



GRADES: 7-11

SUBJECTS: Science, Social Science, Geography, Health, Civics, Government, Environmental Science

TIME: 3 Hours; 2 Blocks or 4 Periods

STATE STANDARDS:

Civics Standard 4 - Participation, P.I. C. 418, C.416 - Grades 9-11; 7.407, 8.409, Grade 7-8

Geography Standard 1 - Maps, P.I.s G.402, G.404 - Grade 9-11; 7.421, 8.421 - Grades 7-8

Geography Standard 2 - Environment, P.I. G.408 - Grades 9-11; 7.423, 8.423 - Grades 7-8

History Standard 1 - Historical Phenomena, P.I. H.401, H.402, H.403 - Grades 9-11; 8.427 - Grade 8; 7.427 Grade 7

History Standard 2 - Research, P.I. - H.405 - Grades 9-11; 7.429 - Grade 7

Science Standard 1 - Nature and Application of Science and Technology (Science as Inquiry), 1.12; P.I.s - 7.350, 8.351, 7.353, 8.354 - Grades 7-8

Science Standard 5 - Earth's Dynamic System (Components of Earth), 5.12; P.I. - 9.75 - Grades 9

Science Standard 8 - Ecology (Interaction of Humans Within Ecosystems), 8.21, 8.22, 8.31; P.I. - 9.75 - Grades 9

WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY?

OVERVIEW OF THE LESSON

Scope and Purpose of the Lesson:

At the heart of this lesson students will locate businesses in their area that release pollution into the air, the types of emissions from these facilities, and the health hazards of these emissions.

◆ Topics Addressed:

Toxic Release Inventory
Local business emissions
Local health hazards
Methods used to reduce pollution emissions
Scientific method

Synopsis of the Lesson:

This lesson contains five activities that use several instructional strategies and is organized around the question of "What Impact Does Industry Have On Air Quality?"

LEARNING OBJECTIVES

Students will be able to:

- ◆ Describe ground level ozone and what contributes to its formation
- ◆ Locate businesses in his/her area that release pollution into the air
- ◆ Identify the types of emissions from these local businesses
- ◆ Compare the number of businesses in each county that release pollution to the air
- ◆ Identify and locate the top 15 facilities in Delaware that release pollution to the air
- ◆ Name the products produced by these top 15 facilities in Delaware
- ◆ Explain the health hazards of the emissions of local businesses
- ◆ Explain methods used to reduce pollution emissions

BACKGROUND

The Toxics Release Inventory, or TRI, is a publicly available database containing information reported annually for certain toxic chemicals that are manufactured, produced, or otherwise used by manufacturing facilities in Delaware and throughout the United States. The reportable list of toxic



chemicals includes 578 individual chemicals and 28 chemical categories as of 1996. New chemicals or chemical categories may be changed by EPA each year. TRI was established in 1986 under Title III, Section 313 of the federal Superfund Amendments and Reauthorization Act (SARA) to provide information to the public about the presence and release of these toxic chemicals in their communities. Title III is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA). Facilities report TRI information to the U.S. Environmental Protection Agency (EPA) and to the state in which the facility is located.

Air releases constitute 93% of the total on-site releases, and 78% of these are VOCs which contribute to ground-level ozone.

TRI Reports are available from DNREC by calling 302-739-4791 or the web at <http://www2.state.de.us/serc/98trirpt.htm>

LESSON PROCEDURE

INTRODUCTION OF LESSON

Start the lesson with a Warm-up, Mind Set, or Anticipatory Set on the overhead or chalk board. The warm up and class discussion should take about **10 minutes**.

1. WARM UP, MIND SET OR ANTICIPATORY SET - Identify the sources of ground level ozone. Give students **2 to 3 minutes** to respond in writing. See Overhead Transparencies.

2. CLASS DISCUSSION - Have the class discuss the warm up. Explain to the class that ground level ozone is found in the earth's lowest layer of the atmosphere which is called the troposphere. In the troposphere, ozone is an air pollutant that damages human health, vegetation, and many common materials. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOCs, also known as ozone precursors. Explain to the class that in Lesson 3 we are going to look at the industrial impacts on the air we breathe. (**5 to 7 minutes** to discuss student answers)

3. LESSON OBJECTIVES - The lesson objectives should be presented on an overhead (see Overhead Transparencies) or on the chalk board. These should be read to the class. (**2 minutes**)

ACTIVITY 1: Reading

1. Description/Overview of Activity:

Students will now complete Reading #1 to get a better background and understanding of ground level ozone.

2. Materials Needed:

Photocopies of Reading 1 - 1 per student (included)

3. Performance Indicators of the Activity:

Geography P.I G.408

Science P.I. 9.75

4. Preparation for Activity:

Make copies of Reading 1 for each student in the class.

5. Activity Outline and Directions to the Teacher:

STEP 1: Reading - Give each student a copy of Reading 1 and explain that this will provide them with background to Lesson one. (**3 minutes total**)

STEP 2: Discussion - conduct a brief discussion on the reading. Answer any questions that students might have or you may have a few questions for the students. (**5 minutes**)

ACTIVITY 2: Delaware Map Activity

Note: This activity is based on the 1996 TRI Report. Results may vary if using another year's report.

1. Description/Overview of Activity:

In Activity 2, students are going to locate and examine some businesses in Delaware that contribute to ground level ozone.

2. Materials Needed:

Photocopies of TRI Facility Locator Map and accompanying materials - 1 packet per student (included)

◆ **OPTION 1** - *The Chemical Scorecard* on the internet at www.scorecard.org

◆ **OPTION 2** - DNREC's *GIS Mapping the Way for Better Decisions* on CD-ROM - one for each county in Delaware.

Photocopies of Map key for the TRI Facility

Photocopies of Report Readings - 1 per student (included)

Photocopies of Handouts per student (included)

3. Performance Indicators of the Activity:

Geography P.I G.408; 7.421; 8.421; 7.423; 8.423

Science P.I. 9.75

4. Preparation for Activity:

Make copies of Reading 1 for each student in the class.



5. Activity Outline and Directions to the Teacher:

STEP 1: Explain to the class that they are now going to locate and examine some businesses in Delaware that contribute to ground-level ozone. You should point out to the class that Volatile Organic Compounds, or VOCs, are significant contributors to the formation of ground-level ozone. Over 93% of all business or facility releases reported in Delaware under TRI (**Delaware Toxics Release Inventory Report**) are to the air, and 78% of these are VOCs. The TRI Report was set up to provide information to the public about the presence and release of toxic chemicals in their communities. The TRI Report is released annually by DNREC in May. For a copy, see the Department's web site or call 739-4791. (2-3 minutes)

STEP 2: MAP AND MAP KEY - Give each student a TRI-Facility Locator Map, Map Key, Handout #1 (one for each county), and the Toxic Release Inventory sheets containing Figures 2, 3, 4, 5, and Table 6 to identify the businesses located on the map and to complete Handout #1. Tell students they will have **15 minutes** to complete the Map Activity and Handout #1. Have students complete the handout appropriate to the county where they live.

◆ **OPTION 1** - Students may use *The Chemical Scorecard* which is a Chemical Information Service. Environmental Defense Fund. (on the internet at www.scorecard.org)

◆ **OPTION 2** - Students may use the **Department of Natural Resources & Environmental Control's Delaware Coastal Management Program** called "*GIS Mapping the Way for Better Decisions*" on CD-ROM — one for each county—in place of using the TRI Facility Locator Map. (Requires PC with Microsoft DOS, Windows 95, or Windows NT CD-ROM drive)

◆ **OPTION 3** - Students may access TRI reports on the DNREC web page at http://www.dnrec.state.de.us/air/aqm_page/reports.htm

STEP 3: Conclude the Map Activity with a large group discussion on the answers to Handout #1 (one for each county in Delaware).

ACTIVITY 3: Oral Reports

1. Description/Overview of Activity:

This is a cooperative learning activity that will be focused on students developing a **3 to 5 minute oral report** on two Delaware businesses, the products they produce, types of toxic chemicals they release, and the health hazards of these toxics. Information from Handouts #2 and #3 will be used to prepare the reports.

2. Materials Needed:

Photocopies of Handouts #2 and #3
Photocopies of Report Readings from Activities 2

3. Performance Indicators of the Activity:

Geography P.I. G.402; G.408
History P.I. H.401
Science P.I. 9.75

4. Preparation for Activity:

Divide the class into cooperative learning groups of four students in each group. Be sure to divide the groups heterogeneously by academic ability, gender, and race.

5. Activity Outline and directions to the Teacher:

STEP 1: The class should be divided into groups of 4 students each to complete a cooperative learning activity. This activity consists of each group developing a 3 to 5 minute oral report. Each group will be given a copy of the Report Readings, Handout #2, and Handout #3 and assigned two of the businesses to report on. Each group will use Handout #2 to provide information for their report. Each report should include: name of businesses, location of each business, products produced by each business, types of toxic chemicals released into the air. Each group will also report on the health hazards of these toxic releases. This information will be obtained from Handout #3. (Give Students **10 minutes** to prepare their group reports and **30 minutes** to give reports to the class)

◆ **OPTION:** Use the **Internet** to look up the health hazards on the EPA's Office of Pollution prevention on Toxics Website (fact sheets) at <http://www.epa.gov/opptintr/chemfact>

ACTIVITY 4 - Scientific Method Activity

1. Description/Overview of Activity:

The focus of this lesson is on pollution prevention. Students will use the scientific method to learn about what we can do to prevent pollution.

2. Materials Needed:

Photocopies of Reading #2
Photocopies of Handout #4

3. Performance Indicators of the Activity:

Geography P.I. G.404
History P.I. H.405
Science P.I. 9.75; 7.350; 8.351; 7.353; 8.354



4. Preparation for Activity:

Students will remain in cooperative learning groups for this activity. This activity is based on Reading #2 and Handout #4.

5. Activity Outline and directions to the Teacher:

STEP 1: Give each student a copy of Reading #2 and a copy of Handout #4. Explain to the students that they will be using the scientific method to solve a major environmental issue.

STEP 2: Review the steps in the Scientific Method with the class before beginning the activity. **(5 minutes)**

- ◆ Problem - state the problem
- ◆ Hypothesis - educated guess
- ◆ Research - gather information
- ◆ Organize the information - categorize
- ◆ Analyze the information
- ◆ Conclusion - revise, accept, or reject the original hypothesis

STEP 3: PROBLEM - The problem is stated at the top of Handout #4: How might toxic releases to air by business be reduced in order to clean up the air in Delaware and the nation? Each group will now formulate their **HYPOTHESIS** and each student will record the group consensus under the problem on Handout #4 **(5-10 minutes to complete)**.

STEP 4: RESEARCH - Students will research pollution prevention by completing Reading #2 and answering the questions on Handout #4. (Give students **15 minutes** to complete Reading #2 and Handout #4).

STEP 5: ANALYZE - Students will analyze and discuss their data to see if their findings support their original hypothesis. **(5 minutes)**.

STEP 6: CONCLUSION - Students will draw conclusions and either use their conclusions to support their hypothesis, change their hypothesis, or disprove their hypothesis. If the group decides to disprove their original hypothesis, they should write a new hypothesis from their findings **(5 minutes)**.

STEP 7: REPORT FINDINGS: - Each group will give a brief summary of their findings—original hypothesis and conclusions **(5-10 minutes)**.

STEP 8: FOLLOW UP DISCUSSION - Use the questions on Handout #4 as a guide to class discussion. This class discussion should take about **10 to 15 minutes**.

ACTIVITY 5: Culminating Activity - Congressional Letters

1. Description/Overview of Activity:

Students will examine historical data relating to their region or county in Delaware and will write letters to Delaware congressional representatives to voice their concerns and opinions.

2. Materials Needed:

Photocopies of TRI materials from Activity 1 - Tables 5 and 6; and Figures 4 and 5, pp. 14-16 (Included—see student materials for Activity 2). Photocopies of scoring rubric (included—see Student Materials)

3. Performance Indicators of the Activity:

Civics P.I. C.416; 7.407; 8.409

Geography P.I. G.402; G.404

History P.I. H.401; H.402; H.403; 7.429; 8.427

Science P.I. 9.75

4. Preparation for Activity:

Students will complete this activity individually. Make copies of TRI materials from the student materials.

5. Activity Outline and directions to the Teacher:

STEP 1: Give each student a copy of the TRI materials. Explain that they will use Tables 5 and 6 as well as Figures 4 and 5 to compare change in industrial emissions to the air from 1994 to 1996. In response to the industries that have had increases in their toxic emissions, students will write letters to Delaware congressional representatives to voice their concerns and opinions. Tell students they will have time to write their letters in class. Also explain that these letters must be typed either in a computer lab or at home. Give each student a copy of the scoring rubric and explain that these letters will be graded. **(4 minutes)**

STEP 2: Explain to students the proper form for writing a formal letter. Explain to the students that they should develop a rough draft of the letter first to be read and checked by the teacher. They should also research the names and addresses of congressional representatives from the district where they live. **(2 minutes)**

STEP 3: Allow students 30 minutes to write their letters. Have students type their letters either as an assignment or have them go to a computer room. **(30-45 minutes)**



CONCLUSION

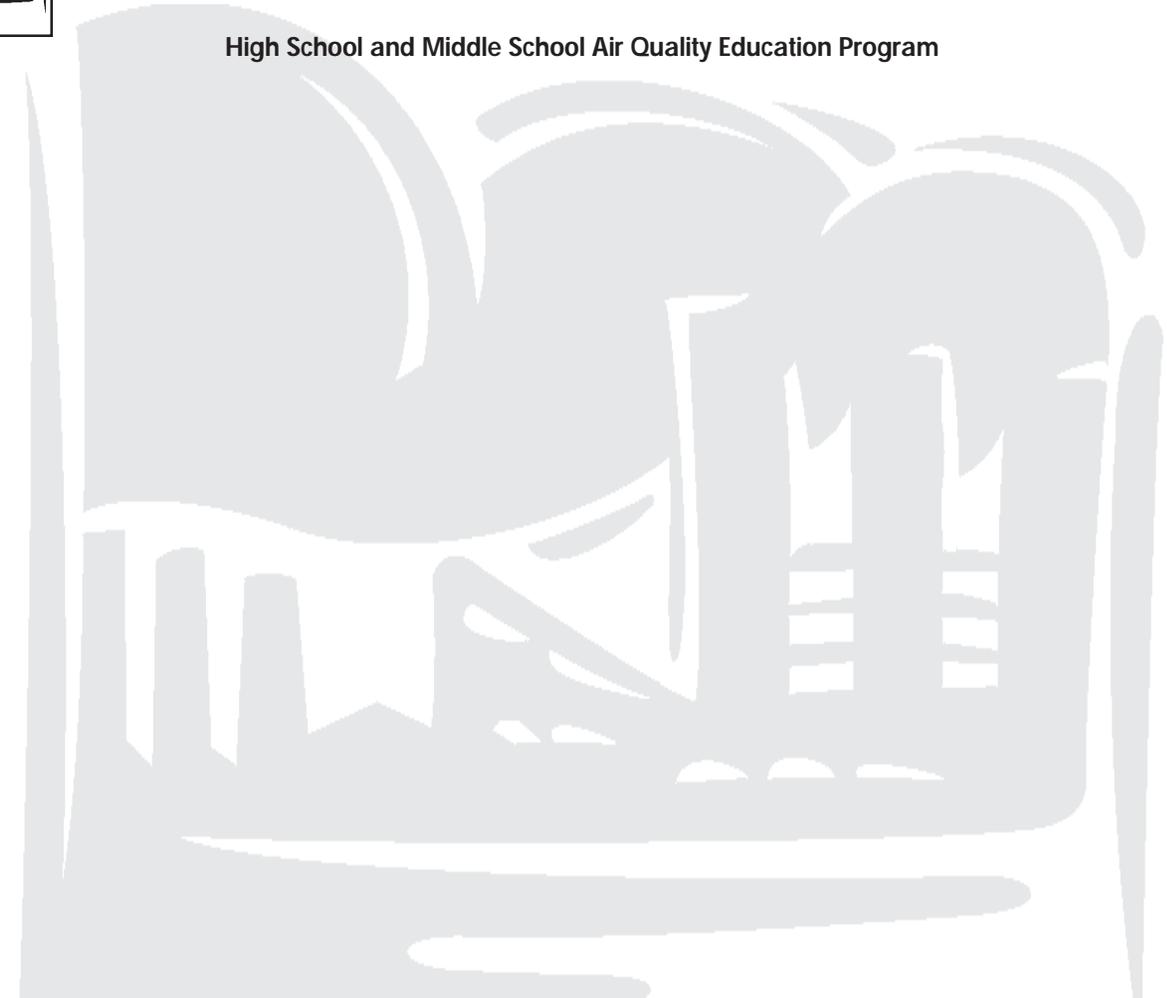
1. A review or return to the lesson objectives to be sure students have accomplished each objective. (5 minutes)

EXTENDED ACTIVITIES

1. CASE STUDIES - Students will complete case studies on the effects of a specific chemical on the environment. They will then write a report on proposed solutions.
2. POLITICAL ISSUES - Students will examine news reports (newspapers and magazines) to find out what position different office-holders take on the issue of toxic releases.
3. EDITORIAL COLUMN - Students will write an editorial column addressing the health effects of toxic releases and what should be done to decrease this trend.



High School and Middle School Air Quality Education Program



**OVERHEAD
TRANSPARENCIES**

INTRODUCTION OF LESSON 2



OVERHEAD TRANSPARENCY: WARM-UP

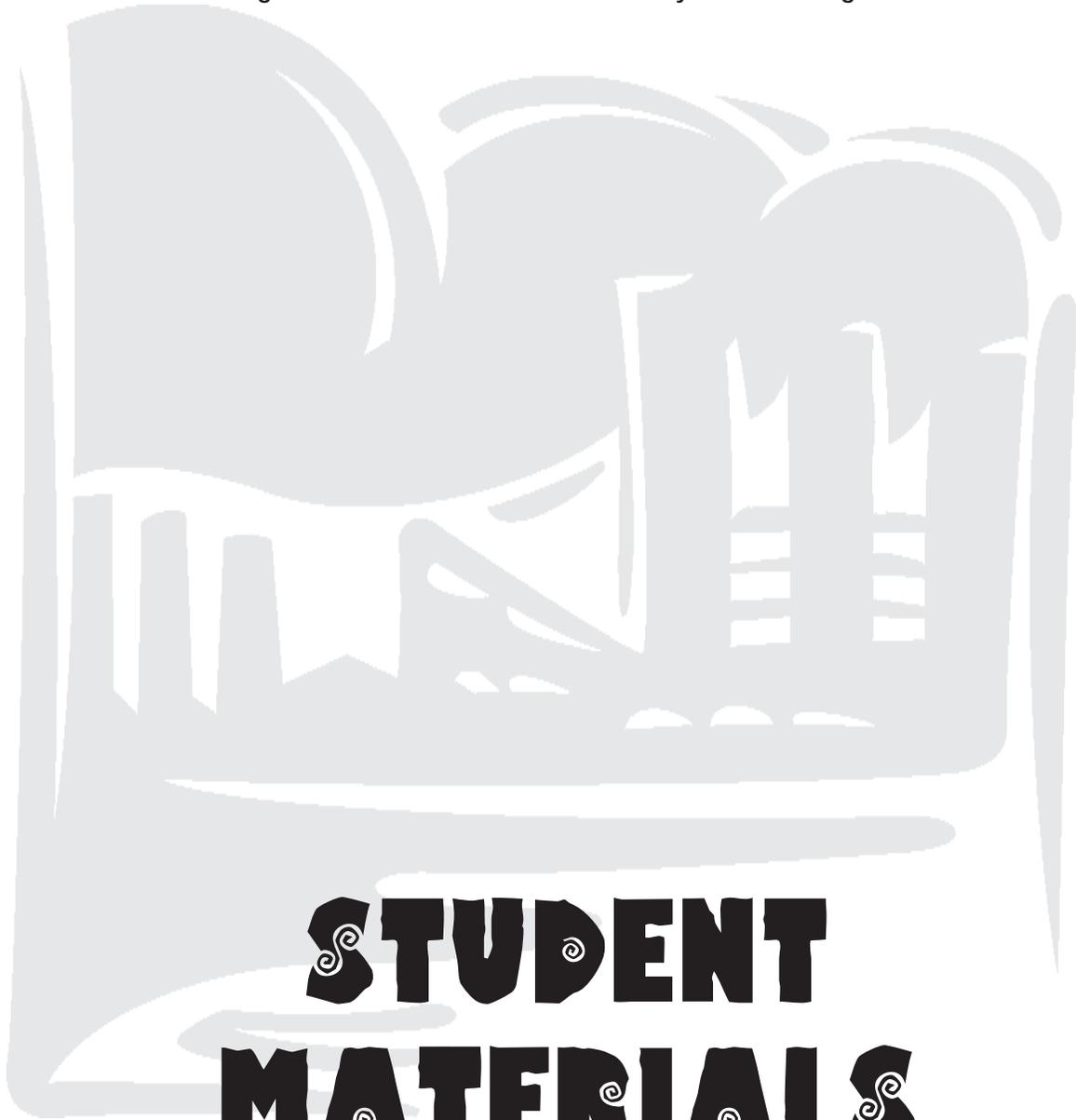


**IDENTIFY THE
SOURCES OF
GROUND LEVEL OZONE**



OVERHEAD TRANSPARENCY: LESSON 3 OBJECTIVES

- ◆ Describe ground level ozone and what contributes to its formation
- ◆ Locate businesses in his/her area that release pollution into the air
- ◆ Identify the types of emissions from these local businesses
- ◆ Compare the number of businesses in each county that release pollution to the air
- ◆ Identify and locate the top 15 facilities in Delaware that release pollution to the air
- ◆ Name the products produced by these top 15 facilities in Delaware
- ◆ Explain the health hazards of the emissions of local businesses
- ◆ Explain methods used to reduce pollution emissions



STUDENT MATERIALS

LESSON 2 ACTIVITY 1



2

GROUND LEVEL OZONE

Lesson 2 Activity 1

Reading 1

We hear a lot in the news these days about ozone. There's that large hole in the ozone layer above the South Pole which we need to protect us against harmful ultraviolet rays. Then we hear that the high levels of ozone are dangerous to the animals, plants and humans. This all sounds pretty confusing which is why it is difficult for people to understand the ozone problem.

There are two different types of ozone. First, there is a protective layer of ozone in the upper atmosphere or stratosphere. Stratospheric ozone forms a layer that shields the earth from ultraviolet radiation. Recently the levels of ozone seem to be decreasing, possibly due to an increase in the amount of chlorofluorocarbons (CFCs) detected in the stratosphere.

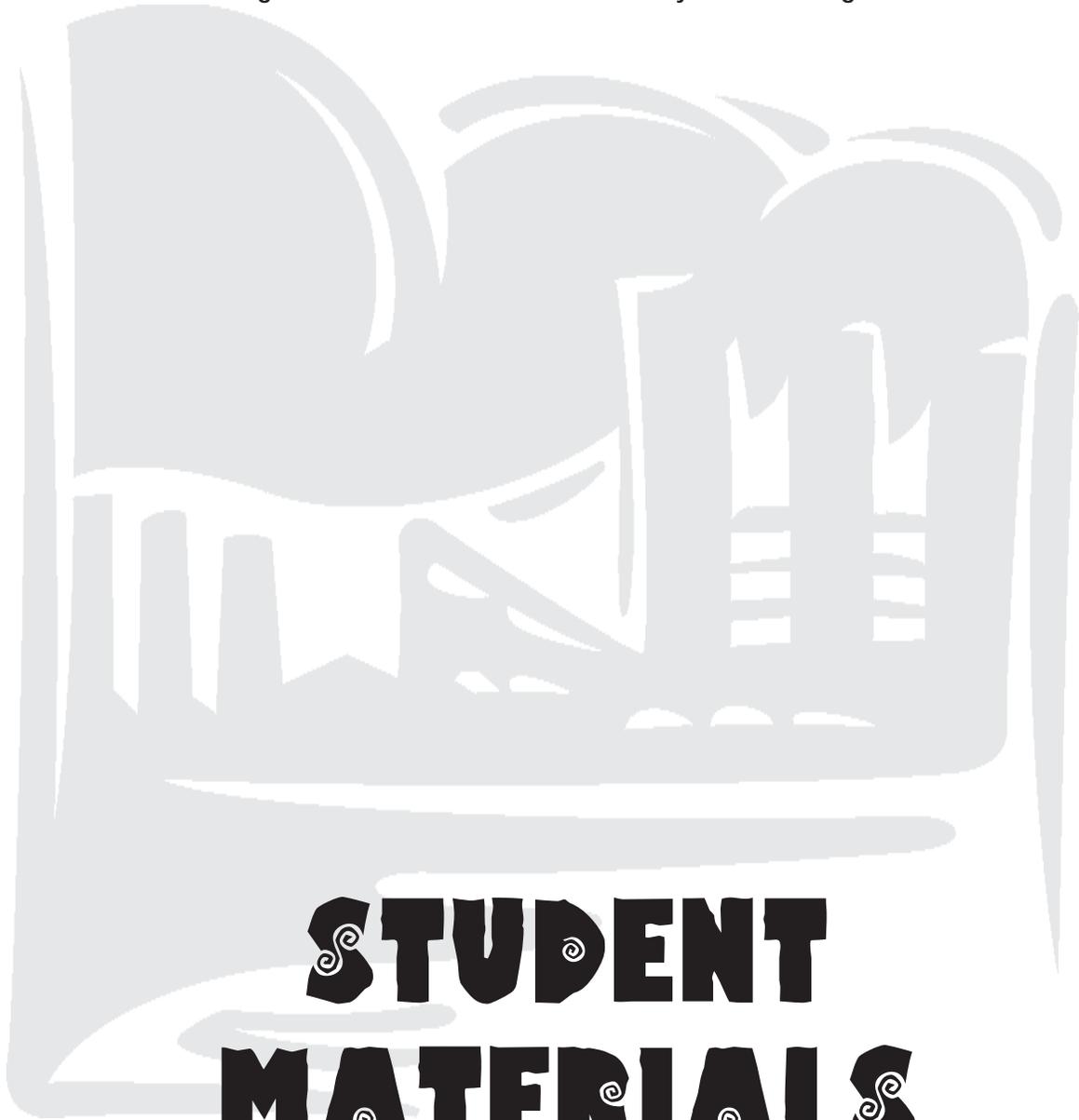
Then there is a second type of ozone located in the lower atmosphere or troposphere. This is what's known as smog. In contrast to ozone found in the stratosphere, ozone in the troposphere, near the Earth's surface, has no function in nature and is a pollutant. A pollutant is defined as an undesirable chemical or other material that has adverse effects on plants, animals, the natural environment, or on human health and property. Ground level ozone is harmful. Increased levels of ozone in the troposphere (near the earth's surface) are caused by the reaction of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) in the presence of sunlight. VOCs and NOx

are emitted by cars, industry, etc.

Our focus in Lesson 2 will be on the second type of ozone or tropospheric ozone. The level of tropospheric ozone usually is highest during the summer months because of the higher temperatures and increased amounts of sunlight. People exposed to high ozone levels for an extended period of time might have decreased lung capacity. This could result in chest pains, shortness of breath and headaches. People with asthma, allergies and lung illnesses could be seriously affected. Over time, the damage to your lungs can be permanent.

The effects of ozone are also apparent in plants, trees and vegetation. The Environmental Protection Agency (EPA) estimates that the national agricultural loss from ozone pollution is 2-3 billion dollars a year. While a farmer can grow new crops next year, animals are at the mercy of the environment. The leaves on trees turn brown due to the pollutant, which in turn affects their growth. As a result, wildlife are forced to find other habitats in which to live and eat.

In Delaware, the ozone level is monitored from April 1 to October 31 at six sites: Brandywine, Bellefonte, Summit Bridge, Felton, Seaford, and Lewes. As a result of this monitoring, it is known that Delaware has exceeded the National Ambient Air Quality Standards (NAAQS) for ozone between 1990 and 1999 in Kent and New Castle counties and ozone levels continue to be a concern.



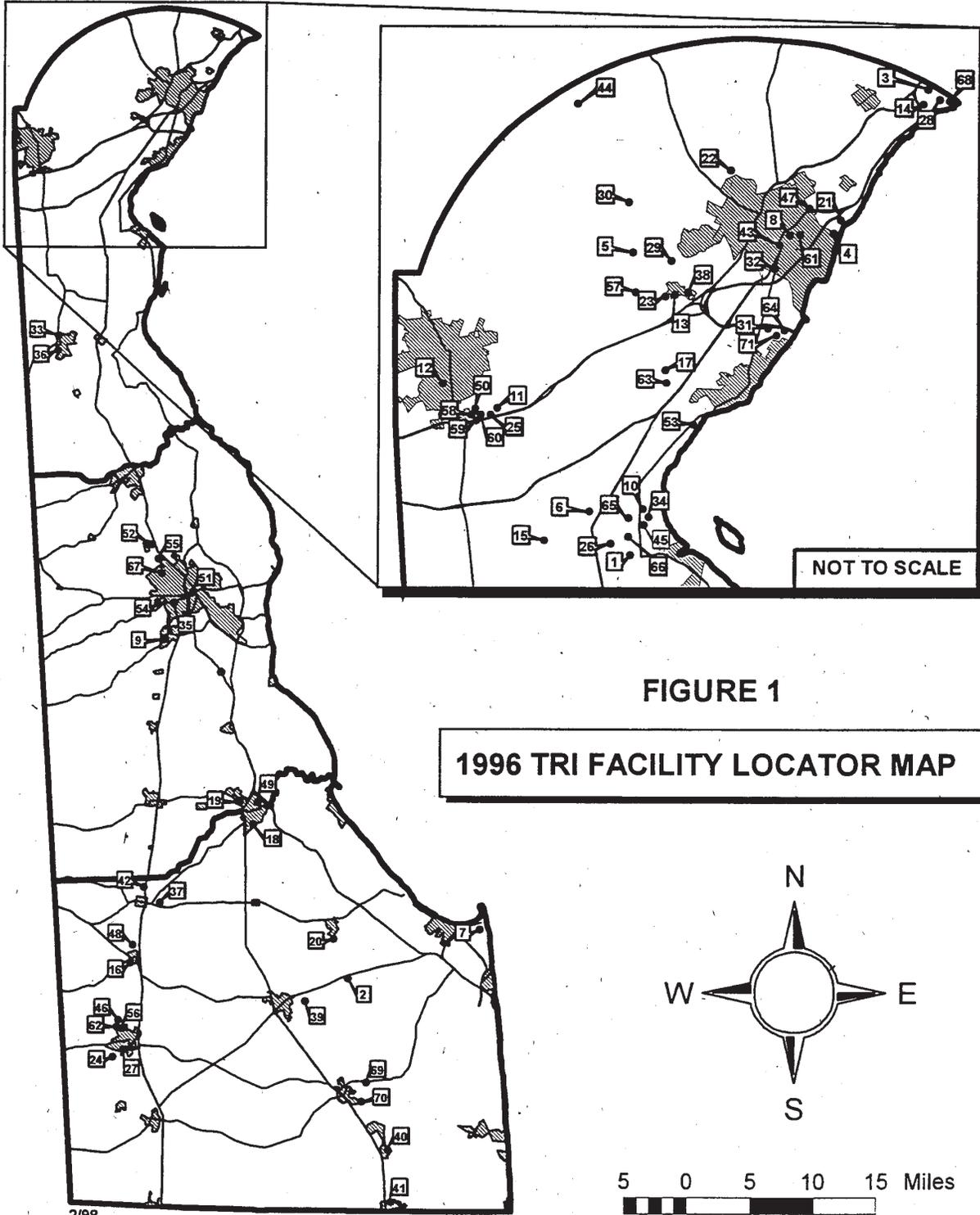
STUDENT MATERIALS

LESSON 2 ACTIVITY 2



TRI

TOXICS RELEASE INVENTORY





On-site Releases

On-site releases are emissions from a facility to the environment as a result of normal operations or accidents, including emissions to the air, discharges to surface water, disposal onto or in the ground, and underground injection. Underground injection is not an approved method of hazardous waste disposal in Delaware, and thus has not been reported by any facility in Delaware since reporting began.

Figure 2 illustrates the number of facilities that reported from each

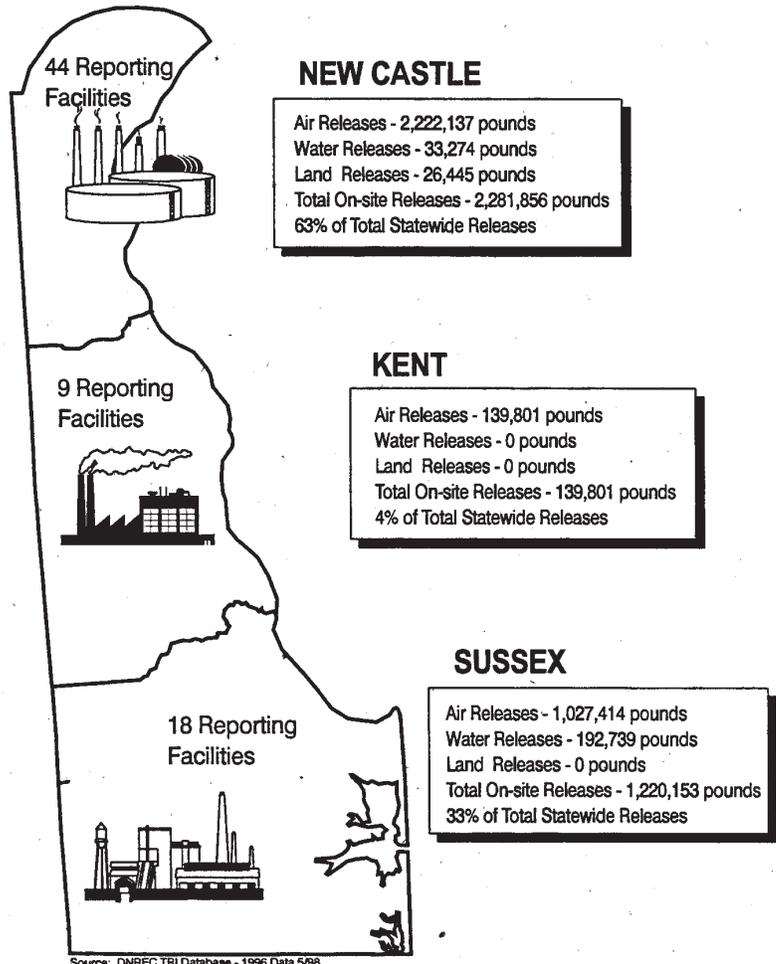
FIGURE 1 MAP KEY

MAP ID	FACILITY
1	AIR LIQUIDE AMERICA
2	ALLEN FAMILY FOODS
3	ALLIEDSIGNAL
4	ALLOY SURFACES
5	AMETEK HAVEG DIVISION
6	ARLON
7	BARCROFT
8	BRANDYWINE COMPOUNDING
9	CAMDEL METALS
10	CHLORAMONE
11	CHROME DEPOSIT
12	CHRYSLER
13	CIBA-GEIGY PIGMENTS
14	CITISTEEL USA
15	COMPOSITES USA
16	DELAGRA
17	DELTECH-FLAIR
18	DENTSPLY/CAULK MAIN
19	DENTSPLY/CAULK WEST
20	DRAPER KING COLE
21	DU PONT EDGE MOOR
22	DU PONT EXPERIMENTAL STATION
23	DU PONT HOLLY RUN
24	DU PONT SEAFORD
25	E-A-R SPECIALTY COMPOSITES
26	FORMOSA PLASTICS
27	GARDNER ASPHALT
28	GENERAL CHEMICAL
29	GENERAL MOTORS
30	HERCULES RESEARCH CENTER
31	ICI SURFACTANTS
32	INSTEEL WIRE PRODUCTS
33	JOHNSON CONTROLS
34	KANEKA
35	KRAFT FOODS
36	MACDERMID
37	MARBLE WORKS
38	MEDAL
39	MFG JUSTIN TANKS
40	MOUNTAIRE FRANKFORD
41	MOUNTAIRE SELBYVILLE
42	NANTICOKE HOMES
43	NORAMCO
44	NVF YORKLYN
45	OCCIDENTAL CHEMICAL
46	ORIENT CHEMICAL
47	PEPSI-COLA BOTTLING
48	PERDUE BRIDGEVILLE
49	PERDUE MILFORD
50	PERMA-FLEX ROLLERS
51	PLAYTEX PRODUCTS
52	PPG ARCHITECTURAL FINISHES
53	PRINTPACK
54	PROCTER & GAMBLE-DOVER WIPES
55	REICHHOLD CHEMICALS
56	RITE OFF
57	ROCKLAND TECHNOLOGIES
58	RODEL
59	RODEL LIQUID PRODUCTS
60	RODEL TECHNICAL CENTER
61	ROLLER SERVICE
62	S.C. JOHNSON POLYMER
63	SPATZ FIBERGLASS
64	SPI POLYOLS
65	STANDARD CHLORINE
66	STAR ENTERPRISE
67	STEELWORKS
68	SUN REFINING & MARKETING
69	TOWNSENDS
70	VLASIC FOODS
71	ZENECA SPECIALTIES C.E.L.

Source: DNREC TRI Database 5/98

FIGURE 2

Delaware at a Glance - Releases by County

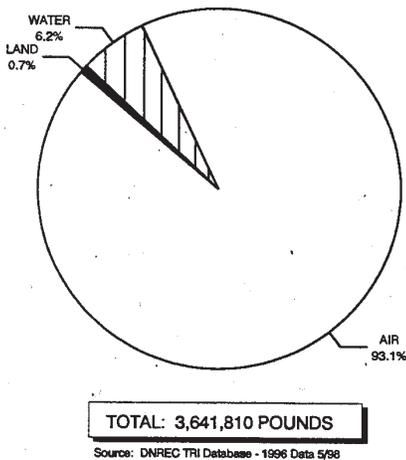




TRI

TOXICS RELEASE INVENTORY

FIGURE 3
STATEWIDE ON-SITE RELEASES



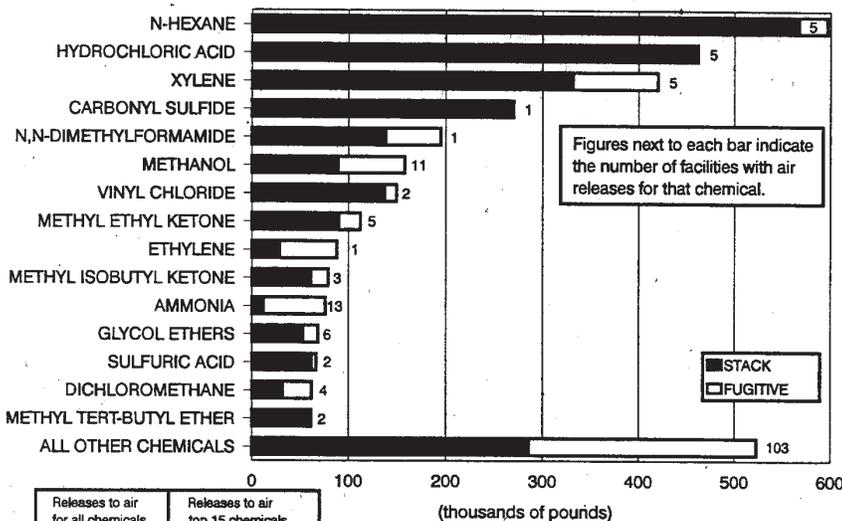
county along with release totals for each county. By county, 63% of the statewide releases occurred in New Castle, 33% in Sussex, and 4% in Kent. Facilities reporting from Kent and Sussex counties are predominantly from the food processing and chemical industries, while those from New Castle County represent a wider variety of industries.

Releases to Air

As illustrated in Figure 3, air releases constitute 93% of the total on-site releases. Figure 4 provides the top 15 TRI chemicals released to Delaware's air in 1996. N-Hexane is the top chemical released to the air, followed by hydrochloric acid and xylene.

N-Hexane, a newly-reportable chemical for 1995, was reported as being released to the air by five facilities. Townsends accounted for 83% of the state's TRI-reported n-hexane air releases. Townsends uses n-hexane in the process of extracting vegetable oil from soybeans.

FIGURE 4
RELEASES TO AIR - TOP 15 CHEMICALS



Hydrochloric acid was reported as being released to the air by five facilities. DuPont Seaford accounted for 96% of the state's TRI-reported hydrochloric acid air releases. Gaseous hydrochloric acid results from the burning of coal in their power plant.

Xylene was reported as being released to the air by five facilities. A primary use of xylene is as a solvent in paints for the automobile manufacturing industry, which represents 98% of the state's TRI-reported xylene releases to Delaware's air.

Releases to Water

As can be seen in Figure 3, there are fewer TRI releases to water than to air. Only a few chemicals were released to water in large amounts. Nitrate compounds, a



TOXICS RELEASE INVENTORY

newly-listed category for 1995, was the top chemical released to Delaware's surface waters followed by zinc compounds. A by-product of the biological treatment of wastes, nitrate compounds were reported as being released to the Nanticoke River by DuPont Seaford. Zinc compounds were primarily reported as being released to the Red Clay Creek by the NVF Company in Yorklyn, where they use zinc chloride as a catalyst in the process of manufacturing vulcanized paper. Table 5 provides the amount of TRI chemicals released to each watershed. These watersheds, except the Nanticoke River, all flow into the Delaware Bay.

**TABLE 5
RELEASES TO WATER BY WATERSHED**

RECEIVING WATER BODY	NO. OF FACILITIES	NO. OF REPORTS	RELEASES (in pounds)
Nanticoke River	1	1	192,739
Red Clay Creek	1	1	28,313
Delaware River	6	13	4,938
Namaans Creek	1	5	14
Christina River	1	1	5
Red Lion Creek	1	1	4

Source: DNREC TRI Database - 1996 Data 5/98

Releases to Land

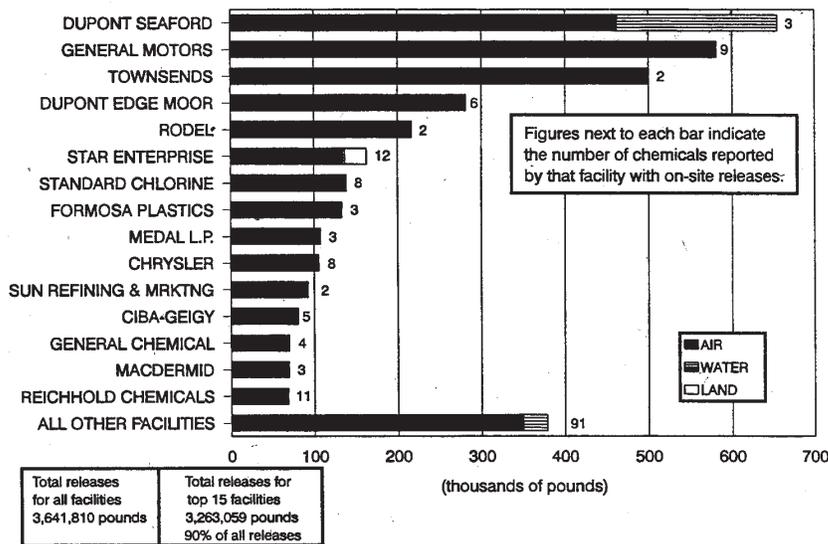
Less than 1% of all reported on-site releases were to the land. Only one chemical, methyl tert-butyl ether (MTBE), was released to the land in a large amount. As a result of a leak from the bottom of a storage tank, Star Enterprise excavated contaminated soil containing 26,000 pounds of MTBE and placed it in an on-site landfill. MTBE is a gasoline formulation component used to enhance octane rating and provide a cleaner burning fuel.

A complete list of 1996 release data, grouped alphabetically by chemical, is provided in Appendix E.

Releases by Facility

Figure 5 illustrates the top 15 facilities with total (air, water, and land) on-site releases for 1996. Table 6, on the next page, provides the releases for 1995 and 1996 with a comparison between the two years and the rank for each facility for each year. The facility with the most TRI releases in 1996 was the DuPont Seaford Nylon Plant, which ranked second last year. The General Motors Wilmington Assembly Plant moved down to

**FIGURE 5
ON-SITE RELEASES - TOP 15 FACILITIES**





TOXICS RELEASE INVENTORY

TABLE 6
TOP 15 FACILITIES - 1995 & 1996 RANKING BY ON-SITE RELEASES
 (in pounds)

1996 Rank	1995 Rank	Facility	STANDARD ANALYSIS			ADJUSTED FOR PRODUCTION		
			1995 Releases	1996 Releases	1995 to 1996 % Change	1995 Adjusted Releases (1)	1996 Adjusted Releases (2)	1995 to 1996 % Change
1	2	DuPont Seaford	774,488	654,970	-15%	774,488	727,744	-6%
2	1	General Motors	995,747	581,039	-42%	995,747	1,185,794	+19%
3	3	Townsend's	532,278	500,154	-6%	532,278	549,016	+3%
4	5	DuPont Edge Moor	253,330	281,441	+11%	253,330	296,254	+17%
5	8	Rodel	159,581	216,761	+36%	159,581	174,105	+9%
6	6	Star Enterprise	195,007	162,642	-17%	195,007	138,022	-29%
7	7	Standard Chlorine (3)	163,536	138,476	-15%	158,493	301,509	+90%
8	9	Formosa Plastics	149,211	132,862	-11%	149,211	152,828	+2%
9	13	Medal L.P.	90,500	107,600	+19%	90,500	82,769	-9%
10	4	Chrysler	399,918	105,655	-74%	399,918	377,339	-6%
11	10	Sun Refining (4)	147,200	92,500	-37%	147,200	84,862	-42%
12	11	Ciba-Geigy	112,430	80,680	-28%	112,430	76,113	-32%
13	25	General Chemical (5)	19,180	70,200	+266%	19,180	69,565	+263%
14	14	MacDermid	83,620	69,477	-17%	83,620	68,789	-18%
15	12	Reichhold Chemicals	98,048	68,602	-30%	97,747	65,703	-33%

- (1) Excludes non-production-related releases by Standard Chlorine (5,043 lbs.) and Reichhold (301 lbs.) for 1995.
 (2) 1996 Adjusted Releases = (1996 Releases - 1996 Non-production-related Releases) / production ratio.
 Non-production-related releases include Star Enterprise (26,000 lbs.), Standard Chlorine (4,606 lbs.), Reichhold (2,899 lbs.), General Chemical (1,400 lbs.), and Formosa (360 lbs.).
 (3) Production ratio for chlorobenzene (0.17) does not account for production as an intermediate, resulting in an inflated 1996 adjusted release total.
 (4) Only releases from the ethylene oxide unit in the Delaware portion of the facility are included in release totals.
 (5) Significant percent increase is the result of stack sampling data which indicated releases greater than previously reported.
 Source: DNREC TRI Database 5/98

second, after two years as the top TRI facility with on-site releases. Eleven of the top 15 facilities reported less releases for 1996 as compared to 1995. Furthermore, statewide reported releases were down 22% from 1995.

When reviewing releases from year to year, it is important to keep in mind that the level of production at a facility may change, and consequently may affect the amount that is released. A production ratio, which is the 1996 level of production divided by the 1995 level, is provided by facilities in the TRI report for each chemical. Using this production ratio, the 1996 data can be adjusted to account for the difference in production from 1995 to 1996. Table 6 provides an adjusted analysis of releases using the production ratio. This analysis assumes a direct linear relationship between the level of production and releases, which may not always be the case. Therefore, this analysis should be used in conjunction with other analyses and information to more accurately gauge a facility's performance.



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

FIGURE 1 MAP KEY

Lesson 1 Activity 2

MAP ID	BUSINESS
1	AIR LIQUIDE AMERICA
2	ALLEN FAMILY FOODS
3	ALLIED-SIGNAL
4	ALLOY SURFACES
5	AMETEK HAVEG DIVISION
6	ARLON
7	BARCROFT
8	BRANDYWINE COMPOUNDING
9	CAMDEL METALS
10	CHLORAMONE
11	CHROME DEPOSIT
12	CHRYSLER
13	CIBA-GEIGY PIGMENTS
14	CITISTEEL USA
15	COMPOSITES USA
16	DELAGRA
17	DELTECH-FLAIR
18	DENTSPLY/CAULK MAIN
19	DENTSPLY/CAULK WEST
20	DRAPER KING COLE
21	DU PONT EDGE MOOR
22	DU PONT EXPERIMENTAL STATION
23	DU PONT HOLLY RUN
24	DU PONT SEAFORD
25	E-A-R SPECIALTY COMPOSITES
26	FORMOSA PLASTICS
27	GARDNER ASPHALT
28	GENERAL CHEMICAL
29	GENERAL MOTORS
30	HERCULES RESEARCH CENTER
31	ICI SURFACTANTS
32	INSTEEL WIRE PRODUCTS
33	JOHNSON CONTROLS
34	KANEKA
35	KRAFT FOODS
36	MACDERMID
37	MARBLE WORKS
38	MEDAL
39	MFG JUSTIN TANKS
40	MOUNTAIRE FRANKFORD

**MAP ID****BUSINESS**

41	MOUNTAIRE SELBYVILLE
42	NANTICOKE HOMES
43	NORAMCO
44	NVF YORKLYN
45	OCCIDENTAL CHEMICAL
46	ORIENT CHEMICAL
47	PEPSI-COLA BOTTLING
48	PERDUE BRIDGEVILLE
49	PERDUE MILFORD
50	PERMA-FLEX ROLLERS
51	PLAYTEX PRODUCTS
52	PPG ARCHITECTURAL FINISHES
53	PRINTPACK
54	PROCTER & GAMBLE-DOVER WIPES
55	REICHHOLD CHEMICALS
56	RITE OFF
57	ROCKLAND TECHNOLOGIES
58	RODEL
59	RODEL LIQUID PRODUCTS
60	RODEL TECHNICAL CENTER
61	ROLLER SERVICE
62	S. C. JOHNSON POLYMER
63	SPATZ FIBERGLASS
64	SPI POLYOLS
65	STANDARD CHLORINE
66	STAR ENTERPRISE
67	STEELWORKS
68	SUN REFINING & MARKETING
69	TOWNSENDS
70	VLASICS FOODS
71	ZENECA SPECIALTIES C.E.L.



2 WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY?

Lesson 2 Activity 2

Report Readings

A brief description of each of the top 15 businesses in 1996 is presented in this reading to provide an understanding of the types of products manufactured at each site.

Rank #1- DuPont Seaford Nylon Plant

This DuPont facility was the first plant worldwide to produce spun nylon fibers, beginning operations in 1939. The spun nylon is used in the apparel industry, in carpeting, and other fabric applications. DuPont Seaford reported on six Toxics Release Inventory (TRI) chemicals for 1996. The majority of their on-site releases were of two chemicals, **hydrochloric acid** to the air and nitrate compounds to the water. Neither of these chemicals are directly used in the production of nylon, but rather are produced as a result of the facility's support operations. Gaseous hydrochloric acid results from the burning of coal in their power plant. The coal containing very small amounts of chlorine is combined with hydrogen to form hydrochloric acid. Nitrate compounds are formed as a by-product of their on-site wastewater treatment plant.

Rank #2 - General Motors (Wilmington)

General Motors assembles automobiles for distribution to dealers across the country. The facility's production in 1996 was approximately half of the production in 1995 due to a facility retooling. This decrease in production contributed to the overall reduction in releases of toxic wastes.

GM reported on eleven TRI chemicals for 1996. Many of these are solvents used in paints or for parts cleaning, while others are materials that are incorporated into the cars themselves, such as **ethylene glycol** (antifreeze) in the radiator. All on-site releases reported by GM were to the air. **Xylene**, a paint solvent used in both the base and

top coats, accounted for over half of their on-site releases for 1996.

Rank #3 - Townsends, Inc.

Townsends, known mostly for poultry products, also produces chicken feed and vegetable oil at their facility near Millsboro. Soybeans, a major agricultural crop in Delaware, are processed to make vegetable oils commonly used in salad dressing, mayonnaise, and baking.

Townsends reported on six TRI chemicals for 1996. One chemical added to the TRI reportable list for 1995, **N-hexane**, contributed to nearly all of their on-site releases. Liquid N-hexane is used to promote separation of oil from the soybeans. Much of the N-hexane is recycled and re-used, with some releases normally occurring during the extraction process. Three other reported chemicals (metal compounds) are used as mineral supplements in the formulation of chicken feed.

Rank #4 - DuPont Edge Moor

The Edge Moor Plant is one of four domestic DuPont facilities that manufactures titanium dioxide, a white pigment that is used in food-grade markets and in the paint, coatings, plastic and paper industries. This facility exclusively serves the paper industry. The plant is located along the Delaware River a few miles north of the Port of Wilmington.

DuPont Edge Moor reported on six TRI chemicals for 1996, with all reported on-site releases emitted to the air. **Carbonyl sulfide** accounted for 96% of their on-site releases. Carbonyl sulfide is a by-product from the use of sulfur-bearing coke in the process of manufacturing the titanium dioxide from titanium-rich ores. Several years ago, the facility patented technology to modify the reactor feed to ensure that raw materials are added in a way that reduces carbonyl sulfide formation at the source.



Rank #5 - Rodel, Inc.

Rodel manufactures polishing pads and slurries for the semiconductor, electronics, and glass industries. Rodel is located south of Newark in the Diamond State Industrial Park.

Rodel reported on five TRI chemicals for 1996. **N,N-Dimethylformamide** (DMF), used as a solvent carrier vehicle in the polishing pad manufacturing process, accounted for 90% of their on-site releases. DMF is a newly reportable chemical for 1995. Releases of DMF mostly occur through evaporation from the coating and washing process. A portion of the DMF remaining in the aqueous wash is recycled through distillation for reuse in the process. Production increases have contributed to their increase of releases. Rodel initiated several pollution prevention projects during 1996 which will significantly reduce DMF releases.

Rank #6 - Star Enterprise (Motiva)

The Star Enterprise Refinery, located in the Delaware City industrial complex, refines crude oil into automobile gasoline, home heating fuel oil, and a variety of other petroleum products and intermediates.

Star reported on twenty TRI chemicals for 1996. About half of these are produced as formulation components in their final products. One of these, **methyl tertiary-butyl ether** (MTBE), accounted for half of their total on-site releases. MTBE is used to enhance the octane rating of gasoline and provide a cleaner burning fuel.

Rank #7 - Standard Chlorine of Delaware, Inc.

Standard Chlorine located in the Delaware City complex, is a producer of chlorinated benzene compounds. These chlorinated benzenes are primarily used by other manufacturers as intermediates in the production of agricultural pesticides, plastics, dyestuffs, and pharmaceuticals. One product, paradichlorobenzene, is repackaged and distributed by others as a moth repellent (moth balls and flakes) or deodorant (urinal blocks).

Standard Chlorine reported on eight TRI chemicals for 1996. The raw materials, chlorine and benzene, were reported, as well as various mono-, di-, and tri-chlorinated benzene compounds. Three chemicals — **benzene**, **1,4-dichlorobenzene** (also known as paradichlorobenzene), and **(mono) chlorobenzene** — accounted for 70% of their on-site releases for 1996. Process waste streams are passed through pollution control equipment, such as carbon absorption columns and scrubbers, before being released.

Rank #8 - Formosa Plastics Corp., Delaware

Formosa, located in the Delaware City complex, produces polyvinyl chloride (PVC) resin for bulk sale to other industries that produce PVC end products, such as flooring, carpet backing, upholstery, toys, and gloves.

Formosa reported on three TRI chemicals for 1996. **Vinyl chloride monomer** (VCM) accounted for nearly 90% of their on-site releases. VCM is the primary ingredient for producing PVC and is released as residual (unreacted) monomer during the drying process of the PVC resin. Permits regulate the concentration limit of the residual monomer in the PVC before drying.

Rank #9 - MEDAL L.P.

MEDAL is an operation which once belonged to the DuPont Company and is now run by Air Liquide America. The facility is located near the Christina River in Newport. The facility manufactures filter systems which are used to separate gases for the purposes of reducing food spoilage and producing more inexpensive fuel.

MEDAL reported on three TRI chemicals for 1996. Two newly reportable chemicals for 1995, **N-hexane** and **N-methyl pyrrolidone**, accounted for the increase in on-site releases. A condensing system was installed to further reduce releases. Production increases have contributed to their increase of releases between 1995 and 1996.

Rank #10 - Chrysler Motors Newark Assembly Plant

Chrysler assembles automobiles for distribution to dealers. The facility began major retooling in June of 1996 in preparation for the production of a new model. The resulting lack of production resulted in a corresponding reduction of releases.

Chrysler reported on eleven TRI chemicals for 1996. Many of these are solvents used in paints or for parts cleaning, while others are materials that are incorporated into the cars themselves, such as ethylene glycol (antifreeze) in the radiator. All on-site releases reported by Chrysler were to the air. **Xylene** and **methyl isobutyl ketone**, paint solvents used in both the base and top coats, accounted for 71% of their on-site releases for 1996. These solvents are released during painting, parts cleaning, and from the parts drying/curing process. A "solvent reduction team" has implemented numerous strategies that are responsible for the reductions in TRI releases experienced by this facility.



Rank #11 - Sun Refining & Marketing Co.

The Sun refinery at Marcus Hook, Pennsylvania extends into Delaware along the Delaware River. While the refinery reported on twenty-nine TRI chemicals for 1996, only two are predominantly manufactured within the Delaware portion of the facility. Only these two chemicals, **ethylene** and **ethylene oxide**, are included in Delaware's database and in the report. However, reports on the remaining twenty-seven chemicals are available to the public through the EPCRA Reporting Program of DNREC.

The refinery manufactures both ethylene and ethylene oxide to be used as raw materials by other chemical manufacturers. All on-site releases of these two chemicals were to the air, with the majority being fugitive process emissions. Process equipment modifications made to the ethylene/ethylene oxide unit in 1996 have reduced fugitive emissions from valve packings.

Rank #12 - Ciba-Geigy Corp. Pigments Division

Ciba-Geigy, located along the Christina River in Newport, manufactures red shade pigments in bulk powder form, which are used in automobile paints, plastics, fibers, and inks.

Ciba-Geigy reported on five TRI chemicals for 1996. Nearly all of their on-site releases were attributable to one chemical—**methanol**. Methanol is both a reactant and solvent in the chemical reactions to manufacture the pigments. The methanol, which is not consumed in the reactions, is then removed by way of distillation. The pigment is subsequently dried and finished to a powder for final sale. All reported on-site releases of methanol were to the air, with the majority being fugitive process emissions. As of January 1, 1997 the facility changed its name to Ciba Specialty Chemicals Corporation.

Rank #13 - General Chemical Delaware Valley Works

General Chemical is located near Claymont along Philadelphia Pike at the state line. This facility was the first plant worldwide to utilize the contact process for manufacturing sulfuric acid, beginning in 1912.

General Chemical reported on four TRI chemicals for 1996. **Sulfuric acid** mist accounted for 88% of their on-site releases. Mist is generated during the sulfuric acid manufacturing process and during the loading of fuming sulfuric acid into tank wagons. The reported release of mist from the manufacturing process is based on stack sampling data, which indicated a significant increase from 1995 to 1996. In 1997, the facility installed new mist eliminators in the process and a new tank wagon loading system that completely eliminates mist from loading op-

erations.

Rank #14 - MacDermid, Inc.

MacDermid bought the Hercules Middletown facility in December of 1995. Producing the same products as Hercules, MacDermid manufactures two main products, an aqueous dry film photoresist and a liquid photosensitive resin. The aqueous dry film photoresist is used primarily in the process of making printed circuit boards. The film is used as an image transfer tool and chemical etchant resist when making the circuit pattern on the board. The photosensitive resin is used to make printing plates primarily for the packaging industry. The plates are used to print images on cardboard boxes and paper bags.

MacDermid reported on three TRI chemicals for 1996. Nearly all of their reported on-site releases were of **methyl ethyl ketone** (MEK). MEK is used in the photoresist process to dilute the photopolymer before application to a plastic sheeting. After application, the MEK is evaporated leaving only the desired coating solution. The evaporated MEK is passed through a catalytic incinerator before being discharged to the atmosphere.

Rank #15 - Reichhold Chemicals, Inc.

Reichhold is located two miles south of Cheswold. Reichhold produces emulsion polymers, sometimes referred to as latex. These products, which are sold in bulk liquid form, are used in the manufacture of paper, carpets, textiles, high performance gloves, coatings, and adhesives.

Most of the eleven TRI chemicals that were reported by Reichhold in 1996 are raw materials that are reacted to form the emulsion polymers. Residual (unreacted) monomers are processed in pollution control equipment before venting to the atmosphere. For 1996, 65% of their on-site releases were attributable to **1,3-butadiene**. New pollution control equipment was added in 1996, which contributed to the 30% reduction of releases experienced between 1995 and 1996.

Source: Delaware Department of Natural Resources and Environmental Control's (DNREC) *Delaware Toxics Release Inventory Report* (TRI) May 1996. TRI report released annually - contact number (302) 739-4791.



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 1

MAP ACTIVITY QUESTIONS

Lesson 2 Activity 2

1. How many businesses in the State of Delaware have reported toxic releases? _____
2. How many businesses in your county have reported toxic releases? _____
3. Which county in Delaware had the most toxic releases? _____
4. Which county in Delaware had the least toxic releases? _____
5. List eight businesses in your county that have reported toxic releases to the air:
 - 1) _____
 - 2) _____
 - 3) _____
 - 4) _____
 - 5) _____
 - 6) _____
 - 7) _____
 - 8) _____
6. List the top 10 businesses in Delaware that have reported the most toxic releases to the air:
 - 1) _____
 - 2) _____
 - 3) _____
 - 4) _____
 - 5) _____
 - 6) _____
 - 7) _____
 - 8) _____
 - 9) _____
 - 10) _____
7. How many of these top ten businesses are in your county? _____
8. Which of the businesses is the closest to your school? _____
9. How many TRI facilities or businesses are located within 5 miles of your school? _____



10. What chemicals do the TRI facilities located within 5 miles of your school release into the air?

11. Make a list of the top 15 chemicals released to the air by these Delaware reporting businesses:

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____
- 6) _____
- 7) _____
- 8) _____
- 9) _____
- 10) _____
- 11) _____
- 12) _____
- 13) _____
- 14) _____
- 15) _____



TEACHER MATERIALS

LESSON 2 ACTIVITY 2



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 1

MAP ACTIVITY ANSWERS - BASED ON 1996 TRI REPORT Lesson 2 Activity 2

New Castle County Schools

1. How many businesses in the State of Delaware have reported toxic releases? 71
2. How many businesses in your county have reported toxic releases? 44
3. Which county in Delaware had the most toxic releases? New Castle County
4. Which county in Delaware had the least toxic releases? Kent County
5. List eight businesses nearest your home that have reported toxic releases:

Possible answers: Alliedsignal, Sun Refining & Marketing, Citisteel USA, General Chemical, DuPont Edge Moor, Alloy Surfaces, Pepsi-Cola Bottling, Roller Service, Brandywine Compounding, DuPont Experimental Station, Noramco, Insteel Wire Products, SPI Polyols, ICI Surfactants, Zeneca Specialties C.E.L., MEDAL, Ciba-Geigy Pigments, DuPont Holly Run, Rockland Technologies, General Motors, Ametek Haveg Division, Hercules Research Center, NVF Yorklyn, Deltech-Flair, Spatz Fiberglass, Printpack, Chloramone, Kaneka, Standard Chlorine, Occidental Chemical, Star Enterprise, Air Liquide America, Formosa Plastics, Arlon, Composites USA, Chrome Deposit, E-A-R Specialty Composites, Rodel Technical Center, Rodel Liquid Products, Perma-Flex Rollers, Rodel, Chrysler, Johnson Controls, MacDermid

6. List the top 10 businesses in Delaware that have reported the most toxic releases:
 - 1) DuPont Seaford
 - 2) General Motors
 - 3) Townsend's
 - 4) DuPont Edge Moor
 - 5) Rodel
 - 6) Star Enterprise
 - 7) Standard Chlorine
 - 8) Formosa Plastics
 - 9) MEDAL L.P.
 - 10) Chrysler
7. How many of these top ten businesses are in your area or county? 8
8. Which of the businesses is the closest to your school? Answers will vary
9. How many TRI facilities or businesses are located within 5 miles of your school? Answers will vary



10. What chemicals do the TRI facilities located within 5 miles of your school release into the air?

Answers will vary

11. Make a list of the top 15 chemicals released to the air by these Delaware reporting businesses:

- 1) N-Hexane
- 2) Hydrochloric Acid
- 3) Xylene
- 4) Carbonyl Sulfide
- 5) N,N-Dimethylformamide
- 6) Methanol
- 7) Vinyl Chloride
- 8) Methyl Ethyl Ketone
- 9) Ethylene
- 10) Methyl Isobutyl Ketone
- 11) Ammonia
- 12) Glycol Ethers
- 13) Sulfuric Acid
- 14) Dichloromethane
- 15) Methyl Tertiary-Butyl Ether



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY?

HANDOUT 1

MAP ACTIVITY ANSWERS - BASED ON 1996 TRI REPORT Lesson 2 Activity 2

Kent County Schools

1. How many businesses in the State of Delaware have reported toxic releases? 71
2. How many businesses in your county have reported toxic releases? 9
3. Which county in Delaware had the most toxic releases? New Castle County
4. Which county in Delaware had the least toxic releases? Kent County
5. List eight businesses nearest your home that have reported toxic releases:
 - 1) PPG Architectural Finishes
 - 2) Reichhold Chemicals
 - 3) Steelworks
 - 4) Playtex Products
 - 5) Procter & Gamble-Dover Wipes
 - 6) Camdel Metals
 - 7) Kraft Foods
 - 8) Dentsply/Caulk West

Other possible answers: Nanticoke Homes, Dentsply/Caulk Main, Marble Works, Perdue Bridgeville, Delagra, Orient Chemical, Rite Off, S.C. Johnson Polymer, Gardner Asphalt, DuPont Seaford

6. List the top 10 businesses in Delaware that have reported the most toxic releases:
 - 1) DuPont Seaford
 - 2) General Motors
 - 3) Townsend's
 - 4) DuPont Edge Moor
 - 5) Rodel
 - 6) Star Enterprise
 - 7) Standard Chlorine
 - 8) Formosa Plastics
 - 9) MEDAL I.P.
 - 10) Chrysler
7. How many of these top ten businesses are in your area or county? 0
8. Which of the businesses is the closest to your school? Answers will vary



9. How many TRI facilities or businesses are located within 5 miles of your school? Answers will vary

10. What chemicals do the TRI facilities located within 5 miles of your school release into the air?
Answers will vary

11. Make a list of the top 15 chemicals released to the air by these Delaware reporting businesses:

- 1) N-Hexane
- 2) Hydrochloric Acid
- 3) Xylene
- 4) Carbonyl Sulfide
- 5) N,N-Dimethylformamide
- 6) Methanol
- 7) Vinyl Chloride
- 8) Methyl Ethyl Ketone
- 9) Ethylene
- 10) Methyl Isobutyl Ketone
- 11) Ammonia
- 12) Glycol Ethers
- 13) Sulfuric Acid
- 14) Dichloromethane
- 15) Methyl Tertiary-Butyl Ether



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 1

MAP ACTIVITY ANSWERS BASED ON 1996 TRI REPORT Lesson 2 Activity 2

Sussex County Schools

1. How many businesses in the State of Delaware have reported toxic releases? 71
2. How many businesses in your county have reported toxic releases? 18
3. Which county in Delaware had the most toxic releases? New Castle County
4. Which county in Delaware had the least toxic releases? Kent County
5. List eight businesses nearest your home that have reported toxic releases:
 - 1) Barcroft
 - 2) Mountaire Selbyville
 - 3) Mountaire Frankford
 - 4) Vlasics Foods
 - 5) Townsend's
 - 6) MFG Justin Tanks
 - 7) Allen Family Foods
 - 8) Draper King Cole

Other possible answers: Nanticoke Homes, Dentsply/Caulk Main, Marble Works, Perdue Bridgeville, Delagra, Orient Chemical, Rite Off, S.C. Johnson Polymer, Gardner Asphalt DuPont Seaford

6. List the top 10 businesses in Delaware that have reported the most toxic releases:
 - 1) DuPont Seaford
 - 2) General Motors
 - 3) Townsend's
 - 4) DuPont Edge Moor
 - 5) Rodel
 - 6) Star Enterprise
 - 7) Standard Chlorine
 - 8) Formosa Plastics
 - 9) MEDAL L.P.
 - 10) Chrysler

7. How many of these top ten businesses are in your area or county? 2
8. Which of the businesses is the closest to your school? Answers will vary



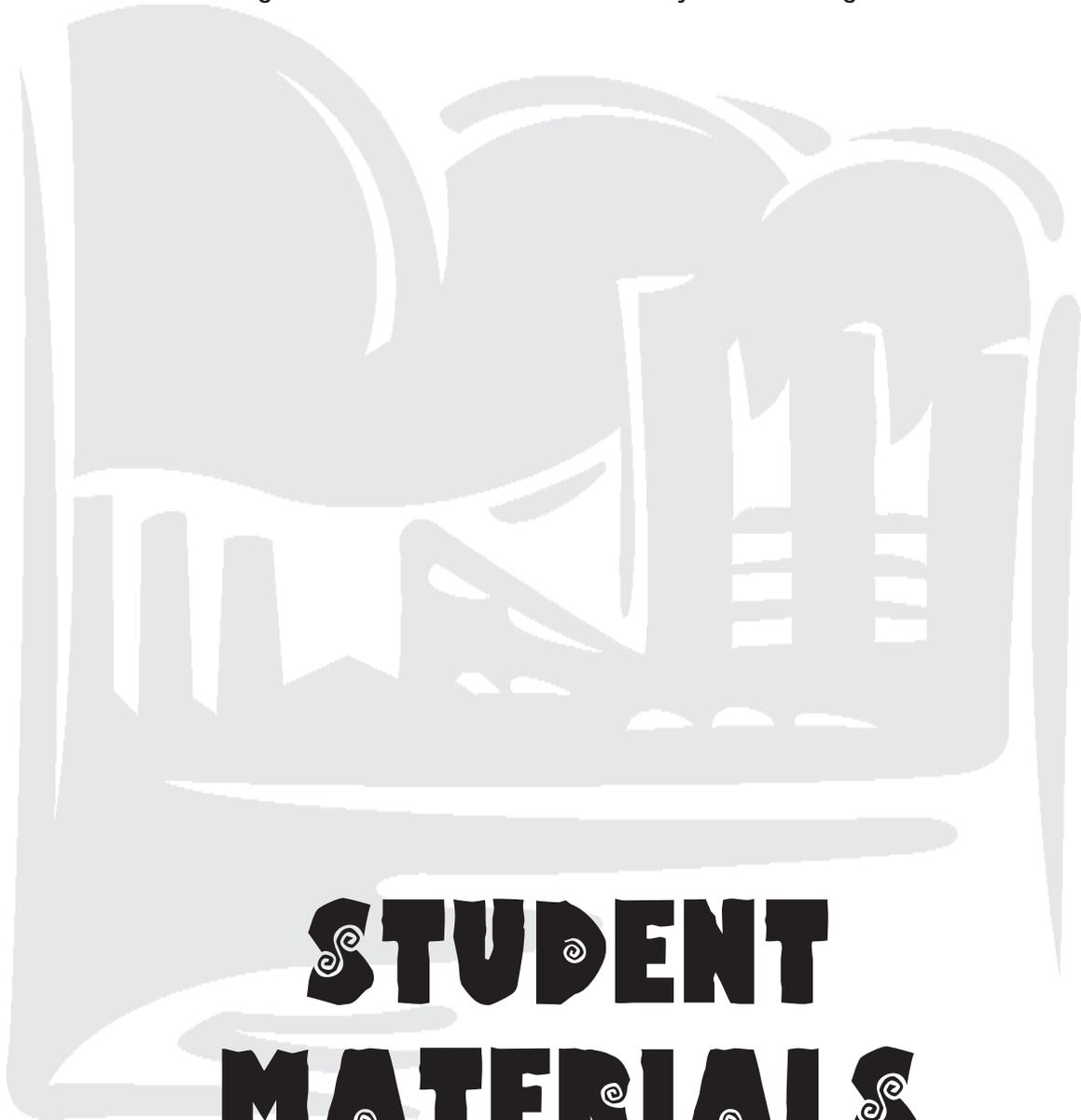
9. How many TRI facilities or businesses are located within 5 miles of your school? Answers will vary

10. What chemicals do the TRI facilities located within 5 miles of your school release into the air?

Answers will vary

11. Make a list of the top 15 chemicals released to the air by these Delaware reporting businesses:

- 1) N-Hexane
- 2) Hydrochloric Acid
- 3) Xylene
- 4) Carbonyl Sulfide
- 5) N,N-Dimethylformamide
- 6) Methanol
- 7) Vinyl Chloride
- 8) Methyl Ethyl Ketone
- 9) Ethylene
- 10) Methyl Isobutyl Ketone
- 11) Ammonia
- 12) Glycol Ethers
- 13) Sulfuric Acid
- 14) Dichloromethane
- 15) Methyl Tertiary-Butyl Ether



STUDENT MATERIALS

LESSON 2 ACTIVITY 3



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 2

REPORT GUIDELINE QUESTIONS

Lesson 2 Activities 3

	NAME OF BUSINESS	LOCATION	PRODUCTS	TOXIC RELEASES
1.	_____	_____	_____	_____
	_____	_____	_____	_____
			_____	_____
			_____	_____
2.	_____	_____	_____	_____
	_____	_____	_____	_____
			_____	_____
			_____	_____

4. Explain the health hazards of these emissions:



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 3 Lesson 2 Activity 3

AIR TOXIC POLLUTANT	EFFECT ON HUMAN HEALTH
Benzene	May cause drowsiness, dizziness, headaches , and unconsciousness in humans. Increased incidence of leukemia have been observed in humans occupationally exposed. Death may result from exposure to very high levels of benzene. EPA has classified benzene as a Group A , known human carcinogen of medium carcinogenic hazard.
1,3-Butadiene	Acute (short-term) exposure by inhalation results in irritation of the eyes, nasal passages, throat, and lungs , and causes neurological effects such as blurred vision, fatigue, headache, and vertigo . Epidemiological studies have reported a possible association between 1,3-butadiene exposure and cardiovascular diseases . EPA has classified 1,3-butadiene as a Group B2 , probable human carcinogen of medium carcinogenic hazard.
Carbonyl Sulfide	Limited information is available. May cause narcotic effects in humans. May also irritate the eyes and skin in humans. EPA has not classified Carbonyl sulfide with respect to potential carcinogenicity.
Chlorobenzene	Chronic (long-term) exposure to humans effects the central nervous system . May cause numbness, cyanosis, hyperesthesia (increased sensation), and muscle spasms. Headaches and irritation of the mucosa of the upper respiratory tract and eyes have been reported to those chronically exposed via inhalation. EPA has classified chlorobenzene as a Group D , not classifiable as to human carcinogenicity.
N,N-Dimethylformamide	Acute (short-term) exposure has been observed to damage the liver . Symptoms of acute exposure include abdominal pain, nausea, vomiting, jaundice, alcohol intolerance, and rashes . Chronic (long-term) occupational exposure has resulted in effects on the liver and digestive disturbances in workers. EPA classified dimethylformamide as a Group 2B , the chemical is possibly carcinogenic to humans.
1,4-Dichlorobenzene	Acute (short-term) health effects can cause headaches, dizziness, nausea , and swelling around the eyes, hands and feet; contact with the dust can cause skin burns; exposure to the vapor can irritate the eyes, nose, and throat , exposure to high concentrations can cause liver damage severe enough to cause death . Chronic (long-term) health effects are: exposure can damage the nervous system causing weakness, trembling, and numbness in the arms and legs; may cause a skin rash ; exposure can damage the lungs, liver and kidneys ; and can damage the blood cells, causing anemia .



AIR TOXIC POLLUTANT

EFFECT ON HUMAN HEALTH

Ethylene

Ethylene gas is **HIGHLY FLAMMABLE AND EXPLOSIVE**. This is the major hazard of ethylene exposure. Acute (short-term) health effects are: exposure can cause you to feel **dizzy, lightheaded**, and to **pass out**; contact with liquid ethylene can cause **frostbite**.

Ethylene Oxide

Acute (short-term) effects are mainly of the **central nervous system (CNS)**, **depression** and **irritation of the eyes and mucous membranes**. High concentrations produce **weakness, nausea, convulsions, and death**. Chronic (long-term) exposure can cause **irritation of the eyes, skin and mucous membranes**; problems in the **functioning of the brain and nerves**; and the formation of **cataracts**. Limited evidence indicate that inhalation exposure may result in **adverse reproductive effects** such as an increased rate of **miscarriages**. Some cancer data show an increase in the incidence of **leukemia, stomach cancer, cancer of the pancreas, and Hodgkin's disease** in workers exposed to ethylene oxide. Ethylene oxide is classified as a **Group B1**, probable human carcinogen of medium carcinogenic hazard.

N-Hexane

Acute (short-term) inhalation cause **mild central nervous system depression and irritation of the skin and mucous membranes**. Nervous system effects include **dizziness, giddiness, slight nausea**, and **headache** in humans. EPA has classified N-hexane as a **Group D**, not classifiable as to human carcinogen.

Hydrochloric Acid

Corrosive to the **eyes, skin, and mucous membranes**. Acute(short-term) inhalation may cause **coughing, hoarseness, inflammation and ulceration of the respiratory tract, chest pain, and pulmonary edema** in humans. Chronic (long-term) exposure causes **gastritis, chronic bronchitis, and dermatitis**. EPA has not classified hydrochloric acid.

Methanol

Acute (short-term) health effects which may occur immediately or shortly after exposure are: contact may **irritate the eyes, nose, mouth, and throat**; breathing the vapor or absorbing the liquid through the skin can cause permanent **blindness**; high concentrations can cause **death**. Chronic (long-term) health effects are: may **damage the liver**; and can cause dryness and cracking of the skin.

Methyl Ethyl Ketone

Acute (short-term) health effects that can occur immediately or shortly after exposure are: **irritate the skin** causing a **rash** or burning feeling on contact; the liquid can severely **burn the eyes**, leading to permanent damage; exposure to the vapor can irritate the **eyes, nose, mouth, and throat**. Exposure to high concentrations can cause **dizziness, lightheadedness, headache, nausea, and blurred vision**; higher levels may cause you to pass out. Chronic (long-term) health effects include **reduced memory** and concentration, **personality changes** (withdrawal, irritability), **fatigue, sleep disturbances, reduced coordination**, and/or effects on nerves supplying internal organs as well as the nerves to the arms and legs.

Methyl Isobutyl Ketone

Acute (short-term) exposure may **irritate the eyes and mucous membranes, and cause weakness, headache, nausea, lightheadedness, vomiting, dizziness, narcosis, and, at high levels, coma and death**. Chronic (long-term) occupational exposure has been observed to cause **nausea, headache, burning in the eyes, weakness, insomnia, intestinal pain, and slight enlargement of the liver**. EPA has classified methyl isobutyl ketone as a **Group D**, not classifiable as to human carcinogen.



AIR TOXIC POLLUTANT

EFFECT ON HUMAN HEALTH

Methyl tertiary-butyl ether (MTBE)

Based on a small number of investigations and surveys it appears that exposure to **MTBE** will result in **headache, eye irritation, burning of the nose or throat, cough, nausea or vomiting, dizziness**, and a sensation of **spaciness or disorientation**.

Sulfuric Acid

Acute (short-term) health effects can severely irritate or even **burn the skin and eyes**; exposure can cause **nose, throat and lung irritation** with cough and/or shortness of breath; higher doses can cause a buildup of **fluid in the lungs** (pulmonary edema), a medical emergency. Chronic (long term) health effects include a probable **carcinogen** in humans, causing cancer (**causes throat cancer** in humans).

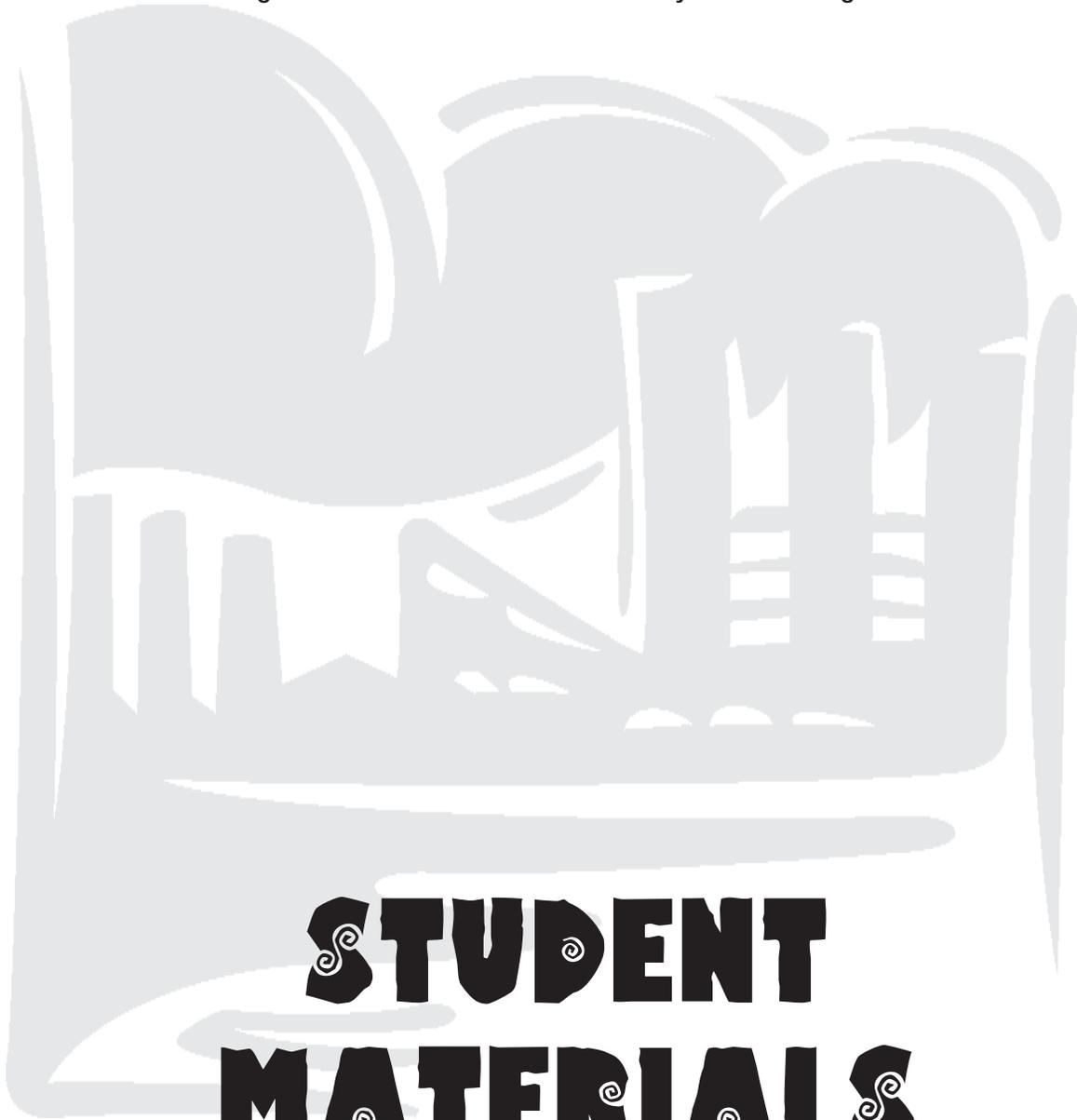
Vinyl Chloride

Acute (short-term) health effects can cause you to feel **dizzy, lightheaded, "high" and sleepy**; high levels can cause you to pass out and die; contact can irritate the skin and eyes; the liquid can cause **frostbite**. Chronic (long-term) health effects: Vinyl Chloride is a **Carcinogen** in humans and **causes cancer**; repeated exposure can cause a disease called "**scleroderma**" which causes the skin to become very smooth, tight and shiny; it causes the bones of the **fingers to erode**; repeated exposure can **permanently damage** the **liver** and damage the **kidneys, nervous system and blood cells**.

Zylene

Acute (short-term) health effects can damage the **developing fetus**; can irritate the **eyes, nose and throat**; repeated exposure may damage bone marrow causing low blood cell count; may also **damage the eyes, and cause stomach problems**; may also cause problems with **memory and concentration**. Zylene is also **flammable** and a fire hazard. Very high levels can cause **death**.

Source: EPA's - *Health Effects Notebook for Hazardous Air Pollutants* (fact sheets)



STUDENT MATERIALS

LESSON 2 ACTIVITY 4



2

GROUND LEVEL ZONE

Lesson 2 Activity 4

Reading 1

In 1970, under the Nixon administration, the United States government established the Environmental Protection Agency (EPA) under the Executive Branch of government. The mission of the EPA was to protect human health and to safeguard the natural environment. Today citizens across the United States are breathing cleaner air, drinking cleaner water, and have less exposure to dangerous toxic compounds than they did in 1970. Since 1970, the total emissions of the six common air pollutants have decreased by an average of 24 percent. Since 1970, emissions of particulate matter decreased by 78 percent. Since 1988, airborne concentrations of fine particulate matter have dropped 20 percent. Since 1970, emissions of lead have declined by 98 percent, primarily by eliminating lead from gasoline and placing controls on specific industrial sources of lead. Since 1978, average blood-lead levels in the blood of children have declined by nearly 75 percent. Between 1987 and 1993, U.S. production of stratospheric ozone-depleting chlorofluoro-carbons fell by more than 60 percent. The percentage of U.S. households that have tested their homes for radon has increased from 3.6 percent in 1990 to 10.2 percent in 1994. These improvements have been realized even as the economy grew by 90 percent, the population rose by 27 percent, and the number of motor vehicle miles driven increased by 111 percent.

The Pollution Prevention Act of 1990 made pollution prevention (P2) the national environmental policy of the United States. This Act established a bold national objective for the Environmental Protection Agency: "That pollution should be prevented or reduced at the source whenever feasible." This means source reduction—preventing or reducing waste where it originates, at the source—including practices that conserve natural resources by reducing or eliminating pollutants through increased efficiency in the use of raw materials, energy, water, and land.

The Pollution Prevention Information Clearinghouse (PPIC) was established. The PPIC is a free, nonregulatory service of the U.S. EPA dedicated to reducing or eliminat-

ing industrial pollutants through technology transfer, education, and public awareness.

In 1993, the Clinton-Gore Administration made a commitment to environmental solutions that reduces all pollution at its source. The Clinton-Gore Administration's budget request for the 1994 fiscal year included a \$33 million increase in spending for pollution prevention programs at EPA. On Earth Day in 1994, President Clinton announced his commitment to an Executive Order establishing voluntary source reduction goals for procurement, and requiring federal agencies to comply with Right-to-Know public reporting requirements for toxic chemical wastes.

To meet the nation's future environmental challenges, the EPA is reinventing the way it provides environmental protection and exploring new directions to implement its programs fairer, faster and more cost-effectively. Reinvention at EPA means focusing on results and providing flexibility and incentives to encourage innovative solutions. It means forming partnerships with states as co-regulators, with stakeholders to support local efforts to forge sustainable futures, and with regulated entities to find leaner, cheaper solutions. It means empowering the public to take action by increasing access to information about pollutants in their communities and making more data available through programs such as the Toxics Release Inventory (TRI) program. It means finding ways to break down the legal barriers that currently make it difficult to implement integrated approaches for managing environmental quality at the facility, industry, and community-wide levels. Building on past successes, EPA is adopting a more comprehensive approach that develops integrated solutions for entire communities and ecosystems.

Sources: EPA's *Pollution Prevention Programs & Projects* (Internet website: <http://www.epa.gov/opptintr/p2home/>)
EPA's *Pollution Prevention Information Clearinghouse* (PPIC) (Internet website: <http://www.epa.gov/opptintr/library/libppic.htm>)



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 4

POLLUTION PREVENTION WORKSHEET

Lesson 2 Activity 4

PROBLEM: How can toxic releases to air by business be reduced in order to clean up the air in Delaware and the nation?

HYPOTHESIS: _____

1. What is the Environmental Protection Agency? _____

2. What U.S. President established the EPA? _____

3. What was the mission or purpose of the EPA? _____

4. How does the air quality today compare with the air quality of 1970? _____

5. What evidence can you give to support your comparison in question #4?

6. What was the Pollution Prevention Act of 1990? _____

7. What was the purpose of the Pollution Prevention Act of 1990? _____



8. What was the purpose of the Pollution Prevention Information Clearinghouse? _____

9. What did the Clinton-Gore Administration do for air quality? _____

10. What is the EPA doing to meet the nation's future environmental challenges? _____

CONCLUSION: (Check one) _____ Supported original hypothesis
_____ Changed original hypothesis
_____ Refuted original hypothesis

NEW OR REVISED CONCLUSION: _____



TEACHER MATERIALS

LESSON 2 ACTIVITY 4



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

HANDOUT 4 Lesson 2 Activity 4

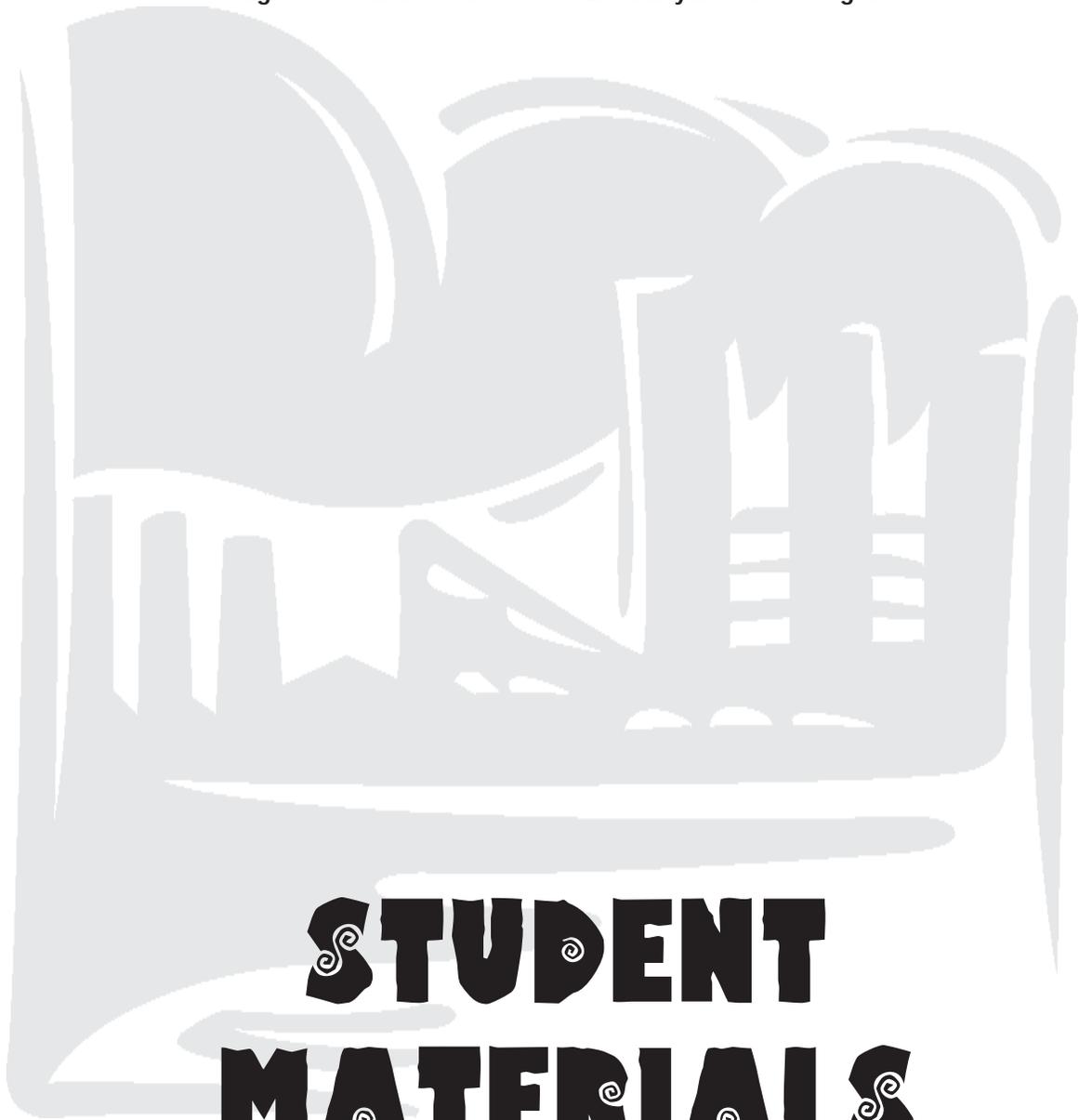
POLLUTION PREVENTION ANSWER KEY

1. What is the Environmental Protection Agency?
The United States government established the Environmental Protection Agency (EPA) under the Executive Branch of government.
2. What U.S. President established the EPA?
In 1970, under the Nixon administration, the United States government established the Environmental Protection Agency.
3. What was the mission or purpose of the EPA?
The mission of the EPA was to protect human health and to safeguard the natural environment.
4. How does the air quality today compare with the air quality of 1970?
Today the citizens across the United States are breathing cleaner air, drinking cleaner water, and have less exposure to dangerous toxic compounds than they did in 1970.
5. What evidence can you give to support your comparison in question #4?
Since 1970, the total emissions of the six common air pollutants have decreased by an average of 24 percent. Since 1970, emissions of particulate matter decreased by 78 percent.
6. What was the Pollution Prevention Act of 1990?
The Pollution Prevention Act of 1990 made pollution prevention (P2) the national environmental policy of the United States.
7. What was the purpose of the Pollution Prevention Act of 1990?
This Act established a bold national objective for the Environmental Protection Agency: "That pollution should be prevented or reduced at the source whenever feasible."
8. What was the purpose of the Pollution Prevention Information Clearinghouse?
The PPIC is a free, nonregulatory service of the U.S. EPA dedicated to reducing or eliminating industrial pollutants through technology transfer, education, and public awareness.
9. What did the Clinton-Gore Administration do for air quality?
In 1993, the Clinton-Gore Administration made a commitment to environmental solutions that reduces all pollution at its source. The Clinton-Gore Administration's budget request for the 1994 fiscal year included a \$33 million increase in spending for pollution prevention programs at EPA. On Earth Day in 1994, President Clinton announced his commitment to an Executive Order establishing voluntary source reduction goals for procurement, and requiring federal agencies to comply with Right-to-Know public reporting requirements for toxic chemical wastes.



10. What is the EPA doing to meet the nation's future environmental challenges?

To meet the nation's future environmental challenges, the EPA is reinventing the way it provides environmental protection and exploring new directions to implement its programs fairer, faster and more cost-effectively. Reinvention at EPA means focusing on results and providing flexibility and incentives to encourage innovative solutions. It means forming partnerships with states as co-regulators, with stakeholders to support local efforts to forge sustainable futures, and with regulated entities to find leaner, cheaper solutions. It means empowering the public to take action by increasing access to information about pollutants in their communities and making more data available through programs such as the Toxics Release Inventory (TRI) program. It means finding ways to break down the legal barriers that currently make it difficult to implement integrated approaches for managing environmental quality at the facility, industry, and community-wide levels. Building on past successes, EPA is adopting a more comprehensive approach that develops integrated solutions for entire communities and ecosystems.



STUDENT MATERIALS

LESSON 2 ACTIVITY 5



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

Lesson 2 Activity 5

SCORING RUBRIC FOR CONGRESSIONAL LETTER

- 4 – The letter is clear and well developed
- 3 – The letter is somewhat clear and well developed
- 2 – The letter is vague and somewhat well developed
- 1 – The letter is vague and not well developed

	0	1	2	3	4	
1. Description of Air Quality Issue P.I. H.401, H.402, H.403; 7.427, 8.427	_____	_____	_____	_____	_____	x 5 = _____
2. Well developed position P.I. C.416	_____	_____	_____	_____	_____	x 5 = _____
3. Supporting details P.I. H.408	_____	_____	_____	_____	_____	x 5 = _____
3. Evidence of research (names and addresses of representatives) P.I. H.405	_____	_____	_____	_____	_____	x 5 = _____
5. Course of Action and influence P.I. C.418; 8.409	_____	_____	_____	_____	_____	x 5 = _____

GRADE _____



WHAT IMPACT DOES INDUSTRY HAVE ON AIR QUALITY ?

Handout 5 Lesson 2 Activity 5 STUDENT DIRECTIONS

AIR QUALITY ISSUE

CONGRESSIONAL LETTER

DESCRIPTION: You will apply what you have learned in this lesson and measure the application of knowledge and skills from the performance indicators of the lesson.

Directions:

1. You will participate in a culminating activity by writing a letter (typed - double spaced) to your congressman concerning the increase in emissions of a specific local industry from 1995 to 1996.
2. You should support your position with well developed ideas and details from your research and what you have learned in class.
3. You should be able to support your position with details from your research.
4. Be sure to explain the course of action that needs to be followed to help solve the issue that you are addressing. In other words, a well developed position.
5. Be sure to follow the proper letter form as described by your teacher.
6. Be sure to examine the scoring rubric that will be used to evaluate and grade your position paper.