



EPA's 33/50 Program Company Profile

Monsanto



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EPA's 33/50 PROGRAM COMPANY PROFILES

This Company Profile is part of a series of reports being developed by EPA to highlight the accomplishments of companies participating in the 33/50 Program. The 33/50 Program is an EPA voluntary pollution reduction initiative that promotes reductions in direct environmental releases and offsite transfers of 17 high-priority toxic chemicals. The program derives its name from its overall goals — an interim goal of a 33% reduction by 1992 and an ultimate goal of a 50% reduction by 1995. The program uses 1988 Toxics Release Inventory (TRI) reporting as a baseline. In February, 1991, EPA began contacting the parent companies of TRI facilities that reported using 33/50 Program chemicals since 1988 to request their participation in the 33/50 Program. As of November, 1995, nearly 1,300 companies had elected to participate in the Program, pledging to reduce emissions of the 17 target chemicals by more than 380 million pounds by 1995. Companies set their own reduction targets, which may vary from the Program's national 33% and 50% reduction goals.

Industry exceeded the 33/50 Program's interim 33% reduction goal by more than 100 million pounds in 1992. National emissions of Program chemicals were reduced by an additional 100 million pounds in 1993, bringing total reductions since 1988 to more than 685 million pounds (46%). Facilities' TRI projections suggest that the Program's ultimate 50% reduction goal will be observed to have been achieved or exceeded in the 1994 TRI data, a full year ahead of schedule. The 1,300 companies enrolled in the 33/50 Program have accounted for most of the Program's pollution reductions. Representing just 15% of eligible companies and owning only a third of the facilities reporting Program chemicals to TRI, participants are responsible for 78% of the reductions since 1988 and 98% of the 100 million pounds reduced in 1993.

EPA is committed to recognizing companies for their participation in the 33/50 Program and for the emissions reductions they achieve. The Program issues periodic Progress Reports, in which participating companies are listed and highlighted. In addition, Company Profiles, such as this one, are being prepared to provide more detailed information about how companies have achieved their emissions reductions. Information presented in these profiles is drawn from a number of sources, including the company's written communications to the 33/50 Program, extensive interviews with company representatives, the annual TRI reports submitted by the company's facilities (including Pollution Prevention Act data reported to TRI in Section 8 of Form R), and, in many cases, site visits to one or more of the company's facilities. Mention of trade names, products, or services in this document does not convey, and should not be interpreted to convey, official EPA approval, endorsement, or recommendation.

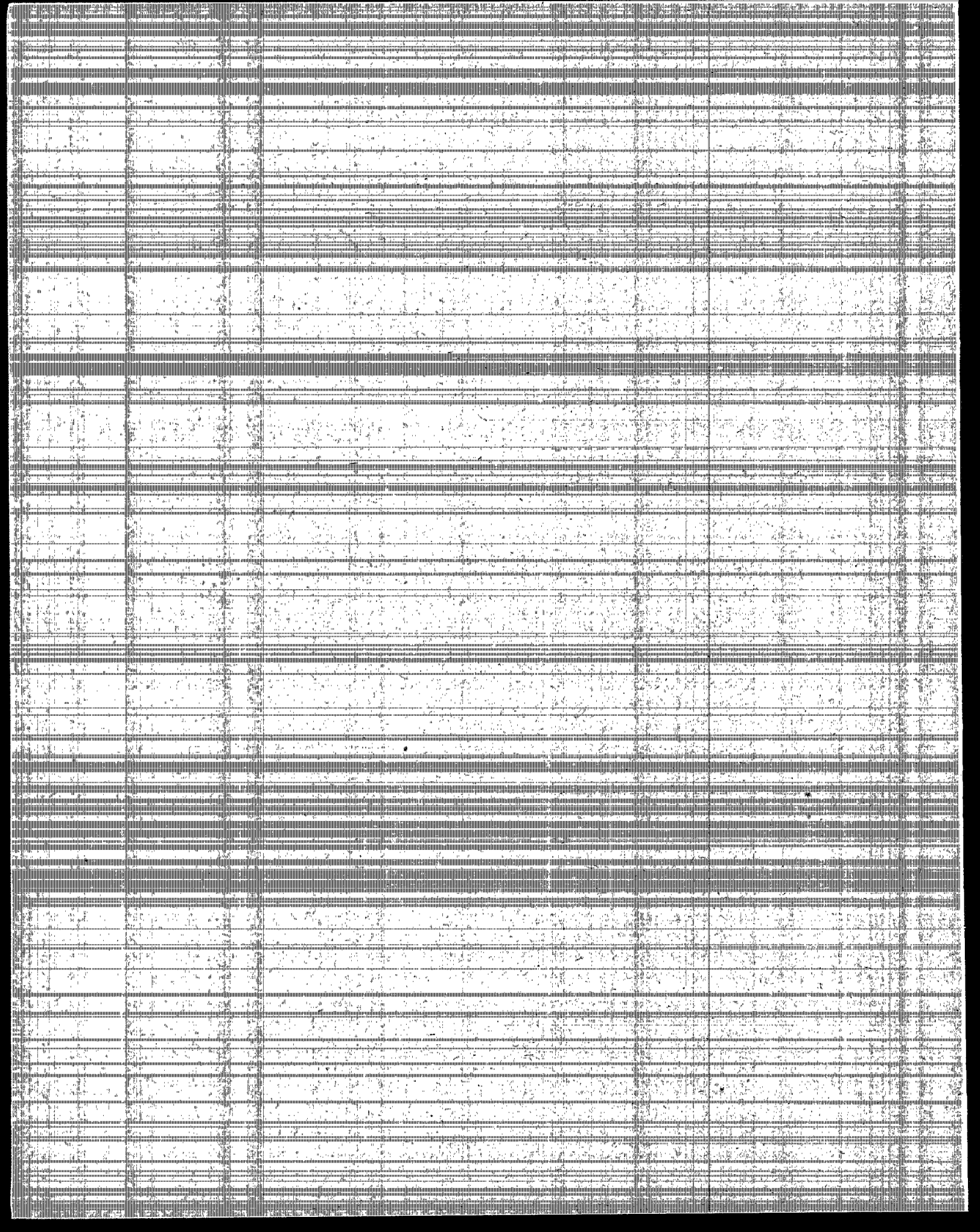
Copies of other 33/50 Program Company Profiles, as well as Reductions Highlights documents summarizing all of these Profiles, may be obtained by contacting the Program as specified in the box below. In addition, all written company communications to EPA regarding the 33/50 Program are available to the public upon request.

17 PRIORITY CHEMICALS TARGETED BY THE 33/50 PROGRAM

BENZENE
CADMIUM & COMPOUNDS
CARBON TETRACHLORIDE
CHLOROFORM
CHROMIUM & COMPOUNDS
CYANIDES
DICHLOROMETHANE*
LEAD & COMPOUNDS
MERCURY & COMPOUNDS
METHYL ETHYL KETONE
METHYL ISOBUTYL KETONE
NICKEL & COMPOUNDS
TETRACHLOROETHYLENE
TOLUENE
1,1,1-TRICHLOROETHANE
TRICHLOROETHYLENE
XYLENES

* Also referred to as methylene chloride

For information on the 33/50 Program, contact the TSCA Hotline at (202) 554-1404 or contact 33/50 Program staff directly by phone at (202) 260-6907 or by mail at Mail Code 7408, Office of Pollution Prevention and Toxics, U.S. EPA, 401 M Street, SW, Washington, D.C. 20460.



MONSANTO COMPANY

SUMMARY

Monsanto Company joined the 33/50 Program in May 1991 with a goal of reducing on-site releases of 33/50 Program chemicals from U.S. facilities by 50 percent by 1995, using 1988 as a baseline. Since then, Monsanto reduced releases of 33/50 Program chemicals by 66 percent from 2,567,783 pounds in 1988 to 865,629 pounds in 1993. Monsanto also reduced off-site transfers of 33/50 Program chemicals by 71 percent from 2,781,569 pounds in 1988 to 817,466 pounds in 1993.

In addition, Monsanto's Air Emissions Reduction Program aims at reducing air emissions of TRI chemicals from all facilities worldwide by 90

percent by the end of 1992, using 1987 as the baseline. This effort was successfully completed by the end of 1992, when a 90 percent reduction in air emissions was achieved. The Company also continues in a parallel effort to reduce multi-media releases and transfers of toxic chemicals from 338 million pounds in the 1990 base year to less than 100 million pounds by the end of 1995. This case study provides an overview of Monsanto's efforts to implement the 33/50 Program at its facilities in the U.S. It also highlights two projects — the reduction of xylene emissions through equipment upgrades and process redesign, and the reduction of toluene emissions using vapor balancing and steam stripping.

COMPANY BACKGROUND

Monsanto, a Fortune 100 Company based in St. Louis, Missouri, is the fourth largest chemical company in the United States. Founded in 1901 when Monsanto Chemical Works was established to manufacture saccharin, the Company now employs nearly 30,000 individuals worldwide at 33 major manufacturing locations. Monsanto manufactures and markets agricultural products, prescription pharmaceuticals, food ingredients, industrial chemicals, and performance chemicals used in consumer products. At the end of 1994, the Company was organized into the following four operating units or subsidiaries:

- The Chemical Group manufactures a range of high-performance materials including fibers, Saflex™ plastic interlayer, phosphorus and its derivatives, rubber and process chemicals, and plastics used to make consumer, household, automotive, and industrial products.

Monsanto

Monsanto manufactures and markets agricultural products, prescription pharmaceuticals, food ingredients, industrial chemicals, and performance chemicals used in consumer products.



The "Monsanto Pledge," drafted in 1992, provides a framework to guide Monsanto's environmental management efforts. It also sets a structure for continuously improving performance, protecting the safety of employees, and creating programs that demonstrate the Company's commitment to social responsibility.

- The Agricultural Group manufactures herbicides, lawn-and-garden products, and products enhanced by biotechnology to improve food production and preserve environmental quality in agricultural, industrial and residential markets.
- Searle, a wholly owned subsidiary of Monsanto, develops and markets prescription pharmaceuticals, including medications to treat infections, arthritis pain, high blood pressure, the formation of ulcers, and insomnia.
- The NutraSweet Company is also a wholly owned subsidiary of Monsanto and manufactures and markets sweeteners and other food ingredients, including NutraSweet™ sweetener, Equal™ and NutraSweet Spoonful™ brand tabletop sweeteners.

In addition to those mentioned above, some of Monsanto's well known brands include Roundup™ and Lasso™ herbicides, Ortho™ lawn-and-garden products, Wear-Dated™ carpet, and Calan™ calcium channel blocker. In 1993, Monsanto reported net sales of \$7.9 billion.

ENVIRONMENTAL STRATEGY

The "Monsanto Pledge," drafted in 1992, provides a framework to guide Monsanto's environmental management efforts. It also sets a structure for continuously improving performance, protecting the safety of employees, and creating programs that demonstrate the Company's commitment to social responsibility. The "Monsanto Pledge," as outlined in the Company's Environmental Annual Review, is to:

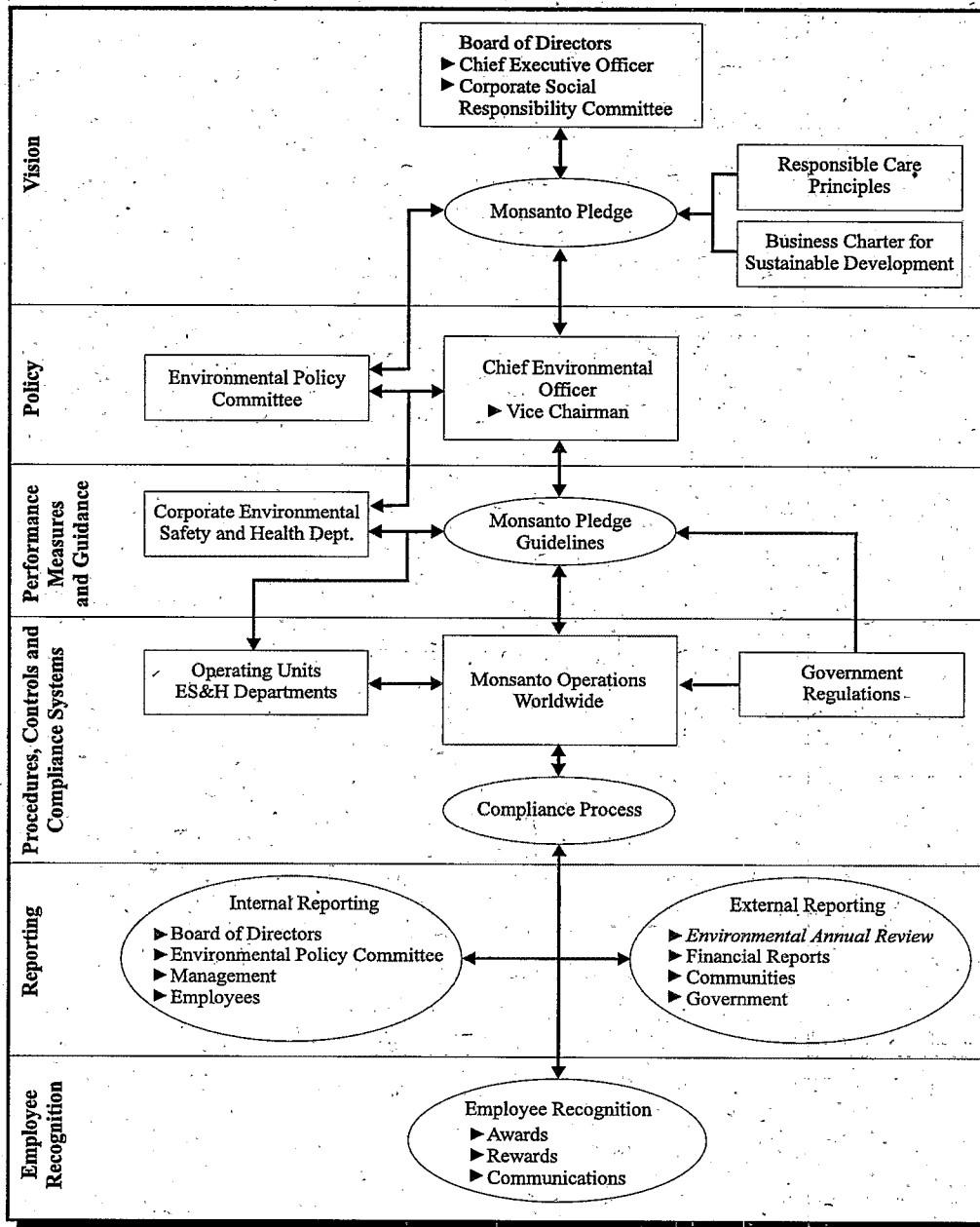
- "reduce all toxic and hazardous releases and emissions, working toward an ultimate goal of zero effect;
- ensure no Monsanto operation poses any undue risk to employees and communities;
- work to achieve sustainable agriculture through new technology and practices;
- ensure groundwater safety;
- maintain community safety awareness at manufacturing sites;
- manage all corporate real estate, including plant sites, to benefit nature; and
- search worldwide for technology to reduce and eliminate waste from operations, with emphasis on not generating waste in the first place."

The Company's environmental programs are specifically tailored to work within the Company's decentralized structure. Each operating unit and subsidiary is responsible for implementing a corporatewide environmental compliance model that ensures regulatory compliance and leads to the fulfillment of the Monsanto Pledge. Exhibit 1 illustrates the Company's Environmental Management System. Monsanto's environmental, safety, and health management system is overseen by the Corporate Social Responsibility Committee of the Board of Directors. The committee, which meets six times each year, is comprised of four outside directors. The committee reviews and monitors the Company's performance as it affects employees, communities, customers, and the environment, and recommends company policies for consideration when appropriate. Monsanto's environmental progress and plans are reviewed annually with the members of the Board of Directors.

An Environmental Policy Committee, headed by the Vice Chairman, monitors Monsanto's environmental policies and fulfillment of the Monsanto Pledge through a series of subcommittees. The Environmental Policy Committee is also responsible for establishing corporate environmental strategy, developing policy, and supporting continuous improvement

Exhibit 1

Monsanto's Environmental Management System



of environmental, safety and health performance. The Corporate Environmental, Safety and Health Department oversees issues at Monsanto relating to regulatory management, safety, toxicology, occupational medicine, quality assurance, and industrial hygiene. The department is responsible for conducting or overseeing periodic environmental, safety, and health audits to ensure compliance with company policy and procedures. Results of these evaluations are reported to corporate, operating unit, and subsidiary management. To oversee the implementation of Monsanto's environmental programs, each of the Company's four operating units and subsidiaries appoints individuals to accept primary responsibility for coordinating environmental operations. Monsanto has more than 1,100 employees at the corporate, operating group, and plant levels worldwide whose primary responsibility is work on environmental, safety, and health issues.

In 1990, Monsanto established a multi-media pollution prevention program that targets releases and transfers of toxic chemicals worldwide.

In early 1995, Monsanto announced a reorganization which led to the formation of 15 "Strategic Business Units (SBUs)," and the parallel reorganization of the Corporate Environmental Safety & Health Division. The SBUs were formed as the Company's business-directed profit centers to obtain business services (including those associated with environmental programs and compliance) from a corporate-wide Business Services function. Each Business Services group, one of which is the Corporate Environmental Safety & Health Division, provides its services to each of the 15 SBUs. The result of this reorganization will not affect the Company's environmental programs and goals, however it will allow the Corporate Environmental Safety & Health Division to manage its programs in a more cost-effective and responsive manner.

Reducing pollution is a primary goal in Monsanto's operations. In 1990, Monsanto established a multi-media pollution prevention program that targets releases and transfers of toxic chemicals worldwide. The goal of this program is to reduce toxic chemical (defined by the Company as those chemicals included in the TRI) releases and transfers worldwide to less than 100 million pounds per year by the end of 1995, using 1990 releases and transfers of TRI chemicals as the baseline. As 1990 releases and transfers of these chemicals worldwide were 337.7 million pounds, this program represents a reduction goal of just over 70 percent.

Monsanto also initiated a program targeted at reducing air emissions of toxic chemicals from all plants worldwide by 90 percent by the end of 1992, using 1987 as a baseline. In the United States, the program defines toxic chemicals as those included in the TRI, while for plants in other countries, the program includes TRI chemicals as well as other chemicals designated locally as chemicals of concern. As of the end of 1992, Monsanto had achieved a worldwide reduction of approximately 90 percent, a significant portion of which can be attributed to the closure of a manufacturing unit in Newport, Wales, United Kingdom, where large amounts of carbon monoxide and butane (locally designated chemicals of concern) were emitted. In the United States, Monsanto achieved a reduction of 85 percent as part of this program.

In addition to participating in the 33/50 Program, selected Monsanto plants also participate in the U.S. EPA's Green Lights and WasteWi\$e voluntary programs.

In addition to participating in the 33/50 Program, selected Monsanto plants also participate in the U.S. EPA's Green Lights and WasteWi\$e voluntary programs. The company has won a number of awards for its environmental programs, both on the national and state level. Monsanto received the Honor Roll Award from the Isaak Walton League in 1990 for its efforts to protect the environment. Monsanto also received the Honor Roll Award in 1992 from the National Environmental Development Association. This award was given to companies for "effective management of environmental quality, protection and enhancement of natural resources, and/or promotion of environmental responsibility both inside and outside the organization." The following is a list of some of the awards received by Monsanto facilities at the state level:

Ohio: Recognition for past and continuous commitment to reduce air emissions, awarded by the Governor of Ohio in 1993.

Massachusetts: The 1991 Outstanding Award for Achievement in the Protection of the Environment and the Preservation of Open Space.

Tennessee: Excellence in Environmental Cleanup Award, given by the Tennessee Association of Business in 1989.

Illinois: First Annual Environmental Citizenship Award, received in 1991.

Michigan: The 1993 Environmental Quality Award from the Michigan Chamber of Commerce.

Florida: Take Pride in Florida Award, for sponsorship of "Environmental Classroom" in 1992.

Monsanto's expenditures in 1993 were approximately \$53 million for environmental capital projects and approximately \$233 million for management of environmental programs, including the operation and maintenance of facilities for environmental control. Monsanto estimates that during 1994 and 1995 approximately \$40 to \$70 million per year will be spent on additional capital projects for environmental protection.

OVERVIEW OF 33/50 AND TRI CHEMICAL RELEASES AND TRANSFERS

In 1988, Monsanto reported releases and transfers of thirteen 33/50 Program chemicals from 27 manufacturing facilities in the U.S. In that year, Monsanto reported a total of 295,062,815 pounds of releases and transfers of all TRI chemicals. Of this total, 5,349,352 pounds were 33/50 Program chemicals. Monsanto's releases and transfers of 33/50 Program chemicals for 1988 and 1993 are shown in Exhibit 2. Additional detail is provided in Appendices A through D. The following is a list of 33/50 chemicals used at Monsanto's facilities and their source of emissions:



Exhibit 2

*Releases and
Transfers of
TRI Chemicals
(1,000 pounds)*

MONSANTO'S RELEASES AND TRANSFERS OF TRI CHEMICALS

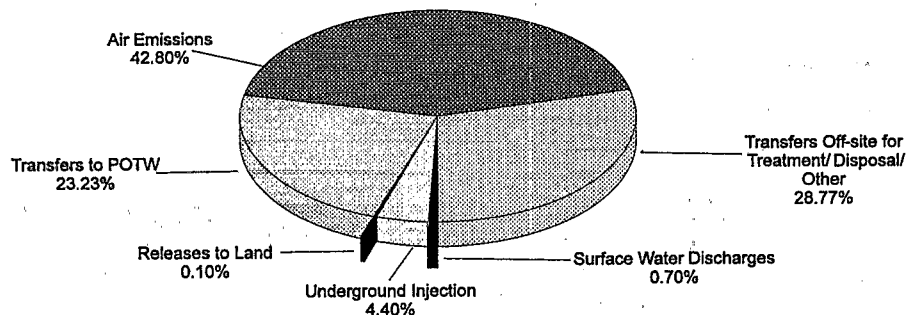
<u>33/50 Chemicals (1,000 lbs.)</u>	<u>1988</u>	<u>1993</u>
Benzene	800	139
Cadmium & Compounds	26	23
Chloroform	<1	NR
Dichloromethane	128	321
Hydrogen Cyanide	81	181
Methyl Ethyl Ketone	75	219
Methyl Isobutyl Ketone	557	74
Nickel & Compounds	11	9
Tetrachloroethylene	530	NR
Toluene	843	314
1,1,1-Trichloroethane	135	NR
Trichloroethylene	237	2
Xylene	1,925	402
33/50 Subtotal*	<u>5,349</u>	<u>1,683</u>
Other TRI Chemicals	289,713	81,223
Total*	295,063	82,906

NR = Not reported, use below reporting threshold

* Columns may not sum to total due to rounding

Exhibit 3

Percentage Breakdown of 33/50 Program Chemical Releases and Transfers for 1988 (by Media)



Benzene is primarily used as a building block chemical in several processes. Almost half of the chemical releases and off-site transfers were transfers to a POTW with large amounts also released as air emissions. Small quantities of benzene were also injected underground or released to land.

Cadmium & cadmium compounds are used in metal plating processes to increase resistivity and provide resistance against corrosion. They were primarily transferred off-site for treatment or disposal.

Chloroform was used as a solvent and was released as air emissions and transfers to a POTW.

Dichloromethane is used as a solvent. Large quantities of the chemical were injected underground, with the remainder released as air emissions.

Hydrogen cyanide is used as a building block chemical in the production of several chemical intermediates. The majority is injected underground, and small quantities are released as air emissions.

Methyl ethyl ketone (MEK) is primarily used as a solvent in several processes. Large quantities are transferred to a POTW, with small amounts transferred off-site, and the remainder released through underground injection and air emissions.

Methyl isobutyl ketone (MIK) is also used as a solvent in several processes. Large quantities of the chemical were transferred off-site, with smaller quantities transferred to a POTW, released as air emissions, and injected underground.

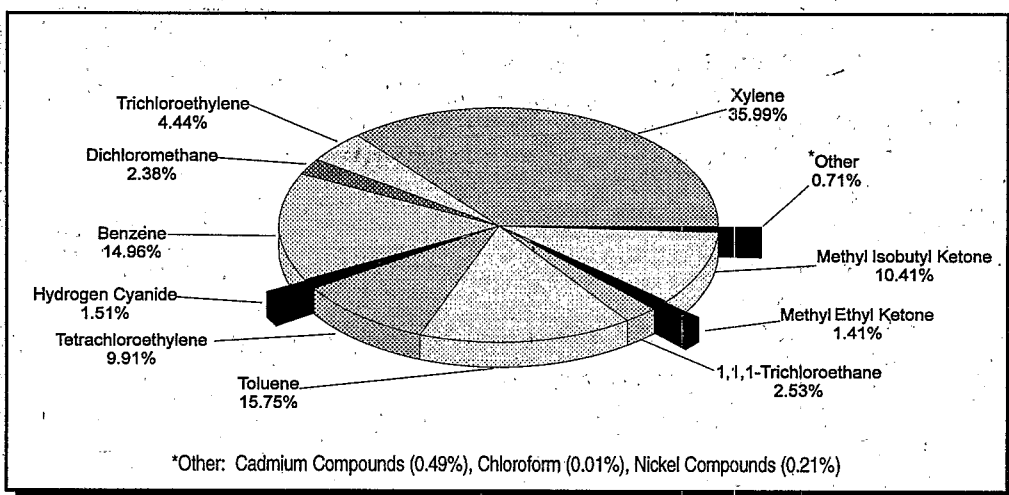
Nickel & nickel compounds are present in metal alloys and are used in plating processes to provide resistance against corrosion. Most nickel is injected underground, however small quantities are discharged to surface water or released to land. Nickel compounds were released to land and discharged to surface water.

Tetrachloroethylene was used as a solvent, and was primarily released as air emissions, with small quantities transferred off-site, and the remainder transferred to a POTW.

In 1988, Monsanto reported releases and transfers of thirteen 33/50 Program chemicals from 27 manufacturing facilities in the U.S.

Exhibit 4

*Percentage Breakdown
of 33/50 Program
Chemical Releases
and Transfers for 1988
(by Chemical)*



Toluene is used as a solvent and as an extractant to remove impurities from chemical manufacturing processes. Toluene is primarily transferred off-site, with large quantities also released as air emissions. Small quantities were discharged to surface water and transferred to a POTW.

1,1,1-Trichloroethane (TCA) was used as a solvent, and the majority of releases of the chemical were to the air, with small quantities transferred off-site.

Trichloroethylene was also used as a solvent, and was primarily released as air emissions, with small amounts transferred off-site.

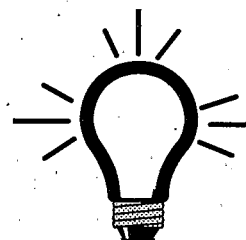
Xylene is used as a carrier solvent in the production of rubber chemicals. It is primarily released as air emissions, with large quantities of the chemical also transferred to a POTW, and the remainder transferred off-site.

Exhibits 3 and 4 illustrate 1988 releases and transfers of 33/50 Program chemicals by release media and by chemical, respectively. In 1988, of the total air emissions of 33/50 chemicals, xylene emissions accounted for 35 percent, tetrachloroethylene accounted for 19 percent, and toluene made up 15 percent. Of total off-site transfers, 19 percent were methyl isobutyl ketone, 17 percent were toluene, and 40 percent were xylene.

33/50 PROGRAM GOALS AND REDUCTION PROJECTS

Monsanto joined the 33/50 Program in May 1991, at which time the company set a goal of reducing on-site releases of 33/50 Program chemicals from U.S. facilities by 50 percent by 1995, using 1988 as a baseline. Since 1988 releases of 33/50 chemicals were 2,567,783 pounds, this translates to a targeted reduction of 1,283,891 pounds by 1995. Monsanto limited its 33/50 Program goal to on-site releases because of the uncertainty of the impact of RCRA waste combustion rules, which imposed requirements that could cause the Company to switch from on-site combustion to off-site combustion and disposal of wastes. The remainder of this section describes two projects that resulted in significant reductions of on-site releases of 33/50 Program chemicals:

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1

Project #1: Krummrich 4-nitrodiphenylamine (4NDPA) Xylene Emission Reduction Program

The W.G. Krummrich Plant, located in Sauget, Illinois, is one of the largest Monsanto manufacturing sites supporting the Chemical Group. It produces a variety of chemical intermediates, including: paradichlorobenzene, a component of mothballs and bathroom cleaners; rubber chemicals, used in the production of tires and other rubber products; phosphorus pentasulfide, used in motor oils to prevent corrosion; monochlorobenzene, used in LassoTM herbicide; and orthonitroaniline, which is used in Monsanto's SafflexTM glass coating.

In 1988, Monsanto made a voluntary pledge to reduce its TRI-reported air emissions by 90 percent by the end of 1992 from a 1987 baseline. This pledge, coupled with the company's participation in the 33/50 Program beginning in 1991, led engineers at the Krummrich plant to assess methods of reducing releases of xylene, among other chemicals, from the plant. Prior to 1988, no major efforts had been made to reduce xylene use, primarily because of the low cost of the chemical, the complexity of the process, and a greater emphasis at the time on wastewater reduction and treatment projects.

Ninety percent of the xylene air emissions at the Krummrich plant are generated by the 4NDPA Department. This department, which opened in the early 1960's, produces 4-nitrodiphenylamine (4NDPA). 4NDPA is not sold by Monsanto, but is an intermediate ingredient used in making additives used in rubber products like tires and hoses. Xylene is used as a carrier solvent in the manufacture of 4NDPA, but it is not consumed in the manufacturing process. In 1987, the 4NDPA Department at the Krummrich plant reported 831,000 pounds of air emissions of TRI chemicals, primarily xylene. However, sampling and tests carried out in 1991 indicated that the 1987 baseline may have been underestimated by approximately 300,000 pounds of additional xylene. It was clear from the onset that the Krummrich 4NDPA Department's air emissions reduction program was critical to the Rubber Chemicals Division, as well as the entire Company, in ensuring that they would be able to meet Monsanto's public pledge of a 90 percent TRI air emissions reduction.

The 4NDPA Department plant and process engineers followed Monsanto's three-tiered priority approach to achieve reductions in air emissions of TRI chemicals — reduce, recycle, treat.

The 4NDPA Department plant and process engineers followed Monsanto's three-tiered priority approach to achieve reductions in air emissions of TRI chemicals — reduce, recycle, treat. The first tier included a number of xylene reduction projects, all of which included supplemental benefits of cost reductions and/or process improvements. Some of the projects undertaken to reduce the usage of xylene included the following:

- **Nitrogen system upgrades** — The 4NDPA Department maintains approximately 30 nitrogen blanketing systems that were installed at various times over the last few decades. In order to reduce xylene emissions from these systems, old units were replaced and the new systems were installed in such a way as to allow for easier troubleshooting, identification of leaks, and repairs. These upgrades resulted in approximately 200,000 pounds of xylene emissions reductions.
- **Centrifuge replacement project** — The centrifuge used by the 4NDPA Department was 25 years old and had significant mechanical reliability problems associated with its use which resulted in preventable xylene emissions. This centrifuge was replaced with a new unit that was designed with special features aimed

at achieving a better seal, thereby reducing xylene emissions. The replacement project accounted for a 200,000 pound reduction in xylene emissions.



- **Melt tank and screw conveyor replacement** — During the 4NDPA production process, the centrifuge discharge was moved directly to a melt tank for further processing. In the past, the discharge was transported between the centrifuge and the melt tank using a screw conveyor. This process resulted in significant xylene emissions as the process was not tightly sealed. When it was necessary to replace the melt tank, the new tank was placed directly beneath the centrifuge, thereby eliminating the need to transport discharge using the screw conveyor. Due to their new proximity to one another, the centrifuge and melt tank were connected using a tightly sealed chute. This process change resulted in a 95,000 pound reduction in xylene emissions.
- **Agitator seal replacement project** — An agitator system used to mix products during an intermediate processing step was difficult to maintain properly and resulted in significant xylene emissions through a seal at the top of the tank. Engineers replaced the agitator system with a new pump and recirculation system that mixes tank contents by pumping material from the bottom of the tank to the top of the tank on a continuous basis. This new system has no seal at the top to allow leakage and has resulted in xylene emissions reductions of 70,000 pounds.

Four additional first tier projects in the 4NDPA Department resulted in reductions ranging from 2,000 to 25,000 pounds, and totalling 52,000 pounds. Therefore, reductions in xylene air emissions achieved from first tier projects alone totalled more than 600,000 pounds. Implementing these first tier projects required a total capital expenditure of \$1.7 million, which yielded an average return on capital of 20 percent.

The second tier projects focused on the capture and recycling of xylene air emissions. They consisted primarily of smaller projects to link tank vents and install additional condensers. In total, these projects resulted in a 160,000 pound reduction in xylene air emissions in the 4NDPA Department.

After reducing the use of xylene and recycling xylene to the maximum extent possible through the first and second tier projects, the 4NDPA Department at Krummrich undertook a third tier project to destroy remaining xylene vapors generated in the manufacturing process. This project involved the installation of a thermal oxidizer in January 1993, which has resulted in a reduction in xylene air emissions of 180,000 pounds.

Underlying all three tiers of the xylene air emissions reduction program was the need for increased levels of preventive and routine maintenance on all equipment to prevent leakage. As a result of this increased maintenance, and the completion of the various reduction, recycling, and treatment projects, the 4NDPA Department at Monsanto's Krummrich plant was successful in reducing xylene air emissions by almost 1,000,000 pounds. In addition, the Department achieved these reductions during a period in which production increased dramatically. During this increase, plant expansions included measures that would allow for further reductions in xylene air emissions.

As a result of increased maintenance, and the completion of the various reduction, recycling, and treatment projects, the 4NDPA Department at Monsanto's Krummrich plant was successful in reducing xylene air emissions by almost 1,000,000 pounds.

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The vapor balancing technique required all tank vents to be tied together and consolidated to one common vent.

Implementing the vapor balancing process, which required piping reinforcements, new agitator seals, and new seal-less pumps, required a total capital investment of \$1,000,000.

Project #2: Reduce Toluene Emissions and Recycle Toluene at a facility in Nitro, West Virginia using Vapor Balancing and Steam Stripping

The facility located in Nitro, West Virginia manufactures chemicals used in the fabrication of rubber tires. The principal chemicals produced are sulfenamides, which are accelerators used to speed up the vulcanization process in the production of rubber chemicals. The vulcanization process is a nonreversible chemical reaction involving the use of sulphur compounds or other suitable catalysts to increase the elasticity of rubber. Sodium 2-Mercaptobenzothiazole (NaMBT), a primary raw material used in the production of sulfenamides is also made at the Nitro plant. During the intermediate stages of the manufacturing process, toluene is used to extract impurities from NaMBT. Prior to process changes, toluene vapors were released from tank vents, and in 1988 the Nitro facility reported 135,000 pounds of toluene air emissions.

In order to reduce these emissions, and also recycle toluene for reuse, plant engineers and personnel from the Environmental Safety & Health Department came together to propose ideas for process modifications. The first step in the process reconfiguration was to determine the extent to which toluene was used in the process. An inventory of chemical use at the facility listed annual toluene usage at 300,000 pounds. The plant engineers considered using individual brine cooled condensers on each tank to reduce toluene air emissions. Because implementing such a system involved very high costs, however, this technique was ruled out.

Engineers decided to use an approach known as vapor balancing to reduce toluene emissions and to recycle toluene by steam stripping. The NaMBT production process at the Nitro facility is comprised of a number of tanks and vessels which include mixers, dissolvers, and storage tanks. The vapor balancing technique required all tank vents to be tied together and consolidated to one common vent. In a closed vent system, when liquid from one tank flows into another tank, the vapor displaced by incoming liquid flows back to the first tank to fill the volume created by emptying it. In this manner the total pressure in all tanks is balanced at the common vent, and toluene vapor is contained within the closed vent system. Any vapor that is not balanced in the common vent is vented through a brine cooled condenser, resulting in no significant solvent loss from the vapor balancing process.

The vapor balancing project also included upgrading old agitator seals on tanks with new double mechanical seal agitators to prevent the leakage of toluene vapors from tanks in the production process. Old pumps in the process were also replaced with seal-less pumps, or were fitted with double mechanical seals.

Because vapor balancing is a closed-loop system, fire safety considerations become extremely important. Should an explosion or fire occur from excessive pressure build up in one tank, the common vent could potentially act as a conduit for flames, and could cause a chain reaction throughout the entire system. To prevent such hazards from occurring, the system was installed with detonation arrestors in three or four places on the vent nozzles of tanks. The detonation arrestors, while maintaining an equilibrium pressure in the entire vent system, also act as safety devices in the event of a fire or explosion hazard. Implementing the vapor balancing process, which required piping reinforcements, new agitator seals, and new seal-less pumps, required a total capital investment of \$1,000,000.



With the adoption of vapor balancing to address toluene emissions, the plant engineers could now evaluate alternative technologies that would recycle toluene for reuse. From previous experience at a Monsanto facility in Antwerp, Belgium, the project engineers considered separating chemicals using steam stripping. After toluene is used in the manufacturing process to remove impurities from NaMBT, a mixture of NaMBT and toluene is stored in an extraction chamber. The steam stripping process involves separating toluene from NaMBT using the "flash separation" technique. "Flash separation" is a common operation employed to separate and partially enrich a vapor-liquid mixture. It occurs simply and spontaneously when a fluid passes through a pipeline restriction (usually a throttling valve) — the pressure drops, and vaporization of the toluene occurs. At this stage the toluene separates from NaMBT. The NaMBT is returned to product storage and the toluene is passed through a condenser to a distillate tank. A distillate pump transfers the toluene into two tanks in the main manufacturing process where it is reused. For safety purposes, and prevention against fire, all flat bottom tanks and condenser outlets are nitrogen inerted (oxygen is displaced with nitrogen), and all tank vents entering the condenser header are fitted with flame arrestors.

Although most of the toluene is recovered in the steam stripping process, about 12 pounds/day of toluene is lost to a vent header from the stripper condenser. Implementing the steam stripping process required a total capital investment of \$300,000. The annual raw material savings as a result of toluene recovery amounts to approximately \$30,000.

Following the implementation of the vapor balancing and steam stripping processes in September 1992, the plant reported 22,600 pounds of toluene air emissions in 1993. This translates to over a 90 percent reduction in toluene air emissions from 1991 levels. Vapor balancing accounted for approximately 65 percent of this reduction and steam stripping accounted for approximately 25 percent. The remaining 10 percent of total reductions was accomplished by plugging leaks using seal-less pumps and mechanical agitator seals.

Implementing the steam stripping process required a total capital investment of \$300,000. The annual raw material savings as a result of toluene recovery amounts to approximately \$30,000.

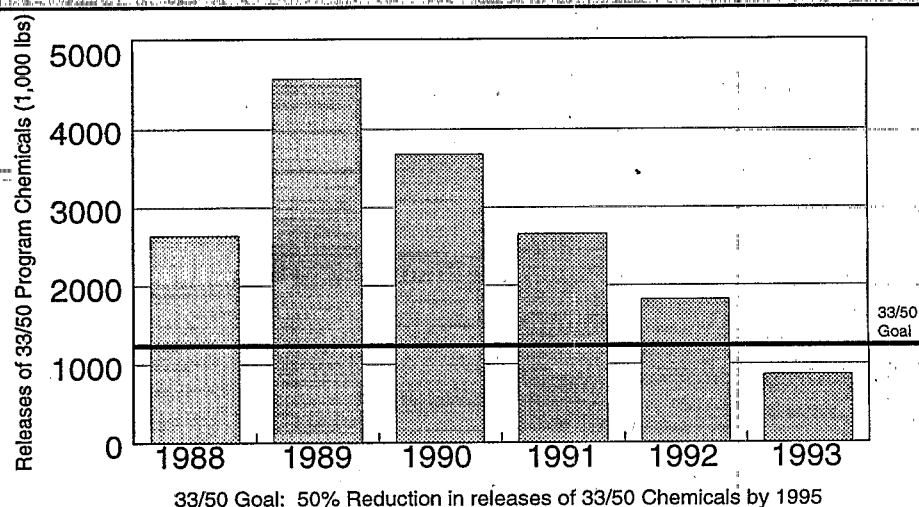
Other Projects:

In addition to the above mentioned projects Monsanto also achieved reductions through many others, including the following projects:

- Use of an Aqueous-Clean-In-Place system, using high pressure water sprays as an alternative to solvent use in cleaning operations. This cleaning system is currently used at a Searle Pharmaceuticals plant to clean reactor tanks, and has reduced toxic air emissions by 87 percent and liquid wastes by 71 percent.
- The use of a cyclone separator to reduce toxic chemical air emissions from manufacturing processes. The separator captures the chemical in a powerful vortex and recycles the chemical into the manufacturing process. By installing this new system, Monsanto's Ruabon plant in Wales, England eliminated more than 121,000 pounds in trichloroethylene emissions.

Exhibit 5

Monsanto's Progress Towards Meeting 33/50 Goals



33/50 PROGRESS

Monsanto was successful in reaching its 33/50 Program goal of a 50 percent reduction in releases of 33/50 Program chemicals two years ahead of schedule, and as of 1993 had achieved a 66 percent reduction. Exhibit 5 illustrates these reductions, and Exhibits 6 and 7 illustrate Monsanto's 1993 releases and transfers of 33/50 chemicals by release media and by chemical, respectively. The major contributors to Monsanto's success include the reductions of the following chemicals:

Benzene	-	255,083 pounds (74 percent reduction)
Toluene	-	323,606 pounds (87 percent reduction)
Trichloroethylene	-	236,260 pounds (100 percent reduction)
Xylene	-	644,694 pounds (80 percent reduction)

Monsanto achieved and exceeded its 33/50 Program goals largely as a result of its voluntary program to reduce air emissions of all TRI chemicals by 90 percent worldwide by the end of 1992. Also, the Company's achievement towards meeting its multimedia goal by the end of 1995 provided an incentive to focus on reducing releases to all media besides air emissions. Exhibit 8 shows releases and transfers of all TRI Chemicals from 1988 to 1993.

Exhibit 6

Percentage Breakdown of 33/50 Program Chemical Releases and Transfers for 1993 (by Media)

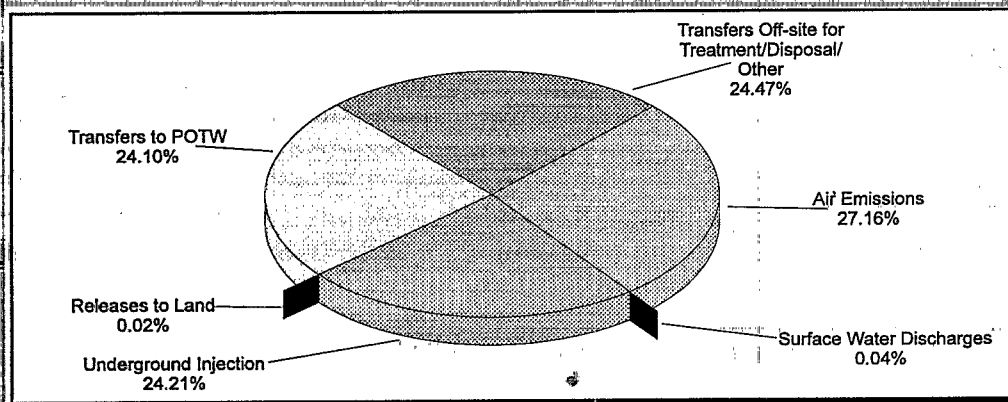
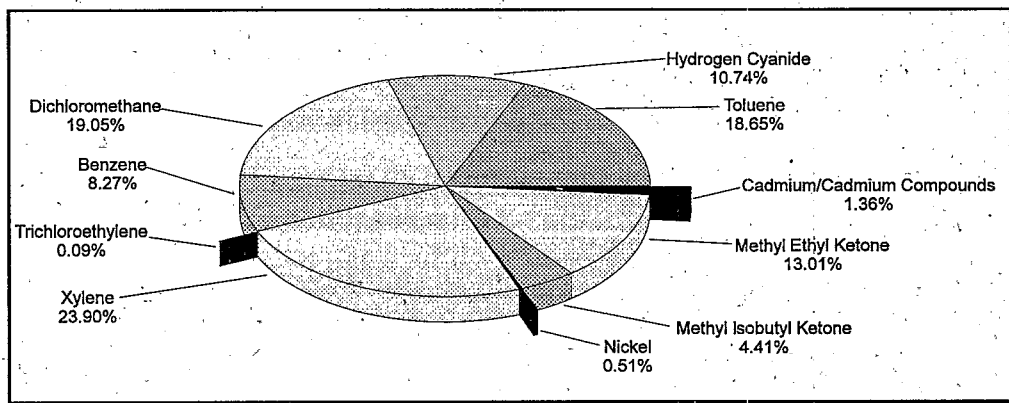


Exhibit 7

*Percentage
Breakdown of 33/50
Program Chemical
Releases and
Transfers for 1993
(by Chemical)*



FUTURE EFFORTS

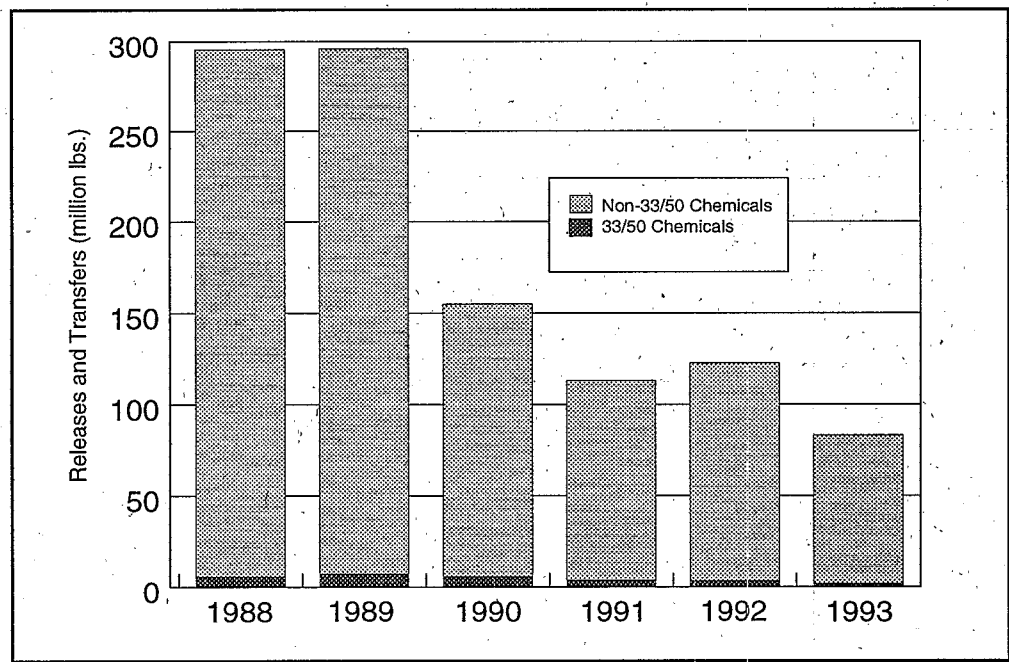
Monsanto plans to reduce the releases and transfers of TRI chemicals from all its facilities worldwide to 100 million pounds by the end of 1995, using 1990 releases and transfers of TRI chemicals as the baseline. In addition, the company is continuing the Air Emission reduction program with a goal of further reducing air emissions to zero. In collaboration with the University of Tennessee, Monsanto is also working to design algorithms and methodologies used in an "effects model" to prioritize the strategy of reducing emissions and off-site transfers of toxic chemicals in industry. These priorities are based on risk and not on the quantity of chemical used. Using this as a basis, 33/50 chemicals would be considered in the risk algorithm, however the quantity released would not be the primary issue of concern.

While effects and potential risk are primary indicators used in the model, cost effectiveness of the project is also an important factor in evaluating alternative projects with differing costs. The "effects model" will also be used to shape Monsanto's corporate goals, which will guide the Company's environmental efforts after the current multi-media goal program has been completed.



Exhibit 8

*Releases and Transfers
of all TRI Chemicals*





CONTACT FOR FURTHER INFORMATION

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Appendix A
Monsanto Company
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers Off-site for Treatment/Disposal/Other (pounds)	Total Releases and Transfers (pounds)	Percent Change 1988-1993 Total Releases and Transfers
Benzene	1988	252,900	3	91,000	2,200	440,170	13,990	800,263	
	1989	286,400	0	99,000	4,000	410,160	11,990	811,550	
	1990	200,300	0	71,000	7,400	150,160	47,393	476,253	
	1991	158,750	0	71,000	0	173	22,135	252,058	
	1992	60,160	0	32,000	220,000	4,500	105,740	422,400	
	1993	55,020	0	36,000	0	310	47,800	139,130	-83%
Cadmium	1988	0	0	0	0	0	7,600	7,600	
	1989	0	0	0	0	0	9,500	9,500	
	1990	0	0	0	0	0	8,600	8,600	
	1991	0	48	0	48	0	1,800	1,896	
	1992	0	39	0	39	0	2,100	2,178	
	1993	0	59	0	59	0	3,100	3,218	-58%
Cadmium compounds	1988	12	64	0	66	0	18,244	18,386	
	1989	11	65	0	13	0	24,185	24,274	
	1990	11	73	0	13	0	19,643	19,740	
	1991	8	9	0	0	0	16,676	16,693	
	1992	6	10	0	0	0	18,700	18,716	
	1993	2	4	0	0	0	19,730	19,736	7%
Chloroform	1988	500	0	0	0	250	0	750	
Chromium compounds	1990	222	0	0	120	0	0	342	
Dichloromethane	1988	46,300	0	81,000	0	250	0	127,550	
	1989	76,697	0	88,000	0	250	0	164,947	
	1990	64,600	0	270,000	0	500	0	335,100	
	1991	56,900	0	270,000	0	0	0	326,900	
	1992	58,100	0	250,000	0	0	0	308,100	
	1993	151,900	0	160,000	0	0	8,800	320,700	151%

Appendix A
Monsanto Company
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers for Treatment/Disposal/Other (pounds)	Total Releases and Transfers (pounds)	Percent Change 1988-1993 Total Releases and Transfers
Hydrogen cyanide	1988	26,000	0	55,000	0	0	0	81,000	
	1989	30,500	0	1,800,000	0	0	0	1,830,500	
	1990	15,500	0	960,000	0	0	0	975,500	
	1991	2,900	0	390,000	0	0	0	392,900	
	1992	1,620	0	200,000	0	0	0	201,620	
	1993	10,700	0	170,000	0	0	0	180,700	123%
Lead	1989	1	2	0	240	0	0	243	
Mercury compounds	1989	2	4	0	0	0	0	6	
	1990	2	1	0	0	0	46	49	
	1991	2	1	0	0	0	320	323	
Methyl ethyl ketone	1988	6,670	39	0	0	11,750	56,750	75,209	
	1989	4,500	36	53,000	0	18,800	50,401	126,737	
	1990	17,840	19	53,000	0	250,000	44,180	365,039	
	1991	20,110	73	53,000	0	272,000	19,959	365,142	
	1992	10,924	38	38,000	0	212,000	73,056	334,018	
	1993	2,795	120	32,000	0	160,000	24,076	218,991	191%
	1988	14,614	0	1,400	0	41,000	500,000	557,014	
Methyl isobutyl ketone	1989	15,033	0	1,600	0	64,000	36,000	116,633	
	1990	31,605	0	1,300	0	160,000	53,000	245,905	
	1991	33,336	0	1,600	0	38,000	74,000	146,936	
	1992	31,336	0	1,600	0	48,000	78,500	159,436	
	1993	20,631	0	1,600	0	35,000	17,000	74,231	-87%
	1988	0	0	7,100	0	0	0	7,100	
	1989	0	0	14,000	0	0	0	14,000	
Nickel	1990	10	260	6,100	0	110	0	6,480	
	1991	0	540	3,100	250	0	0	3,890	
	1992	0	493	5,200	260	0	0	5,953	
	1993	0	490	7,800	340	0	0	8,630	22%

Appendix A
Monsanto Company
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers Off-site for Treatment/Disposal/Other (pounds)	Total Releases and Transfers (pounds)	Percent Change 1988-1993 Total Releases and Transfers
Nickel compounds	1988	0	1,100	0	2,929	0	1	4,030	
	1989	0	1,100	0	30	0	1	1,131	
	1990	0	1,100	0	30	0	1	1,131	
Tetrachloroethylene	1988	439,000	0	0	0	14,000	77,100	530,100	
	1989	338,000	0	0	0	34,000	35,000	407,000	
	1990	308,000	0	0	0	95,000	28,000	431,000	
	1991	63,006	0	0	0	0	9,700	72,706	
* Toluene	1988	351,691	22,000	0	150	3,005	465,717	842,563	
	1989	449,833	22,000	0	150	3,505	691,873	1,167,361	
	1990	386,868	34,000	0	160	997	399,178	821,203	
	1991	406,355	3	0	0	1,541	134,825	542,724	
	1992	85,685	3	0	0	722	375,667	462,077	
	1993	50,232	3	0	0	236	263,455	313,926	-63%
1,1,1-Trichloroethane	1988	119,200	17	0	0	0	16,100	135,317	
	1989	171,600	140	0	0	24	7,800	179,564	
	1990	203,000	0	0	0	0	0	203,000	
	1991	180,000	0	0	0	0	0	180,000	
	1992	128,000	0	0	0	0	0	128,000	
	1993	0	0	0	0	0	0	0	
Trichloroethylene	1988	235,930	330	0	0	0	1,100	237,360	
	1989	287,240	420	0	0	0	9,700	297,360	
	1990	81,040	72	0	0	0	2,780	83,892	
	1991	42,400	0	0	0	0	6,100	48,500	
	1992	23,000	0	0	0	0	3,700	26,700	
	1993	0	0	0	0	0	1,570	1,570	-99%
Xylene (mixed isomers)	1988	796,550	14,018	0	0	732,001	382,541	1,925,110	
	1989	736,480	16,017	0	0	599,000	362,685	1,714,182	
	1990	844,970	13,014	0	0	271,300	139,691	1,268,975	
	1991	836,550	23	0	0	145,300	45,940	1,027,813	
	1992	634,177	11	0	0	150,049	47,474	831,711	
	1993	165,873	1	0	0	210,049	26,340	402,263	-79%

Appendix A
Monsanto Company
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers		Percent Change 1988-1993
							Off-site for Treatment/Disposal/Other (pounds)	Total Releases and Transfers (pounds)	
33/50 Program Chemicals									
	1988	2,289,367	37,571	235,500	5,345	1,242,426	1,539,143	5,349,352	
	1989	2,396,297	39,784	2,055,600	4,433	1,129,739	1,239,135	6,864,988	
	1990	2,153,968	48,539	1,361,400	7,723	928,067	742,512	5,242,209	
	1991	1,800,317	697	788,700	298	457,014	331,455	3,378,481	
	1992	1,033,008	594	526,800	220,299	415,271	704,937	2,900,909	
	1993	457,153	677	407,400	399	405,595	411,871	1,683,095	-69%
All Non 33/50 TRI Chemicals									
	1988	14,605,825	5,420,662	231,061,672	406,296	33,765,883	4,453,125	289,713,463	
	1989	10,670,132	5,088,078	231,184,878	319,091	36,746,123	4,861,707	288,870,009	
	1990	7,566,525	1,733,038	85,516,972	79,261	48,332,517	6,060,092	149,288,405	
	1991	6,183,591	2,107,217	65,361,537	84,260	29,233,217	6,216,863	109,186,685	
	1992	6,577,238	2,492,023	65,580,380	65,707	39,183,654	5,297,773	119,196,775	
	1993	4,460,379	1,472,726	48,123,258	132,960	21,579,505	5,454,011	81,222,839	-72%
All TRI Chemicals									
	1988	16,895,192	5,458,233	231,297,172	411,641	35,008,309	5,992,268	295,062,815	
	1989	13,066,429	5,127,862	233,240,478	323,524	37,875,862	6,100,842	295,734,997	
	1990	9,720,493	1,781,577	86,878,372	86,984	49,260,584	6,802,604	154,530,614	
	1991	7,983,908	2,107,914	66,150,237	84,558	29,690,231	6,548,318	112,565,166	
	1992	7,610,246	2,492,617	66,107,180	286,006	39,598,925	6,002,710	122,097,684	
	1993	4,917,532	1,473,403	48,530,658	133,359	21,985,100	5,865,882	82,905,934	-72%
Percent Change, 1988-1993									
33/50 Program Chemicals		-80%	-98%	73%	-93%	-67%	-73%	-69%	
Non 33/50 Program Chemicals		-69%	-73%	-79%	-67%	-36%	22%	-72%	
All TRI Chemicals		-71%	-73%	-79%	-68%	-37%	-2%	-72%	

(1) 1991, 1992 and 1993 Total Releases and Transfers do not include off-site recycling or energy recovery.

Appendix B
Monsanto Company, Selected Facilities
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface		Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers		Total Releases and Transfers (pounds) (1)
			Water Discharges (pounds)	Off-site for Treatment/Disposal/Other (pounds)						
<u>MONSANTO CO. - SAUGET, IL</u>										
Benzene	1988	52,900	0	0	0	0	440,000	10,000	502,900	
	1989	52,900	0	0	0	0	410,000	8,500	471,400	
	1990	28,800	0	0	0	0	150,000	46,300	225,100	
	1991	86,000	0	0	0	0	170	15,330	101,500	
	1992	50,900	0	0	0	0	4,500	105,600	161,000	
	1993	47,100	0	0	0	0	310	47,700	95,110	
Methyl ethyl ketone	1988	450	0	0	0	0	1,500	0	1,950	
	1989	450	0	0	0	0	7,800	0	8,250	
	1990	1,800	0	0	0	0	80,000	180	81,980	
	1991	1,300	0	0	0	0	82,000	4	83,304	
	1992	830	0	0	0	0	52,000	500	53,330	
	1993	810	0	0	0	0	50,000	0	50,810	
Methyl isobutyl ketone	1988	13,000	0	0	0	0	41,000	500,000	554,000	
	1989	15,000	0	0	0	0	64,000	36,000	115,000	
	1990	30,000	0	0	0	0	160,000	53,000	243,000	
	1991	33,000	0	0	0	0	38,000	74,000	145,000	
	1992	31,000	0	0	0	0	48,000	78,500	157,500	
	1993	20,600	0	0	0	0	35,000	17,000	72,600	
Xylene (mixed isomers)	1988	690,000	0	0	0	0	720,000	200,000	1,610,000	
	1989	620,000	0	0	0	0	560,000	258,000	1,438,000	
	1990	740,000	0	0	0	0	270,000	80,374	1,090,374	
	1991	800,000	0	0	0	0	140,000	37,940	977,940	
	1992	540,000	0	0	0	0	150,000	40,029	730,029	
	1993	160,000	0	0	0	0	210,000	17,000	387,000	
<u>33/50 Program Chemicals</u>	1988	756,350	0	0	0	0	1,202,500	710,000	2,668,850	
	1989	688,350	0	0	0	0	1,041,800	302,500	2,032,650	
	1990	800,600	0	0	0	0	660,000	179,854	1,640,454	
	1991	920,300	0	0	0	0	260,170	127,274	1,307,744	
	1992	622,730	0	0	0	0	254,500	224,629	1,101,859	
	1993	228,510	0	0	0	0	295,310	81,700	605,520	

Appendix B
Monsanto Company, Selected Facilities
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers	
							Off-site for Treatment/Disposal/Other (pounds)	Total Releases and Transfers (pounds) (1)
All Non 33/50 TRI Chemicals	1988	3,056,728	0	0	0	21,177,141	257,900	24,491,769
	1989	2,738,253	0	0	0	20,712,341	288,109	23,738,703
	1990	985,370	0	0	0	38,462,431	658,018	40,105,819
	1991	774,140	0	0	0	20,319,551	796,980	21,890,671
	1992	857,339	0	0	0	33,426,450	834,957	35,118,746
	1993	696,899	0	0	4,000	15,103,168	1,109,088	16,913,155
All TRI Chemicals	1988	3,813,078	0	0	0	22,379,641	967,900	27,160,619
	1989	3,426,603	0	0	0	21,754,141	590,609	25,771,353
	1990	1,785,970	0	0	0	39,122,431	837,872	41,746,273
	1991	1,694,440	0	0	0	20,579,721	924,254	23,198,415
	1992	1,480,069	0	0	0	33,680,950	1,059,586	36,220,605
	1993	925,409	0	0	4,000	15,398,478	1,190,788	17,518,675
MONSANTO CO.- NITRO, WV								
Toluene	1988	135,000	22,000	0	150	0	0	157,150
	1989	156,000	22,000	0	150	0	0	178,150
	1990	220,000	34,000	0	160	0	0	254,160
	1991	349,000	3	0	0	0	3,700	352,703
	1992	35,000	3	0	0	0	690	35,693
	1993	22,600	3	0	0	0	3,680	26,283
Trichloroethylene	1988	216,800	330	0	0	0	0	217,130
	1989	258,800	420	0	0	0	0	259,220
	1990	43,000	72	0	0	0	0	43,072
Xylene (mixed isomers)	1988	104,000	14,000	0	0	0	64,000	182,000
	1989	114,000	16,000	0	0	0	0	130,000
	1990	103,000	13,000	0	0	0	0	116,000
	1991	35,000	23	0	0	0	0	35,023
	1992	93,000	11	0	0	0	410	93,421
	1993	5,500	1	0	0	0	2,680	8,181
33/50 Program Chemicals	1988	455,800	36,330	0	150	0	64,000	556,280
	1989	528,800	38,420	0	150	0	0	567,370
	1990	366,000	47,072	0	160	0	0	413,232
	1991	384,000	26	0	0	0	3,700	387,726
	1992	128,000	14	0	0	0	1,100	129,114
	1993	28,100	4	0	0	0	6,360	34,464

Appendix B
Monsanto Company, Selected Facilities
Releases and Transfers of TRI Chemicals, 1988-1993

Chemical	Year	Total Air Emissions (pounds)	Surface Water Discharges (pounds)	Underground Injection (pounds)	Releases to Land (pounds)	Transfers to POTW (pounds)	Transfers	
							Off-site for Treatment/ Disposal/Other (pounds)	Total Releases and Transfers (pounds) (1)
All Non 33/50 TRI Chemicals	1988	281,312	398,020	0	1,000	0	2,800	683,132
	1989	268,735	393,830	0	1,800	0	14,000	678,365
	1990	363,235	93,300	0	1,800	0	960	459,295
	1991	335,841	63,502	0	0	0	4,200	403,543
	1992	241,013	65,108	0	0	0	16,666	322,787
	1993	151,342	651	0	0	0	21,731	173,724
All TRI Chemicals	1988	737,112	434,350	0	1,150	0	66,800	1,239,412
	1989	797,535	432,250	0	1,950	0	14,000	1,245,735
	1990	729,235	140,372	0	1,960	0	960	872,527
	1991	719,841	63,528	0	0	0	7,900	791,269
	1992	369,013	65,122	0	0	0	17,766	451,901
	1993	179,442	655	0	0	0	28,091	208,188

(1) 1991, 1992, and 1993 Total Releases and Transfers do not include transfers off-site for recycling or energy recovery.

Appendix C
Monsanto Company
Pollution Prevention Act Reporting, 1991-1993 Data and 1994-1995 Projections

Chemical	Year	Recycled On-Site (pounds)	Recycled Off-Site (pounds)	Energy Recovery On-Site (pounds)	Energy Recovery Off-Site (pounds)	Treated On-Site (pounds)	Treated Off-Site (pounds)	Quantity Released (pounds)	Percent Change 1991-1995	Total Production Related Wastes (pounds)	Percent Change 1991-1995
Benzene	1991	23,000	0	1,100,000	560,000	470,000	21,860	215,300		2,390,160	
	1992	0	0	50,000	180,000	1,750,000	103,740	315,500		2,399,240	
	1993	0	0	0	77,000	1,600,004	48,100	90,800		1,815,904	
	1994	0	0	0	0	1,600,000	48,100	59,800		1,707,900	
	1995	0	0	0	0	1,600,000	48,100	56,200	-74%	1,704,300	-29%
Cadmium	1991	0	12,000	0	0	0	0	1,900		13,900	
	1992	0	21,000	0	0	0	0	2,100		23,100	
	1993	0	21,000	0	0	0	0	3,200		24,200	
	1994	0	26,000	0	0	0	0	3,500		29,500	
	1995	0	32,000	0	0	0	0	3,700	95%	35,700	157%
Cadmium compounds	1991	0	0	0	0	0	0	16,690		16,690	
	1992	0	0	0	0	0	0	18,720		18,720	
	1993	0	0	0	0	0	0	19,740		19,740	
	1994	0	0	0	0	0	0	20,740		20,740	
	1995	0	0	0	0	0	0	22,740	36%	22,740	36%
Dichloromethane	1991	210,000	5,200	0	0	3,500	0	325,000		543,700	
	1992	210,000	4,500	0	0	3,500	0	304,000		522,000	
	1993	950,000	0	0	0	850	8,800	310,000		1,269,650	
	1994	1,100,000	0	0	0	600	0	240,000		1,340,600	
	1995	1,400,000	0	0	0	750	0	300,000	-8%	1,700,750	213%
Hydrogen cyanide	1991	0	0	0	0	2,100,000	0	390,000		2,490,000	
	1992	0	0	0	0	1,800,000	0	200,000		2,000,000	
	1993	0	0	0	0	2,000,000	0	180,000		2,180,000	
	1994	0	0	0	0	2,100,000	0	180,000		2,280,000	
	1995	0	0	0	0	2,200,000	0	180,000	-54%	2,380,000	-4%
Mercury compounds	1991	0	0	0	0	0	0	330		330	
	1992	0	0	0	0	0	0	330		330	
	1993	0	0	0	0	0	0	330		330	
	1994	0	0	0	0	0	0	0		0	
	1995	0	0	0	0	0	0	0	-100%	0	-100%

Appendix C
Monsanto Company
Pollution Prevention Act Reporting, 1991-1993 Data and 1994-1995 Projections

Chemical	Year	Recycled On-Site (pounds)	Recycled Off-Site (pounds)	Energy Recovery On-Site (pounds)	Energy Recovery Off-Site (pounds)	Treated On-Site (pounds)	Treated Off-Site (pounds)	Quantity Released (pounds)	Percent Change 1991-1995 Quantity Released	Total Production Related Wastes (pounds)	Percent Change 1991-1995 Production Related Wastes
Methyl ethyl ketone	1991	0	0	400,000	44,000	41,000	295,000	16,000		796,000	
	1992	0	0	244,700	5,000	40,000	283,500	49,830		623,030	
	1993	0	0	244,700	220	110,000	175,100	35,570		565,590	
	1994	0	0	244,700	110	100,000	93,100	35,570		473,480	
	1995	0	0	244,700	110	100,000	93,100	35,570	122%	473,480	-41%
Methyl isobutyl ketone	1991	0	0	0	0	320,000	110,000	34,900		464,900	
	1992	0	0	0	0	320,000	130,000	32,900		482,900	
	1993	0	0	0	0	320,000	52,000	22,600		394,600	
	1994	0	0	0	0	370,000	52,000	22,600		444,600	
	1995	0	0	0	0	430,000	52,000	22,600	-35%	504,600	9%
Nickel	1991	0	64,000	0	0	0	0	680		64,680	
	1992	0	114,000	0	0	0	0	5,980		119,980	
	1993	0	143,000	0	0	0	0	8,580		151,580	
	1994	0	132,000	0	0	0	0	8,580		140,580	
	1995	0	138,000	0	0	0	0	8,580	1162%	146,580	127%
Tetrachloroethylene	1991	0	0	0	0	0	9,700	63,000		72,700	
	1992	0	0	0	0	0	29	0		29	
	1993	0	0	0	0	0	0	0		0	
	1994	0	0	0	0	0	0	0		0	
	1995	0	0	0	0	0	0	0	-100%	0	-100%
Toluene	1991	0	0	0	254,231	152,600	131,412	405,541		943,784	
	1992	0	0	0	131,000	635,800	374,680	85,489		1,226,969	
	1993	0	0	0	161,700	1,064,394	262,403	51,047		1,539,544	
	1994	0	0	0	150,110	741,830	250,104	33,845		1,175,889	
	1995	0	0	0	150,110	654,010	245,700	16,232	-96%	1,066,052	13%
1,1,1-Trichloroethane	1991	0	92,000	0	0	0	0	180,000		272,000	
	1992	0	86,000	0	0	0	0	130,000		216,000	
	1993	0	0	0	0	0	0	0		0	
	1994	0	0	0	0	0	0	0		0	
	1995	0	0	0	0	0	0	0	-100%	0	-100%

Appendix C
Monsanto Company
Pollution Prevention Act Reporting, 1991-1993 Data and 1994-1995 Projections

Chemical	Year	Recycled On-Site (pounds)	Recycled Off-Site (pounds)	Energy Recovery On-Site (pounds)	Energy Recovery Off-Site (pounds)	Treated On-Site (pounds)	Treated Off-Site (pounds)	Quantity Released (pounds)	Percent Change 1991-1995 Quantity Released	Total Production Related Wastes (pounds)	Percent Change 1991-1995 Production Related Wastes
Trichloroethylene	1991	0	31,000	0	22,000	5,900	6,100	42,100		107,100	
	1992	0	48,000	0	32,000	26,000	3,700	23,400		133,100	
	1993	0	27,000	0	0	0	1,600	0		28,600	
	1994	0	0	0	0	0	0	0	-100%	0	-100%
	1995	0	0	0	0	0	0	0		0	
Xylene (mixed isomers)	1991	0	0	132,000	116,000	354,031	193,000	836,490		1,631,521	
	1992	0	0	222,115	17,700	393,045	196,225	635,190		1,464,275	
	1993	0	0	79,230	11,000	613,622	237,280	168,348		1,109,480	
	1994	0	0	60,230	140,000	613,920	231,320	168,372		1,213,842	
	1995	0	0	60,230	11,000	613,920	231,320	168,372	-80%	1,084,842	-34%
33/50 Program Chemicals	1991	233,000	204,200	1,632,000	996,231	3,447,031	767,072	2,527,931		9,807,465	
	1992	210,000	273,500	516,815	365,700	4,968,345	1,091,874	1,803,439		9,229,673	
	1993	950,000	191,000	323,930	249,920	5,708,870	785,283	890,215		9,099,218	
	1994	1,100,000	158,000	304,930	290,220	5,526,350	674,624	773,007		8,827,131	
	1995	1,400,000	170,000	304,930	161,220	5,598,680	670,220	813,994	-68%	9,119,044	-7%
All Non 33/50 TRI Chemicals	1991	52,708,400	20,300	35,572,689	568,628	96,023,732	34,484,474	65,043,512		284,423,735	
	1992	16,465,003	227,700	26,364,442	736,462	96,951,265	36,925,063	20,427,849		198,097,784	
	1993	33,543,800	403,522	26,333,500	650,645	97,810,356	26,826,400	54,425,732		239,993,955	
	1994	38,484,800	400,240	27,583,250	722,240	104,622,901	22,855,748	54,571,730		249,240,909	
	1995	40,204,800	500,240	27,343,000	759,240	107,093,697	15,710,596	54,281,689	-17%	245,893,262	-14%
All TRI Chemicals	1991	52,941,400	224,500	37,204,689	1,564,859	99,472,763	35,251,546	67,571,443		294,231,200	
	1992	16,675,003	501,200	26,881,257	1,102,162	101,919,610	38,016,937	22,231,288		207,327,457	
	1993	34,493,800	594,522	26,657,430	900,565	103,519,226	27,611,683	55,315,947		249,093,173	
	1994	39,584,800	558,240	27,888,180	1,012,460	110,149,251	23,530,372	55,344,737		258,068,040	
	1995	41,604,800	670,240	27,647,930	920,460	112,692,377	16,380,816	55,095,683	-18%	255,012,306	-13%
Percent Changes, 1991-1995											
33/50 Program Chemicals		501%	-17%	-81%	-84%	62%	-13%	-68%		-7%	
Non 33/50 Program Chemicals		-24%	2364%	-23%	34%	12%	-54%	-17%		-14%	
All TRI Chemicals		-21%	199%	-26%	-41%	13%	-54%	-18%		-13%	

Appendix D
Monsanto Company, Selected Facilities
Pollution Prevention Act Reporting, 1991-1993 Data and 1994-1995 Projections

Chemical	Year	Energy Recovery				Treated On-Site (pounds)	Treated Off-Site (pounds)	Quantity Released (pounds)	Percent Change 1991-1995	Total Production Related Wastes (pounds)	Percent Change 1991-1995
		Recycled On-Site (pounds)	Recycled Off-Site (pounds)	On-Site (pounds)	Off-Site (pounds)						
<u>MONSANTO CO. - SAUGET, IL</u>											
Benzene	1991	0	0	0	0	0	15,000	71,000		86,000	
	1992	0	0	0	0	0	100,000	51,000		151,000	
	1993	0	0	0	0	0	48,000	47,000		95,000	
	1994	0	0	0	0	0	48,000	47,000		95,000	
	1995	0	0	0	0	0	48,000	47,000	-34%	95,000	10%
Methyl ethyl ketone	1991	0	0	0	0	0	82,000	1,300		83,300	
	1992	0	0	0	0	0	52,000	830		52,830	
	1993	0	0	0	0	0	50,000	810		50,810	
	1994	0	0	0	0	0	50,000	810		50,810	
	1995	0	0	0	0	0	50,000	810	-38%	50,810	-39%
Methyl isobutyl ketone	1991	0	0	0	0	0	110,000	33,000		143,000	
	1992	0	0	0	0	0	130,000	31,000		161,000	
	1993	0	0	0	0	0	52,000	21,000		73,000	
	1994	0	0	0	0	0	52,000	21,000		73,000	
	1995	0	0	0	0	0	52,000	21,000	-36%	73,000	-49%
Xylene (mixed isomers)	1991	0	0	0	0	340,000	180,000	800,000		1,320,000	
	1992	0	0	15	0	370,000	190,000	540,000		1,100,015	
	1993	0	0	230	0	610,000	230,000	160,000		1,000,230	
	1994	0	0	230	0	610,000	230,000	160,000		1,000,230	
	1995	0	0	230	0	610,000	230,000	160,000	-80%	1,000,230	-24%
<u>33/50 Program Chemicals</u>	1991	0	0	0	0	340,000	387,000	905,300		1,632,300	
	1992	0	0	15	0	370,000	472,000	622,830		1,464,845	
	1993	0	0	230	0	610,000	380,000	228,810		1,219,040	
	1994	0	0	230	0	610,000	380,000	228,810		1,219,040	
	1995	0	0	230	0	610,000	380,000	228,810	-75%	1,219,040	-25%
All Non 33/50 Program Chemicals	1991	0	0	0	0	3,030,000	21,079,501	781,350		24,890,851	
	1992	0	0	51	0	86,000	26,924,590	710,474		27,721,115	
	1993	0	0	2,000	0	234,000	16,205,937	698,604		17,140,541	
	1994	0	0	2,000	0	234,000	14,201,137	698,604		15,135,741	
	1995	0	0	2,000	0	234,000	7,301,137	698,604	-11%	8,235,741	-67%

Appendix D
Monsanto Company, Selected Facilities

Pollution Prevention Act Reporting, 1991-1993 Data and 1994-1995 Projections

Chemical	Year	Recycled On-Site (pounds)	Recycled Off-Site (pounds)	Energy Recovery On-Site (pounds)	Energy Recovery Off-Site (pounds)	Treated On-Site (pounds)	Treated Off-Site (pounds)	Quantity Released (pounds)	Percent Change 1991-1995	Total Production (pounds)	Percent Change 1991-1995
All TRI Chemicals	1991	0	0	0	0	3,370,000	21,466,501	1,686,650		26,523,151	
	1992	0	0	66	0	456,000	27,396,590	1,333,304		29,185,960	
	1993	0	0	2,230	0	844,000	16,585,937	927,414		18,359,581	
	1994	0	0	2,230	0	844,000	14,581,137	927,414		16,354,781	
	1995	0	0	2,230	0	844,000	7,681,137	927,414	-45%	9,454,781	-64%
MONSANTO CO.-NITRO, WV											
Toluene	1991	0	0	0	0	2,600	0	350,000		352,600	
	1992	0	0	0	0	4,300	0	36,000		40,300	
	1993	0	0	0	0	16,000	2,000	24,000		42,000	
	1994	0	0	0	0	4,300	1,800	16,000		22,100	
	1995	0	0	0	0	4,300	1,800	10,000	-97%	16,100	-95%
Xylene (mixed isomers)	1991	0	0	80,000	62,000	14,000	0	35,000		191,000	
	1992	0	0	220,000	14,000	23,000	0	93,000		350,000	
	1993	0	0	79,000	11,000	1,500	570	7,600		99,670	
	1994	0	0	60,000	140,000	1,800	410	8,000		210,210	
	1995	0	0	60,000	11,000	1,800	410	8,000	-77%	~81,210	-57%
33/50 Program Chemicals											
	1991	0	0	80,000	62,000	16,600	0	385,000		543,600	
	1992	0	0	220,000	14,000	27,300	0	129,000		390,300	
	1993	0	0	79,000	11,000	17,500	2,570	31,600		141,670	
	1994	0	0	60,000	140,000	6,100	2,210	24,000		232,310	
	1995	0	0	60,000	11,000	6,100	2,210	18,000	-95%	97,310	-82%
All Non 33/50 Program Chemicals	1991	0	0	26,600	43,013	1,970,333	4,200	395,733		2,439,879	
	1992	0	0	58,901	8,100	2,069,280	9,800	312,066		2,458,147	
	1993	0	0	0	5,000	1,214,280	10,716	162,978		1,392,974	
	1994	0	0	3,600	10,700	1,350,680	11,416	144,485		1,520,881	
	1995	0	0	3,600	10,700	1,348,680	11,416	154,985	-61%	1,529,381	-37%
All TRI Chemicals	1991	0	0	106,600	105,013	1,986,933	4,200	780,733		2,983,479	
	1992	0	0	278,901	22,100	2,096,580	9,800	441,066		2,848,447	
	1993	0	0	79,000	16,000	1,231,780	13,286	194,578		1,534,644	
	1994	0	0	63,600	150,700	1,356,780	13,626	168,485		1,753,191	
	1995	0	0	63,600	21,700	1,354,780	13,626	172,985	-78%	1,626,691	-45%