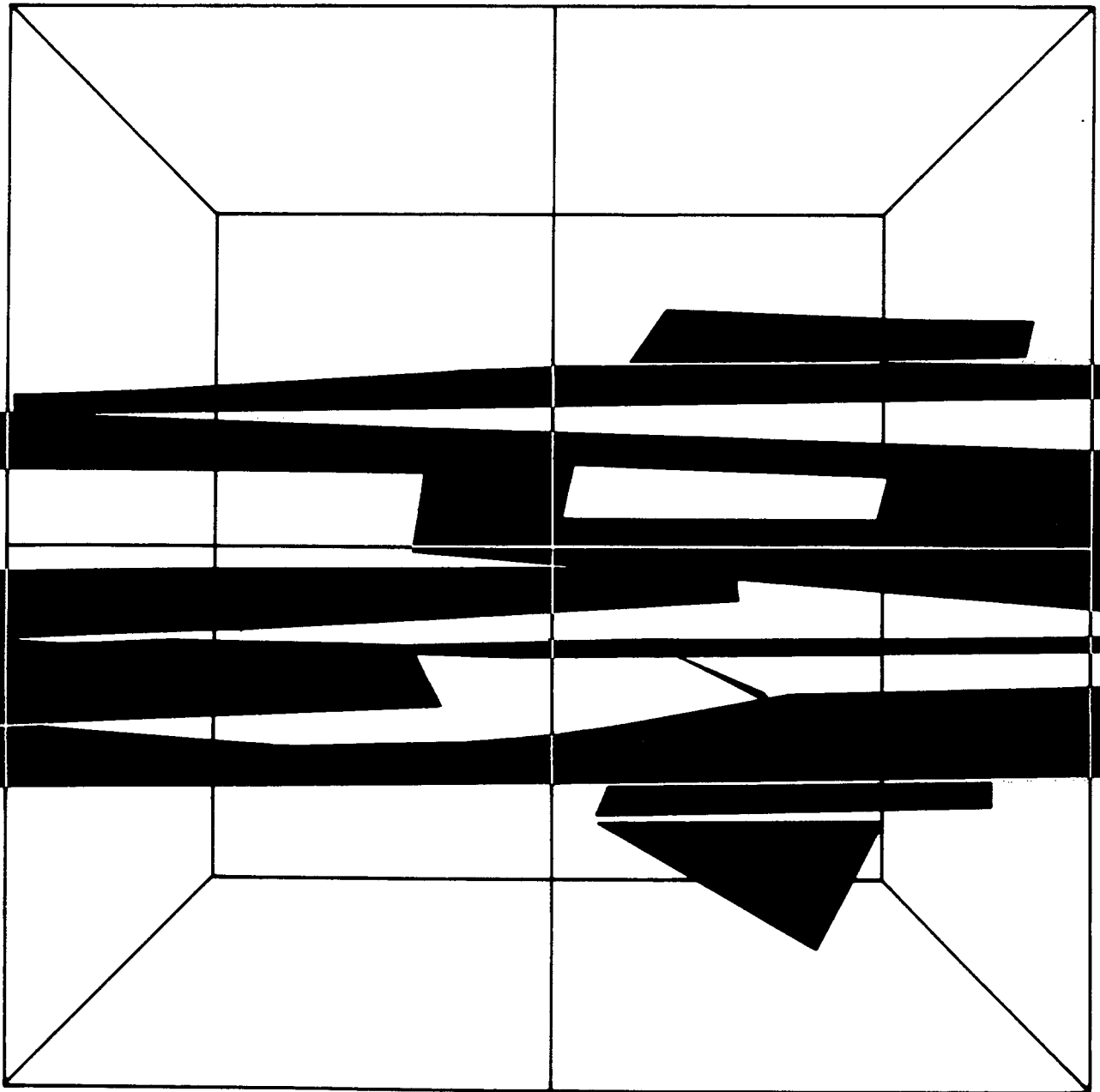


# Summary of Spill Events in Canada, 1974-1983

EPS 5/SP/1  
November 1987



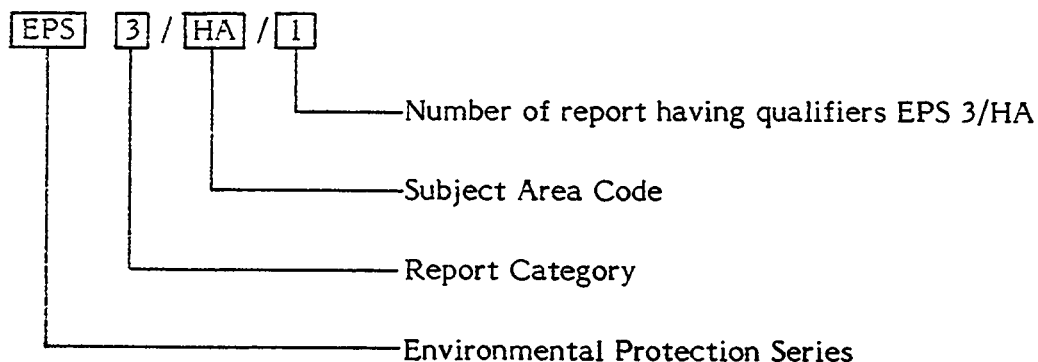
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## **SUMMARY OF SPILL EVENTS IN CANADA, 1974-1983**

**R.A. Beach and Gilles Cloutier**

**National Environmental Emergency Centre  
Management and Emergencies Branch  
Conservation and Protection  
Environment Canada**

**Report EPS 5/SP/1  
November, 1987**

## READERS' COMMENTS

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## SUMMARY

The Environmental Emergency Program Division, Management and Emergencies Branch maintains a database for all spills reported to Environment Canada. An analysis of 10 years of data, 1974 through 1983, is presented in this paper. A Summary Ledger (Appendix 1) presents the results for each year. A statistical analysis of the results reveals the following significant patterns and trends.

- The total number of events reported from 1974 to 1983 was 21 587.
- The number of events reported per year increased until 1980, then decreased until 1983.
- This rise and fall in events reported is a reflection of the actual number of spills occurring in Canada.
- The source with greatest spill tonnage reported was industrial plants.
- The source with most events reported was production fields (mines and wells).
- Pipeline spills decreased sharply in 1982 and 1983.
- Events and tonnes spilled in marine events remained constant throughout the period.
- Tank truck road accidents decreased over the 10-year period.
- Production field pipe leak events decreased, but tonnage spilled remained constant.
- For the "Industrial Plant" category, overflows decreased over the 10-year period, while "discharges" (intentional or accidental) increased.
- For "Oils", the most frequently spilled material was crude oil.
- The most important "Non-Oils" spilled were saline water, sewage, and industrial waste.
- The proportion of events reported that involved chemicals (i.e., "Non-oils", but excluding salt water) increased from 10 percent in 1974 to 25 percent in 1983.

## RÉSUMÉ

La Division des urgences environnementales de la Direction de la gestion et des urgences tient à jour une banque de données sur tous les déversements signalés à Environnement Canada. Le présent document sert à présenter l'analyse des données recueillies de 1974 à 1983. Celles-ci sont présentées sous forme de relevés sommaires annuels à l'annexe 1. Une analyse statistique des résultats permet de déceler les tendances significatives suivantes:

- le nombre total d'incidents enregistrés de 1974 à 1983 fut de 21 587;
- le nombre d'incidents signalés chaque année a augmenté jusqu'en 1980, puis a diminué jusqu'en 1983;
- cette augmentation et cette diminution des incidents signalés correspondent au nombre réel d'incidents qui se produisent au Canada;
- la source dont le tonnage déversé est le plus grand: les usines;
- la source qui compte le plus grand nombre d'incidents: les gisements productifs (mines et puits);
- les déversements des pipelines ont diminué considérablement en 1982 et 1983;
- le nombre d'incidents et les quantités déversées dans le domaine maritime sont demeurés constants au cours de toute cette période;
- le nombre d'accidents routiers mettant en cause des camions a baissé au cours de cette période de dix ans;
- le nombre de fuites des conduites de gisements productifs a diminué mais les quantités déversées sont demeurées constantes;
- dans la catégorie "usines industrielles", les débordements ont diminué au cours de la période, tandis que les "rejets" ("intentionnels ou accidentels") ont augmenté;
- dans la catégorie "hydrocarbures", le produit le plus fréquemment déversé est le pétrole brut;
- dans la catégorie "autre" (matières autres que les hydrocarbures), les déversements les plus importants en volume sont les déversements d'eau salée (de gisement), d'eaux usées et de déchets industriels;
- le pourcentage d'incidents signalés au cours desquels des produits chimiques ("produits non pétroliers" moins "eau salée") ont été répandus est passé de 10 p. 100 en 1974 à 25 p. 100 en 1983.

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## 1 INTRODUCTION

The Environmental Emergency Program Division (EPPD), Management and Emergencies Branch, of Environment Canada maintains a computerized database called NATES (National Analysis of Trends in Emergencies System). The system allows Environment Canada and other participating government agencies to store and analyze information on spills and other pollution incidents.

Spill data are entered into the system from coding forms. Each coding form contains 43 pieces of information, called fields. Examples of fields are "Date", "Amount Spilled", and "Cause". Other fields contain information such as geographical details, cleanup method, percent cleaned up, etc.

The field structure allows searching through the database for very specific information. For example, in a typical search, one might ask for all gasoline spills in 1983 where the source was a tank truck and the cause an overturn.

The above search methods have been used in the past to generate yearly summaries of environmental emergencies in Canada. Summaries were published for 1974 to 1978. In this current analysis, the above summaries are being republished — since a considerable number of data have been added or amended — with additional data for 1979 to 1983. The format of the presentation has been slightly modified to reflect the breakdown of causes for certain spill categories better.

From an examination of 10 years of data, certain trends can be discerned. This report presents some basic patterns and trends found in the NATES spill data from 1974 to 1983. These will be useful to all those working with spills:

- first responders;
- research and development workers;
- prevention and loss control program officers; and
- regulators.

The extensive tables and "summary ledgers" in the report allow the reader to obtain a fair amount of detail in specific fields of interest.

## 2 DESCRIPTION OF SUMMARY LEDGER

A ledger consists of two parts (see page 33 for an example). The first part, found on the left-hand side of the page, breaks down the data by sector source, and cause. The second part, on the right-hand side, breaks down the data by material. In both sections, the breakdown is by number of events as well as by tonnes (metric) spilled.

The 1974 summary (Appendix 1) can serve as an example. At the top left-hand side, is the heading, "Number of Events by Source"; under that heading is information to the effect that 17 events can be attributed to tankers, 22 to bulk carriers, etc. Looking at tanker incidents:

- 1 event occurred in the government sector;
- 11 in the transportation sector;
- 3 in petroleum; and
- 2 in the category "Other".

The causes of these 17 tanker incidents are further broken down as follows:

- 4 under "Collision, Grounding or Sinking" for a total of 458 tonnes;
- 10 under "Transfer Accidents" for 40.1 tonnes; and
- 3 under "Other" causes for a total of 10.1 tonnes.

Tanker incidents account for a total of 509 tonnes of materials spilled.

Looking at the right-hand side of the ledger, the tonnes spilled and the number of events are classified by product. For example, one can see that 163 spills involved crude oil for a total of 14 823 tonnes.

Note that each NATES record (or "event") may have one or two materials spilled. When two materials are spilled, we say there is one event, but two spills. Therefore the total number of spills equals "total events" plus "events with two materials spilled".

### 3 ANALYSIS OF RESULTS

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**Significant Trend: Total number of spills peaked in 1980.  
Steady decrease from 1980 onward.**

---

Table 1 gives a year-by-year summary of the total number of spills and total tonnes spilled. Figure 1 is a line graph representing these data. There is an increase in spills every year from 1974 to 1980, then a steady decrease from 1980 to 1983.

TABLE 1 SUMMARY OF SPILL DATA

Year	Number of Spill Events	Quantity of Material Spilled (t)
1974	1 141	128 550
1975	1 769	485 240
1976	1 944	409 560
1977	2 373	110 920
1978	2 428	166 970
1979	2 791	125 130
1980	2 861	367 270
1981	2 376	959 580
1982	1 989	403 760
1983	1 915	512 480
10-Year Total	21 587	3 669 460

Do changes in the number of spills reported reflect changes in reporting quality or variations in the actual number of spills occurring? A reporting network is judged by two factors: quality and quantity. Quality reporting means that persons or agencies consistently report all significant spills. When small spills are regularly reported, as well as the larger conspicuous ones, then the quality is good. A spill size distribution analysis of NATES data shows that the median spill size for oils has stayed constant with time: the quality is uniform. A similar analysis shows that reporting quality for non-oils improved with time.

The quantity of reporting is a measure of the number of reporting agencies and of the numbers of spills that come to the attention of these agencies. Our sources for spill data remained constant throughout the 10-year period, and reporting quality remained constant or improved. Therefore, the conclusion that the number of spills per

year occurring in Canada increased from 1974 to 1980 and then decreased from 1981 to 1983 is valid.

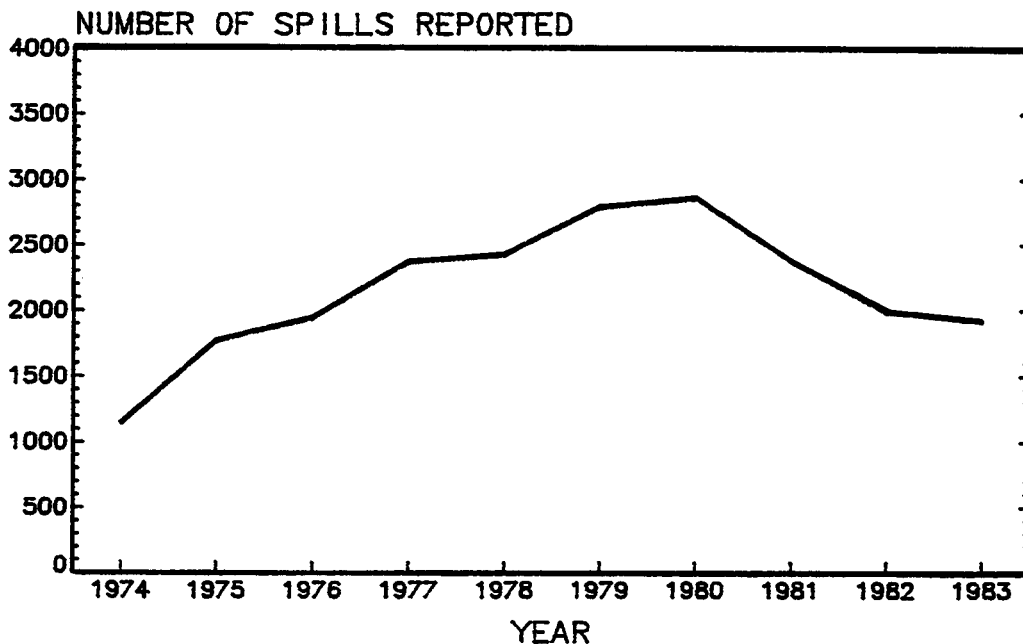


FIGURE 1 SUMMARY OF SPILL DATA

### 3.1 Sector

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#### Most Important Sectors: Petroleum and Transport

---

During the 10-year period (1974 to 1983), the most important sectors were petroleum with 58 percent and transport with 16 percent of all events (see Table 2). Note that only percentages are used to analyze results in this paper. This eliminates the effects of fluctuations in yearly totals. Raw numbers might give false trends.

There are many reasons why the petroleum sector is responsible for most spill events.

1. Petroleum products are everywhere; they are produced, stored, shipped and used in very large volumes.
2. Since these products are frequently transported in trucks owned by oil companies, transport or handling accidents are often classed, for NATES purposes, in the petroleum sector.

TABLE 2 SECTOR ANALYSIS

Year	Number of Events % of Total in Boldface							
	Petroleum	Transport	Chemical	Mining & Metallurgy	Government	P. & Paper, Forestry	Other	Total
1974	502 <b>44</b>	169 <b>15</b>	43 <b>4</b>	26 <b>2</b>	63 <b>6</b>	26 <b>2</b>	312 <b>27</b>	1 141 <b>100*</b>
1975	1 135 <b>64</b>	194 <b>11</b>	65 <b>4</b>	45 <b>3</b>	50 <b>3</b>	51 <b>3</b>	229 <b>13</b>	1 769 <b>100</b>
1976	1 212 <b>62</b>	266 <b>14</b>	73 <b>4</b>	54 <b>3</b>	38 <b>2</b>	60 <b>3</b>	241 <b>12</b>	1 944 <b>100</b>
1977	1 428 <b>60</b>	382 <b>16</b>	84 <b>4</b>	56 <b>2</b>	68 <b>3</b>	72 <b>3</b>	283 <b>12</b>	2 373 <b>100</b>
1978	1 498 <b>62</b>	352 <b>14</b>	91 <b>4</b>	42 <b>2</b>	75 <b>3</b>	46 <b>2</b>	324 <b>13</b>	2 428 <b>100</b>
1979	1 628 <b>58</b>	515 <b>18</b>	81 <b>3</b>	61 <b>2</b>	66 <b>2</b>	41 <b>1</b>	399 <b>14</b>	2 791 <b>100</b>
1980	1 648 <b>58</b>	506 <b>18</b>	87 <b>3</b>	84 <b>3</b>	52 <b>2</b>	49 <b>2</b>	435 <b>15</b>	2 861 <b>100</b>
1981	1 178 <b>50</b>	432 <b>18</b>	133 <b>6</b>	109 <b>5</b>	43 <b>2</b>	62 <b>3</b>	419 <b>18</b>	2 376 <b>100</b>
1982	1 107 <b>56</b>	317 <b>16</b>	78 <b>4</b>	105 <b>5</b>	49 <b>2</b>	29 <b>1</b>	304 <b>15</b>	1 989 <b>100</b>
1983	1 093 <b>57</b>	275 <b>14</b>	60 <b>3</b>	107 <b>6</b>	104 <b>5</b>	38 <b>2</b>	238 <b>12</b>	1 915 <b>100</b>
Total	12 429 <b>58</b>	3 408 <b>16</b>	795 <b>4</b>	689 <b>3</b>	608 <b>3</b>	474 <b>2</b>	3 184 <b>15</b>	21 587 <b>100</b>

\* percentages in table may not always add to 100% because of rounding errors.

3. Good internal reporting practices by oil companies combined with stringent government regulations have meant that a high proportion of all petroleum spills are reported.

These three factors combine to make the petroleum sector the most important in terms of number of spills reported every year in Canada.

Ranking third in the database is the chemical sector at 4 percent. This number is not as high as it would be if petrochemicals, such as ethylene and benzene, had been listed under "Chemical" instead of "Petroleum".

The next three sectors, "Mining and Metallurgy", "Government", "Pulp and Paper, Forestry" make up a total of 8 percent of all events. The "Other" category comprises 15 percent of all events not included in the above ranking. There is no clear

change from one year to another. The percentage figures do not fluctuate very much. For example, in the transportation sector, the overall percentage is 16 and the values range from 11 to 18 percent. According to 1974 to 1983 data, no significant changes are indicated in any of the sectors. Such recent events as the Bhopal disaster and the Kenora PCB spill might suggest that better reporting is to be expected in the chemical sector in the next few years. Improved prevention programs however might result in fewer spills, therefore it is difficult to predict what will happen. In the transportation sector, Transportation of Dangerous Goods Act (TDGA) regulations came into effect on 1 July 1985. These regulations will probably result in increased reporting of transport accidents.

### 3.2 Sources

---

**Source with Greatest Tonnage: Industrial Plants.**  
**Most Frequent Source: Production Fields.**  
**Significant Trend: Pipeline events decreased sharply in 1982-83.**

---

On breaking the spill events in Table 3 down by source, the following overall ranking can be observed.

Rank	Sources	Percentage of Total Events
1	Mines, Wells, and Batteries*	33
2	Storage Depots	12
3	Tank Trucks	11
4	Industrial Plants	10
5	Other Sources	8
6	Pipelines	7
7	Other Motor Vehicles	5
8	Tankers, Bulk Carriers, and Other Watercraft	5
9	Trains	3
10	Service Stations	3
11	Refineries and Marine Terminals	1
12	Aircraft	1

\* There is not much scatter; percentages for each year are close to this average figure.

TABLE 3 SOURCE ANALYSIS (Number of Events)

Year	Number of Events											Total	
	Mines, Wells & Batteries	Storage Depot	Tank Trucks	Industrial Plants	Pipelines	Other Motor Vehicles	Tankers, Bulk Carriers and Other Watercraft	Trains	Service Stations	Refineries & Marine Terminals	Aircraft		Other Sources
1974	211	76	73	167	56	99	141	28	9	25	3	253	1 141
	<b>18</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>9</b>	<b>12</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>0*</b>	<b>22</b>	<b>100</b>
1975	540	90	114	265	231	124	93	43	21	19	17	212	1 769
	<b>31</b>	<b>5</b>	<b>6</b>	<b>15</b>	<b>13</b>	<b>7</b>	<b>5</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>12</b>	<b>100</b>
1976	583	229	265	222	198	58	85	49	53	22	19	161	1 944
	<b>30</b>	<b>12</b>	<b>14</b>	<b>11</b>	<b>10</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>8</b>	<b>100</b>
1977	752	350	304	210	205	79	96	63	66	28	26	194	2 373
	<b>32</b>	<b>15</b>	<b>13</b>	<b>9</b>	<b>9</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>8</b>	<b>100</b>
1978	880	351	232	149	169	100	99	71	61	51	53	212	2 428
	<b>36</b>	<b>15</b>	<b>10</b>	<b>6</b>	<b>7</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>9</b>	<b>100</b>
1979	1 038	391	427	191	170	98	88	75	103	35	41	134	2 791
	<b>37</b>	<b>14</b>	<b>15</b>	<b>7</b>	<b>6</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>5</b>	<b>100</b>
1980	1 026	331	419	196	254	93	148	81	73	38	50	152	2 861
	<b>36</b>	<b>12</b>	<b>15</b>	<b>7</b>	<b>9</b>	<b>3</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>5</b>	<b>100</b>
1981	546	250	253	331	233	196	121	109	94	27	13	203	2 376
	<b>23</b>	<b>11</b>	<b>11</b>	<b>14</b>	<b>10</b>	<b>8</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>9</b>	<b>100</b>
1982	794	206	215	256	46	94	101	82	61	24	8	102	1 989
	<b>40</b>	<b>10</b>	<b>11</b>	<b>13</b>	<b>2</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>5</b>	<b>100</b>
1983	843	221	174	209	50	106	57	78	52	13	13	99	1 915
	<b>44</b>	<b>12</b>	<b>9</b>	<b>11</b>	<b>3</b>	<b>6</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>5</b>	<b>100</b>
Total	7 213	2 495	2 476	2 196	1 612	1 047	1 029	679	593	282	243	1 722	21 587
	<b>33</b>	<b>12</b>	<b>11</b>	<b>10</b>	<b>7</b>	<b>5</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>8</b>	<b>100</b>

\* Because of rounding, all percentages less than 0.5% are printed as 0%

TABLE 4 SOURCE ANALYSIS (Amount Spilled)

Year	Tonnes Spilled											Total (Tonnes)	
	Industrial Plants	Mines, Wells & Batteries	Storage Depots	Pipelines	Tankers, Bulk Carriers and Other Watercraft	Trains	Tank Trucks	Refineries & Marine Terminals	Other Motor Vehicles	Service Stations	Aircraft		Other Sources
1974	55 668 43	41 084 32	1 098 1	15 885 12	1 991 2	4 896 4	783 0	1 082 1	799 1	14 0	6 0	5 244 4	128 550 100
1975	19 211 4	17 060 4	3 809 1	12 382 3	6 731 1	1 615 0	942 0	367 0	1 410 0	64 0	42 0	421 606 87	485 240 100
1976	122 446 30	28 543 7	2 274 1	11 587 3	5 599 1	1 980 0	1 784 3	1 808 0	399 0	144 0	29 0	232 964 57	409 560 100
1977	14 751 13	66 104 60	3 925 4	11 446 10	6 805 6	1 475 1	3 354 1	1 599 1	538 0	155 0	80 0	694 1	110 920 100
1978	29 876 18	22 567 14	63 508 38	20 300 12	14 987 9	1 570 1	1 354 3	1 528 1	925 1	206 0	24 0	10 129 6	166 970 100
1979	7 654 6	33 260 27	39 852 32	22 401 18	6 544 5	9 241 7	4 079 1	650 1	778 1	160 0	19 0	493 0	125 130 100
1980	281 446 77	18 486 5	31 144 9	15 214 4	7 521 2	478 0	2 852 0	6 985 2	371 0	168 0	9 0	2 600 1	367 270 100
1981	922 647 96	10 766 1	4 690 0	7 051 1	5 501 1	3 322 0	1 977 0	424 0	725 0	470 0	20 0	1 992 0	959 580 100
1982	13 216 3	344 159 81	37 504 9	1 455 0	10 105 2	3 294 1	1 931 0	244 0	310 0	253 0	17 0	14 699 3	427 190 100
1983	9 126 18	21 189 5	2 842 1	2 211 0	5 075 1	980 0	1 233 5	61 0	330 0	127 0	19 0	469 288 92	512 480 100
Total	1 476 041 42	603 218 16	190 646 5	119 932 3	70 859 2	28 851 1	20 289 1	14 748 0	6 585 0	1 761 0	265 0	1 159 709 31	3 692 890 100



The number of events in "Industrial Plants" and "Other Sources" was higher in 1974 and 1975; they averaged about 15 percent and both stabilized at lower levels in subsequent years.

Of the above sources, "Pipelines" showed an abrupt change in the last two years. From 1974 to 1981, pipelines accounted for close to 9 percent of spill events, but in 1982 and 1983 this percentage decreased to an average of 2.5. This trend is possibly a result of successes in loss control programs.

Table 4 is a breakdown of sources by the number of tonnes spilled. Some sources are involved in few events, yet they spilled very large amounts; for other sources, the opposite is true.

The following list ranks the sources in descending order of the amount of material spilled.

Rank	Sources	Percentage of Total Tonnes Spilled
1	Industrial Plant	42
2	Other Sources*	31
3	Mines, Wells, and Batteries	16
4	Storage Depots	5
5	Pipelines	3
6	Trains	2
7	Tankers, Bulk Carriers, and Other Watercraft	1
8	Tank Trucks	1
9	Other Motor Vehicles	<0.5
10	Refineries and Marine Terminals	<0.5
11	Service Stations	<0.5
12	Aircraft	<0.5

\* "Other Sources" includes sources other than those particularly listed.

In the category ranking first, "Industrial Plants", most of the tonnage came from five major events, all over 50 000 tonnes. These five events totalled 1 267 500 tonnes or 86 percent of the tonnage in the category.

In the "Other Sources" category, three events accounted for 1 074 600 tonnes or 93 percent of the tonnage in that category. These three events were all discharges of sewage arising from equipment failures or storm overflows.

In "Mines, Wells, and Batteries", of the 603 200 tonnes spilled from 1974 to 1983, six events of 5 000 tonnes or more make up 365 000 tonnes or 61 percent. The single largest event was the Lodgepole gas-well blowout in 1982, where 280 000 tonnes of sour natural gas entered the environment.

About 80 percent of the tonnes spilled in the "Storage Depots" category came from seven events of 4 000 tonnes or more, of which the largest is 53 000 tonnes.

### 3.3 Analysis of Source and Cause

Six major sources were examined to determine the breakdown of events and tonnes by cause. These six sources are:

- watercraft (tankers, bulk carriers, and other vessels),
- tank trucks,
- other motor vehicles,
- mines, wells and batteries,
- storage depots, and
- industrial plants.

Tables 5 to 10 summarize the results.

For each of these sources, it was determined whether any of the causes changed significantly with time. This was done by plotting the percentages held by each cause against time. Through regression analysis a best-fit was found and the regression coefficient, "r", was calculated. If the magnitude of "r" was greater than 0.75, the upward or downward trend was considered significant.

#### 3.3.1 Tankers, Bulk Carriers, and Other Watercraft

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**Most Frequent Cause: "Collision, Grounding and Sinking".**  
**No significant upward or downward trends.**

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For the 10-year period from 1974 to 1983, the following patterns were evident. The "Collision, Grounding and Sinking" category held the majority of tonnes spilled: 51 percent. This is to be expected since ship casualty accidents are not very frequent, but when they do happen, large quantities of material are spilled.

Transfer accidents were the most important in terms of number of events: 53 percent. Transfer accidents are often the result of handling errors in loading or unloading ships. They are more frequent than ship casualties but the tonnage spilled is much less. Personnel are usually close at hand to stop the discharge.

From 1974 to 1983, there were no significant upward or downward trends in any of the above causes. The number of events and tonnes per year did not change significantly. (See Table 5.)

TABLE 5 WATERCRAFT: TANKS, BULK CARRIERS AND OTHER VESSELS

Year	Transfer Accident		Collision, Ground, Sinking		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	60	371	21	4 277	60	248	141	4 896
	<b>59</b>	<b>8</b>	<b>21</b>	<b>87</b>	<b>59</b>	<b>5</b>	<b>100</b>	<b>100</b>
1975	52	116	13	613	28	886	93	1 615
	<b>56</b>	<b>7</b>	<b>14</b>	<b>38</b>	<b>30</b>	<b>55</b>	<b>100</b>	<b>100</b>
1976	53	206	13	1 613	19	160	85	1 979
	<b>62</b>	<b>10</b>	<b>15</b>	<b>82</b>	<b>22</b>	<b>8</b>	<b>100</b>	<b>100</b>
1977	47	249	11	931	38	294	96	1 474
	<b>49</b>	<b>17</b>	<b>11</b>	<b>63</b>	<b>41</b>	<b>20</b>	<b>100</b>	<b>100</b>
1978	51	154	15	1 343	33	73	99	1 570
	<b>52</b>	<b>10</b>	<b>15</b>	<b>86</b>	<b>33</b>	<b>5</b>	<b>100</b>	<b>100</b>
1979	49	108	6	948	33	8 186	88	9 242
	<b>56</b>	<b>1</b>	<b>7</b>	<b>10</b>	<b>38</b>	<b>89</b>	<b>100</b>	<b>100</b>
1980	68	145	12	121	68	213	148	479
	<b>46</b>	<b>30</b>	<b>8</b>	<b>25</b>	<b>46</b>	<b>44</b>	<b>100</b>	<b>100</b>
1981	75	97	13	2 296	33	931	121	3 324
	<b>62</b>	<b>3</b>	<b>11</b>	<b>69</b>	<b>27</b>	<b>28</b>	<b>100</b>	<b>100</b>
1982	58	199	16	2 106	27	989	101	3 294
	<b>57</b>	<b>6</b>	<b>16</b>	<b>64</b>	<b>27</b>	<b>30</b>	<b>100</b>	<b>100</b>
1983	28	73	7	504	22	404	57	981
	<b>49</b>	<b>7</b>	<b>12</b>	<b>51</b>	<b>39</b>	<b>41</b>	<b>100</b>	<b>100</b>
Total	541	1 718	127	14 752	361	12 384	1 029	28 854
	<b>53</b>	<b>6</b>	<b>12</b>	<b>51</b>	<b>35</b>	<b>43</b>	<b>100</b>	<b>100</b>

% of Total in Boldface

TABLE 6 TANK TRUCKS % of Total in Boldface

Year	Road Accident		Transfer Acc.		Tank Leak		Discharge		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	52 71	620 79	8 11	20 3	2 3	4 1	-	-	11 15	139 18	73 100	783 100
1975	78 68	786 83	14 12	45 5	1 1	0 0	1 1	0	20 18	110 12	114 100	942 100
1976	138 52	1 247 70	57 22	232 13	20 8	68 4	12 5	4 0	38 14	234 13	265 100	1 784 100
1977	152 50	1 977 59	85 28	373 11	12 4	80 2	10 3	9 0	45 15	915 27	304 100	3 354 100
1978	133 57	1 004 74	49 21	111 8	9 4	82 6	7 3	27 2	34 15	130 10	232 100	1 354 100
1979	200 46	2 671 65	134 31	955 23	22 5	76 2	34 8	200 5	37 9	177 4	427 100	4 079 100
1980	172 41	2 012 71	124 30	199 7	27 6	88 3	69 16	442 15	27 6	111 4	419 100	2 852 100
1981	130 51	1 239 63	53 21	167 8	19 8	121 6	20 8	178 9	31 12	273 14	253 100	1 977 100
1982	88 41	1 241 64	49 23	164 8	47 22	389 20	7 3	40 2	24 11	97 5	215 100	1 931 100
1983	55 32	471 38	53 30	437 35	36 21	222 18	15 9	47 4	15 9	56 5	174 100	1 233 100
Total	1 198 48	13 268 65	626 25	2 703 13	195 8	1 130 6	175 7	948 5	282 11	2 242 11	2 476 100	20 290 100

### 3.3.2 Tank Trucks

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**Most Important Cause:** Road Accident.  
**Significant Trend:** Road accidents decrease over 10 years (tonnes and events).

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Table 6 shows that events and tonnes per year for tank trucks rose from 1974 to 1979, then decreased until 1983, following the trend for overall totals (see Figure 1). The most important cause for tank truck spills was "Road Accident", at 48 percent of the events and 65 percent of the tonnage.

Rank	Sources	Number of Events (%)	Amount Spilled (%)
1	Road Accident	48	65
2	Transfer Accident	25	13
3	Other	11	11
4	Tank Leaks	<10	<10
5	Discharge	<10	<10

The percentage of events attributed to road accidents per year decreased gradually from close to 70 percent in 1974 to just over 30 percent in 1983. Tonnages also decreased. In 1974-75 roughly 80 percent of the tonnes spilled by tank trucks were linked with road accidents. In the last three years, the average percentage was 55. Percentages of events and tonnes spilled in tank leaks rose from 1974 to 1983: both events and tonnes were less than 5 percent in 1974 yet about 20 percent in 1983.

### 3.3.3 Other Motor Vehicles

**Most Important Cause: Road Accidents.**

**No significant trends upward or downward from 1976-1983.**

There was no pattern in events per year for "Other Motor Vehicles". The most important cause, both in terms of events and tonnage, was "Road Accidents". (See Table 7.)

TABLE 7 OTHER MOTOR VEHICLES

% of Total in Boldface

Year	Road Accident		Tank & Cont. Leak		Transfer Accident		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	73	695	1	0	14	45	11	60	99	799
	<b>74</b>	<b>87</b>	<b>1</b>	<b>0</b>	<b>14</b>	<b>6</b>	<b>11</b>	<b>8</b>	<b>100</b>	<b>100</b>
1975	84	1 348	4	1	27	27	9	34	124	1 410
	<b>68</b>	<b>97</b>	<b>3</b>	<b>0</b>	<b>22</b>	<b>2</b>	<b>7</b>	<b>2</b>	<b>100</b>	<b>100</b>
1976	23	270	12	26	11	10	12	92	58	399
	<b>40</b>	<b>67</b>	<b>21</b>	<b>7</b>	<b>19</b>	<b>3</b>	<b>21</b>	<b>23</b>	<b>100</b>	<b>100</b>
1977	27	386	19	5	10	33	23	114	79	538
	<b>34</b>	<b>72</b>	<b>24</b>	<b>1</b>	<b>13</b>	<b>6</b>	<b>29</b>	<b>21</b>	<b>100</b>	<b>100</b>
1978	41	487	8	2	19	296	32	140	100	925
	<b>41</b>	<b>52</b>	<b>8</b>	<b>0</b>	<b>19</b>	<b>32</b>	<b>32</b>	<b>15</b>	<b>100</b>	<b>100</b>
1979	49	498	16	91	16	46	17	143	98	778
	<b>50</b>	<b>64</b>	<b>16</b>	<b>12</b>	<b>16</b>	<b>6</b>	<b>17</b>	<b>18</b>	<b>100</b>	<b>100</b>
1980	29	298	30	4	14	3	20	67	93	371
	<b>31</b>	<b>80</b>	<b>32</b>	<b>1</b>	<b>15</b>	<b>1</b>	<b>22</b>	<b>18</b>	<b>100</b>	<b>100</b>
1981	70	309	26	22	9	64	91	329	196	725
	<b>36</b>	<b>43</b>	<b>13</b>	<b>3</b>	<b>5</b>	<b>9</b>	<b>46</b>	<b>45</b>	<b>100</b>	<b>100</b>
1982	40	238	23	28	9	8	22	37	94	310
	<b>43</b>	<b>77</b>	<b>24</b>	<b>9</b>	<b>10</b>	<b>3</b>	<b>23</b>	<b>12</b>	<b>100</b>	<b>100</b>
1983	32	163	32	56	12	27	30	84	106	330
	<b>30</b>	<b>49</b>	<b>30</b>	<b>17</b>	<b>11</b>	<b>8</b>	<b>28</b>	<b>25</b>	<b>100</b>	<b>100</b>
Total	468	4 692	171	235	141	559	267	1 100	1 047	6 585
	<b>45</b>	<b>71</b>	<b>16</b>	<b>4</b>	<b>13</b>	<b>8</b>	<b>26</b>	<b>17</b>	<b>100</b>	<b>100</b>

From 1976 to 1983, none of the causes showed any significant year-to-year trend. However, in 1974 and 1975, road accidents occurred more often and with greater tonnage spilled than in the following years. "Tank and Container Leaks" and "Other" causes were lower in the first two years for both events and tonnes than in subsequent years.

Rank	Causes	Events (%)	Tonnage Spilled (%)
1	Road Accidents	45	71
2	Other	26	17
3	Transfer Accidents	13	8
4	Tank and Container Leaks	16	4

### 3.3.4 Mines, Wells, and Batteries

**Significant Event: Lodgepole Blowout.**

**Most Frequent Source: "Pipe, Valve Leaks".**

**Significant Trend: "Pipe Leaks" decreased from 50 to 25 percent of events.**

TABLE 8 MINES, WELLS AND BATTERIES

Year	% of Total in Boldface									
	Pipe Leak		Valve, Fitting		Overflow, Blowout		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	130 <b>62</b>	4 925 <b>12</b>	62 <b>29</b>	3 077 <b>7</b>	11 <b>5</b>	22 842 <b>56</b>	8 <b>4</b>	10 240 <b>25</b>	211 <b>100</b>	41 084 <b>100</b>
1975	217 <b>40</b>	6 688 <b>39</b>	133 <b>25</b>	3 392 <b>20</b>	43 <b>8</b>	709 <b>4</b>	147 <b>27</b>	6 272 <b>37</b>	540 <b>100</b>	17 060 <b>100</b>
1976	263 <b>45</b>	15 238 <b>53</b>	126 <b>22</b>	1 500 <b>5</b>	46 <b>8</b>	8 373 <b>29</b>	148 <b>25</b>	3 432 <b>12</b>	583 <b>100</b>	28 543 <b>100</b>
1977	353 <b>47</b>	7 896 <b>12</b>	157 <b>21</b>	2 714 <b>4</b>	83 <b>11</b>	22 452 <b>34</b>	159 <b>21</b>	33 042 <b>50</b>	752 <b>100</b>	66 104 <b>100</b>
1978	416 <b>47</b>	9 172 <b>41</b>	190 <b>22</b>	3 560 <b>16</b>	101 <b>11</b>	4 644 <b>21</b>	173 <b>20</b>	5 192 <b>23</b>	880 <b>100</b>	22 567 <b>100</b>
1979	494 <b>48</b>	16 350 <b>49</b>	292 <b>28</b>	6 236 <b>19</b>	111 <b>11</b>	7 245 <b>22</b>	141 <b>14</b>	3 428 <b>10</b>	1 038 <b>100</b>	33 260 <b>100</b>
1980	498 <b>49</b>	9 172 <b>50</b>	274 <b>27</b>	5 101 <b>28</b>	87 <b>8</b>	1 964 <b>11</b>	167 <b>16</b>	2 249 <b>12</b>	1 026 <b>100</b>	18 486 <b>100</b>
1981	121 <b>22</b>	2 402 <b>22</b>	88 <b>16</b>	1 441 <b>13</b>	55 <b>10</b>	1 172 <b>11</b>	282 <b>52</b>	5 751 <b>53</b>	546 <b>100</b>	10 766 <b>100</b>
1982	185 <b>23</b>	5 833 <b>2</b>	115 <b>14</b>	2 833 <b>1</b>	69 <b>9</b>	287 628 <b>90</b>	425 <b>53</b>	24 466 <b>8</b>	794 <b>100</b>	320 759 <b>100</b>
1983	257 <b>30</b>	6 756 <b>32</b>	168 <b>20</b>	5 086 <b>24</b>	79 <b>9</b>	2 322 <b>11</b>	339 <b>40</b>	7 026 <b>33</b>	843 <b>100</b>	21 189 <b>100</b>
Total	2 934 <b>41</b>	84 432 <b>15</b>	1 605 <b>22</b>	34 940 <b>6</b>	685 <b>9</b>	359 351 <b>62</b>	1 989 <b>28</b>	101 098 <b>17</b>	7 213 <b>100</b>	579 818 <b>100</b>

The number of events involving "Mines, Wells and Batteries" per year rose steadily from 1974 to 1979, but declined in 1980 and 1981, with a slight rise in 1982-3 (see Table 8).

The tonnage spilled per year did not show any significant change in the 10-year period. However, 1982 was an exceptional year: the Lodgepole blowout discharged a total of 280 000 tonnes of condensates and gases into the environment.

The most frequent cause of spills in the "Mines, Wells and Batteries" category was "Pipe Leaks". However, pipe leaks accounted for only 15 percent of the total tonnes. The category that contains the largest number of events is "Pipe Leaks".

Rank	Causes	Number of Events (%)	Tonnage Spilled (%)
1	Pipe Leaks	41	15
2	Other	28	17
3	Valves, Fittings	22	6
4	Overflow, Blowout	9	62

The category with the lowest proportion of events ("Overflow, Blowout") had, however, the highest percentage of tonnes. A good part of this number, though, is a result of the Lodgepole incident which alone accounts for 48 percent of tonnes spilled in the 10-year period. This anomaly (although it might not be an anomaly if such an accident were to happen roughly every 10 years) also accounts for the low tonnage figures in the other categories.

"Pipe Leak" was the only cause that declined significantly. It averaged close to 50 percent from 1974 to 1980, and then it dropped to a mean of 25 percent from 1981 to 1983.



## 3.3.5 Storage Depots

**Most Frequent Causes: "Pipe, Valve Leak" and "Overflow".**  
**No significant trend upward or downward.**

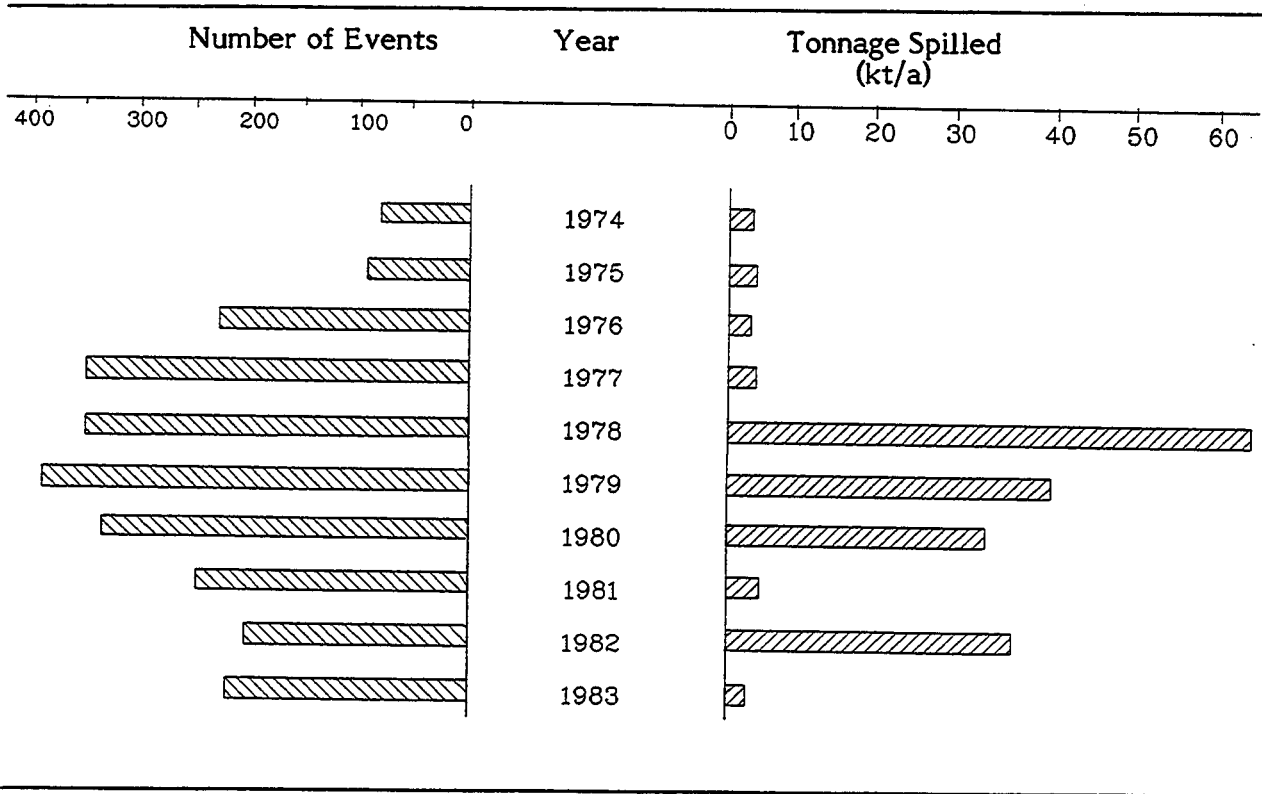
The number of events per year involving storage depots (see Table 9) followed the pattern shown in Figure 1 (total number of events per year).

TABLE 9 STORAGE DEPOTS

% of Total in Boldface

Year	Pipe, Valve Leak		Overflow		Tank Leak		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	25	275	14	48	31	700	6	74	76	1 098
	<b>33</b>	<b>25</b>	<b>18</b>	<b>4</b>	<b>41</b>	<b>64</b>	<b>8</b>	<b>7</b>	<b>100</b>	<b>100</b>
1975	29	214	18	195	36	3 388	7	13	90	3 809
	<b>32</b>	<b>6</b>	<b>20</b>	<b>5</b>	<b>40</b>	<b>89</b>	<b>8</b>	<b>0</b>	<b>100</b>	<b>100</b>
1976	72	444	88	419	37	482	32	929	229	2 274
	<b>31</b>	<b>20</b>	<b>38</b>	<b>18</b>	<b>16</b>	<b>21</b>	<b>14</b>	<b>41</b>	<b>100</b>	<b>100</b>
1977	121	3 038	125	302	58	441	46	144	350	3 925
	<b>35</b>	<b>77</b>	<b>36</b>	<b>8</b>	<b>17</b>	<b>11</b>	<b>13</b>	<b>4</b>	<b>100</b>	<b>100</b>
1978	105	1 372	118	1 044	63	2 555	65	58 537	351	63 508
	<b>30</b>	<b>2</b>	<b>34</b>	<b>2</b>	<b>18</b>	<b>4</b>	<b>19</b>	<b>92</b>	<b>100</b>	<b>100</b>
1979	118	10 017	141	27 965	60	348	74	1 522	391	39 852
	<b>30</b>	<b>25</b>	<b>36</b>	<b>70</b>	<b>15</b>	<b>1</b>	<b>19</b>	<b>4</b>	<b>100</b>	<b>100</b>
1980	76	939	88	1 002	62	1 825	105	27 378	331	31 144
	<b>23</b>	<b>3</b>	<b>27</b>	<b>3</b>	<b>19</b>	<b>6</b>	<b>32</b>	<b>88</b>	<b>100</b>	<b>100</b>
1981	61	1 579	60	253	59	689	70	2 168	250	4 690
	<b>24</b>	<b>34</b>	<b>24</b>	<b>5</b>	<b>24</b>	<b>15</b>	<b>28</b>	<b>46</b>	<b>100</b>	<b>100</b>
1982	72	1 532	41	313	46	253	47	35 406	206	37 504
	<b>35</b>	<b>4</b>	<b>20</b>	<b>1</b>	<b>22</b>	<b>1</b>	<b>23</b>	<b>94</b>	<b>100</b>	<b>100</b>
1983	75	604	43	940	50	1 199	53	99	221	2 842
	<b>34</b>	<b>21</b>	<b>19</b>	<b>33</b>	<b>23</b>	<b>42</b>	<b>24</b>	<b>3</b>	<b>100</b>	<b>100</b>
Total	752	20 014	736	32 481	502	11 880	505	126 270	2 495	190 646
	<b>30</b>	<b>10</b>	<b>29</b>	<b>17</b>	<b>20</b>	<b>6</b>	<b>20</b>	<b>66</b>	<b>100</b>	<b>100</b>

The fluctuations shown in tonnes spilled reflect the randomness of spill events. (See bar graph.) (The random nature of spills does not preclude analysis of trends over longer periods of time.)



Two causes were most important in terms of number of events: "Pipe, Valve Leaks" (which includes all fitting leaks) with 30 percent and "Overflow" with 29 percent of all events. "Pipe, Valve Leaks" accounted for 10 percent of the tonnage, "Overflow" for 17 percent. "Tank Leak" accounted for 20 percent of the events, as did the "Other" category. However, "Tank Leak" had only 6 percent of the tonnage, while "Other" accounted for 66 percent. This high figure is mostly due to the fact that most of the very large spills involving storage depots had "Other" as a cause. In the three largest spills, the causes were discharge, process upset and error; these three causes are all part of the "Other" category.

Only one of the causes showed any trends: "Other" increased from about 10 to 20 percent of the events over the 10-year period.

Industrial plants were involved in 2 196 events from 1974 to 1983 for a total of about 1.48 million tonnes (see Table 10). There were no statistically significant trends in yearly totals.

Rank	Sources	Spill Event (%)	Tonnage Spilled (%)
1	Pipe, Valve Leaks	30	10
2	Overflow	29	17
3	Tank Leak	20	6
4	Other	20	66

### 3.3.6 Industrial Plants (Excluding Refineries)

Significant Causes: "Pipe, Valve Leak", "Overflow" and "Other".  
Significant Trends: "Other" and "Discharge" increasing.  
"Overflow" decreasing.

TABLE 10 INDUSTRIAL PLANTS

Year	Pipe, Valve Leak		Overflow		Discharge		Other		Total	
	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes	Events	Tonnes
1974	75 44	47 281 12	74 44	6 845 12	1 1	0.2 0	17 10	1 542 3	167 100	55 668 100
1975	118 45	2 738 14	110 42	2 277 12	-	-	37 14	14 196 74	265 100	19 211 100
1976	71 32	1 188 1	62 28	1 459 1	21 9	169 0	68 31	119 630 98	222 100	122 446 100
1977	60 29	7 649 52	47 22	3 805 26	21 10	1 058 7	82 39	2 239 15	210 100	14 751 100
1978	49 33	14 124 47	35 23	1 062 4	18 12	11 198 37	47 32	3 493 12	149 100	29 876 100
1979	52 27	388 5	32 17	2 245 30	25 13	216 3	82 43	4 805 63	191 100	7 654 100
1980	30 15	294 0	43 22	13 852 5	30 15	260 154 92	93 47	7 147 3	196 100	281 446 100
1981	78 24	13 097 1	56 17	438 428 48	63 19	2 728 0	134 40	468 394 51	331 100	922 647 100
1982	91 36	6 063 46	45 18	1 216 9	22 9	114 1	98 38	5 823 44	256 100	13 216 100
1983	48 23	768 8	50 24	1 416 16	29 14	5 711 63	82 39	1 232 13	209 100	9 126 100
Total	672 31	93 590 6	554 25	472 605 32	230 10	281 348 19	740 34	628 501 43	2 196 100	1 476 041 100

The most important causes, apart from "Other", were "Pipe, Valve Leak" in terms of events (31 percent) and "Overflow" in terms of tonnes (32 percent). The "Other" category accounted for 34 percent of the events and 43 percent of the total tonnage (see Table 10). This preponderance of "Other" causes is due to the fact that there are many causes for industrial plant spills, and none of these causes accounts for a significant percentage of spill events. Therefore the three most important causes only account for two-thirds of the events and slightly over one-half of the total tonnes spilled.

The following causes displayed significant trends:

- "Overflow" events, started at about 40 percent of the yearly events in 1974-5 and decreased to about 20 percent.
- "Discharge" events increased from nearly 0 percent in 1974 to about 15 percent in 1983.
- "Other" events increased from about 10 to 40 percent in the 10-year period.

#### 4 BREAKDOWN BY TYPE OF MATERIAL

##### 4.1 Oils

**Most frequently spilled material: Crude Oil.**

**Significant Trends:** Reported spills of crude oil increased from 17 percent in 1974 to 54 percent in 1983.

Gasoline spills increased until 1977, and then decreased.

Fuel 4&5 and Fuel 6 events decreased till 1978 then stayed constant.

"Condensates and Gases" had very few events but constituted a large proportion of total tonnage.

The "Oil" category of materials comprises several sub-categories:

- crude oil,
- gasoline,
- various heavier oils,
- asphalt,
- condensates and gases.

TABLE 11 SPILL FREQUENCY BREAKDOWN BY MATERIAL (Oils)

Year	Number of Spills % of Total in Boldface									
	Crude Oil	No. 2 Fuel	Gasoline	No. 4 & 5 Fuel	No. 6 Fuel	Waste Oil	Condensates and Gases	Asphalt	Other Oils	Total
1974	163 <b>17</b>	49 <b>5</b>	104 <b>11</b>	256 <b>26</b>	97 <b>10</b>	31 <b>3</b>	14 <b>1</b>	6 <b>1</b>	251 <b>26</b>	971 <b>100</b>
1975	552 <b>38</b>	78 <b>5</b>	157 <b>11</b>	306 <b>21</b>	93 <b>6</b>	35 <b>2</b>	67 <b>5</b>	18 <b>1</b>	148 <b>10</b>	1 454 <b>100</b>
1976	540 <b>35</b>	319 <b>21</b>	220 <b>14</b>	151 <b>10</b>	85 <b>6</b>	37 <b>2</b>	33 <b>2</b>	20 <b>1</b>	126 <b>8</b>	1 531 <b>100</b>
1977	661 <b>36</b>	433 <b>24</b>	302 <b>17</b>	132 <b>7</b>	96 <b>5</b>	47 <b>3</b>	33 <b>2</b>	16 <b>1</b>	99 <b>5</b>	1 819 <b>100</b>
1978	747 <b>39</b>	476 <b>25</b>	263 <b>14</b>	109 <b>6</b>	80 <b>4</b>	65 <b>3</b>	35 <b>2</b>	25 <b>1</b>	93 <b>5</b>	1 893 <b>100</b>
1979	881 <b>40</b>	566 <b>26</b>	354 <b>16</b>	51 <b>2</b>	86 <b>4</b>	62 <b>3</b>	44 <b>2</b>	24 <b>1</b>	117 <b>5</b>	2 185 <b>100</b>
1980	888 <b>42</b>	505 <b>24</b>	305 <b>14</b>	59 <b>3</b>	70 <b>3</b>	81 <b>4</b>	56 <b>3</b>	26 <b>1</b>	116 <b>6</b>	2 106 <b>100</b>
1981	761 <b>43</b>	416 <b>23</b>	223 <b>12</b>	66 <b>4</b>	69 <b>4</b>	46 <b>3</b>	49 <b>3</b>	29 <b>2</b>	127 <b>7</b>	1 786 <b>100</b>
1982	736 <b>47</b>	352 <b>23</b>	159 <b>10</b>	46 <b>3</b>	52 <b>3</b>	36 <b>2</b>	52 <b>3</b>	14 <b>1</b>	107 <b>7</b>	1 554 <b>100</b>
1983	754 <b>54</b>	291 <b>21</b>	112 <b>8</b>	31 <b>2</b>	27 <b>2</b>	30 <b>2</b>	48 <b>3</b>	26 <b>2</b>	72 <b>5</b>	1 391 <b>100</b>
Total	6 683 <b>40</b>	3 485 <b>21</b>	2 199 <b>13</b>	1 207 <b>7</b>	755 <b>5</b>	470 <b>3</b>	431 <b>3</b>	204 <b>1</b>	1 256 <b>8</b>	16 690 <b>100</b>

Table 11 shows that the total number of spills per year increased from 971 spills in 1974 to reach a maximum of 2 185 in 1979 and then steadily decreased to 1 391 spills in 1983.

Overall totals for the 10-year period show the following ranking:

Rank	Material Spilled	Events (%)
1	Crude Oil	40
2	No. 2 Fuel (diesel, jet fuel, kerosene, home-heating oil)	21
3	Gasoline	13
4	"Other Oils"	8
5	No. 4 & 5 Fuel (heavy fuel oil, marine diesel)	7
6	No. 6 Fuel	5
	Waste Oil	
	Gases and Condensates	7
	Asphalt	

It is not unexpected to find crude oil ranked first since all other petroleum products come from crude-oil feedstocks. Both gasoline and No. 2 fuel are the major products of crude-oil refining. It is to be expected that these two products will occupy a major share of spill events. This is statistically confirmed.

Figure 2 shows the trend of frequency of spillage for various oils.

A category with a surprisingly low percentage of total spills is "Condensates and Gases". Natural gas production in Canada is roughly of the same order of magnitude as crude oil (total accepted by refineries). However, condensates and gases only account for 3 percent of the spill events. Two hypotheses are possible to explain this phenomenon:

1. Crude oil leaks are much more obvious than gas leaks: the evidence is unmistakable. (Gas leaks are often invisible; no evidence remains after dispersion.) Therefore, crude oil spills are reported to environmental authorities more often than gas leaks.
2. The difference between the two transportation and distribution systems; that is, gas piping systems are closed and need little human handling,

whereas crude oil handling requires operations such as connecting hoses, pumping to open tanks, and in some cases carrying by tank truck. Therefore it is reasonable to expect a greater number of crude oil spills than condensate and gas spills.

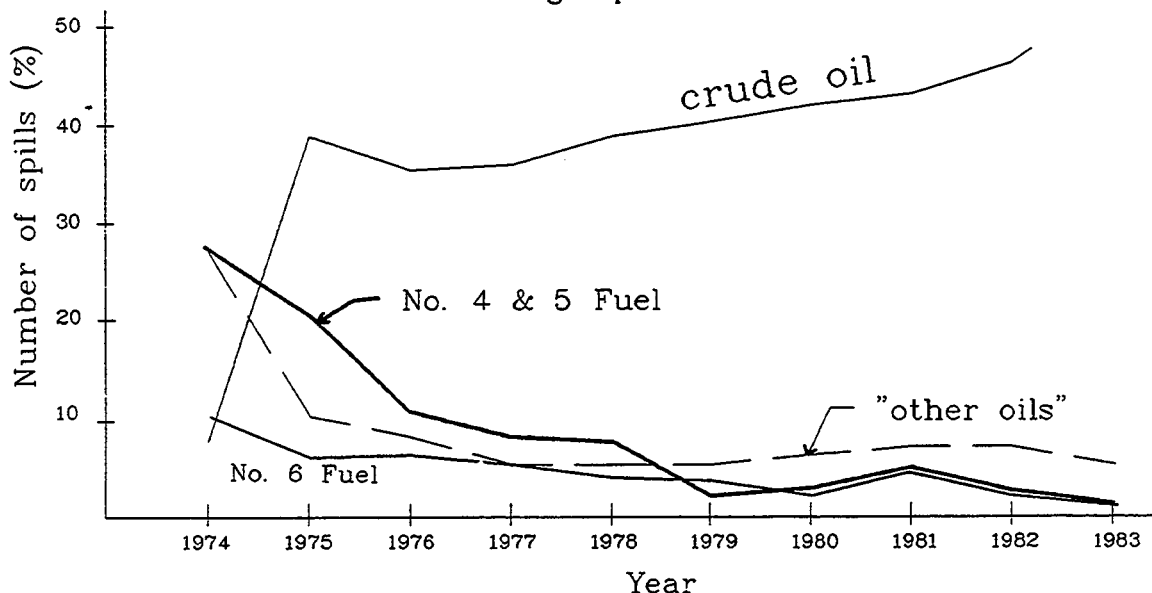


FIGURE 2 TRENDS IN SPILL EVENTS FOR SOME OILS

Table 12 is a record of tonnes spilled per year by material. Looking at 10-year totals, one sees that two categories account for 80 percent of the total tonnage: "Condensates and Gases" at 59 percent and "Crude Oil" at 21 percent. These figures are a reversal of the situation with number of events (Table 11). Crude oil spills were over ten times more prevalent than "Condensates and Gases" spill events. This discrepancy can be explained by the fact that one event, the Lodgepole gas-well blowout in 1982, accounts for 87 percent of the tonnes released in the "Condensates and Gases" category.

If one eliminates this one event from the database, the new totals would be:

Crude Oil:	44 percent
Condensates and Gases:	16 percent

Based on probability calculations, the Lodgepole blowout can be ignored if such a large event only happens, say, every 50 years. If these calculations show that it is a 10-year event, Lodgepole must be included in the summary.

Year-by-year analysis of the data shows no upward or downward trends in percentage figures. There is a lot of scatter, because of the year-to-year variations in the totals. The raw numbers, i.e. the actual tonnages, showed less scatter.

TABLE 12 SPILL AMOUNT BREAKDOWN BY MATERIAL (Oils)

Year	Tonnes Spilled % of Total in Boldface									
	Condensates and Gases	Crude Oil	No. 2 Fuel	No. 6 Fuel	No. 4 & 5 Fuel	Gasoline	Other Oils	Waste Oil	Asphalt	Total
1974	3 623 <b>13</b>	14 823 <b>53</b>	1 046 <b>4</b>	1 106 <b>4</b>	5 594 <b>20</b>	810 <b>3</b>	222 <b>1</b>	631 <b>2</b>	82 <b>0</b>	27 935 <b>100</b>
1975	600 <b>3</b>	11 530 <b>52</b>	836 <b>4</b>	2 499 <b>11</b>	2 844 <b>13</b>	3 095 <b>14</b>	256 <b>1</b>	321 <b>1</b>	266 <b>1</b>	22 250 <b>100</b>
1976	7 429 <b>27</b>	10 901 <b>40</b>	1 650 <b>6</b>	2 084 <b>8</b>	2 231 <b>8</b>	2 156 <b>8</b>	220 <b>1</b>	38 <b>0</b>	372 <b>1</b>	27 085 <b>100</b>
1977	20 865 <b>52</b>	10 699 <b>27</b>	3 753 <b>9</b>	804 <b>2</b>	1 587 <b>4</b>	1 638 <b>4</b>	551 <b>1</b>	85 <b>0</b>	103 <b>0</b>	40 085 <b>100</b>
1978	845 <b>4</b>	12 067 <b>52</b>	2 801 <b>12</b>	3 288 <b>14</b>	1 932 <b>8</b>	1 237 <b>5</b>	454 <b>2</b>	72 <b>0</b>	476 <b>2</b>	23 170 <b>100</b>
1979	3 306 <b>10</b>	12 540 <b>37</b>	4 724 <b>14</b>	9 054 <b>27</b>	1 801 <b>5</b>	1 567 <b>5</b>	339 <b>1</b>	319 <b>1</b>	392 <b>1</b>	34 045 <b>100</b>
1980	705 <b>3</b>	15 274 <b>68</b>	3 517 <b>16</b>	585 <b>3</b>	649 <b>3</b>	918 <b>4</b>	278 <b>1</b>	108 <b>0</b>	479 <b>2</b>	22 510 <b>100</b>
1981	1 160 <b>4</b>	8 041 <b>28</b>	12 589 <b>44</b>	763 <b>3</b>	1 184 <b>4</b>	1 767 <b>6</b>	1 013 <b>4</b>	1 886 <b>7</b>	287 <b>1</b>	28 690 <b>100</b>
1982	281 181 <b>94</b>	10 658 <b>4</b>	4 602 <b>2</b>	915 <b>0</b>	1 067 <b>0</b>	847 <b>0</b>	609 <b>0</b>	46 <b>0</b>	147 <b>0</b>	300 070 <b>100</b>
1983	768 <b>6</b>	8 553 <b>65</b>	1 467 <b>11</b>	803 <b>6</b>	422 <b>3</b>	460 <b>3</b>	300 <b>2</b>	69 <b>1</b>	337 <b>3</b>	13 180 <b>100</b>
Total	320 482 <b>59</b>	115 086 <b>21</b>	36 985 <b>7</b>	21 901 <b>4</b>	19 311 <b>4</b>	14 495 <b>3</b>	4 242 <b>1</b>	3 575 <b>1</b>	2 941 <b>1</b>	539 020 <b>100</b>

Rank	Material Spilled	Tonnage (%)
1	Condensates and gases	59
2	Crude oil	21
3	Fuel No. 2	7
4	Fuel No. 4 & 5	6
	Fuel No. 6	6
5	Gasoline	3
	Waste oil	1
	Asphalt	1
	"Other Oils"	1



## 4.2 Non-Oils

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**Material Most Frequently Spilled: Saline Water.**

**Materials with Greatest Tonnage Spilled: Sewage and Industrial Waste.**

**Significant Trend: Total tonnage increased until 1980, then decreased.**

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Table 13 is a breakdown of the number of spill events by material spilled for "Non-Oils". The totals show that 53 percent of reported spills involved saline water (mixed with crude oil as it comes out of the well.) Second were industrial chemicals at 19 percent; third was "Others" at 7 percent. Acids and industrial wastes were each involved in 5 percent of spills.

"Non-Oils" showed the following yearly totals: 268 spills in 1974, rising to 1187 spills in 1980, and then declining to 772 in 1983.

Salt water spills account for a large proportion (40 to 60 percent) of non-oil spills. By subtracting the number of salt water discharges from non-oil spills, we obtain the number of chemicals spills. To put this number in perspective, it can be expressed as a percentage of all spills. Figure 3 is a line graph showing the percentage of chemical spills over time. The trend is clear: starting at 11 percent in 1974, there is a fairly steady increase to about 25 percent in 1983.

Pesticides and fertilizers showed an increase in the number of spills in the last 3 years. Saline water showed a marked decrease in this same period. Disregarding "scatter", all other materials were constant from one year to the next.

The tonnage spilled for non-oils (see Table 14) is concentrated in four categories: "Others" at 37 percent; industrial wastes at 33 percent; industrial chemicals, 19 percent; saline water, 7 percent; these four add up to a total of 96 percent. The "Others" category includes "sewage". Three sewage discharge events account for 93 percent (1 074 643 tonnes) of the "Others" total.

There were no clear trends in any category, except for "Industrial Wastes" where the percentages decreased sharply in the last 4 years.

TABLE 13 SPILL FREQUENCY BREAKDOWN BY MATERIAL (NON-OILS)

Year	Saline Water	Industrial Chemicals	Industrial Wastes	Acids	Pesticides	Minerals	Fertilizers	Bases	Paints & Dyes	Radioactive Material	Number of Spills		
											Metals	Others	Total
1974	144	40	21	14	2	15	-	14	2	-	2	14	268
	54	15	8	5	1	6		5	1		1	5	100
1975	314	67	27	31	22	18	4	11	4	-	1	27	526
	60	13	5	6	4	3	1	2	1		0	5	100
1976	394	78	35	28	20	9	11	10	3	6	5	42	641
	61	12	5	4	3	1	2	2	0	1	1	7	100
1977	470	123	44	37	19	22	7	13	10	4	5	56	810
	58	15	5	5	2	3	1	2	1	0	1	7	100
1978	549	133	46	41	23	19	10	20	7	3	2	21	874
	63	15	5	5	3	2	1	2	1	0	0	2	100
1979	630	174	31	49	14	19	19	10	14	4	4	51	1 019
	62	17	3	5	1	2	2	1	1	0	0	5	100
1980	710	213	47	54	26	16	24	15	12	5	2	63	1 187
	60	18	4	5	2	1	2	1	1	0	0	5	100
1981	335	262	68	61	47	16	36	10	19	2	2	61	919
	36	29	7	7	5	2	4	1	2	0	0	7	100
1982	269	186	72	37	18	16	13	7	8	3	5	64	698
	39	27	10	5	3	2	2	1	1	0	1	9	100
1983	305	173	31	54	42	7	23	13	6	8	3	107	772
	40	22	4	7	5	1	3	2	1	1	0	14	100
Total	4 120	1 449	422	406	233	157	147	123	85	35	31	506	7 714
	53	19	5	5	3	2	2	2	1	0	0	7	100

TABLE 14 SPILL AMOUNT BREAKDOWN BY MATERIAL (NON-OILS)

Year	Tonnes Spilled											Total	
	Industrial Wastes	Industrial Chemicals	Saline Water	Minerals	Acids	Bases	Fertilizers	Paints & Dyes	Metals	Radioactive Material	Pesticides		Others
1974	73 041 73	8 656 9	15 132 15	1 437 1	95 0	732 1	-	-	14 0	-	1 0	1 508 1	100 615 100
1975	16 053 3	25 847 6	13 420 3	5 545 1	2 933 1	734 0	15 0	2 0	19 0	-	42 0	398 365 86	462 990 100
1976	69 694 18	2 777 1	21 019 5	53 060 14	1 848 0	126 0	150 0	3 0	1 545 0	14 0	28 0	232 212 61	382 475 100
1977	36 612 52	9 159 13	17 545 25	651 1	2 977 4	777 1	60 0	22 0	168 0	2 0	30 0	2 835 4	70 835 100
1978	70 423 49	12 865 9	34 000 24	1 835 1	4 371 3	672 0	3 362 2	4 627 3	1 000 1	-	97 0	10 551 7	143 800 100
1979	2 175 2	42 814 47	37 431 41	2 394 3	276 0	794 1	400 0	102 0	77 0	2 0	44 0	4 579 5	91 085 100
1980	298 535 87	19 980 6	17 423 5	6 293 2	536 0	316 0	708 0	34 0	3 0	-	49 0	883 0	344 760 100
1981	452 705 49	463 616 50	5 386 1	2 964 0	496 0	1 649 0	844 0	19 0	-	57 0	88 0	3 070 0	930 890 100
1982	23 418 23	7 455 7	47 857 46	5 900 6	3 396 0	48 0	160 0	21 0	10 0	729 1	3 0	14 688 14	103 690 100
1983	4 450 1	2 645 1	10 654 2	3 939 1	955 0	550 0	345 0	2 0	16 0	422 0	102 0	475 223 95	499 300 100
Total	1 047 106 33	595 814 19	219 867 7	84 018 3	17 903 1	6 398 0	6 044 0	4 838 0	2 852 0	1 226 0	484 0	1 143 914 37	3 130 440 100

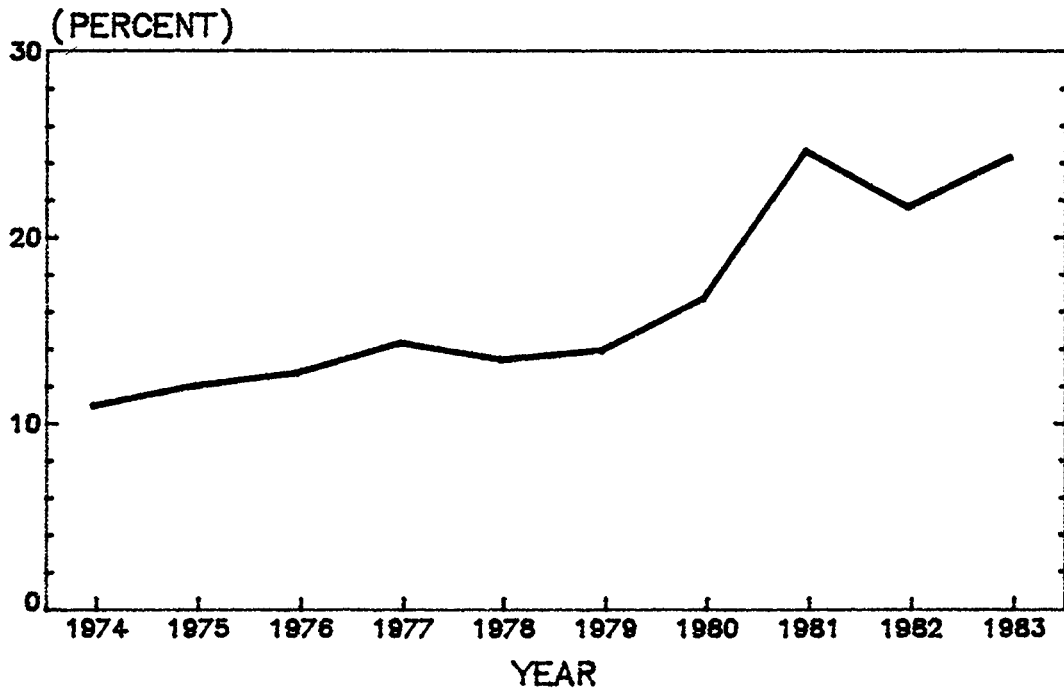


FIGURE 3      PERCENTAGE OF SPILLS THAT INVOLVE CHEMICALS  
(Excludes all salt water spills)

## 5 FUTURE TRENDS

To know what kind of trends and patterns to expect in the future is of interest to regulators, prevention program officers, and first responders from the private or public sectors. Extrapolating from the 10-year data set found in this paper is one way to predict future trends. There are limitations, however. The fact that a given trend has been constant for several years is no guarantee that it will not change in the future. For example, a chemical commodity quite suddenly receiving a large amount of publicity will acquire a level of notoriety that ensures that it will be reported virtually every time it is released into the environment. Therefore the number of reports Environment Canada receives will increase, even though the actual number of incidents will probably decrease.

Taking the above reservations into account, we can make the following predictions:

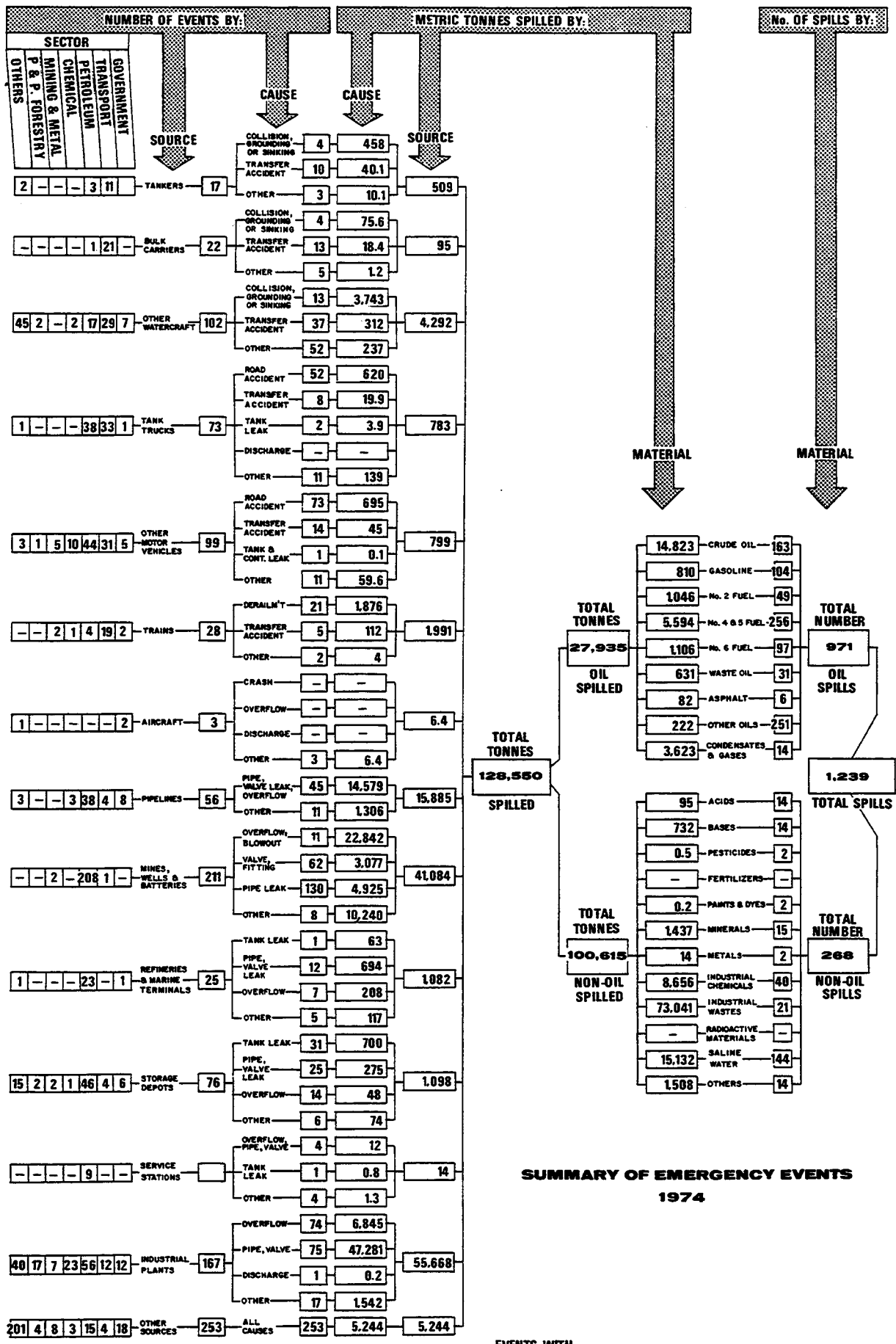
- The number of spills reported will decrease slowly or stay constant.
- The petroleum sector will continue to account for about one-half of all spill events; the transportation sector, about 10 to 20 percent;
- "Mines, Wells, and Batteries" will likely make up about one-third of spill events reported, or about 500 to 900 events per year.
- "Tank trucks" and "Other motor vehicles" will continue to have about 100 to 200 events per year. The major cause of these incidents will be road accidents.
- Storage depots and industrial plants will both contribute over 200 spills per year.
- About one-third of all spills will involve non-oils; two-thirds will be oils.



**APPENDIX 1**  
**SUMMARY LEDGER**



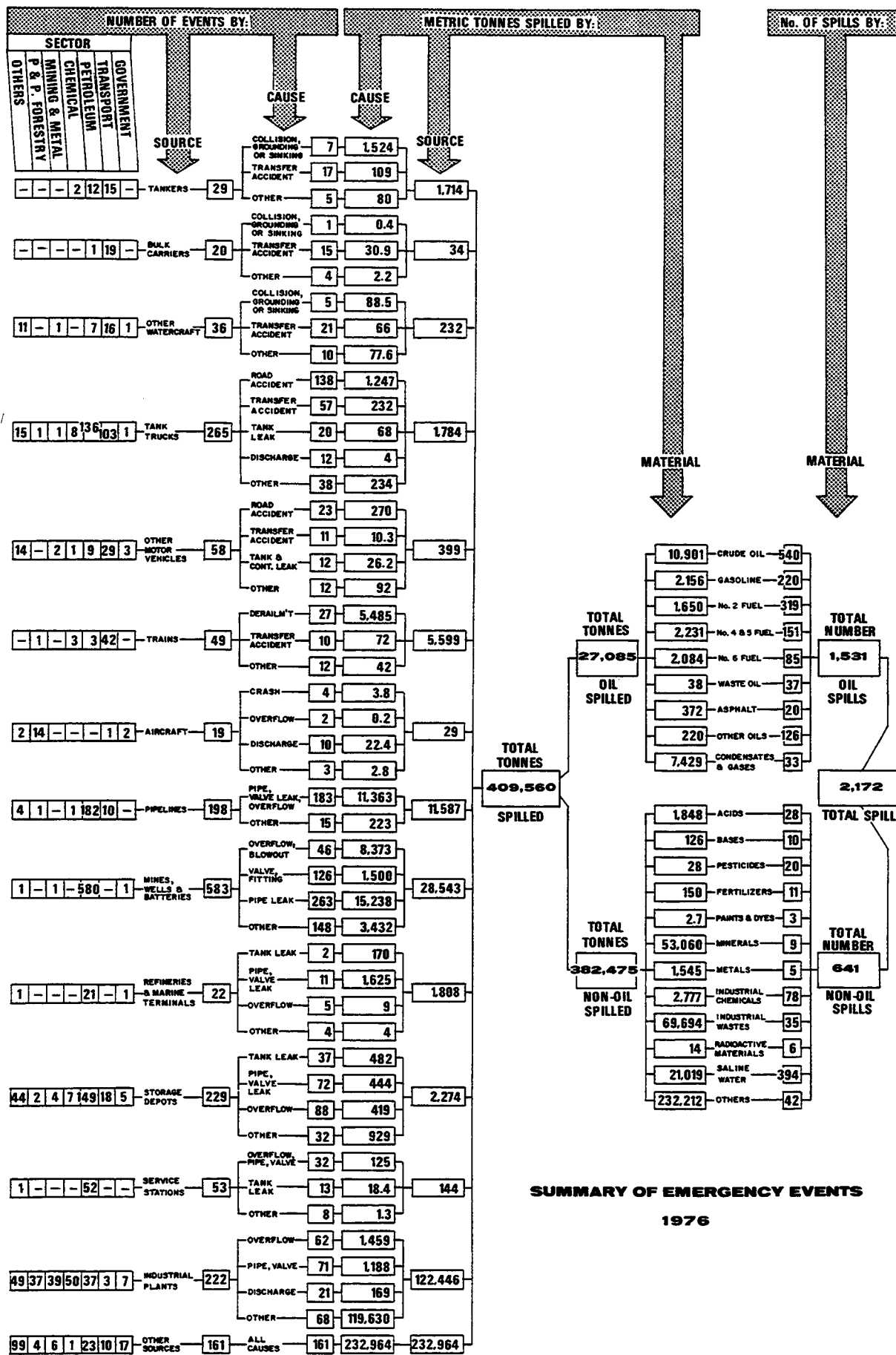




**SUMMARY OF EMERGENCY EVENTS 1974**

SECTOR TOTALS	TOTAL EVENTS	+	EVENTS WITH TWO MATERIALS SPILLED	=	TOTAL SPILLS
312 26 502 63 26 43 169	1,141		98		1,239





**SUMMARY OF EMERGENCY EVENTS 1976**

241	54	1212	38
60	73	266	

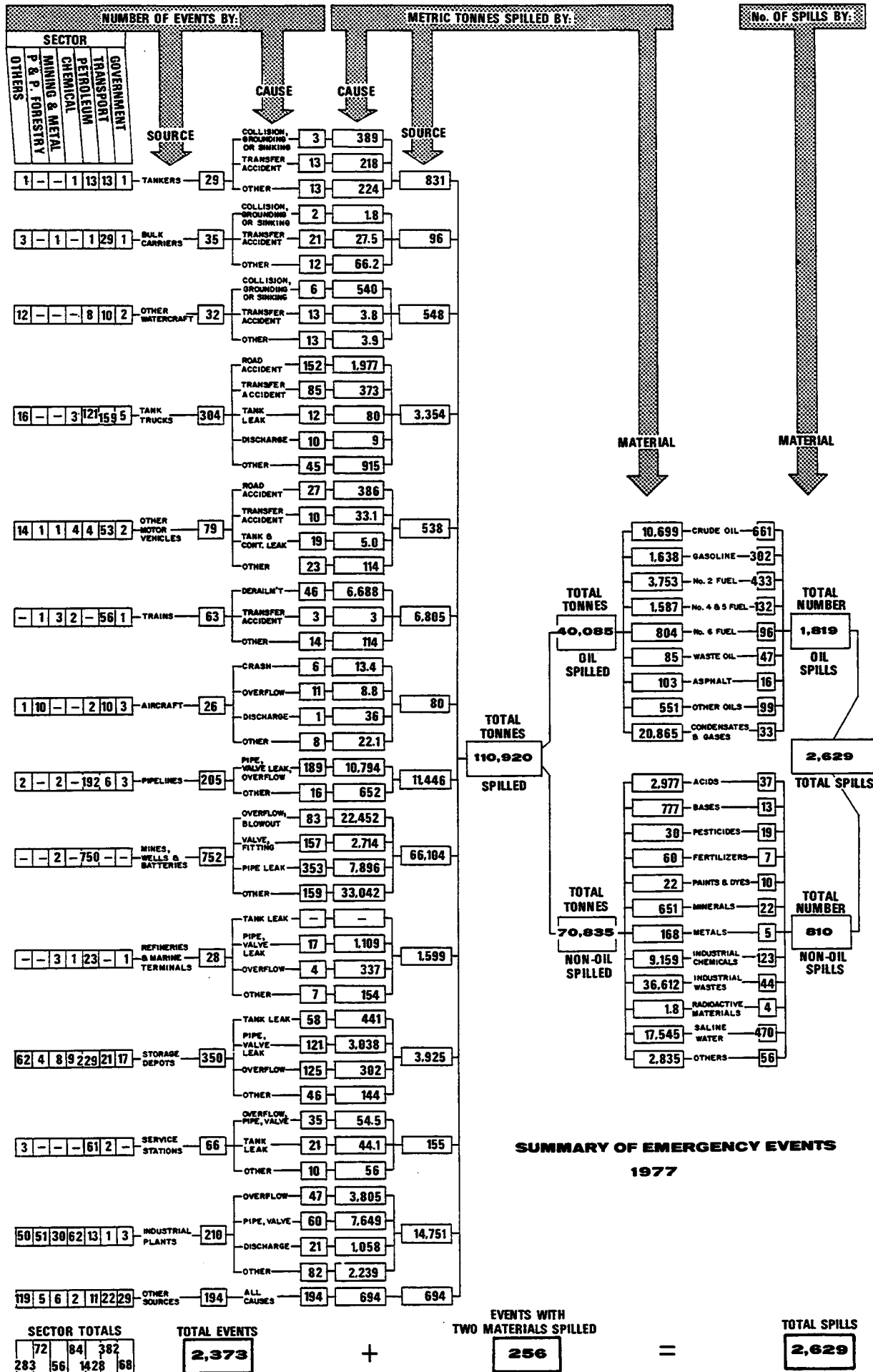
TOTAL EVENTS  
**1,944**

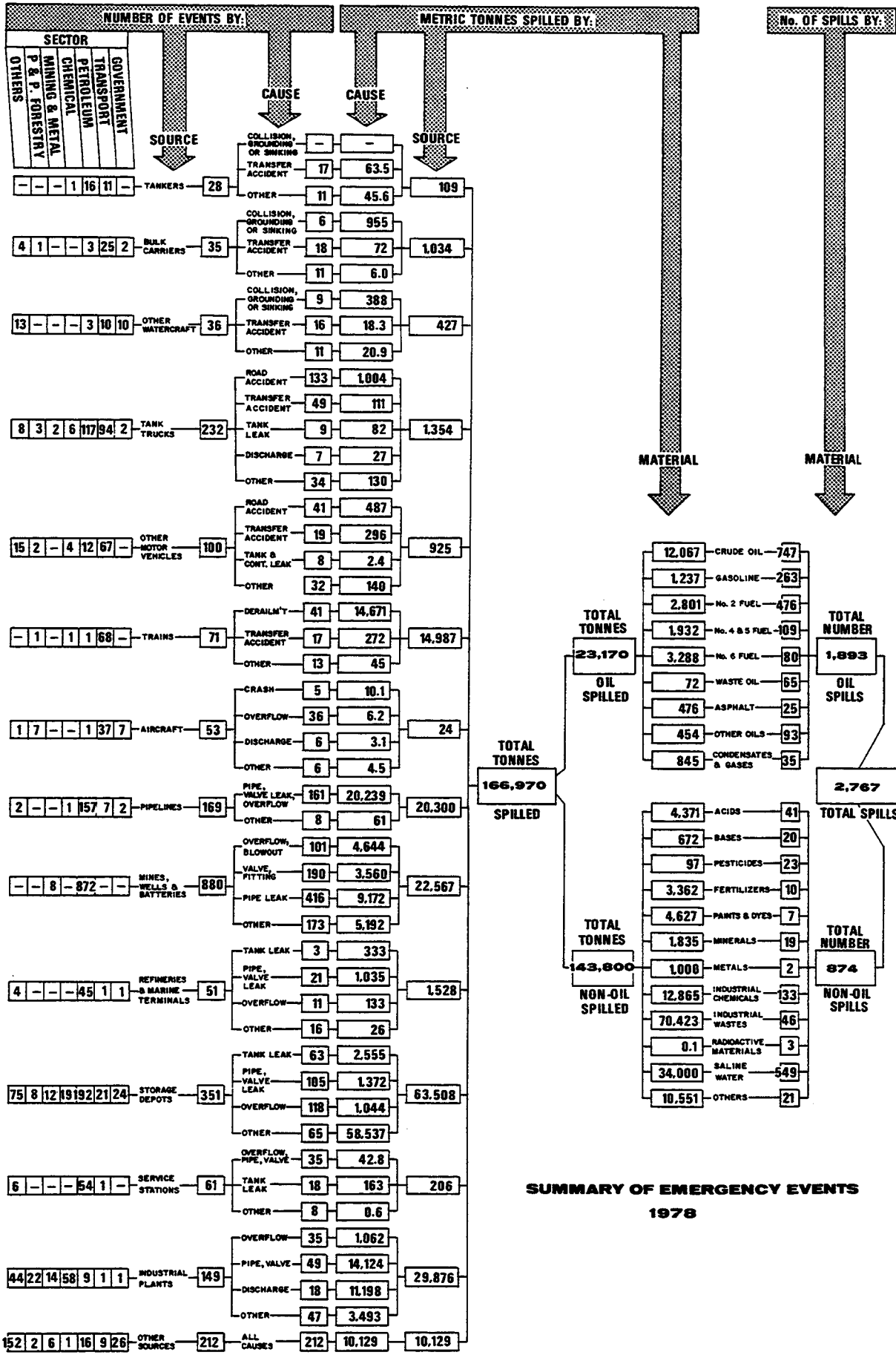
EVENTS WITH TWO MATERIALS SPILLED  
**228**

TOTAL SPILLS  
**2,172**

+

=





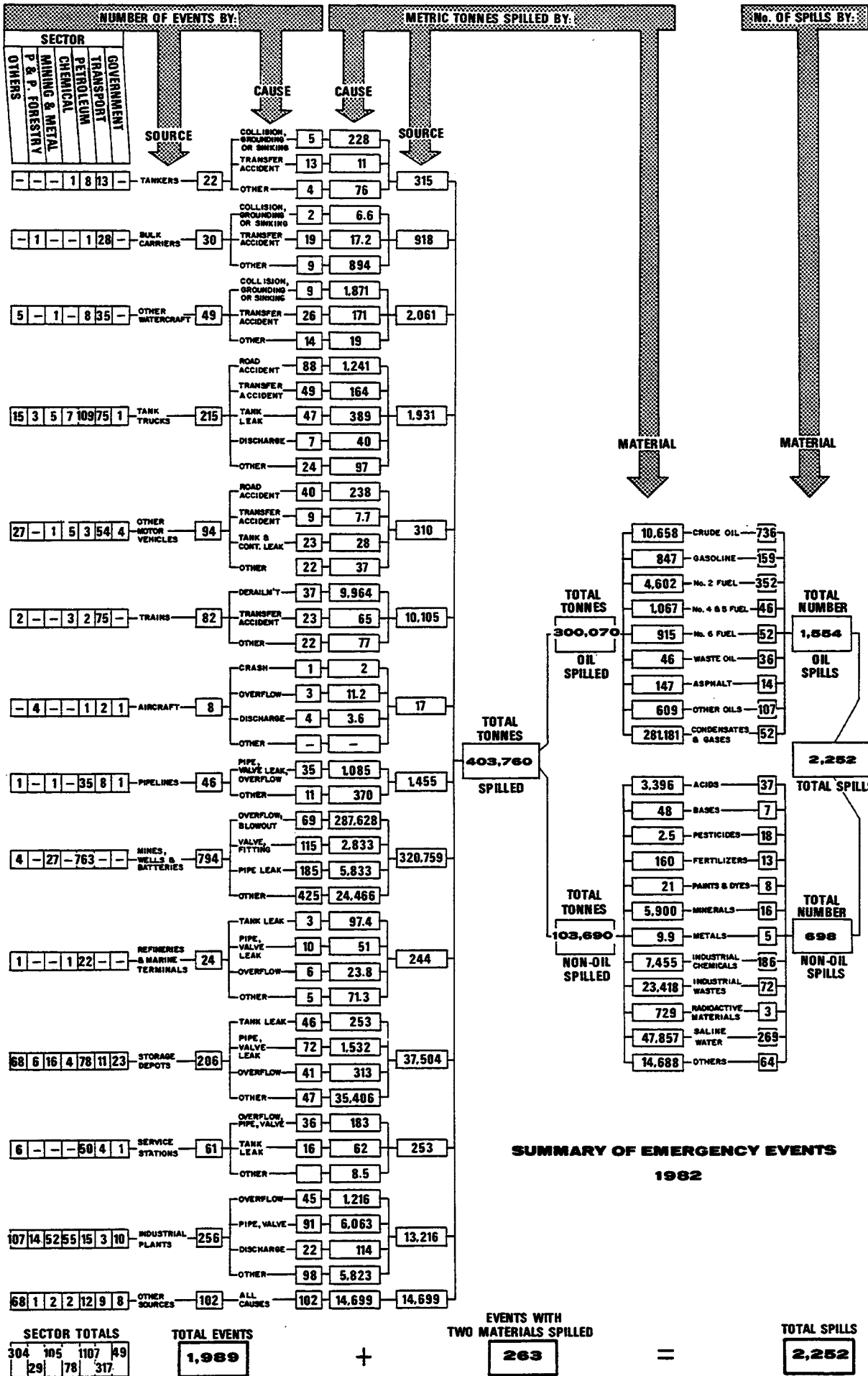
**SUMMARY OF EMERGENCY EVENTS 1978**



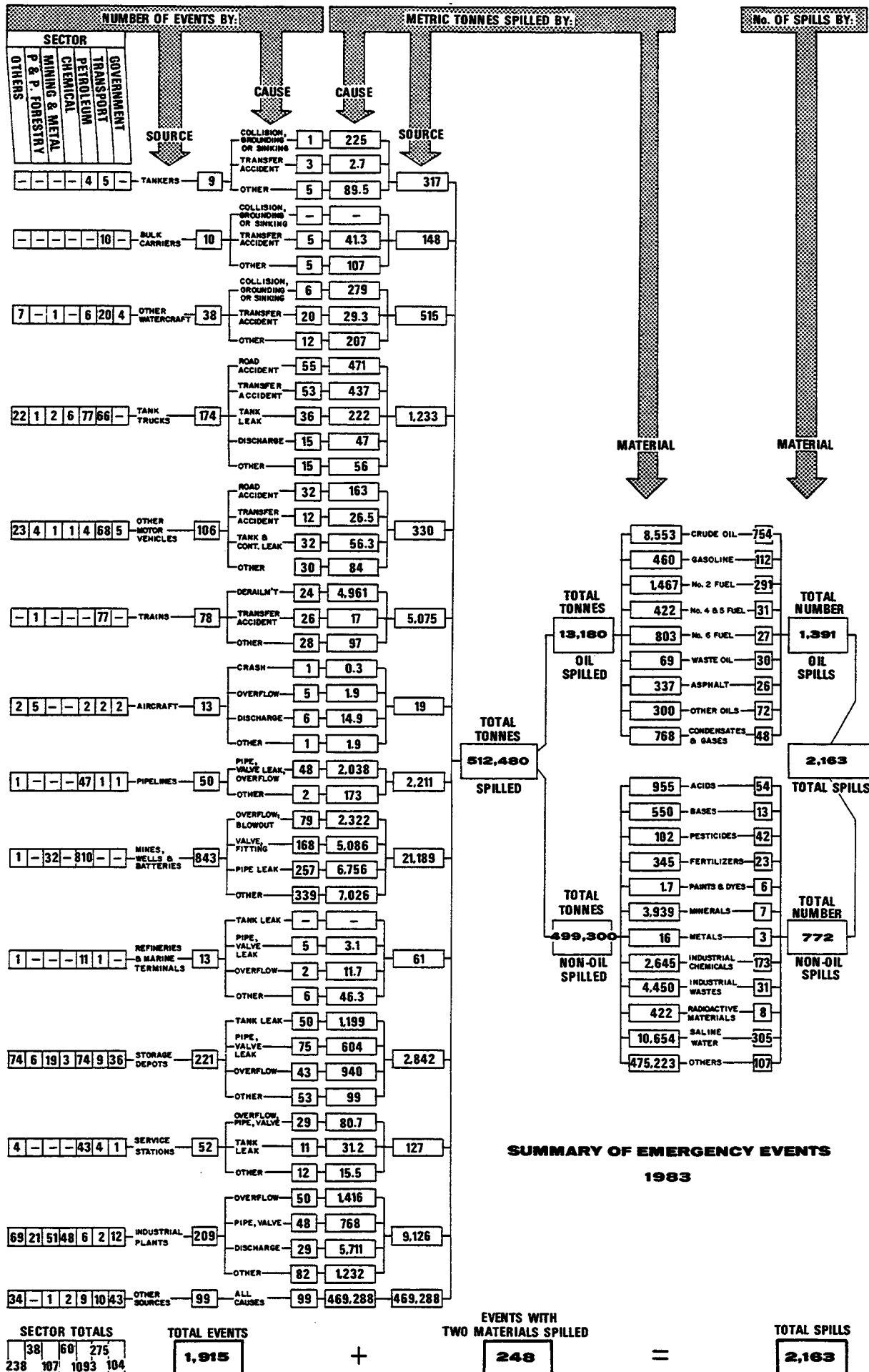








**SUMMARY OF EMERGENCY EVENTS 1982**



**APPENDIX 2**

**NATES CODING FORM**







**APPENDIX 3**

**GLOSSARY**





## GLOSSARY

Acid	includes all varieties regardless of strength.
Amount Spilled	the units used for amount spilled are always metric tonnes.
Base	includes caustic soda and all other bases regardless of strength.
Bulk Carrier	any ship or other watercraft capable of carrying solid cargo in bulk.
Cause	refers to the immediate cause of the accident or the equipment component that failed.
Collision	applies to events where a ship or vehicle was in collision with some other object.
Condensate	applies only to the product so designated within the oil industry.
Date	in the NATES data base, we always refer to the accident date.
Discharge	includes all types of deliberate and erroneous spills that are not covered by other "cause" categories.
Event	in the NATES data base, an event refers to one occurrence of an environmental accident. By our definition several spills may occur in one event: each different material released corresponds to one spill.
Fertilizer	covers all types of fertilizer: chemical (including anhydrous ammonia) and "organic" (manure and sewage plant fertilizers).
Fuel 2	includes aviation turbine fuel and similar light kerosenes such as high performance diesel fuel, arctic diesel, home-heating oil, etc.
Fuel 4 and 5	covers the heavier distillate fuels such as industrial heating (furnace) oil and marine diesel fuel.
Fuel 6	includes the bunker grade fuels such as "Bunker C".
Grounding	only applies to a watercraft that hits bottom (water too shallow).
Industrial Chemical	includes solids, liquids and gases not classed as metals, acids, bases or other material codes.

Industrial Plant	this category encompasses power plants, heating plants and other manufacturing and processing facilities (except those mentioned in other source codes).
Industrial Waste	does NOT include waste oils, but covers all other forms of industrial waste; e.g. pulp and paper waste, chemical effluents, etc.
Marine Terminal	includes water-front facilities, mono-buoys, and other such installations built expressly for transferring material on or off ships.
Metal	covers all refined metals such as steel, aluminum, iron, gold, copper, etc. in all forms (e.g. molten, solid, powdered).
Mineral	covers all ores, concentrates, and other such unrefined materials.
Mines, Wells, and Batteries	refers to mines as well as all production and exploratory oil and gas wells, and associated piping in batteries.
Mining and Metallurgy	includes all mining operations and associated equipment and vehicles, steel manufacturing (as well as other metals).
Other Motor Vehicle	includes all motor vehicles not included in "tank truck" and "transport" (excludes aircraft, rail, and watercraft).
Other Watercraft	all watercraft that are not covered by the "Tanker" and "Bulk Carrier" categories.
Overflow	refers to overfilling of tanks and containers, mobile or fixed.
Overturn	applies to vehicles that accidentally roll, upset, overturn, etc.
Paint, Dye	covers all paints and dyes regardless of the base used.
Pesticide	is used in the generic sense and includes herbicides, fungicides, insecticides, etc.
Petroleum Sector	includes all services operated by the petroleum industry: gas stations and company bulk transport. The petrochemical sector is included in this heading.
Pipe Leak	includes leaks from a pipe, an unidentified part of a piping system, and flexible hose.
Pipeline	includes bulk transportation lines only: not local "in-plant" piping. <b>n.b.</b> large pipelines fall in the "Transportation" sector (rather than in the "Petroleum" sector).

Radioactive Material	applies to any radioactive material even if it falls into one of the other material categories.
Regression Analysis	given a 10-year set of data points, regression analysis gives the best-fit straight line through the points. It allows us to see if the trend is up or down, and gives us an indication of the probability of the trend being significant (i.e. not due to chance).
Saline Water	pertains primarily to the brine solution found in oil and natural gas fields.
Sector	the economic or industrial sector.
Sewer	all storm and sanitary sewers, and associated sewage treatment plants.
Sinking	applies to watercraft in cases where the cause of sinking cannot be described by another code such as collision or grounding. Also includes vehicles falling through ice bridges/roads.
Source	the type of conveyance involved if the event happened in transit; otherwise, the type of facility at which the spill occurred.
Spill	refers to the release of one substance to the environment. If, in a given spill event, two materials are spilled, (as in a train derailment for example) then we say there is one event, and two spills.
Storage Depot	for the purpose of this report, all depots, be they bulk storage or not, are included in this category.
Tank Truck	includes all road vehicles carrying liquid or gaseous cargo in bulk.
Tanker	any ship or other watercraft carrying liquid or gaseous cargo in bulk.
Transfer Accident	an incident that occurs during the transfer of cargo or fuel from one tank or container to another.
Transport	refers to all non-passenger transportation vehicles except for tank trucks (excludes aircraft, rail, and watercraft).
Transportation Sector	applies only to the commercial carriers whose only business is transporting materials for their customers. It does not include transportation services operated by industries such as the petroleum, mining, and food retail industries.

**Valve, Fitting**

applies when the spilled material escapes through a valve, gauge, filter, pump, joint gasket, or other similar accessory/component of a piping system, tank or other container.







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