that "nothing in the current proposal addresses the danger to the public from incidents involving ammonium nitrate or other reactive chemicals."[73]

The 2016-2017 debate over including ammonium nitrate in the RMP rule ended up being moot. In 2019, the EPA under former coal-industry lobbyist Andrew Wheeler rolled back that rule, one of dozens of environmental regulations reversed during President Donald Trump's four-year term. In 2022, the EPA announced plans to restore the rule. But as of the date of publication of this report, EPA had not included ammonium nitrate to the list of chemicals that require risk management plans and inspections.[74]

During both rule revisions – 2017 and 2022 – the EPA faced stiff opposition from the fertilizer industry. An Oct. 31, 2022, letter from major industry trade group the Fertilizer Institute wrote that ammonium nitrate is already "subject to a myriad of existing regulations" that are "designed to protect the public."[75] A similar letter submitted the same day to EPA from the Institute of Makers of Explosives touted ammonium nitrate's benefits compared to other explosive materials when properly stored and handled. "Ammonium nitrate is not a volatile or self-reactive chemical requiring constant diligence in its handling," the letter states. "Rather, it is a stable, relatively benign substance when it is managed properly. Moreover, the proper management of [ammonium nitrate] is simple, well-understood and easily accomplished."[76]

In a technical advisory document issued in April 2022 as part of its latest RMP rule revision, the EPA shed some light on its thinking behind its decision not to add ammonium nitrate to the list. Though the agency acknowledged "incidents involving [ammonium nitrate] may be among the most severe and highest-profile accidental releases both in the United States and around the world," it still "contends that there are numerous issues that make regulating [ammonium nitrate] and other reactive substances complex and distinct."[77] These issues include the already existing regulations under OSHA rules, anti-terrorism laws, transportation codes, and regulations governing the handling of explosives. The EPA also pointed out that more specific regulations might work better for smaller retail facilities, such as the West and Winston-Salem fertilizer depots, whereas the RMP rule is intended more for large manufacturers with large safety staffs.

State of Texas Response

In response to the West incident, the Texas Legislature in 2015 passed a bill that shifted inspection responsibility for facilities that store ammonium nitrate from the state's health department to the Texas Commission on Environmental Quality (TCEQ) and established regular inspections.[78] The bill also required that local fire marshals be given access to inspect fertilizer facilities, though it did not require these inspections. Facilities were also required to provide forms disclosing their stored ammonium nitrate to local fire departments.

In response to an open records request by the Environmental Integrity Project, the TCEQ provided data stating that 30 facilities in 25 counties in Texas currently store ammonium

nitrate. The state agency said it would not disclose how much of the fertilizer is stored at each site, citing the state's Homeland Security Act. Following 2016, the first year of the 2015 bill's implementation, the TCEQ moved from an annual inspection schedule to inspecting such facilities every two years. The agency attributed the decline in inspections from 2016 onward to its switch to biannual inspections, as well as the closure of some fertilizer facilities (see table below). The TCEQ did not provide data on the number of active facilities per year.

TABLE 6: TEXAS STATE INSPECTIONS OF FACILITIES STORING AMMONIUM NITRATE

Fiscal Year	Number of Ammonium Nitrate Inspections
2016	38
2017	18
2018	20
2019	20
2020	19
2021	16
2022	16

Source: Texas Commission on Environmental Quality.

Despite the efforts to strengthen safety regulations following the West, Texas, disaster, ammonium nitrate continues to be involved in fires, near-explosions, spills and other accidents across the U.S. This highlights the need for stronger rules and continued vigilance as the fertilizer industry plans an expansion.

The Near Disaster in Winston-Salem, North Carolina, 2022

On. Jan. 31, 2022, the U.S. narrowly averted another explosion that could easily have exceeded the destruction caused by the West explosion. At around 8 p.m., in Winston-Salem, North Carolina, a fire broke out at a farm products retail site holding 1.2 million pounds of stored ammonium nitrate fertilizer surrounded by residential neighborhoods.[79]

With a population of around 260,000, including homes and commercial strips only a few hundred feet from the site, the potential impact of an explosion was even greater than in the more sparsely populated West, Texas. Firefighters and other first responders, who had studied the tactics of the response in West, evacuated approximately 6,000 people from nearby neighborhoods, including students of nearby Wake Forest University.[80] Many nearby residents were Spanish-only speakers, and city officials recruited the help of Spanish-speaking residents to help get evacuation notices out in multiple languages.[81] Firefighters also pulled back their own forces enough to contain the blaze to the Weaver site without putting them at risk of a possible explosion.

It took three nights for the fire at the Weaver plant to burn itself out, with most residents able to return to their homes around Feb. 3, 2022.[82] The dangerous quantities of fertilizer stored on-site did not explode. The incident led to many residents and advocacy groups questioning how much worse the incident could have been.

"The West plant was storing less than half of what was on site at the Winston plant," Jason Torian, a North Carolina-based community organizer with Blue Ridge Environmental Defense League, wrote in a Nov. 3, 2022, comment letter to the EPA.[83] "One can only imagine the unspeakable devastation that would have resulted if an explosion had occurred. …It's my hope that the situation in Winston-Salem can be a teachable moment and not a precursor of disasters to come."

Other Safety Risks of Ammonia Fertilizers

Although most ammonia is used to produce fertilizer, one significant safety risk associated with ammonia has to do with its use as a refrigerant in industrial cooling systems, such as those used by meatpacking plants, frozen food manufacturers, and similar facilities.[84] Ammonia leaks from refrigeration facilities have led to evacuations to avoid exposing plant employees and nearby residents to clouds of the caustic gas, which causes severe lung damage and can be fatal. Typically, firefighters respond to these incidents by spraying ammonia clouds with water, which neutralizes the gas but can lead to harmful runoff to nearby waterways. For example, a July 2020 leak from a meatpacking plant in San Antonio, Texas, led to the deaths of hundreds of fish after runoff from the firefighting response flowed into a storm drain and on to the San Antonio River.[85]

Because ammonia fertilizer often starts as anhydrous ammonia, gaseous ammonia leaks are also a risk at fertilizer manufacturing and storage sites, during transportation, and during its application on crops. One particularly harmful example comes from Lake County, Illinois, north of Chicago.[86] In April 2019, about 750 gallons of anhydrous ammonia leaked from two tanks mounted on a trailer pulled by a farmer's tractor. A cloud of ammonia gas blew over the town of Beach Park, sending 83 people to nearby hospitals for evaluation. Eight people were placed in intensive care, with all but one of them requiring ventilators.

To better understand the frequency of leaks and spills of anhydrous ammonia and ammonium nitrate, the Environmental Integrity Project reviewed a decade of reports from the U.S. Coast Guard's National Response Center (NRC) database. Companies that spill chemicals are required to report to the NRC. From 2013 to 2023, ammonium nitrate – either in solid pellet form or in a liquid solution – was involved in 106 spills or accidental releases nationwide. Of these, seven were associated with a fire, though it was not clear from the data whether the fire occurred before or after the release. Five of these incidents required evacuations of nearby residents, employees, or both. Two of these accidents resulted in a fatality – one person for each incident. And 13 people were injured in nine separate incidents, with three people being the largest number injured in a single incident.[87]

Ammonia spills can have harmful effects on streams, river, lakes, and saltwater ecosystems because of its toxicity to aquatic life even at extremely low concentrations – as little as a half cup of ammonia in one million gallons of water.[88] Out of the 106 total ammonium nitrate spills from 2013 to 2023, 14 involved the release of ammonium nitrate solid or liquid solution into waterways. Another 44 spills were on land; and the rest made contact with a medium other than water or soil, such as concrete, the ballast tanks of ships, or other locations. Many spills and leaks likely go unreported.

Leaks of anhydrous ammonia can be much more consequential because of the substance's ability to form deadly clouds when released into the atmosphere. The NRC database includes records of 6,090 leaks or releases of anhydrous ammonia from 2013 to 2023. However, many of these leaks are from facilities that use anhydrous ammonia in refrigeration, and therefore may not be attributable to the fertilizer industry. Although about 88 percent of ammonia is used in fertilizer production, the NRC data do not clearly distinguish between facilities that use ammonia for refrigeration and those that use it for fertilizer or some other purpose, such as fuel. Anhydrous ammonia accidents listed in the NRC database involved a total of 12 deaths, 316 injuries, and 72,120 people evacuated.[89] Thirteen anhydrous ammonia releases during that period led to a total of $25.5 million in damage. Of these 6,090 total incidents, 77 included the release of ammonia into waterways.

TABLE 7: EMERGENCY INCIDENTS INVOLVING AMMONIA CHEMICALS, 2013-2023

Type of ammonia	Total incidents	Fires	Evacuations	Injuries	Deaths
Ammonium nitrate	106	7	5	13	2
Anhydrous ammonia	6,090	50	1,042	316	12

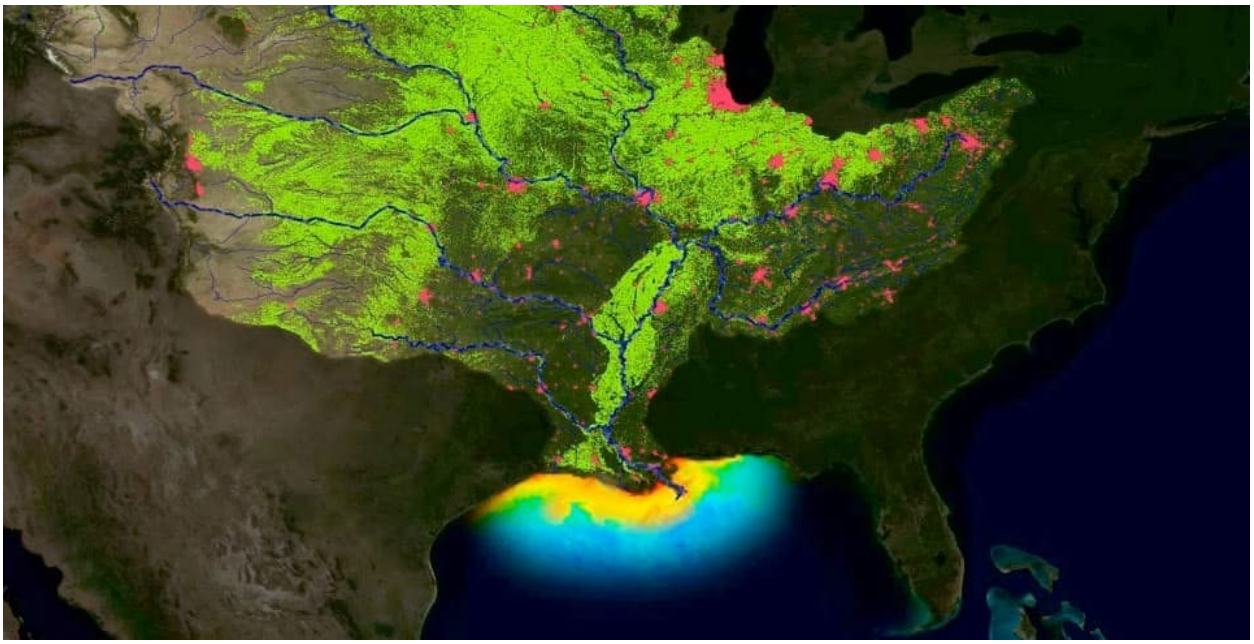
Source: U.S. Coast Guard National Response Center. Note: The response data do not distinguish between anhydrous ammonia used as fertilizer and as a refrigerant.

Water Pollution from End Users of Fertilizer: Farm Runoff

Even more than the water pollution from spills or the outfall pipes of fertilizer factories, the end-users of chemical fertilizer – including farmers and homeowners who fertilize their lawns – make up the most significant sources of nitrogen pollution to streams, rivers, lakes, and groundwater. Many people are familiar with the effects of nitrogen runoff pollution in waterways, even if they don't know the cause. Green-colored waterways thick with algae are common downstream from farms, as well as near over-fertilized golf courses and suburban subdivisions.

Nitrogen serves as a food not only for crops and other plants, but also for a single-celled organism called cyanobacteria, also called blue-green algae.[90] Like plants, these bacteria produce their own energy from the sun, with nitrogen as their food source. When levels of nitrogen pollution go up in a stream or river, these algae can bloom out of control,

decreasing levels of oxygen in the water and preventing sunlight from penetrating deep into the water column. This chokes out aquatic plants and invertebrates that form the food chain's base, as well as lowering oxygen levels that fish, mollusks, crustaceans, and other organisms need to breathe, a process called eutrophication. Waterways suffering from eutrophication can become so impaired that scientists consider them "dead zones." A prime example is the Gulf of Mexico Dead Zone, the second-largest dead zone in the world, which extends from the coast of Southeast Texas through southern Louisiana south of New Orleans. This large marine environment with low oxygen levels is caused by excess nutrients from fertilizer and manure use by Midwestern farmers, whose runoff enters the Mississippi River and flows into the Gulf of Mexico.[91]



A National Oceanic and Atmospheric Administration map shows how nitrogen runoff from cities (red) and agricultural areas (green) makes its way into the Gulf of Mexico via the Mississippi River and its tributaries.

Agriculture is by far the world's largest source of nitrogen pollution, responsible for two-thirds of nitrogen runoff worldwide.[92] Though farmers rely on nitrogen fertilizers to meet expected demands for crops that produce food, fuel, and fibers, half of the nitrogen they apply does not get taken up by plants but instead is lost to the environment.[93] Researchers have generally attributed this runoff and leaching of nitrogen to farmers applying more nitrogen than crops need. Heavy rains can worsen the problem. One United Nations study focusing on the Mississippi River Basin found that one-third of annual total runoff and leaching of nitrogen in the soil came from heavy rains, occurring on only nine days on average per year. Farmers in the Midwest apply most nitrogen fertilizers – 90 percent – in spring before crops start germinating.[94] This means that heavy rains can wash this nitrogen out of the soil before crops begin taking it up.

According to a U.S. Geological Survey (USGS) study of nitrogen pollution from both commercial fertilizers and manure, about 98 percent of chemical nitrogen fertilizer used in

the U.S. is spread on farms.[95] Increasing fertilizer use is tied to a trend towards industrial-style agricultural operations, and the USGS has found that "concentrations of total nitrogen were higher in agricultural streams than in streams draining urban, mixed use land, or undeveloped areas," with a median concentration around 6 times greater than background concentrations. [96] Since 1950, the amount of chemical nitrogen fertilizer used on farms in the U.S. has increased from less than 1 billion kilograms per year to more than 12 billion kilograms per year in 2017**,** according to the USGS report. [97]

Nitrogen fertilizers are also among the most common pollutants found in private drinking water wells in areas with intensive farming.[98] Unlike the drinking water used by people living in cities or towns with public water treatment systems, most well water is not treated before being used as drinking water. One USGS review found that 83 percent of studies of shallow groundwater in agricultural areas had one or more samples with nitrate in concentration greater than the EPA's maximum contaminant levels allowed in drinking water.[99] Excess nitrate consumption affects how the blood carries oxygen and has been linked to anemia, cardiovascular disease, lung disease, sepsis, and problems with red blood cells that carry oxygen from the lungs to other tissues in the body.[100]

Recommendations for farmers to reduce nitrogen fertilizer over-application and runoff have centered on what experts have called the 4R System – using the right fertilizer product, at the right rate, at the right time, in the right place.[101] This requires farmers to study their soils, the fertilizer products they intend to use, and how and when their crops will use nitrogen in their soils to grow. Most states have agronomic experts available to assist farmers to create

Fertilizers serve as nutrients for cyanobacteria, or blue-green algae. Blooms of this algae can reduce oxygen levels in a water body, choking out native plants, fish, and other aquatic life.

nutrient-control plans that adopt these principles to control nitrogen pollution in waterways. And some states[102] – including Maryland – require most farmers to have these nutrient management plans, although farmers do not always follow them.[103]

Farmers that have adopted conservation-minded agricultural practices, like rotating crops and rotating livestock grazing on cropland, improve the health of their soil and require much less, or no, synthetic fertilizer.[104]

Though agriculture represents the bulk of excess nitrogen fertilizer application, use of these fertilizers in homes, parks, golf courses, and businesses also cause runoff and leaching problems. Unlike farmers, who often can't avoid fertilizer use, much of the fertilizer use by non-farmers is for growing lawns and turf grass, which is often cosmetic or recreational, but provide less of a societal benefit than farmers' crops. Even in golf courses, reducing overapplication of nitrogen fertilizer can help in multiple ways, because an overly lush, overfed fairway can be worse for play than courses with shorter grass, according to the United States Golf Association.[105]

Homeowners can reduce or eliminate their use of chemical nitrogen fertilizer, sometimes by replacing non-native lawn grasses with native plants that require no fertilizer. Even when property owners desire a lush, green lawn, they do not have to rely on exotic grasses that require nitrogen fertilizer.[106] In dry areas, people can replace turf grass with rock or gravel beds intermixed with wildflowers, native shrubs, and indigenous trees that also provide food and habitat for pollinators, birds, and other wildlife.

Conclusion

Nitrogen fertilizers are useful products that have boosted crop yields enough to allow the global human population to explode in numbers during the past century. However, these fertilizers come with a significant set of harms and risks that are not properly managed. For decades, the EPA has failed to modernize and strengthen its water pollution control technology standards for fertilizer manufacturing plants, even though the federal Clean Water Act requires the agency to review these standards every five years. EPA must act to strengthen the effluent limitation guidelines for fertilizer plants that reflect advances in technology over the last four decades to protect the nation's waterways from pollution. In the safety arena, while safety standards for anhydrous ammonia are stronger than those applying to other forms of ammonia, the standards and community disclosure requirements for ammonium nitrate, its most explosive form, are lacking and threaten future disasters if not strengthened. End-users of nitrogen fertilizer, including farmers, have and continue to over-apply these products, degrading the nation's waterways, threatening drinking water supplies, and killing off aquatic life.

These facts demonstrate that the U.S. is not currently prepared for a boom in domestic nitrogen fertilizer production. The time for stronger regulation is now, with at least nine new fertilizer plants proposed across the country, and three fertilizer factories planning expansions, which could – taken as a whole – boost nitrogen fertilizer production in the

U.S. by 58 percent within a few years. If federal and state agencies can strengthen their standards and enforcement for this industry, these facilities could operate responsibly and safely, and contribute to lowering and stabilizing fertilizer prices, while also avoiding threatening people's safety and the environment. But without stronger pollution control and safety standards, this fertilizer boom could be dangerous to both local residents – like those in West, Texas – and to the planet's health.

Policy Recommendations:

- The EPA should update and strengthen its water pollution control standards – called effluent limitation guidelines – for nitrogen fertilizer manufacturers to reflect current technologies. On April 11, a coalition of 13 environmental groups, led by the Environmental Integrity Project, filed a federal lawsuit against EPA asking for the agency to update its standards for fertilizer plants and other industries.[107]
- After tightening up these guidelines, state and federal regulators should strictly enforce permit limits for water and air pollution from the industry and impose penalties for violations. Consistent penalties will provide the owners of plants with an economic incentive to upgrade their facilities to prevent spills, leaks, and other releases.
- The EPA should add ammonium nitrate to the list of more than 140 hazardous chemicals that require facility owners to plan for disasters and share information about chemical hazards with local emergency planners.
- The Occupational Safety and Health Administration should ensure that retailers of nitrogen fertilizers are regulated under its Process Safety Management standards and inspect these facilities regularly to make sure explosive fertilizers are stored correctly and protected from fires that could cause explosions.
- The EPA should remove an exemption for fertilizer retailers from its Emergency Planning and Community Right-to-Know Act, thereby making it easier for first responders and the public to understand whether explosive nitrogen fertilizers are located near communities.

Appendix A: Ammonia Fertilizer Manufacturing in U.S. 2021

Company	City, State	Ammonia Production Capacity (1,000 metric tons per year) *
CF Industries Holdings, Inc.	Donaldsonville, LA	4,648
CF Industries Holdings, Inc.	Port Neal, IA	1,320
CF Industries Holdings, Inc.	Claremore, OK	1,299
Koch Fertilizer, LLC	Enid, OK	998
Dyno Nobel Louisiana Ammonia, LLC	Waggaman, LA	859
Iowa Fertilizer Co.	Wever, IA	827
Nutrient Ltd.	Augusta, GA	821
Yara Freeport LLC	Freeport, TX	805
Nutrien Ltd.	Lima, OH	778
CF Industries Holdings, Inc.	Yazoo City, MS	612
Nutrien Ltd.	Geismar, LA	574
AdvanSix Inc.	Hopewell, VA	569
The Mosaic Company	Donaldsonville, LA	548
Nutrien Ltd.	Borger, TX	526
LSB Industries, Inc.	El Dorado, AR	526
CF Industries Holdings, Inc.	Woodward, OK	515
Coffeyville Resources Nitrogen Fertilizers	Coffeyville, KS	403
Dakota Gasification Co.	Beulah, ND	381
Koch Fertilizer, LLC	Fort Dodge, IA	376
East Dubuque Nitrogen Fertilizers, LLC	East Dubuque, IL	362
OCI Partners LP	Beaumont, TX	356
Koch Fertilizer, LLC	Dodge City, KS	301
Koch Fertilizer, LLC	Beatrice, NE	284
LSB Industries, Inc.	Pryor, OK	258
J.R. Simplot Co.	Rock Springs, WY	199
LSB Industries, Inc.	Cherokee, AL	199
Dyno Nobel Inc.	Cheyenne, WY	191
Dyno Nobel Inc.	St. Helens, OR	107
Green Valley Chemical Corp.	Creston, IA	34
NE Nitro (formerly Fortigen Geneva, LLC)	Geneva, NE	33
Nutrien Ltd.	Kenai, AK	Idled since 2007
TOTAL		**19,710**

*Source: USGS 2021 Minerals Yearbook, Nitrogen, available at: https://www.usgs.gov/centers/national-minerals-information-center/nitrogen-statistics-and-information. Note: One plant identified by USGS as an ammonia manufacturing plant in Kennewick, WA, no longer makes ammonia on-site and has been omitted from this table. *Capacity adjusted to reflect operation 365 days per year.*

Appendix B: Methods

EIP identified operating ammonia plants using a combination of data compiled by the USGS and independent research. Trends in the number of plants and their nameplate capacity are from USGS, publicly available permit documents, and company announcements.

We calculated water pollutant loadings and whether plants discharged into impaired waterways using the same methods outlined in EIP's 2023 report, Oil's Unchecked Outfalls.[108] We used discharge monitoring report (DMR) data available through EPA's Enforcement and Compliance History Online (ECHO) database, where available. If monthly average monitoring data for a pollutant were not available through discharge monitoring reports, a company failed to report, or if plants were not required to monitor or report under their current permit, we used reported monitoring values included in permit applications. Monitoring data in permit applications is supposed to be representative of discharges from a plant and is sufficient for setting legal permit limits. However, it may only reflect a small number of samples or reflect maximum concentrations or loading rates instead of averages. EIP relied on publicly available permit documents to identify waste streams discharged through each outfall.

Projected ammonia loads for new or expanded plants were calculated based on the following twelve plants for which planned capacity figures were available: Air Products, Gulf Coast Ammonia in Texas City, Texas; Blue Bayou Ammonia LLC in Texas City, Texas; CF Industries Holdings, Inc. in Donaldsonville Louisiana; Cronus Chemicals, LLC in Tuscola, Illinois; Grannus Ammonia and Hydrogen Project near Stockton, California; Midwest Fertilizer Company, LLC in Mount Vernon, Indiana; Monolith Materials in Hallam, Nebraska; Northern Plains Nitrogen, LLP in Grand Forks, North Dakota; Nutrien Ltd. in Geismar, Louisiana; Nutrien Ltd. in Kenai, Alaska; Nutrien Ltd. in Lima, Ohio; and OCI Clean Ammonia LLC in Beaumont, Texas. Potential ammonia discharges from process wastewater outfalls are based on permitted values available in public permit documents. If permits or permit applications were not available, we estimated potential ammonia discharges by multiplying the plant's proposed capacity by the new source performance standard rate for ammonia manufacturers, 0.055 pounds per 1,000 pounds of ammonia produced. We used a similar method to account for other fertilizer products that a plant plans to make. Estimated potential ammonia loading rates are based on the information available to date and are subject to change. Some plants may not discharge to waterways, or they may send their wastewater to a municipal or industrial wastewater treatment plant.

For the stormwater analysis, stormwater outfalls were identified based on outfall descriptions in permit documents. Outfalls that comingled stormwater and process water were excluded, as those outfalls were included in the loading analysis.

The demographic analysis related to ammonia discharges is based on the location of the process wastewater outfall and EPA's Environmental Justice Screening Tool version 2.1.

Air emission data are from state air emission inventories. The data reflect emissions reported for calendar year 2021, with the exception of the Dakota Gasification Plant in Beulah, ND, where the most recent available data are from 2018. Greenhouse gas emission data are from EPA's Greenhouse Gas Reporting Program and reflect emissions reported to Subpart G (ammonia manufacturing), Subpart V (nitric acid production), and Subpart C (General Stationary Fuel Combustion). We included emissions from three facilities with ammonia manufacturing capacity – Yara in Freeport, TX, OCI in Beaumont, TX, and JR Simplot in Rock Springs, WY – that were reported to other chemicals, petrochemicals, and phosphoric acid production. We also excluded emissions from Nutrien's plant in Kennewick, WA, because it no longer manufactures ammonia on-site. Emissions are presented as carbon dioxide equivalents and the global warming potentials used by the greenhouse gas reporting program. We adjusted metric tons to short tons.

Information about proposed projects comes from state permit documents, company press releases, and industry news sources compiled on Oil and Gas Watch database[109] as of April 1, 2023. Where available, we use potential greenhouse gas emissions estimates provided by companies in their Clean Air Act New Source Review permits or permit applications.

Where Clean Air Act permits were unavailable, we estimated greenhouse gas emissions using a project's stated ammonia production capacity and emissions factors published in peer-reviewed articles and government reports. These publications estimate that traditional ammonia production using natural gas methane as a feedstock emits between 1.2 and 2.1 tons of greenhouse gases per ton of ammonia produced.[110] Our estimates assume that new plants will also use natural gas as a feedstock and will be designed similarly to traditional ammonia plants. We conservatively assume that new plants will operate at about 84 percent of rated capacity, as existing plants did in 2021.[111]

Seven proposed projects have not announced capacity figures and were excluded from our emissions projections. For green ammonia projects, we conservatively assume that 100 percent of power generation will come from renewable sources and that these projects will not emit greenhouse gases. Some projects – like the massive 10 million metric ton per year plant announced by South Korea's Lotte Chemical Corporation, Japan's Mitsubishi Corporation, and the German utility RWE for the Port of Corpus Christi – are planning to manufacture both blue and green ammonia. In these instances, we assume a 50/50 ratio of blue to green ammonia when estimating greenhouse gas emissions unless a company has announced how much blue or green ammonia they intend to make.

For the environmental compliance section of the report, EIP used EPA's Enforcement and Compliance History (ECHO) Online database.[112] For Table 3, ranking the facilities with the most water pollution violations, we searched the period March 2018 to March 2023 and ranked the facilities with the most effluent violations (not reporting or record keeping violations) based on discharge monitoring data. Violations of permitted effluent limits listed do not necessarily mean they have been decided by a court or legal action but are what EPA's database describes as exceedances of permit limits. For Table 4, ranking the facilities with the most quarters of significant air pollution violations, we used the period from March

2020 to March 2023, because EPA ECHO only provides three years of quarterly compliance information for air violations.

Appendix C: Proposed Ammonia Nitrogen Fertilizer Plants

Company	City, State	Planned Ammonia Capacity Increase (1,000 metric tons per year)	Classification	Products	Status	Potential GHG Emissions (Tons, CO2e)
Blue Bayou Ammonia LLC	Texas City, TX	3,000	New	Blue Ammonia	Proposed	5,833,425*
OCI Clean Ammonia LLC/Linde Inc. **	Beaumont, TX	2,190	New	Blue Ammonia, Nitric Acid, Urea, UAN, DEF	Under construction, One Air Permit Issued, Another Pending **	2,967,888
Air Products, Gulf Coast Ammonia	Texas City, TX	1,350	New	Ammonia	Under construction, Air Permit Issued	2,625,041*
Nutrien Ltd.	Geismar, LA	1,300	Expand	Blue Ammonia	Proposed, Air Permit Pending	446,112
Cronus Chemicals, LLC	Tuscola, IL	1,004	New	Ammonia	On Hold, Air Permit Pending	1,822,415
Northern Plains Nitrogen, LLP	Grand Forks, ND	885	New	Blue Ammonia, Urea, UAN, DEF, Ammonium Nitrate, Ammonium Thiosulfate, Ammonia Polyphosphate	Proposed	1,146,226
Nutrien Ltd.	Kenai, AK	630	Restart/Expand	Ammonia, Urea	On Hold, Air Permit Expired	2,197,970
Midwest Fertilizer Company, LLC	Mount Vernon, IN	591	New	Ammonia, Nitric Acid, Urea, UAN, DEF	Proposed, Air Permit Issued	1,615,044
Monolith Materials	Hallam, NE	340	New	Ammonia, Carbon Black	Proposed, Air Permit Issued	115,176
Grannus Ammonia and Hydrogen Project	Near Stockton, CA	150	New	Blue Ammonia	Proposed	291,671*
CF Industries Holdings, Inc.	Donaldsonville, LA	20	Expand	Green Ammonia	Under construction, Air Permit Issued	0*
KeyState Natural Gas Synthesis Energy	West Keating Township, PA	TBD	New	Blue Ammonia, Urea, DEF	Proposed	TBD
Proposed fertilizer projects		**11,460**				**19,060,968**

Appendix C2: Proposed New Ammonia Projects for Use as Fuel

Company	City/State	Planned Ammonia Capacity Increase (1,000 metric tons per year)	Classification	Products	Status	Potential GHG Emissions (Tons CO_2e)
Lotte/Mitsubishi/RWE ***	TBD, Corpus Christi, TX	10,000	New	Blue Ammonia, Green Ammonia	Proposed	9,722,374*
Ascension Clean Energy, Denbury Carbon Solutions, Hafnia	Donaldsonville, LA	7,200	New	Blue Ammonia	Proposed	14,000,219*
Sustainable Fuels Group/Copenhagen Infrastructure Partners	TBD, TX/LA Gulf Coast	2,920	New	Blue Ammonia	Proposed	5,677,867*
AmmPower, Port of South Louisiana	Port of South Louisiana, LA	1,460	New	Green Ammonia	Proposed	0*
CF Industries/Mitsui	Donaldsonville, LA	1,400	New	Blue Ammonia	Proposed	2,722,265*
Enbridge Ingleside LLC	Ingleside, TX	1,400	New	Blue Ammonia	Proposed	2,722,265*
Avina Clean Energy	TX Gulf Coast	700	New	Green Ammonia	Proposed	0*
Air Products Blue Energy LLC †	Darrow, LA	TBD	New	Blue Ammonia	Proposed, Air Permit Pending	TBD
Cook Inlet Blue Hydrogen and Ammonia Hub	Cook Inlet, AK	TBD	New	Blue Ammonia	Proposed	TBD
ExxonMobil Chemical	Baytown, TX	TBD	New	Blue Ammonia	Proposed	TBD
G2 Net Zero LNG LLC	Cameron, LA	TBD	New	Blue Ammonia	Proposed	TBD
Grannus Alaska	Port McKenzie, AK	TBD	New	Blue Ammonia	Proposed	TBD
Texas Green Fuels LLC ††	Galveston Bay, TX	TBD	New	Green Ammonia	Proposed	TBD
US LP, Chevron, LyondellBasell Industries, Uniper	TBD, LA	TBD	New	Blue Ammonia, Green Ammonia	Proposed	TBD
Proposed ammonia fuel projects		**25,080**		**Total Known GHG**		**34,844,990**
TOTAL Ammonia Capacity Planned (Fertilizer and fuel together)		**36,540**		**TOTAL Estimated GHG Emissions (Fertilizer and fuel together)**		**53,905,958**

Note: TBD = To Be Determined; UAN = Urea Ammonium Nitrate; DEF = Diesel Exhaust Fluid. Blue ammonia refers to ammonia produced using fossil fuels, with carbon dioxide from the production process captured and used or sequestered in geologic formations deep underground. Green ammonia refers to ammonia produced using renewable electricity, deionized water, and atmospheric nitrogen. Air permits refer to Clean Air Act New Source Review (NSR) pre-construction permits. Permit status only applies to the project listed; facilities may have other active or pending permits. Greenhouse gas emissions (as CO2e) are sourced from permit documents unless otherwise noted. Source: Oil and Gas Watch, as of April 1, 2023

** Greenhouse gas emissions were estimated using ammonia production capacity figures and emissions factors. While we provide a range of estimates throughout this report, emissions in the last column assume that projects will emit 2.1 tons of CO_2e for every ton of ammonia produced. We use emissions factors at the higher end of the range because they are more consistent with reported emission rates. We conservatively assume that plants will operate at 84 percent of rated capacity and that green ammonia projects will not emit greenhouse gases. Emissions estimates do* ***not*** *incorporate potential CO_2 reductions through carbon capture use and storage. For more information about how emissions were estimated, see Appendix B.*

*** Linde will supply hydrogen to OCI Clean Ammonia and will be permitted separately. The air permit for Linde's hydrogen project is pending as of April 11, 2023. OCI's final air permit only covers the proposed ammonia plant, not the proposed urea and nitric acid plants.*

**** Lotte/Mitsubishi/RWE are planning to manufacture both blue and green ammonia at their proposed plant in Corpus Christi. They have not yet announced how much blue vs. green ammonia they plan to make. We assumed a 50/50 ratio of blue to green ammonia when estimating emissions for this project.*

† Air Products' Darrow facility would be capable of producing 750 million cubic feet per day of hydrogen, however, ammonia production capacity has not yet been announced.

†† Although Texas Green Fuels LLC claims it will use renewable energy for all electricity requirements, the company's website indicates that carbon capture may still be necessary to remove "any CO_2 that may be generated during production" (see: https://txgreenfuels.com/faq/).

Appendix D: Reported Emissions of Air Pollutants from Nitrogen Fertilizer Plants in 2021

Company	City, State	NOx (tpy)	PM2.5 (tpy)	SO2 (tpy)	VOCs (tpy)	Ammonia (tpy)	Benzene (tpy)	GHG Emissions (tpy CO2e)
AdvanSix Inc.	Hopewell, VA	1,726	144	229	173	594		1,330,398
CF Industries Holdings, Inc.	Donaldsonville, LA	2,654	422	16.9	182	4,033	0.02	9,978,941
CF Industries Holdings, Inc.	Yazoo City, MS	26.6	0.36	0.08	1.0	4.5	0	2,304,045
CF Industries Holdings, Inc.	Claremore, OK	1,014		7.3	47.1			3,095,449
CF Industries Holdings, Inc.	Woodward, OK	400	43.5	2.1	72.5			1,374,175
CF Industries Holdings, Inc.	Port Neal, IA	321	105	3.1	57.6	408		3,047,047
Coffeyville Resources Nitrogen Fertilizers, LLC	Coffeyville, KS	311	102	75.9	672	48.0	3.18	1,845,289
Dakota Gasification Co. *	Beulah, ND	2,438	121	2,837	882	58.2	5.16	3,883,892
Dyno Nobel Inc.	Cheyenne, WY	664	66.4	0.67	28.6	336	0.38	499,131
Dyno Nobel Inc.	St. Helens, OR	29.9	47.4	1.6	7.8			219,332
Dyno Nobel Louisiana Ammonia, LLC	Waggaman, LA	698	66.5	983	339	53.0	<0.017	1,095,810
East Dubuque Nitrogen Fertilizers, LLC	East Dubuque, IL	437	67.0	2.4	46.4	573		837,983
Green Valley Chemical Corp.	Creston, IA	113	4.5	0.54	124	0.71		71,443
Iowa Fertilizer Co.	Wever, IA	196.	15.2	2.7	94.7	130	<0.01	1,623,954
J.R. Simplot Co.	Rock Springs, WY	87.2	32.0	636	28.5	27.1	<0.01	437,414
Koch Fertilizer, LLC	Enid, OK	625		5.1	71.8			2,341,277
Koch Fertilizer, LLC	Dodge City, KS	209	3.8	1.3	22.1	1,240		620,098

Company	City, State	NOx (tpy)	PM2.5 (tpy)	SO2 (tpy)	VOCs (tpy)	Ammonia (tpy)	Benzene (tpy)	GHG Emissions (tpy CO2e)
Koch Fertilizer, LLC	Fort Dodge, IA	235	15.3	0.27	18.3	276		1,022,658
Koch Fertilizer, LLC	Beatrice, NE	161	15.6	1.1	40.8	292		604,009
LSB Industries, Inc.	El Dorado, AR	120	39.4	235	9.73E+00	209		1,048,839
LSB Industries, Inc.	Pryor, OK	87.4		0.08	10.1			335,927
LSB Industries, Inc.	Cherokee, AL	264	19.0	5.3	37.9	52.6		506,211
The Mosaic Company	Faustina (Donaldsonville), LA	19.2	97.9	4.6	5.6	172	<0.01	654,799
NE Nitro (formerly Fortigen Geneva, LLC)	Geneva, NE	14.0	2.6	0.24	27.6	0.22	0	68,319
Nutrien Ltd.	Augusta, GA	821	142	0.59	51.3	2,118		2,070,059
Nutrien Ltd.	Borger, TX	204	42.5	0.33	23.8	275	0	805,532
Nutrien Ltd.	Geismar, LA	456	86.6	3.2	32.9	277	0.01	1,608,075
Nutrien Ltd.	Lima, OH	1,245	66.3	5.4	595	1,289	1.34	1,907,922
Yara Freeport	Freeport TX	508.7	159.1	165	186.7	8.94	1.91	669,148
OCI Partners	Beaumont TX	63.9	3.2	0.28	91.8	15.6		858,806
TOTALS		**16,146**	**1,929**	**5,227**	**3,981**	**12,491**	**12**	**46,765,981**

*Note: All units are in short tons. Criteria pollutant emissions are from state emissions inventories and greenhouse gas emissions are from the EPA's Greenhouse Gas Reporting Program. *Criteria emissions for the Dakota Gasification plant are from 2018, not 2021.*

Appendix E: Recommendations of the Government Accountability Office After the West, Texas Disaster and Whether They Were Implemented.

Agency affected	Recommendation	Status
Department of Homeland Security, Department of Labor, Environmental Protection Agency	To improve federal oversight of facilities with ammonium nitrate, that the Secretary of Labor, the Administrator of EPA, and the Secretary of Homeland Security, as part of their efforts as members of the Chemical Facility Safety and Security Working Group established by the Executive Order issued in August 2013, should develop and implement methods of improving data sharing among federal agencies and with states.	Implemented
Department of Labor	The Secretary of Labor should direct the Assistant Secretary for Occupational Safety and Health to take steps to identify high risk facilities working with ammonium nitrate and develop options to target them for inspection.	Implemented
Department of Labor	To strengthen federal oversight of facilities with ammonium nitrate, the Secretary of Labor and the Administrator of EPA should direct OSHA and EPA, respectively, to consider revising their related regulations to cover ammonium nitrate and jointly develop a plan to require high risk facilities with ammonium nitrate to assess the risks and implement safeguards to prevent accidents involving this chemical.	Partially addressed OSHA in 2013 issued a request for information seeking comments on ammonium nitrate for is process safety management standards and held a roundtable with small businesses to solicit feedback in 2017. In 2018, it launched a targeted inspection program to "address hazards from exposure to fertilizer-grade ammonium nitrate and agricultural anhydrous ammonium." In 2021, it moved the proposal from its long-term regulatory agenda to its short-term agenda.

Agency affected	Recommendation	Status
Environmental Protection Agency	To strengthen federal oversight of facilities with ammonium nitrate, the Secretary of Labor and the Administrator of EPA should direct OSHA and EPA, respectively, to consider revising their related regulations to cover ammonium nitrate and jointly develop a plan to require high risk facilities with ammonium nitrate to assess the risks and implement safeguards to prevent accidents involving this chemical.	Implemented* *OSHA and EPA both issued non-binding guidance on ammonium nitrate and have *considered* whether to introduce binding regulations to their process safety management and RMP rules, but they have not done so.
Department of Labor	The Secretary of Labor should direct the Assistant Secretary for Occupational Safety and Health to consider updating regulations for the storage of ammonium nitrate taking into consideration, as appropriate, other related standards and current practices.	Partially addressed OSHA in 2013 issued a request for information seeking comments on ammonium nitrate for is process safety management standards and held a roundtable with small businesses to solicit feedback in 2017. In 2018, it launched a targeted inspection program to "address hazards from exposure to fertilizer-grade ammonium nitrate and agricultural anhydrous ammonium." In 2021, it moved the proposal from its long-term regulatory agenda to its short-term agenda.
Department of Labor	The Secretary of Labor should direct the Assistant Secretary for Occupational Safety and Health to extend OSHA's outreach to the fertilizer industry. For example, OSHA could work with the fertilizer industry to develop and disseminate informational materials related to storage of ammonium nitrate	Implemented

Endnotes

[1] The ammonia production capacity for fertilizer in the U.S. would rise from about 19.7 million metric tons per year to about 31.2 million metric tons per year if these projects are built. Among these three proposed expansions is the proposed restart and expansion of the Kenai Nitrogen plant in Alaska, which is currently closed but is proposing to re-open and expand.

[2] Based on an estimated 123,000 pounds of total nitrogen discharged by an average POTW. U.S. Environmental Protection Agency, "Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," September 2015. Link: https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric-envir_10-20-15.pdf.

[3] U.S. Environmental Protection Agency, "Enforcement and Compliance Online History (ECHO) database." Accessed April 13, 2023. Link: https://echo.epa.gov/

[4] 29 fertilizer plants had records available for air pollution and greenhouse gas emissions in 2021. Criteria emissions for one facility, the Dakota Gasification plant in Beulah, ND, are from 2018, the most recent data available.

[5] U.S Environmental Protection Agency, "Facility Level Information of Greenhouse Gases Tool, 2021 Greenhouse Gas Emissions from Large Facilities." Accessed April 13, 2023. Greenhouse gas emissions data is from the U.S. Greenhouse Gas Reporting Program and is presented in short tons (2,000 pounds), as expressed as carbon dioxide equivalents, CO2e. Link: https://ghgdata.epa.gov/ghgp/main.do?site_preference=normal

[6] U.S. Coast Guard, "National Response Center." Accessed March 23, 2023. Link: https://nrc.uscg.mil/

[7] Ibid.

[8] U.S. Chemical Safety Board, "West Fertilizer Explosion and Fire." January 28, 2016. Link: https://www.csb.gov/west-fertilizer-explosion-and-fire-/

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[14] National Oceanic and Atmospheric Administration, "Dead Zone in the Gulf of Mexico." Accessed March 28, 2023. Link: https://oceantoday.noaa.gov/deadzonegulf/#:~:text=Urban%20runoff%2C%20such%20as%20fertilizer,the%20Gulf%20that%20turns%20deadly.

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[29] Environmental Integrity Project, "Oil & Gas Watch database of public records and data." Link: https://oilandgaswatch.org/

[30] Among these three proposed expansions is the proposed re-opening and expansion of the Kenai Nitrogen plant in Alaska, which is currently closed but is proposing to re-open and expand. Permit applications and other public records compiled and available on EIP's Oil & Gas Watch database. Link: https://oilandgaswatch.org/

[31] The three other plants include: the production of urea at an existing Nutrien plant in Lima, OH (329,000 metric tons per year); the production of urea ammonium nitrate at the existing Koch Fertilizer plant in Fort Dodge, IA (35,000 metric tons per year); and the production of ammonium sulfate at the proposed new American Plant Food plant in Waggaman, LA (572,000 metric tons per year).

[32] This was with plants operating at 85 percent capacity. Source: U.S. Geological Society, "Mineral Commodity Summary- Nitrogen 2022" p.1, Link: https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-nitrogen.pdf, and "Mineral Commodity Summary- Nitrogen 2023" p. 1, Link: https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-nitrogen.pdf. Production adjusted by EIP to reflect ammonia production, not contained nitrogen. Ammonia, by weight, is 82 percent nitrogen.

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[39] By wastewater, we mean process wastewater in this report.

[40] The four facilities that inject their wastewater into wells are Nutrien in Borger, TX, LSB Industries in Pryor, OK, Dyno Nobel in Cheyenne, WY, and Dakota Gasification in Beulah, ND. Another plant, Koch Fertilizer in Fort Dodge, IA, sprays its process wastewater on cropland.

[41] Total nitrogen is a combination of nitrogen from ammonia, nitrate, nitrite, and organic nitrogen.

[42] Down to 2-8 mg/L nitrogen in wastewater.

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[47] Based on estimates from EPA database EJSCREEN v. 2.0, using the coordinates for the process wastewater outfalls and a 3-mile buffer.

[48] Federal rules currently allow new sources to discharge up to 0.055 pounds of ammonia for every 1,000 pounds of ammonia manufactured. Actual permitted levels may differ. Several proposed plants have permits that indicate that they will not discharge process wastewater. Many have not yet applied for water pollution control permits and information is not yet available about whether they will discharge process wastewater.

[49] One plant discharges to a waterway that has not been recently assessed for any designated uses.

[50] EIP's method for determining impaired waterways is based on outfall locations from permit documents and data available through ATTAINS for receiving waterways. It generated significantly different results than what was available through ECHO. For example, results from ECHO show that 16 (not 131) plants discharged to an impaired waterway, and 9 plants that discharged to waters impaired because of causes connected to eutrophication (algae, low dissolved oxygen, nutrients, ammonia, biological oxygen demand). Because of these differences, we encourage EPA to consider the accuracy of its methods for determining a point source category's impact on impaired waterways in its future analyses.

[51] The seven facilities reporting stormwater ammonia (as N) concentrations greater than 10 mg/L were LSB Industries, Inc.'s facilities In Cherokee, AL and El Dorado, AR; CF Industries Holdings, Inc.'s facility in Donaldsonville, LA; The Mosaic Company's facility in Faustina, LA; Nutrien Ltd.'s facility in Lima, OH; Yara Freeport LLC/BASF Freeport's facility in Freeport, TX; and AdvanSix Inc.'s facility in Hopewell, VA.

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