DEVELOPMENT DOCUMENT
for
HAZARDOUS SUBSTANCE REGULATIONS

(Regulations mandated by Section 311, Pub. L. 92–500 Federal Water Pollution Control Act Amendments of 1972)

DRAFT

January 1976

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Hazardous Substances Branch
Criteria and Standards Division
Office of Water Planning and Standards
Office of Water and Hazardous Materials

Foreword

This development document is one of a series of publications by the Environmental Protection Agency to present information which is considered useful in developing a national program for the control of hazardous substance spills. Contained in this volume the reader will find an explanation of criteria and rationale used to select elements and compounds for priority attention under the national program. Review of the document and its data supplement in its entirety should provide the reader with a technical basis for the four key regulations needed to implement the national program provided for under Section 311 of The Federal Water Pollution Control Act Amendments of 1972.

The information contained in this document is intended to build upon detailed information provided in EPA Report #440/9-75-005 a-d, Determination of Harmful Quantities and Rates of Penalty for Hazardous Substances. The present document contains condensed versions of some information from the previous report and frequently refers to it, but contains much additional information.

It is reasonable to anticipate that additional publications in this hazardous substance series will include methods and costs of spill prevention, procedures for spill response and mitigation, safety information, recent bioassay results and updates of previous reports such as the Field Detection and Damage Assessment Handbook for Oil and Hazardous Material Spills.

This document is intended to provide information supplemental to that contained in the preambles to the several hazardous substance regulations. Individuals whose work is particularly acknowledged are Dr. Gregory Kew, Mr. Jonathan Amson, Mr. Robert Sanford, Mr. Charles Gentry, Jr., and Dr. Allen Jennings. Ms. Mary Smaldore's contribution as typist is most appreciated.

The sole purpose of assembling the information has been to provide a basis to meet the regulation requirements under Section 311. As such, this information should not be confused with that collected for other purposes nor should it be viewed as valid for alternative uses. Although the Agency has attempted to include all available information, there is no attempt to represent the data as complete or final. Additions and corrections are encouraged and may be achieved by contacting Hazardous Substances Branch, WH-595, Office of Water Planning and Standards, Environmental Protection Agency, Washington, D.C. 20460 (202) 245-3036.

Dr. C. Hugh Thompson
Chief
Hazardous Substances Branch WH-595

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INTRODUCTION

A unique source of water pollutants came to national and international prominence in the two years immediately preceding passage of the Federal Water Pollution Control Act of 1970 (The Act). Oil spills from the tankers Torrey Canyon and Ocean Eagle, from offshore platforms in the Gulf of Mexico and off Santa Barbara, California pointed out the need to address this source of water pollution. Section 11 of the 1970 Water Pollution Control Act empowered the Federal Government to take action against the discharge of oil. Dischargers were required to report spills and held liable for cleanup and oil removal costs. Provision for prevention of spills and coordinated federal response to combat spills and their effects were also included.

Congress realized that a number of chemical substances, in addition to oil, were involved in pollution resulting from spills and consequently included Section 12 of the Act. This section dealt with spills of substances other than oil and authorized the executive branch of the Federal government to develop regulations designating materials as "hazardous substances" and to establish methods for their removal from water. Although no liabilities or sanctions against the discharger of hazardous substances were included, the Federal government was authorized to take actions necessary to remove the pollutant and protect public health or welfare.

Amendments to the Act in 1972 combined the previous Sections 11 and 12 into a new Section 311 and provided a series of liabilities and sanctions against the spill or discharge of designated hazardous substances. Certain key regulations were required before the hazardous substance portion of Section 311 could be implemented. These dealt with the designation of hazardous substances, determination of their removability, establishment of harmful quantities, and setting of penalty rates. With these four regulations the Federal government can require reporting of spills exceeding the harmful quantities, can assess civil penalties for discharges exceeding the harmful quantity, can reclaim costs of spill clean-up and damage mitigation, and can take direct actions to protect public and environmental health if the discharger refuses or is unable to do so. This document is intended to reconstruct or outline the background and data used in developing these regulations.

CHAPTER I

MAGNITUDE OF THE CHEMICAL SPILL PROBLEM

A. Introduction

The design of a regulatory framework and operational program to control chemical spills is dependent upon the definition of the problem. This chapter sets the basic scope and definition of the spill problem in qualitative and, to the extent possible, quantitative terms. Throughout this section certain guideposts appear, indicating a possible approach to subsets of the overall problem. All of these will be expanded in later chapters dealing with development of the individual regulations.

Spills are unique among the various routes by which pollutants reach water. Spills from vessels, motor and rail carriers cannot be predicted on either a time or location basis. While the location of spills from a fixed facility can be predicted, the time of occurrence cannot.

In contrast, non-spill discharges from fixed facilities occur at predictable places and on a routine schedule corresponding to manufacturing or processing activities. Other predictable activities include those subject to permits under the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500), and the Marine Protection, Research and Sanctuaries Act of 1972 (P.L. 92-532), such as ocean dumping of wastes and dredged spoil disposal.

A spill from either a fixed facility or a transportation source is generally a sudden, unplanned release of a pollutant resulting in a rapid increase in concentration of the material in the water. The rate of concentration increase depends on the rate of pollutant discharge and flow characteristics of the receiving water body. The peak concentration attained in the receiving water depends primarily on the total quantity released and the flow characteristics of that water body. After peak concentration is reached, dilution begins, with the rate of dilution dependent on the flow characteristics of the affected water body. Water quality in the spill area is usually affected for only a relatively short period of time by the material itself, but the long-term effects resulting from severe or widespread damage can reduce the overall environmental quality. Exceptions to these generalities are spills of nondegradable chemicals of low solubility which can persist in the sediments, or spills in quiescent water bodies where dilution rates are slow. In these cases, long-term contamination and resultant impaired water quality are of great concern.

B. Water Uses

Hazardous substances, other than oil, are defined in Section 311 of P. L. 92-500 as "... such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the U.S. or adjoining shorelines or the waters of the contiguous zone, present an imminent and substantial danger to the public health and welfare, including but not limited to, fish, shellfish, wildlife, shorelines, and beaches." When developing a list of hazardous substances it is necessary to consider the potential effect of spills on intended water uses such as public water supply, propagation of fish or wildlife, recreation, aesthetics, agriculture and industrial needs. All of these uses are applicable to fresh waters. In estuaries or in waters of the coastal and contiguous zones, fish or wildlife propagation, aesthetics, and recreation are the most important water uses. However, it is recognized that the future may include water supply in the uses of marine waters.

Examination of the potential impact of a chemical spill on each water use requires consideration of the unique aspects of spill situations and the toxic nature of the many chemicals that may be designated as "hazardous". It should be noted that (1) a spill usually results in a concentrated "slug" of material; (2) transportation spills are unpredictable as to both time and location; (3) fixed facility spills are unpredictable in time. These three factors and their impact on potential water uses are discussed further below.

1. Public Water Supplies

Water treatment plants producing a potable public water supply are designed to remove certain classes of pollutants from the water with the degree of treatment employed primarily dependent upon the quality of raw water[1]. The objective of any potable water treatment facility is to produce clean water free from pathogenic organisms, hazardous or radioactive materials, and objectionable taste, odor, and color. Turbidity is generally removed in a three-step process involving gravity sedimentation, flocculation precipitation, and filtration. Pathogenic organisms are dealt with by disinfective chlorination with either gaseous chlorine or hypochlorite salts. Objectionable tastes and odors arising from dissolved gases are often overcome by aeration. More severe taste and odor problems, as well as color imparting chemicals, are usually removed by the use of activated carbon. Waters with excessive hardness (high magnesium or calcium content) are softened by either the lime-soda precipitation process or an ion-exchange process usually employing natural or synthetic zeolite[1].

Water from subsurface sources generally is chlorinated as a preventive measure and softened as required, while water from surface sources requires, at minimum, flocculation, filtration and chlorination. Many water treatment plants are effective in the removal of suspended solids and disinfection, but have only limited effectiveness in the removal of dissolved materials.

Only the most sophisticated treatment plants which employ activated carbon and ion exchange in addition to the other, more standard flocculation and filtration processes, are equipped to effectively remove certain levels of both organic and inorganic materials. Since the design of even the most advanced water supply treatment plants is subject to stringent cost versus benefit analysis, most operate within specified limits and few, if any, are equipped to deal with the possibility of sudden high concentration of contaminant resulting from a chemical spill. Small water supplies are therefore very vunerable to small spills of hazardous substances.

Upstream treatment plants employing less refined treatment in relatively clean waters, may be more severely impacted by a spill than those situated below areas of heavy industrial and municipal use. Many spills do not reach surface waters, but even in these cases ground water aquifers may be affected, resulting in eventual contamination of drinking water supplies. Because public water supplies can be threatened by a chemical spill, orally administered mammalian toxicity data and Federal Drinking Water Standards have been considered as primary data by which the potential impact of a material on potable water use may be assessed. The protection of public water supplies primarily depends on prompt notification of a discharge of a hazardous substance. Several programs exist today as an attempt to accomplish this task[2]. The critical factor for any system is timely notice of the spill. The designation of the list of hazardous substances and the determination of harmful quantities are of utmost importance in this notification activity and the protection of public health via the drinking water.

2. <u>Propagation of Fish or Wildlife</u>

The biota of any aquatic ecosystem represents that balance among trophic levels, species, and numbers of individuals best able to exist in that particular water body. The balance obtained is the product of adaptation of the biota to the available water quality. It can be said, therefore, that the aquatic ecosystem observed is in part a reflection of water quality at the time. By adaptation, given species in given numbers populate waters of given quality[3]. Observation and experiment demonstrate that changes in water quality produced by the introduction of a pollutant will dictate alterations in the biota[4-6]. Sensitive species will be eliminated or reduced in number; some will adapt and repopulate; tolerant species will remain unaffected; some may increase in number; new, tolerant species may become established[4]. A new balance is then reached which again depends on the currently existing water quality. Abatement of the pollutant discharge again dictates changes in the biota with eventual return to the previous balance. Completely analogous short-term alterations can be observed with natural changes in water quality precipitated by seasonal changes.

A guiding principle in the area of water quality is that man places higher value on those ecosystems which are supported by the higher water quality. Value in relation to fish and wildlife water uses can be expressed in terms of economically important food fish, recreationally important game fish and animals, and aesthetically enjoyable wildlife. Classically, water quality criteria have been developed for sensitive, important species so that standards for their protection could be established. The traditional criteria have been based primarily on acute fish bioassays, and are expressed as median tolerance limits (TLm) and LC50 values, or that concentration at which half the test population die in a given time period. Extrapolation of this laboratory data to the development of criteria has been accomplished by the use of application factors along with other considerations.

The true application factor for a particular material or waste is derived by dividing the "no effect level" by the 96-hour TLm for a particular species. The derived factor is then multiplied by the TLm value for any other species to arrive at an acceptable long-term receiving water concentration of the material to the species in question[3].

The inherent difficulties in establishing truly harmless levels have led to use of estimated application factors for approximating the "no effect level" of various materials. Their use has been an accepted practice for arriving at water quality criteria for a variety of pollutants[3]. These estimated factors, based on persistence, chemical structure, and chronic effects, have typically ranged from 0.01 to 0.1.

It will be recalled that spills usually result in short-term exposure of the aquatic biota to hazardous substances. Although chronic and sublethal effects are often considered in the protection of aquatic biota, they are more applicable in the setting of criteria to control the continuous discharge. Consequently, acute toxicity data, evaluated without the use of application factors, have been considered to be the most realistic basis for a decision on the designation of a material as hazardous under Section 311.

Three potential routes of acute exposure to mammalian life are oral, dermal or inhalational exposure. Consequently, the same three types of data, or any combination, can be used to evaluate the potential danger posed by candidate materials to mammalian life, including man.

Unfortunately, designation of a material as hazardous and the resultant prompt reporting of incidents will do little to actually protect exposed fish and wildlife. Their ultimate protection from a chemical spill hinges on prevention of the discharge by the assessment of deterrent penalties or by the implementation of an adequate spill prevention plan. Both of these control methods first require a designation of those materials likely to adversely affect the propagation of fish and wildlife.

3. Recreation or Aesthetics

The importance of clean water as a recreational resource to Americans has been documented[3]. Further, trends indicate that increasing numbers of people are seeking water as an integral part of their outdoor recreation[7].

Recreational water uses can be divided into two classes, active and passive. Active water uses consist primarily of swimming, fishing, and boating while the passive uses are more aesthetic in nature and include activities such as walking alongside or sitting by water. Chemical spills can obviously impair all aspects of recreational water use. Since principles for evaluating the impact of various substances on fish are discussed in the previous section, sport fishing need not be further addressed. Of the other recreational uses, the active, direct contact uses offer the greatest potential danger to the public. The unexpected, sudden release of materials which are corrosive, irritating or dermally toxic, or which release toxic vapors, can place swimmers and boaters in direct jeopardy and impair water use until the spill passes, dilutes to a safe level, or is in some way mitigated.

The assessment of a material's threat to contact recreation can be made by the evaluation of appropriate acute toxicity data. Acute inhalation and dermal toxicity data are considered as the most applicable since they represent probable routes of exposure to individuals participating in contact recreation. When available, skin and eye irritation data may be used, but these data are generally developed by long-term exposure and caution must be exercised when applying them to the spill situation.

Impairment of aesthetic recreational uses arises from the previously mentioned toxic or irritating properties of chemicals, but other less well defined characteristics such as color and odor can impact the aesthetic quality of water. Fouled beaches are typically associated with oil spills and public outcry frequently accompanies such incidents. The possibility for equivalent situations does exist for some chemicals but the non-persistent or soluble nature of most tend to minimize the potential. Because of the temporal and subjective nature of aesthetic impairment, guidelines for evaluation are not presented in this document and aesthetic impairment has not been considered as a criterion for designating hazardous substances.

4. Agricultural Uses

Because livestock watering and irrigation are the primary and most widespread agricultural water uses, the impact of chemical spills on these uses will be the principal area of concern in this section. In certain locales, washing and hydrocooling of fruits and vegetables prior to marketing are important water uses, while elsewhere high purity water of potable quality is required for milk production. Of all agricultural water uses, irrigation is the largest single-purpose consumptive use[3]. Although farmstead water uses include drinking water, the guidelines presented for public water supplies are applicable and should be adequate.

Livestock watering from either flowing streams or impoundments fed by streams are endangered by upstream chemical spills. Since the most probable route of exposure is by ingestion, acute mammalian oral toxicity data are preferred to evaluate the danger potential of candidate materials.

Spills of phytotoxic materials in irrigation water sources can either destroy or debilitate crops for an entire season. In these cases, severe economic loss by the grower is a very real possibility and short-term spills can produce a long-term effect. The assessment of a material's potential impact on irrigation water use can best be achieved by the examination of acute phytotoxicity data. Some data exist which are based on short-term exposures of four days or less[8] but current testing protocol may specify exposure times of up to 14 days[9].

As with other previously discussed uses, the protection of livestock and crops from a chemical spill hinges on early warning facilitated by immediate notification. If sufficient warning is given, animals can be removed from risk and irrigation pumping can be halted until the danger passes. However, the ultimate protection of water quality for agricultural usage again revolves around spill prevention.

5. Industrial Uses

Industrial water uses are many and varied with the type and degree of treatment being as individual and varied as the industrial processes themselves[10]. Any attempt to delineate each industrial water use, the required treatment, or the spill impact on each would be a lengthy process and outside the scope of this document. It is sufficient to say that a finite potential does exist for chemical spill impairment of industrial water uses. As with other withdrawal uses, early notification is an effective method by which potential damages can be minimized.

C. The Number of Spills

Data relative to hazardous substances spills are limited because reporting of discharges is not now, nor will be required, until such time as the substances are designated and their harmful quantities are established. Discussions of the magnitude of the chemical spill problem must, therefore, be based, in part, on extrapolations and reasonable assumptions. The oil spill reporting systems established after final promulgation of 40 CFR Part 110 has served as a relatively convenient mechanism for voluntary reporting of chemical spills. The existing data consists of records of spills which were voluntarily reported to EPA or the Coast Guard or which were fortuitously discovered by the Agencies over a two and one-half year interval. Thus, the current data represent a limited percentage of the actual chemical spills. While not complete, it may be assumed that the data are representative of the chemicals spilled, and of the sources and causes of the spills.

For the years 1974, 1973, and the last six months of 1972, a total of 379 reported spill incidents are on record involving substances currently under consideration for designation. Of these reports, 360 (or 95%) involved the actual release of the substance. The remainder can be classified as "potential" releases and generally resulted from a transportation accident in which the container did not leak.

It is noted that 174 of the 379 reports received (46%) show that the chemical in question actually reached a surface water body. This is an average of 70 spills per year. Assuming the distribution of all spills is identical to that for voluntarily reported spills, 46% of all hazardous substance spills would be subject to notification requirements, clean-up liability, and civil penalty provisions of Section 311.

Prior to promulgation of 40 CFR Part 110, which defined the harmful quantity of oil and thereby activated mandatory reporting of oil spills, voluntary reports were received by both the Coast Guard and the Federal Water Pollution Control Administration (predecessor to the EPA Office of Water Programs). Following rulemaking and mandatory reporting, the number of reports increased at least ten-fold. It is therefore reasonable to assume that a similar increase in spill reports will accompany the promulgation of regulations which activate the hazardous substances portion of Section 311. Thus, the number of reportable spills might reasonably be predicted to increase from 70 to 700 per year following institution of the mandatory reporting requirements.

If anything, this estimate of 700 spills per year is likely to be conservative, because the nature of many chemicals proposed as hazardous does not result in readily observed effects when they are spilled. This is in contrast to the situation for oils where a relatively small volume spilled results in the familiar and obvious sheen or discoloration of the water. Furthermore, while many substances proposed as hazardous are widely recognized as water pollutants, others are less well known.

Industry has usually not considered these latter chemicals worthy of concern unless they are discharged in extremely large quantities. Consequently, a more realistic estimate of the number of spills of proposed substances actually reaching a surface water body may be somewhat greater.

Further statistics are available from the voluntary data base, but must be used cautiously because of the incomplete nature of the data. Reported incidents involving proposed hazardous substances, whether actually spilled from containers or not, can be broken down according as shown in the following tables:

TABLE I-1
Sources of Spills

Source	Number of Spills	% of Total
Vessel	40	10
Rail	98	26
Highway	60	16
Fixed Facility	181	48
Total	379	100

For those cases that actually resulted in surface water pollution, the frequency and percent contribution are somewhat different:

TABLE I-2
Frequency of Spills

Source	Number of Spills	% of Total
Vessel	27	16
Rail	15	9
Highway	25	14
Fixed Facility	107	61
Total	174	100

If the number of spills that reached water is divided by the total number of spills for each discharge category, the resulting percentage obtained represents the relative risk of water pollution resulting from an accident for each spill category. This is shown in the table below:

TABLE I-3
Pollution Incidents from Sources

Source	% of Incidents resulting in Water Pollution for Each Source Category
Vessel	68
Rail	15
Highway	42
Fixed Facility	59

If the poundage spilled for each category is divided by the total amount spilled, one obtains the relative contribution of each spill category to the total problem:

TABLE I-4
Amounts Spilled

Source	Pounds	% of Total Pounds
Vessel	19,060,400	31
Rail	8,187,498	13
Highway	989,635	2
Fixed Facility	32,498,430	54
Total	60,735,963	100

The causes of spill incidents may be summarized as follows:

TABLE I-5
Causes of Spills

Cause	Number	Percentage
Equipment Failure	196	59
Derailment	59	30
Tank Failures	37	19
Valve Failures	32	16
Transfer Line Failures	26	13
Pump & Flange Failures	14	7
Corrosion	7	4
Other Causes	10	5
Unknown	11	6
Human Error	61	18
Tank Overflows	20	33
Open Valves	13	21
Vessel Groundings	8	13
Vessel-Bridge Collisions	2	3
Railroad Switching	2	3
Other Causes	3	5
Unknown	13	21
Other	74	22
Collisions	43	58
Fire, Explosion, etc.	11	15
Vandalism, Intentional Damage, etc.	7	9
Unknown	13	18

The variety of actions taken to minimize or mitigate the effects of spills reaching water may be summarized as follows:

TABLE I-6

Spill Mitigation Attempts

Method	Number of times used
1. Boom	10
2. Skim	8
3. Vacuum	11
4. Physical pickup	17
5. Sorption techniques	10
6. Neutralization techniques	48
7. Containment (diking, holding ponds, ditching, etc.)	29
8. Controlled burning	2
9. Dirt topping	5
TOTAL =	140

Methods of doubtful value	Number of times used
1. Water dispersal (flushing or dilution)	33
2. Chemical dispersant	1
TOTAL =	34

TABLE I-7
Accident Frequency by State and Year

	1970*	1971	1972	1973**	1974
Ala.	1	1	1	3	5
Alaska		1			1
Ariz.					
Ark.				2	3
Calif.		18	10		
Colo.		1	20	3	39
Conn.		1	2		2
Del.		1		4	6
Fla.		1	1	1	6
Ga.		1		5	16
Hawaii					
Idaho					1
Illinois	1	12	7	5	23
Ind.		6	4	3	14
Iowa		1			
Kansas		1			
Kentucky	1	2	3	3	2
La.	2	9	6	7	12
Maine					1
Md.	1	3	9	1	11
Mass.		2	3		3
Mich.	3	2		1	17
Minn.		1	1	2	18
Miss.		6	1	2	6
Missouri		2	2	1	
Mont.		2		5	
Neb.	1		1		
Nev.					
N.H.					
N.J.		5	2	1	
N.M.		1	1		1
N.Y.	1	2	1		2
N.C.		7	7	5	16
N.D.			2		4
Ohio		19	17	15	38
Okla.		1	1	6	7

(Continued on following page)

*Data for five months only
**Data for seven months only

TABLE I-7 (continued)

	1970*	1971	1972	1973**	1974
Oregon	5	7	1	1	
Penn.		14	9	7	27
R.I.					
S.C.		3		2	9
S.D.		1			2
Tenn.		4	3	3	18
Texas		14	5	8	19
Utah			2	4	16
Vermont					1
Va.	2	7	6	7	15
Wash.		5		1	2
W.Va.	1	13	12	7	21
Wisc.			1		7
Wyo.		3	2	1	7
Wash., D.C.					2

*Data for five months only
**Data for seven months only

TABLE I-8
Hazardous Substance Accident Frequency by Month (1970 - 1974)

	1970	1971	1972	1973	1974
Jan.		5	25	22	22
Feb.	None	7	0	16	18
Mar.	recorded	7	10	18	34
Apr.	in this	8	18	7	38
May	period	17	3	None	32
June		15	21	recorded	40
July		15	9	in this	58
Aug.	3	12	13	period	58
Sept.	4	23	0	11	18
Oct.	5	19	8	23	20
Nov.	4	25	20	13	32
Dec.	6	25	17	12	28

Again, it must be emphasized that the above analyses are based on incomplete, voluntary data and may conceivably be skewed. The reporting required after final promulgation of rules on designation, removability, and harmful quantities should create a more complete data base from which to derive statistics of the sort found above. A more detailed presentation of the data which went into the preceeding summaries are found in the Appendix at the end of this volume.

Pollution-caused fish kills have increased dramatically in recent years (Table I-9). The total reported number of fish killed went from six million in 1960 to 119 million in 1974, a 2,000% increase. Although these totals include fish kills caused by the release of improperly treated sewage and agricultural runoff, many of them resulted from abnormal discharges (spills) of chemicals from both fixed facilities and transportation sources. The actual number of fish killed is likely to be much higher than the number reported, since fish kill notification is not mandatory under Federal law nor is it mandatory in most localities.

EPA figures shown in Table I-9 indicate that between 1960 and 1974 the number of combined industrial and transporation-related fish kill reports from the various States increased from 103 in 1960 to 208 in 1974. The data of Table I-9 are recognized as not clearly indicative of the changes caused by spills alone, but assist in an understanding of the magnitude of the problem.

TABLE I-9 Historical Summary of Pollution-Caused Fish Kills, 1960 - 1974

	1960 [2]	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Number of states responding	38	45	37	38	40	44	46	40	42	45	45	46	50	50	50
Number of reports	299	413	421	442	590	625	532	454	542	594	635	860	760	749	721
Reports which state number of fish killed	151	265	246	304	470	520	453	364	469	492	563	759	697	703	648
Total reported number of fish killed	6,035,000	14,910,000	44,001,000	6,937,000	22,914,000	12,140,000	9,614,000	11,231,000	15 815,000	41,166 000	22,290,000	73 670 000	17 717 000	37,814,000	119,052,000
Average size of kill [1]	2,925	6,535	5,710	7,775	5,490	4,310	5,620	6 450	6,015	5 860	6,412	6,251	4,639	5,527	6,532
Largest kill reported	5,000,000	5,387,000	3,180,000	2,000,000	7,887,000	3,000,000	1,000,000	6,549,000	4,029,000	26 527,000	3,240,000	5,500 000	2,922,000	10,000,000	47,112,000
Number of reported incidents for each pollution source operation															
Agricultural	79	74	51	84	131	114	88	87	77	117	108	132	113	161	145
Industrial	103	169	209	199	193	244	195	139	177	199	213	231	193	196	168
Municipal [3]	24	52	33	60	120	125	87	91	122	84	120	162	157	146	169
Transportation	0	0	1	17	26	27	27	23	39	32	28	52	56	65	40
Other	33	58	47	27	17	23	38	35	23	33	28	64	72	56	74
Unknown	50	60	80	55	103	92	97	79	104	129	138	219	163	125	125
Total reports	289	413	421	442	590	625	532	454	542	594	635	860	760	748	721

Number of reports and fish killed by size grouping	1960 No. reports	1960 No. fish (millions)	1961 No. reports	1961 No. fish (millions)	1962 No. reports	1962 No. fish (millions)	1963 No. reports	1963 No. fish (millions)	1964 No. reports	1964 No. fish (millions)	1965 No. reports	1965 No. fish (millions)	1966 No. reports	1966 No. fish (millions)	1967 No. reports	1967 No. fish (millions)
1 000 000 or more	1	5 0	4	12 6	2	41 0	1	2 0	5	16 9	3	5 4	2	2 0	1	6 5
100,000 to 1 000,000	3	0 53	5	0 85	9	1 69	12	2 68	15	3 82	17	4 52	23	5 42	7	2 60
10 000 to 100,000	15	0 31	45	1 05	38	1 01	54	1 82	59	1 65	63	1 42	58	1 53	49	1 58
1 000 to 10 000	64	0 18	107	0 34	89	0 30	134	0 41	167	0 49	202	0 59	165	0 55	143	0 45
0 to 1,000	68	0 02	104	0 03	108	0 03	103	0 03	224	0 07	235	0 07	185	0 05	164	0 05
No size reported for incident	138		118		175		138		120		105		79		90	
Average duration of kill in days		2 95		2 64		2 59		3 18		2 44		2 57		2 71		3 34

Number of reports and fish killed by size grouping	1968 No. reports	1968 No. fish (millions)	1969 No. reports	1969 No. fish (millions)	1970 No. reports	1970 No. fish (millions)	1971 No. reports	1971 No. fish (millions)	1972 No. reports	1972 No. fish (millions)	1973 No. reports	1973 No. fish (millions)	1974 No. reports	1974 No. fish (millions)
1 000 000 or more	3	6 1	4	35 1	5	11 4	28	63 0	6	8 27	6	29.53	6	107.6
100,000 to 1 000,000	30	7 44	9	3 15	26	7 44	26	6 37	27	5 43	19	4.65	20	7.0
10 000 to 100,000	64	1 79	81	2 06	91	2 72	1 4	3 33	81	2 60	87	2.74	110	3.6
1 000 to 10 000	153	0 48	165	0 52	198	0 62	206	0 36	216	0 62	251	0.81	187	0.6
0 to 1,000	219	0 06	233	0 06	243	0 07	315	0 10	367	0 09	339	0.29	325	0.1
No size reported for incident	73		102		72		101		63		46	—	73	—
Average duration of kill in days		2 89		3 11		3 25		3 35		3.40		2.72		3.58

[1] Derived after excluding reports of 100 000 kills or more as being unrepresentative
[2] Reporting system in effect for last six months of 1960
[3] Municipal operations include electric power generating stations

E. State Interest in Hazardous Substance Spill Programs

In addition to Federal regulation of navigable waters, States exercise certain authorities over waters within their geographic boundaries. Lack of Federal regulations addressing hazardous substance spills has prompted several state governments to enact spill control programs designed to protect public health and environmental resources. While most elements of the problem are common to all jurisdictions, the emphasis placed on controling chemical spills varies from state to state depending on several factors such as the degree of industrialization and chemical transportation, amount of surface water, and the value placed on water resources.

Although degree of emphasis on environmental protection in general is somewhat variable, all state governments evidence immediate concern when aware that a chemical spill threatens human health. The respective Departments of Health or State Pollution Control Boards are the agencies concerned if a spill into a watercourse should make the water unfit for human consumption. Pollution caused fish kills have traditionally received a high level of interest at the State level because fish kills are obvious indicators that something is drastically wrong with the water. All states can take action in the form of compensation for the value of fish killed in a pollution incident, but there is no other uniform system of civil or criminal penalties which all states use to control pollution incidents.

Increasing public awareness has resulted in pressures on both the Federal and State levels to reexamine the hazards associated with the storage and transportation of hazardous substances. Many states are now requiring that spills be reported. Some specify that all spills greater than a certain number of gallons or pounds be reported, while for others, there is no such quantity specified. Further, there may be civil and/or criminal penalties for failure to file a report in addition to the act of spilling itself.

The following table lists States responding to an EPA questionnaire regarding specific hazardous substance spill regulations:

TABLE I-10
State Hazardous Substance Spill Regulatory Programs

State	Reporting Requirement	Harmful Quantity	Sanctions
Arizona	No	No	Yes***
Arkansas	No	No	No
California	No	No	Yes***
Colorado	No	No	No
Connecticut	No*	Yes	Yes
Florida	Yes	Yes	Yes
Georgia	Yes	Yes	Yes
Hawaii	No	No	Yes***
Idaho	Yes	No	Yes
Illinois	No*	Yes*	Yes
Indiana	Yes-Stationary Facilities Only	No	Yes
Kansas	No	No	No
Kentucky	Yes	Yes	Yes
Louisiana	Yes	Yes	Yes
Maine	No	No	No
Maryland	No	No	No
Massachusetts	No	No	No
Michigan	No	Yes**	Yes
Minnesota	Yes	No	No
Mississippi	No	No	No
Montana	No	No	No

(continued on following page)

TABLE I-10 continued

	Reporting Requirement	Harmful Quantity	Sanctions
Nebraska	No	No	No
Nevada	No	No	Yes***
New Hampshire	No	No	Yes***
New Jersey	Yes	Yes	Yes
New York	Yes	Yes	Yes
New Mexico	No-Pending	Yes	Yes
North Carolina	No	No	No
North Dakota	No	No	No
Ohio	Yes-Effluent Permitholders	Case by Case	Yes
Oklahoma	Yes	Yes	Yes
Oregon	Yes	No	Yes
Rhode Island	No*	Yes	Yes
South Carolina	No	Yes	Yes
South Dakota	No	No	No
Tennessee	Yes	Yes	Yes
Texas	Yes	Yes	Yes
Utah	Yes-Eff. 6/1/73		
Vermont	No*	Yes	Yes
Virginia	No	No	Yes
Washington	Yes	Yes	Yes
Wisconsin	Yes	No	No
Wyoming	No	No	No

* Reliance upon State-Federal Water Quality Standards.
** Quantity and substance tailored to receiving water bodies.
*** Use state game and fish or other laws not requiring identification of spilled material.

F. Industrial Interest in Hazardous Substance Programs

Recognizing the responsibilities and consequences of uncontrolled release of hazardous chemicals to the environment, the chemical industry has instituted storage and handling standards, emergency procedures, and emergency information systems to respond to accidents, through individual company programs, cooperative agreements, and trade organizations.

1. Industrial Emergency Programs

Millions of pounds of chemicals are shipped around the country each day. Generally, handling and transportation of chemicals is uneventful and rountine. However, shipments can be damaged through mishandling or transportation accidents. Manufacturing and storage facilities have experienced a spill problem of roughly equal magnitude.

Some of these spills are preventable while others appear inevitable. Many firms maintain their own specially trained strike forces to respond to such contingencies.

2. Emergency Information Systems

When a spill does occur, it is crucial that people be protected from injury and that the discharge be rendered innocuous as quickly as possible. Nothing is more important in the first minutes following a spill than obtaining complete information on the substance spilled, including its effects on the environment. The use of emergency information systems alleviate much confusion and provides on-scene authorities with an improved basis for making decisions regarding procedures to be followed in containing and controlling a spill.

a. CHEMCARD

The Manufacturing Chemists Association pioneered efforts in this area when they created the "Chem Card". Each card carries a description of the material as well as information relative to general hazards associated with fire, explosion, and human health. Appropriate emergency steps to be taken in the event of an accident are also presented.

b. CHEMTREC

MCA has also initiated the Chemical Transportation Emergency Center, CHEMTREC, to provide emergency information to public officials and operators in transportation incidents involving hazardous chemicals. It offers a national toll free telephone manned 24 hours a day, seven days a week. Trained duty officers provide immediate information concerning steps to be taken in coping with the shipping accident. If more detailed assistance is required, the CHEMTREC operator acts as a link between the manufacturer and the on-scene personnel.

In addition to these efforts by the MCA, individual programs have been initiated by some companies to provide emergency assistance whenever and wherever their products are involved.

c. TERP

In 1966, Dupont developed the Transportation Emergency Reporting Procedure (TERP) which provides immediate information on any of its 1500 products which might be involved in a potentially hazardous incident. This program consists of a "hot line" telephone, through which expert advice can be channeled when needed. On being contacted, the coordination staff notifies the authorities at the scene of the hazardous situation and offers assistance by providing consultation and advice concerning the hazard potential of the materials. If needed, the company dispatches personnel to the scene.

Other chemical companies have developed similar emergency systems for their own products, such as American Cyanimid's TWERP (Transportation and Warehouse Emergency Reporting Procedure), Union Carbide's HELP system (Hazardous Emergency Leaks Procedure), Dow Chemical's DERS (Distribution Emergency Response System, Allied Chemical's TESAC (Transportation Emergency System), and many more which have been formed as companies realize the need.

There are also other emergency systems organized by trade organizations, such as the Chlorine Institute's Chlorine Emergency Plan (CHLOREP), the Pesticide Safety Team Network of the National Agricultural Chemicals Association, the American Water Works Association's Emergency Manual for Hazardous Materials Spill, and the American Railroad Association's Bureau of Explosives.

3. Industrial Economic Interests

Industry is interested in the direct economic losses involved in hazardous substance spills, in addition to the public health, safety, and public relations aspects. A brief summary giving some limited perspective of the dimensions of this problem is found below:

TABLE I-11

Estimates of direct economic losses from spills

Total poundage reported spilled in OHM-SIRS file during the interval July, 1972 through 1974	81,699,955 lb.

Direct cost of product loss for 15 representative substances (prices from Chemical Marketing Reporter, May 5, 1975)

Acrylonitrile	1,382,424 lb. x $0.24/lb. =	$331,782
Ammonia	18,712,880 lb. x $0.09/lb. =	$1,684,159
Benzene	13,600 lb. x $0.09/lb. =	$1,224
Chlorosulfonic Acid	208,000 lb. x $0.05/lb. =	$10,400
Formaldehyde	396,832 lb. x $0.05/lb. =	$19,842
Hydrochloric Acid	220,560 lb. x $0.05/lb. =	$2,205
Methyl Methacrylate	193,600 lb. x $0.32/lb. =	$61,952
Nitric Acid	909,400 lb. x $0.07/lb. =	$63,658
Phosphoric Acid	850,900 lb. x $0.19/lb. =	$161,670
Sulfuric Acid	19,639,153 lb. x $0.03/lb. =	$589,174
Sodium Hydroxide	5,653,158 lb. x $0.14/lb. =	$791,442
Styrene	468,880 lb. x $0.25/lb. =	$117,220
Toluene	1,117,646 lb. x $0.07/lb. =	$78,235
Vinyl Acetate	154,712 lb. x $0.19/lb. =	$29,395
Xylene	438,136 lb. x $0.07/lb. =	$30,669
TOTAL	50,359,881 lb.	$3,973,037

Economic loss of above 15 substances versus total 1974 chemical sales of 50 top U.S. chemical producers (Chemical and Engineering News, May 5, 1975):

$$\frac{\$3,973,037}{\$52,010,000,000} = 0.00008 = 0.008\%$$

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CHAPTER II

ISSUES RELATING TO THE PROPOSED REGULATIONS

The discussion and analysis presented in Chapter I illustrates the great need for chemical spill regulations to reduce the number and magnitude of spills and which emphasize the mitigation of damages to beneficial water uses. This chapter will state some of the issues which have been raised and explore alternative solutions.

The designation of regulated materials should be comprehensive to cover the broad range of materials which may pose danger to public health or welfare. Nonetheless, this must, by law, be a clearly delineated listing of substances. The proposed designation achieves both the desired breadth and the legally required specificity by providing selection criteria and an initial list of chemicals meeting those criteria.

The selection criteria provide an outline for evaluating the toxicological properties and likelihood for spills of potentially hazardous substances. These criteria represent an attempt to quantify the legal phrase, "...imminent and substantial danger to public health or welfare...". With specific criteria clearly set forth, the designation list can be expanded in the future with a minimum of confusion, as need and data warrant. Affected industries will also be aware of the potential of their products for future listing and can plan facilities, transportation, and handling accordingly. Similarly, public interest groups will be aware of the data required to support petitions requesting the addition of substances to the list. The designation thus provides the cornerstone for the regulatory goals of spill reduction and damage mitigation.

The determination of actual removability, which must accompany the designation, is also directly functional in achieving these goals. Substances judged to be actually removable are subject only to clean-up liability while discharge of a substance determined to be not actually removable under Section 311(b)(2)(B)(i) could lead to assessment of civil penalties under Section 311(b)(2)(B)(iii). The determination that a substances is not actually removable in proposed 40 CFR Part 117 does not preclude liability of the discharger for damage mitigation under the definition of "removal" found in Section 311(a)(8) or concomitant liabilities under Sections 311(f) and (g). (This definition of removal covers both removal or the taking of other steps which will minimize or mitigate damage. Such a "dual definition" of removal permits a restrictive interpretation of "actual removal" while still preserving incentive for the discharger to mitigate damage.)

Mechanisms leading to reduction of the number or magnitude of spills are presently at the discretion of potential dischargers, but would presumably involve prevention through improved handling procedures, operator training, and equipment installation or modification. The economic incentives provided by the potential civil penalties are clear, though the spill prevention actions taken by a potential discharger would depend on an anlysis of cost vs. the risk of penalty assessment. (An example might be introduction of safety features on tank trucks which involve one or more of the following negative results; 1) increased equipment cost, 2) reduced carrying capacity, or 3) increased operating cost. While fewer spills might well result, the overall cost might exceed civil penalties anticipated from their past spill record.

Questions arise in considering how to implement civil penalties for nonremovable hazardous substances. For instance, what is the function of a penalty in the case of the non-preventable spill, and how can the penalty system be best used to encourage environmental damage mitigation?

Continuing discussions with safety organizations, other governmental agenies concerned with transportation problems, and with industry, indicate that the majority of spills result from accidents rather than deliberate or negligent acts. The proportion of these which could be termed "preventable" accidents with further reasonable expenditures is not presently known, though such information should result from the improved data base to be generated by compulsory spill reporting after final promulgation of 40 CFR Part 118.

Cost effective steps may reduce the number and magnitude of spills but cannot achieve a 100% reduction. Since no level of civil penalty can totally eliminate spills of hazardous substances, one must also consider damage mitigation and spill response aimed at protecting public and environmental health. Section 311 authorizes the Administrator to select which one of the two available penalty schemes to use in a given spill incident. Steps involved in this decision have been clarified (proposed 40 CFR Part 119) so that dischargers are kept abreast of potential actions on the part of EPA. Basically, proof of gross negligence on the part of the discharger is used as the discriminator between the penalty options mentioned in Sections 311(b)(2)(B)(iii)(aa) and 311(b)(2)(B)(iii)(bb). If the discharger has taken reasonable steps to prevent the spill or makes use of adequate response techniques which result in significant damage mitigation and/or protection of water uses, this will result in application of the lesser penalty option having an upper limit of $5,000 per spill event. The discharger is still liable for mitigation expenses, so the economic incentive to reduce spillage is not lost. Proof of gross negligence on the part of the discharger would subject him to the higher civil penalties of Section 311(b)(2)(B)(iii)(bb), as well as liability for response and mitigation expenses which may be taken by the government.

Section 311(b)(4) requires that a "harmful quantity" be specified for each designated hazardous substance. Spills of more than this amount must be reported to the appropriate Federal agency. Also, attempts must be made to mitigate damage resulting from such spills and civil penalties may be assessed. Final promulgation of proposed 40 CFR Part 118 activates the requirement for immediate notification. If the harmful quantity specified is small, reporting of a large proportion of the total number of spills is assured and a good accounting of potential environmental damages may be expected. As indicated earlier, the basic thrust of Section 311 is to provide economic incentive for spill prevention. The additional expenditures which might be economically justifiable based on this are therefore dependent on the number of spill events reported as well as on the magnitude of the penalty arising from each.

The variety of possible enforcement actions and flexibility possible in penalty assessment should avoid undue hardship on owners or operators. Upon discharge of the harmful quantity, the U. S. Coast Guard (USCG) may assess a civil penalty of up to $5,000 per spill event under Section 311(b)(6). Under the current enforcement program for oil spills, the amount of the penalty is based on a variety of factors including the gravity of the violation and the economic strength of the discharger. It is reasonable to assume similar procedures will be adopted for spills of hazardous substances. Thus, for a small spill exceeding the harmful quantity, the penalty assessed by the USCG could be minimal. Adequate spill prevention and damage mitigation steps taken by the discharger can also minimize civil penalties assessed by EPA under Section 311(b)(2)(B)(iii), as mentioned earlier.

CHAPTER III

LEGISLATIVE HISTORY AND LEGAL IMPLICATIONS

The following chapter was created to outline the legal framework and policy upon which the proposed regulations are based. First, Congressional committee interpretive language is reproduced here, for ease of reference. The discussion found immediately thereafter is intended to illustrate the operative provisions of Section 311 and to explain their relationship to the legal requirements of other sections of the Federal Water Pollution Control Act Amendments of 1972. Finally, the relationship of Section 311 to other Federal and international laws and regulations is explored.

A. Congressional Committee Interpretive Language

1. House Public Works Committee Interpretive Language on Section 311 of H.R. 11896 (reference 1)

Section 311 closely follows existing Section 11 with respect to oil spills. New provisions for hazardous substances have been added. The discharger of any hazardous substances that cannot be cleaned up is liable to a penalty of not to exceed $50,000 per discharge depending upon the characteristics of the discharged substance except where the United States can show that such discharge was a result of willful negligence or willful misconduct within the privity and knowledge of the owner or operator, such owner or operator shall be liable to a civil penalty as determined by the Administrator. A discharger of a hazardous substance may raise the same defenses as a discharger of oil under existing law: an Act of God, act of war, negligence on the part of the U.S. Government, or an act of a third party. The Administrator will be required to publish a list of hazardous substances. The list of hazardous substances must be easy to understand, and must receive widespread publicity. A pollutant may be designated hazardous if it presents an aiminent and substantial danger to the public health or welfare, including, fish, shellfish, and beaches. Any substance designated as hazardous will have a determination made by the Administrator as to whether the designated substance is actually removable. In this regard, the Committee expects that the Administrator will take a reasonable and not a restrictive attitude in the interpretation of the term "actually removable". The Administrator can specify conditions in a graduated approach under which the substance is removable or not removable, in whole or in part. The definition of the terms 'remove' and 'removal' refers to actual removal by any means including physical, chemical, biological degradation or any other appropriate method or the taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare. The authorization for appropriations in Section 311(k) is merely a restatement of existing of existing provisions. This is not an increase in the authorization and any funds previously appropriated are chargeable to this fund. Section 311(h) provides that either the district court of Guam or the District Court of the United States for the District of Hawaii shall have jurisdiction of actions arising in the Trust Territory of the Pacific Islands under Section 11 except those actions arising under Section 311 (i)(1). The language "notice and opportunity for a hearing" of Section 311(b)(6) is not intended to impose in every instance the complex procedural requirements associated with formal adjudicatory hearings on the record before a hearing examiner such as are used for ratemaking and similar federal rule issuance. The committee believes that effective administrative enforcement will be enhanced by assessment procedures which are expeditious. Provisions of title 5 of the United States Code commonly referred to as the Administrative Procedure Act, as amended, will nevertheless apply to assure due process and protection of a respondent's rights. In that regard, the respondent has the opportunity of a de novo hearing in any collection proceeding initiated by a United States Attorney after the conclusion of administrative procedures. The net result is to parallel the penalty assessment method which the Coast Guard has used in the past in connection with laws which it administers.

2. <u>Senate Public Works Committee Interpretive Language on Section 311 of S. 2770</u> (reference 2)

Section 311 enacted as a part of the Water Quality Improvement Act which provides for the control of oil pollution has been modified in three respects. First, the Federal Maritime Commission (which has been charged by the President with responsibility to regulate and enforce the financial responsibility requirements of this Section) is provided enforcement authority required to carry out effectively its functions with respect to vessels which violate the financial responsibility provisions. Second, the Committee bill provides for the assessment of the penalty for discharging oil or hazardous substances in the case where the owner or operator acted "willfully or negligently". As contained in existing law the penalty applied to a "knowing" discharge and was only being sought when "actual knowledge" could be shown. Third, the Committee determined, on the basis of reports authorized by and subsequently submitted pursuant to the Water Quality Improvement Act, that hazardous substances heretofore treated in a separate section should be subject to the same control mechanism applied to oil. Under present law major spills of hazardous substances which could cause significant environmental and economic damage are not subject to liability for the cost of clean-up of those spills. The Committee was concerned that many hazardous substances cannot be cleaned-up by standard methods because they immediately dissolve in the receiving waters. These substances, the discharge of which may cause environmental disaster, could not be subject to any meaningful clean-up liability. A clean-up liability provision therefore would provide no incentive to carriers and handlers of these substances to exercise the great caution that such materials warrant. The Committee notes that in the March, 1971 report entitled "Control of Hazardous Polluting Substances", the Administration made the following recommendation: "We have examined the issue of whether there should be financial limitations of liability for the costs of removal of hazardous polluting substances, and we have concluded that there should be no liability limitations imposed." The Committee believes that the discharge of such substances should be subject to penalty even though clean-up is not practicable. In this way, each carrier or handler evaluates the risk of discharge and determines whether or not the potentially penalty is worth the risk. Because the penalty to be imposed under this section should relate to the environmental hazard involved, the Committee determined that the Administrator should set the amount of penalty on the basis of the actual amounts of material released into the waste environment. The bill would establish a minimum fine of $50,000 and a limit per barrel fine of $5,000. The Administrator is expected by regulation to set the fine per barrel of discharge based on toxicity, degradability, and disposability of such substances. Because no outside limit is proposed the potential penalty would be the amount of substance involved times the amount of penalty set by the Administrator. Concern has been expressed as to the potential magnitude of a fine to which a carrier or handler of a hazardous substance might be exposed. The Committee examined this concern and concluded that the penalty would be limited in two ways: First, the Administrator would establish per unit limits on the basis of the hazard posed by each of the substances designated. Second, the penalty would be strictly limited to those substances actually released into the water. The Committee recognizes that a bulk carriage of a substance which has an extremely high per unit penalty will be exposed to an unacceptable level of liability. Faced with this fact, bulk carriage of extremely toxic materials in most cases will pose an unacceptable risk. Thus by determining not to haul, in bulk, such hazardous materials the carrier will avoid unacceptable economic risk and the public will not be confronted with unacceptable environmental risk (over which only the carrier has any control).

3. Final Conference Committee Language (reference 3)

Conference substitute

This is the same as the Senate bill and the House amendment with the following changes:

(1) Subsection (b)(2)(B) is revised as follows:

(A) The Administrator shall include in any designation of a hazardous substance a determination of whether it can actually be removed.

(B) As provided in the House amendment, if a hazardous substance is determined not removable, then the owner or operator of any vessel or onshore or offshore facility from which there is discharged such substances shall be liable, subject to subsection (f) defenses, to the United States for a civil penalty per discharge established by the Administrator based on toxicity, degradability, and dispersal characteristics of the hazardous substance. This applies during the two-year period beginning on the date of enactment of the Federal Water Pollution Control Act Amendments of 1972. Such civil penalty shall be in an amount not to exceed $50,000 unless there is a showing of willful negligence or misconduct within the privity and knowledge of the owner in which case there is no limit to the civil penalty.

(C) As modified from the Senate bill, from and after two years after the date of enactment of this Act, the owner or operator of any vessel or onshore or offshore facility from which there is discharged any hazardous substance not removable shall be liable, subject to subsection (f) defenses, to either (i) a penalty in an amount established by the Administrator based on toxicity, degradability, and dispersal characteristics of the substance, but not less than $500 nor more than $5,000 or (ii) a penalty determined by the number of units discharged multiplied by the amount established for that unit, but not more than $5,000,000 in the case of a discharge from a vessel and $500,000 in the case of a discharge from an onshore or offshore facility. The determination of which of these two penalties shall be imposed shall be that made by the Administrator in his discretion. The Administrator is required to establish by regulation for every hazardous substance which he designates a unit of measure based on usual trade practices and is required to establish for each such unit a fixed monetary amount not less than $100 nor more than $1,000 per unit. This amount is to be based on toxicity, degradability, and dispersal characteristics of the substance and must be established within six months of the designation of the hazardous substance.

(2) Subsection (c)(2), which requires a "National Contingency Plan", is amended as proposed in the Senate bill to require that plan to include a system whereby the State or States affected by a discharge of oil or hazardous substance may act to remove the discharge and thereafter be reimbursed for reasonable costs.

(3) As modified from the Senate bill, subsection (p), relating to financial responsibility, is further amended to provide for a fine of not more than $10,000 for failure to comply with this subsection and authorizes the Secretary of the Treasury to refuse clearance to vessels not having evidence of financial responsibility and the Coast Guard to deny entry or detain at any port any vessel not producing on request such evidence of financial responsibility.

Notwithstanding the broad definition of "discharge" in subsection (a)(2) the provisions of this section are not intended to apply to the discharge of oil from any onshore or offshore facility, which discharge is not in harmful quantities and is pursuant to, and not in violation of, a permit issued to such facility under Section 402 of this Act. The Conferees direct that the Administrator initiate a study in cooperation with such nonagency scientists and other experts as are available, to identify and quantify the impact of the discharge of designated hazardous substances on the biological, physical and chemical integrity of the Nation's waters. Such study should be submitted to Congress no later than 18 months after enactment of this Act together with any appropriate recommendations. The Conferees hope that during the next two years the appropriate committees of the Congress will consider the need for legislation to improve methods of storing, shipping, and handling hazardous substances which cannot be removed from the water. If such legislation is enacted, the Conferees agree that the liability provisions of this section will be reviewed and necessary changes proposed by the Committees on Public Works.

B. Purpose and Implications of Section 311

1. Introduction

The goals of Section 311 are spill prevention, spill mitigation and establishment of associated liability for the mitigation costs. Enforcement through civil penalties are tools of this section, but not goals in and of themselves.

The statute addresses spill prevention by authorizing the President to issue regulations "establishing procedures, methods, and equipment and other requirements for equipment to prevent discharges of oil and hazardous substances" [Section 311(j)(1)(C)]. The enforcement of this provision is a civil penalty of up to $5,000 per day administered by the Coast Guard for transportation related sources and by EPA for non-transporation related sources Section 311(j)(2).

The key to the spill clean-up system is the requirement in Section 311(b)(5) that any person in charge of a vessel or facility from which a discharge of oil or a hazardous substance in a harmful quantity occurs, must "immediately" notify the designated Federal agency. Failure to give notice is a criminal offense punishable by up to $10,000 or 1 year in jail or both. Section 311(c) authorizes the President "to act to remove" any spilled oil or hazardous substance, and to promulgate a "National Contingency Plan" to coordinate the Federal clean-up effort. That Plan promulated by the Council on Environmental Quality gives the Coast Guard the lead responsibility for Federal clean-up efforts in coastal waters and the Great Lakes, and EPA the lead responsibility for inland waters. In addition, any discharge of oil or hazardous substances in harmful quantities entails a civil penalty assessable by the Coast Guard Section 311(b)(6) . Discharges of "non-removable" hazardous substances in harmful quantities are also subject to an additional civil penalty assessable by EPA Section 311(b)(2)(B) .

Finally, Section 311(f) defines the liability of owners and operators of vessels and facilities to reimburse the Federal Government for removal costs. Liability limits are established, and a defense to liability is provided where the owner or operator "can prove that a discharge was caused solely by (a) an act of God, (b) an act of war, (c) negligence on the part of the United States Government, or (d) an act or omission of a third party without regard to whether any such act or omission was or was not negligent." Where a third party caused the discharge, he may be held liable for removal costs subject to the same liability limits [Section 311(g)], and where the owner or operator of a vessel or facility from which a discharge occurs acts to remove the oil or hazardous substance, he may recover the removal costs from the Government if he shows that one of the four defenses to liability existed [Section 311(i)]. Any monies recovered from persons responsible for a spill are deposited in a revolving fund which is used to finance the Federal government's spill clean-up efforts [Section 311(k)]. Finally, Section 311(p) requires owners or operators of vessels of over 300 gross tons to have evidence of financial responsibility in an amount up to the maximum liability for a spill under Section 311(f).

2. The Designation of Hazardous Substances

Section 311(b)(2)(A) requires EPA to promulgate regulations "designating as hazardous substances, other than oil ..., such elements and compounds which, when discharged in any quantity..., present an imminent and substantial danger to the public health or welfare, including... fish, shellfish, wildlife, shorelines, and beaches." Although the phrase "in any quantity" might be thought to restrict the designation of hazardous substances to those which are harmful in even the smallest quantities, this was clearly not the Congressional intent. Senator Dole, who was responsible for this language, explained that "The threat to health and welfare [of hazardous substances] depends on many factors such as the characteristics of the water into which the substances are discharged; the concentrations of the substances discharged; and the nature of the substance discharged." [Cong. Rec., daily ed. Oct. 7, 1969, at S 12063.]. This view is borne out by Section 311(b)(4), which requires the President to determine "those quantities of ... any hazardous substance the discharge of which, at such times, locations, circumstances and condtions, will be harmful to the public health or welfare..."

Within the meaning of this language, the list of hazardous substances could include any substance which may be harmful in some circumstances when discharged in sufficient quantities. But this would include any substance, since any substance may be harmful if discharged in sufficient quantity into a sufficiently small body of water. Thus there must clearly be some room for a reasonable administrative definition of what constitutes a sufficient potential of harm to the environment in order to qualify a substance for designation as a hazardous substance. With such a definition, it can be suggested that Congress recognized that the list of hazardous substances could "cover a tremendous range of chemical elements and compounds with various characteristics." [115 Cong. Rec., (Oct. 7, 1969) (Sen. Dole)].

3. <u>The Determination of Removability</u>

Section 311(b)(2)(B)(i) requires the Environmental Protection Agency to include in its designation of hazardous substances "a determination whether any such designated hazardous substance can actually be removed."

At least two problems are presented by this provision. In the first place, the statute defines removal in terms so broad that virtually any substance could be considered "removable." Section 311(a)(8) defines "remove" and "removal" as removal of the oil or hazardous substances from the water and shorelines <u>or taking of such other actions as may be necessary to minimize or mitigate damage to the public health or welfare</u>...' (emphasis added). This broad definition -- which includes such actions as filtering a downstream water supply or warning its users -- is necessary to give a broad scope to the Federal Government's "removal" actions under Section 311(c). To impose a correspondingly broad liability under Section 311(b)(2)(B) would render that provision meaningless, since some type of action to "minimize or mitigate damage" can be taken in most cases for virtually any hazardous substance. A distinction between the definition of "removal" for purposes of liability for Federal clean-up costs, and the definition for purposes of the penalty for spilling "nonremovable" substances, can be made on the basis of Section 311(b)(2)(B)(i), which phrases the test for penalty purposes in terms of whether the substance can "actually" be removed. Under this test a substance might not actually be removable and the discharger thereby subject to penalty while at same time the discharger remains liable for actions necessary to minimize or mitigate damage, short of actual removal.

Another problem with the determination of removability is the variety of circumstances that can influence whether a spilled substance can be physically removed from the water in any particular situation. If the notification is prompt, if the weather is calm enough to permit surface skimming, if the body of water is small enough to allow filtering, or if the circumstances are such as to allow the spill to be contained in a dike, then a substance might be removed from the water in whole or in part, although the same substance spilled in different circumstances or different quantities could not be removed, or could only be removed to a lesser degree. There is some recognition of the problem in the legislative history of the 1972 Amendments; the House Committee Report suggests that "the Administrator can specify conditions in a graduated approach under which the substance is removable or not removable, in whole or in part." [House Report No. 92-911, 92d Cong. 2d Sess., at 117.] However, it is not clear how a "graduated approach" would work for determining whether a spill was subject to the penalties of Section 311(b)(2)(B). The best solution is to base the "removability" determination on some general, overall assessment of average or typical conditions, leaving to individual penalty proceedings the job of determining the actual degree of removal that was possible under the circumstances of a particular spill as a factor bearing on the amount of penalty to be assessed.

4. The Determination of Harmful Quantities

Section 311(b)(4) requires a regulation to "determine ... those quantities of oil and any hazardous substance the discharge of which, at such times, locations, circumstances, and conditions, will be harmful to the public health or welfare ..." Section 311(b)(3) prohibits the discharge of oil and hazardous substances "in harmful quantities" except "where permitted in quantities and at times and locations or under such circumstances or conditions as the President may, by regulation, determine not to be harmful." It is believed that this non-harmful concept provides the basis for exemption of discharges which are made in compliance with the NPDES permit specified under Section 402 of the Act and other permitted discharges.

The language dealing with harmful quantities presents a problem in interpretation. The degree of harm which a given substance may pose to the environment can vary greatly depending on a number of circumstances including size of the body of water into which it is spilled, the flushing characteristics of the body of water, its temperature, the size of the spill and the rapidity with which the substance is released into the water at the spill site. Must the "harmful quantity" regulation present a formula whereby all the relevant circumstances of a particular spill are taken into account, with the actual harmful quantity being calculated separately for each spill according to the formula? Or is it sufficient if the Environmental Protection Agency, in formulating the regulation, takes all the possible "times, locations, circumstances, and conditions" into account in order to construct a model spill situation, in the basis of which a single harmful quantity is stated?

Ideally, it might be best if the regulation were to state a formula, on the basis of which the harmful quantity in each particular spill situation could be computed, taking into account all the pertinent factors. However, because the pertinent factors are so varied and numerous, such a formula - if one indeed exists - would have to be enormously complicated. And yet the statutory scheme demands simplicity.

Section 311(b)(5) requires any person in charge of a vessel or facility, as soon as he has knowledge of a spill of a harmful quantity, to "... immediately notify the appropriate agency of the United States

Government." A criminal penalty attaches to any failure to comply with this requirement. The emphasis on rapidity of notification is essential to the operation of the statute, since rapidity in the Federal Government''s response can be crucial to a successful spill mitigation operation. And yet, personnel at a spill site are seldom in a position to apply a complex "harmful quantity" formula. It may be assumed that frequently the amount spilled and the rate of release is not known immediately. Moreover, where the spill is transportation-related, there is essentially no feasible way that the personnel at the site can have immediate or adequate knowledge of the size and flushing characteristics of the receiving body of water. Thus, any regulation which requires a calculation at the spill site under a formula that takes into account all the relevant circumstances, would render the notification requirement unworkable.

The present wording of Section 311(b)(3) and (4) derives from the Section 11 of the 1970 Amendments to the Federal Water Pollution Control Act, which required a "harmful quantity" determination for oil taking into account "times, locations, circumstances, and conditions." Under that statutory language, the Secretary of the Interior (EPA's predecessor) promulgated a regulation which defined harmful quantities of oil to include quantities which:

(a) Violate applicable water quality standards, or

(b) Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

[35 F.R. 14306 (Sept. 11, 1970), 40 C.F.R. 110.3.] These regulations establish an across-the-board test (the creation of a film or sheen) which is not dependent on the particular circumstances of the spill, but rather is designed to provide a workable requirement for spill notification. Congress obviously knew about the "sheen" regulation but did nothing to change it in the 1972 Amendments; instead, it re-enacted the pertinent statutory language, adding only the requirement that a harmful quantity determination also be made with reference to hazardous substances. Thus, it is a fair inference that an across-the-board harmful quantity determination, similar to the oil regulation, may be made with respect to each hazardous substance rather than a determination that would require an elaborate calculation of a separate harmful quantity for each spill. A single harmful quantity for each hazardous substance is the only way to render the notification provision of the statute workable. A technical complication does exist, however, and that is, that the predominately soluble hazardous substances do not lend themselves to being quantified by a physical/chemical basis which is readily observable like the oil determination. Therefore, the legal and technical limits indicate that a numerical quantity be determining for each substance.

5. Rates of Penalty

As the foregoing discussion indicates, both the determination of harmful quantity and the determination of actual removablity must be made in advance, across-the-board, with reliance on typical spill situations. Thus, for any reportable spill the penalty provisions of Section 311(b)(2)(B) (spills of nonremovable substances) and Section 311(b)(6) (spills in harmful quantities) will apply even though the circumstances of the particular spill may permit a substantial degree of actual removal or substantial mitigation of potential harm, or both. In these circumstances, there would be discretion in the administrative proceedings to adjust the penalty to reflect the particular circumstances of the spill involved. Section 311(b)(2)(B) permits adjustment of the penalty on, at least, the basis of "the toxicity, degradability, and dispersal characteristics" of the spilled substance, while Section 311(b)(6) permits adjustment of the penalty on the basis of the "garvity of the violation." Under both provisions, the administrative agency would have discretion to consider, as one of the factors affecting the size of the penalty, whether a substantial degree of mitigation, in fact, occurred.

C. Relationship to Other Provisions of Federal Law

1. Other sections of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA)

The Federal Water Pollution Control Act Amendments of 1972 also provide for:

(a) Gathering of information on current water quality-Section 305 ;

(b) Guidelines for evaluation of the nature and extent of pollution from non-point sources-Section 304(e) ;

(c) Establishment of water quality criteria reflecting the latest scientific information-Section 304(a) ;

(d) Setting of water quality standards-Section 303 ;

(e) Establishment of "national standards of performance" based on best available control technology-Section 306 ;

(e) Establishment of "national standards of performance" based on best available control technology-Section 306 ;

(f) Setting of effluent guidelines and limitations to assure that water quality standards can be attained-Sections 301, 302, and 304(b) ;

(g) Publication of a list of toxic pollutants, setting of standards for these materials and establishment of "pretreatment standards" to apply before their introduction into public treatment plants-Section 307 ;

(h) Control of effluents arising from normal operating situations in industrial and other facilities, by issuance of permits under a "National Pollutant Discharge Elimination System" - Section 402 .

(i) Emergency powers are given to the Administrator to seek district court relief for incidents of pollution sources which present an imminent and substantial endangerment to the health of persons or to the welfare of persons , - Section 504 .

(j) The identification and removal of toxic pollutants in harbors and navigable waterways are to be conducted working through the Secretary of the Army-Section 115 .

Some of the materials of concern under the above Sections are also of concern under Section 311. However, substantial differences in approach are required for Section 311 since the focus of all other sections listed above is on continuous or routine discharges and effects. Overall, the others address the chronic effects of pollution and the discharge of pollutants under specified controlled conditions while Section 311 is unique in addressing acute effects, the coverage of uncontrolled, episodic, acute discharges which are non-routine or abnormal.

2. Ocean Dumping

The Marine Protection, Research, and Sanctuaries Act of 1972, P.L. 92-532 (Ocean Dumping Law) requires the issuance of a permit by the Administrator of the Environmental Protection Agency prior to the dumping of any material from vessels into the territorial sea or the contiguous zone of the United States. The Administrator is required to establish criteria for such dumping.

"Dumping" is defined to mean "a disposition of material" (Section 3(f)). "Material" is defined in Section 3(c) to mean any matter, presumably including any hazardous substance; however, "oil within the meaning of Section 11 of the Federal Water Pollution Control Act" is excluded. It must be recognized that the Ocean Dumping Law and Section 311 deal with very different problems. Permits under the Ocean Dumping Law will specify the quantity, conditions and site of the disposition of material. It will thus be a controlled disposition. By contrast, Section 311 is addressed primarily to spills, which are typically uncontrolled situations. Thus, it may be that controlled disposition of certain materials would be permitted under the Ocean Dumping Law on the grounds that minimal harm to the environment in the immediate vicinity would occur, even though that material is designated as a hazardous substance on the basis that an uncontrolled spill could present an imminent and substantial danger to public health, public welfare, or the environment on a larger scale.

3. Federal Insecticide, Fungicide, and Rodenticide Act

Several legislative acts and regulations prohibit the distribution, sale or receipt of a non-registered pesticide. The basic legislation is the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) which is amended by the Federal Environmental Pesticide Act (FEPCA) of 1972, (86 stat. 973, 7 U.S.C. 136 et seq. P.L. 92-516). Hereafter, these will be referred to as "amended FIFRA". The implementing regulation is 40 CFR Part 162, recently amended by the Federal Register, Vol. 40, No. 129, Part II, pp. 28242-28286, July 3, 1975. Among the requirements for registration of a pesticide under amended FIFRA is that the pesticide, used in accordance with commonly recognized practice, must not cause an unreasonable risk to man or the environment, taking into account the economic, social and environmental costs. The registration procedure requires the applicant to file a statement which includes a copy of the labeling, the claims made for the pesticide, directions for its use, and its complete formula. The Environmental Protection Agency can require that claims be substantiated by full description of tests performed and results achieved.

While amended FIFRA is intended to result in planned, controlled application of registered pesticides, Section 311 has been interpreted to deal with unplanned, uncontrolled spills. Consequently, there is no inconsistency in the designation of a registered pesticide as a hazardous substance.

4. The Ports and Waterways Safety Act of 1972 (PWSA)

The Ports and Waterways Safety Act, (P.L. 92-339, 46 U.S.C. 291 et seq.), includes provisions which directly depend upon the Environmental Protection Agency's actions concerning hazardous substances under Section 311. Section 201 of the PWSA provides for the establishment of standards for the design, construction, alteration, repair, maintenance, and operation of vessels documented under the laws of the United States or entering navigable waters, and which carry oil, flammable liquids, or any liquid cargo designated as a hazardous polluting substance under Section 12(a) of the Federal Water Pollution Control Act. (Section 12(a) refers to the 1970 Act P.L. 91-224 which was amended into Section 311 in the 1972 Act P.L. 92-500). Regulations will be established under Section 201, PWSA after designation of hazardous substances has been finalized under P.L. 92-500, Section 311(b)(2)(A).

D. International Implications

The participation of EPA personnel in numerous Intergovernmental Maritime Consultative Organization (IMCO) meeting preparatory to the International Convention for Prevention of Pollution From Ships (1973), has aided wide exposure and acceptance of the regulation concepts. EPA's Hazardous Substances Branch has made a detailed comparison and review of the IMCO/GESAMP* proposed list and rating of noxious substances (Annex II of the International Convention; Regulations for the Control of Pollution by Noxious Substances Other Than Oil Carried in Bulk). Discrepancies between the EPA data base and the GESAMP

* Group of Experts on the Scientific Aspects of Marine Pollution - jointly sponsored by the United Nations specialized Agencies.

list hazard ratings were noted and the technical back-up was forwarded to GESAMP for their consideration and review.

On April 15, 1972, the United States and Canada signed The Great Lakes Water Quality Agreement on water pollution control in the Great Lakes. In Annexes 3 and 7 of this agreement, the two countries agreed to adopt regulations including programs and measures for the prevention of discharges of harmful quantities of oil and hazardous substances into the Great Lakes. It was also agreed that within one year after the signing, consultations would be held for the purpose of developing Annex 9 to identify hazardous substances and taking such other steps as to assure regulatory compatability. The steps are in process and the goals are expected to be acheived.

E. Public Participation

For many years various governmental organizations have been concerned with the regulation of the accidential spillage of various substances. However, regulation of spills for the primary purpose of protecting against environmental damage, particularly damage to beneficial uses of water effectively began with a conference on Hazardous Polluting Substance held in New Orleans, La., in September of 1970.

This meeting was sponsored by the U.S. Coast Guard with considerable participation by Deparment of Interior personnel (EPA's predesessor agency) and its purpose was to encourage public dialogue and obtain information on the state-of-the-art of hazardous polluting substances pursuant to Section 12(g) of the Federal Water Pollution Control Act, as amended. In this report, usually referred to as the 12(g) Report, was born the concept of penalizing for environmental insults. These insults were the recognized aftermath of spilling soluble chemicals for which the usual oil spill type clean-up actions would be of no help.

Since the New Orleans meeting EPA personnel have participated in national symposia on spill prevention and control such as those held in Houston (1972), San Francisco (1974), Denver (1975) New Orleans (1976), and have co-sponsored a three-day symposium on drafts of proposed hazardous substance regulations.

The concepts illustrated in these regulations have been evolved over several years of EPA staff experience. Additional input has been received through meetings with and requests from foreign governments, Federal, State and municipal agencies, trade associations, environmental and professional organizations. A partial list of such contacts follows to demonstrate the attempt by EPA to get many viewpoints.

(1) Foreign Governments, organizations, groups

- U.S.-Canadian Great Lakes Water Quality Agreement, Article 5 and associated annexes of 1971.
- Gordon Conference 1972 (Subject: Oil and Hazardous Materials)
- IMCO, Noxious Substances, Annex II of Convention 1973
- Sweden - exchange of data on program development & technology
- Italy - reviewing regulations and standards with industry and government
- France - receiving information on mitigation technology
- Soviet Union - exchange of receiving water quality data and lists of toxi materials
- Great Britain - exchange of program and technical data visitations
- GESAMP - interdisplinary and international debate on noxious and hazardous substances.

(2) Other Sections of EPA

- Office of General Counsel, Office of Enforcement - Division of Oil and Special Materials Control, Effluent Guidelines Division, Office of Water Supply, Office of Planning and Management, Office of Toxic Substances, Office of Pesticide Programs, Office of Solid Waste Management, Office of Research and Development, and Regional Offices for Oil and Hazardous Materials.

(3) Other Federal and Related Agencies

- Council on Environmental Quality
- Department of Defense
- Atomic Energy Commision
- National Oceanographic and Atmospheric Administration
- Coast Guard
- Department of Transportation
- Department of Commerce (MARAD and Maritime Commission)
- Department of State
- Bureau of Narcotics and Dangerous Drugs
- Defense Supply Agency
- Government Services Administration
- Federal Aviation Administration
- Department of Health, Education, and Welfare
- Food and Drug Administration
- National Transportation Safety Board
- Joint Army Navy NASA Interagency Force
- Federal Railway Administration (DOT)
- Office of Pipeline Safety (DOT)
- National Academy of Sciences
- Tennessee Valley Authority

(4) State Agencies

- Pennsylvania
- Ohio
- Oregon
- North Carolina
- Virginia
- California
- New York
- Illinois
- Hawaii
- Connecticut
- Colorado
  - (See also Chapter I list of State Agencies with programs)

(5) Municipal Agencies and Jurisdictions

- Chicago Metropolitan SanitaryDistrict
- Los Angeles Water and Power Company
- New Orleans Sanitary District
- New York City Sanitary District

- Oakland Sanitary District
- Honolulu Sanitary District
- St. Louis Sanitary District
- Toledo Chamber of Commerce

(6) Environmental Groups

- Environmental Defense Fund
- Natural Resources Defense Council
- National Wildlife Federation
- Sierra Club

(7) Trade Associations

- Manufacturing Chemists Association
- National Agricultural Chemist Association
- American Railroad Association
- American Waterway Operators
- Chlorine Institutre
- National Tank Truck Carriers
- American Insurance Institute
- American Federation of Firefighters
- Fire Chiefs Association
- Water Quality Assurance Groups
- Soap and Detergent Association
- American Petroleum Institute
- Pharmaceutical Institute
- Indepdent Liquid Terminals Association
- Wastewater Equipment Manufacturers Association
- National Solid Waste Management Association
- Transportation Association of America

(8) Professional Organizations

- American Water Works Association
- Consulting Engineers Council
- International Water Pollution Control Association
- Water Pollution Control Federation
- American Institute of Chemical Engineers

(9) Meetings, Conferences and Seminars

- New Orleans meeting on Hazardous Polluting Substances - 1970
- Washington, D.C. Conference on Prevention and Control of Oil Spills - 1971
- Houston Meeting on Spill Control of Hazardous Substances - 1972
- Gordon Conference Oil and Other Hazardous Materials - 1973
- Hazardous Substances Regulations Conferences - 1974
- Transportation Association of America - 1975

4. Summary of Selected Toxicity Criteria

In summary, the proposed selection criteria for hazardous substances are as follows: any element, compound, or mixture thereof, possesses sufficient danger potential to be designated as a hazardous substance, if it is lethal to:

(a) One-half of a test population of aquatic animals in 96 hours or less at a concentration of 500 milligrams per liter (mg/l) or less; or

(b) One-half of a test population of animals in 14 days or less when administered as a single oral dose equal to or less than 50 milligrams per kilogram (mg/kg) of body weight; or

(c) One-half of a test population of animals in 14 days or less when dermally exposed to an amount equal to or less than 200 mg/kg of body weight for 24 hours; or

(d) One-half of a test population of animals in 14 days or less when exposed to a vapor concentration equal to or less than 20 cubic centimeters per cubic meters (volume/volume) in air for one hour; or

(e) Aquatic flora as measured by a 50% decrease in cell count, biomass, or photosynthetic ability in 14 days or less at concentrations equal to or less than 100 milligrams per liter (mg/l).

In addition to meeting one or more of the above acute lethality criteria, a candidate substance must have a reasonable potential for being discharged, i.e., spilled into a water body. Factors considered typical four-day exposure time for aquatic animals. These two major differences in bioassay procedure indicate that the threshold level for plant life should be lower than that for animal life and result in a more restrictive selection of substances toxic to aquatic plant life.

In spill situations exposure of humans and wildlife, other than aquatic species, to pollutants can occur by way of ingestion from drinking water, skin contact, or inhalation of either vapor or spray. Previously, toxicity tests have involved a variety of substance administration routes, including intraperitoneal, subcutaneous, intravenous and intramuscular. The oral administration, acute dermal, and inhalation data are considered by the Agency as the most applicable to the establishment of imminent and substantial danger to humans and wildlife from spilled pollutants.

Environmental Protection Agency publications 40 CFR Part 162 and Federal Register, Vol. 40, No. 129, Part II, pp. 28242, 28286, July 3, 1975, specify that those materials found to be "highly toxic" represent a significant danger potential to public health and/or wildlife. Members of this category are defined as those materials which have mammalian toxicity as expressed by an oral LD50 equal to or less than 50 mg/kg; an inhalation LC50 equal to or less than 20 ppm as a vapor, or equal to or less than 0.2 mg/l as a dust or aerosol; or a dermal LD50 equal to or less than 200 mg/kg. These previously recognized and defended criteria are considered as selection criteria also for designation of hazardous substances in the proposed rule.

important role by providing habitat for fish and other aquatic fauna. Substances which are relatively non-toxic to fish but highly damaging to aquatic plants thus can cause damage to the aquatic community comparable to damage resulting from materials that are highly toxic to fish. Consequently, a material shown to have phytotoxic action to aquatic algae and vascular plants as measured by ILm, (median inhibitory limit) of 100 ppm or less is considered to have the potential to pose a substantial danger to the aquatic environment when spilled. It should be noted that although no substance on the current proposed list of hazardous materials is listed because of only its phytotoxic action, this criterion is maintained to permit future addition of substances which may be shown to be detrimental to this segment of aquatic ecosystems and therefore would pose substantial danger to public welfare including shorelines and beaches.

The use of the value of 100 mg/l for the limiting value for phytotoxic action rather than the threshold of 500 mg/l proposed for acute toxicity to aquatic animal life is supported by significant variations in the experimental procedure used to evaluate the effect level. The prescribed end-point in aquatic animal bioassay is the death of test organisms whereas the aquatic plant bioassay effect can be a measure of metabolic rate (as in the case of photosynthetic activity) or decreased reproduction (cell count and biomass), both of which may be reversible processes following passage or dilution of the pollutant. The second major variation in experimental design is the exposure time. The prescribed exposure time for plant life is 14 days, or 3.5 times the twice as great as the concentration which kills half a test population of the same species in 96-hours (see Vol. II reference 3, p. 107). Consequently, a 96-hour, 500 ppm aquatic toxicity limit is supported as a significant criteria for substance deletion on the basis of the achievable pollutant concentration in the reasonable spill situation.

The Agency has evaluated past spill records in conjunction with fish kill reports. Twenty-two of the elements and compounds earlier proposed for designation as hazardous substances were reported as causative agents in recent fish kill reports. Of these, seven have involved chemicals with 96-hour LC50 values of greater than 100 mg/l but none have LC50 values consistently greater than 500 mg/l. If the upper limit were set at 100 mg/l materials which are known to have been spilled and which have caused fish kills would not be regulated and these materials are major in use and size of handling.

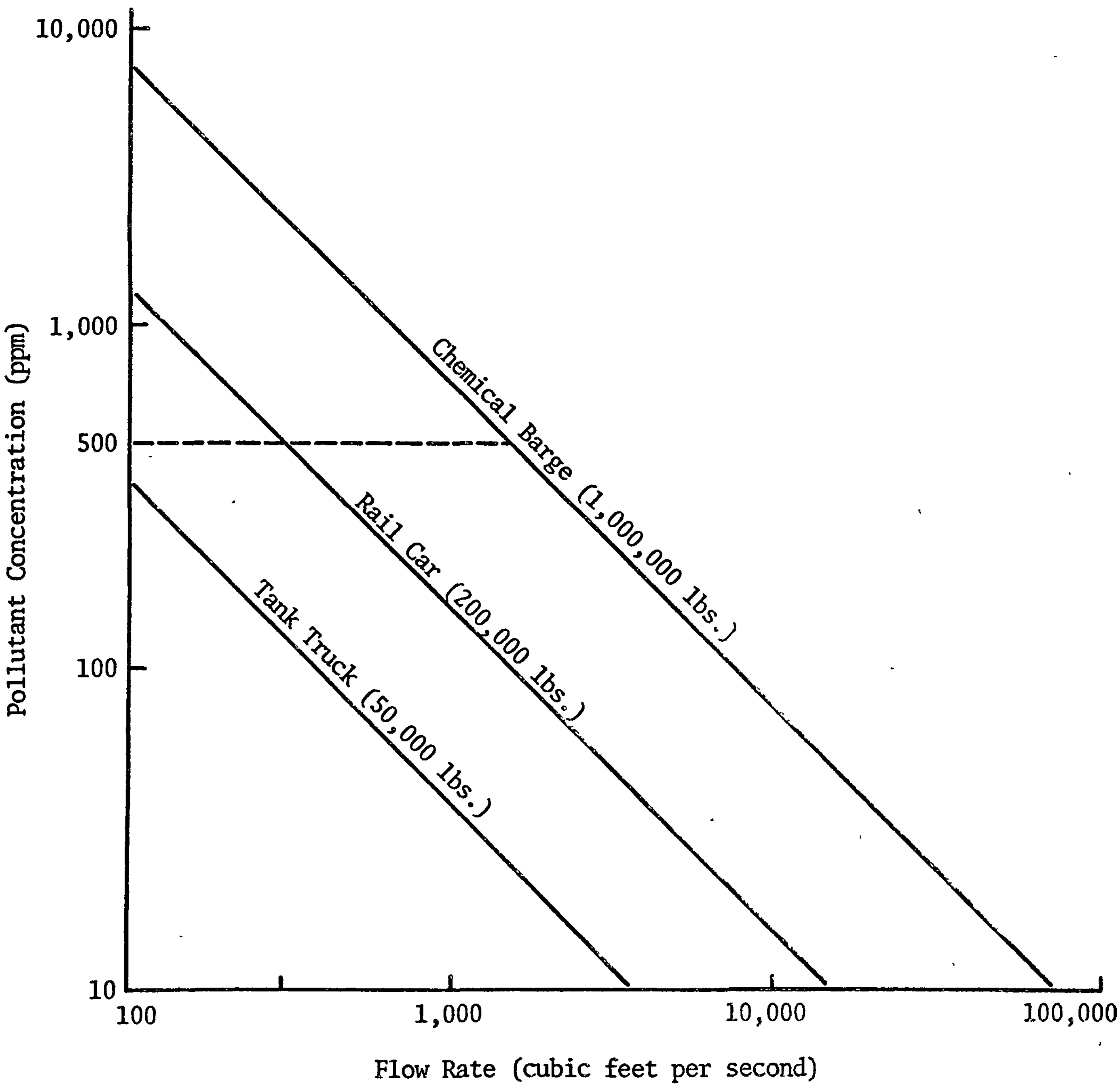
Thus, an upper aquatic toxicity selection limit of 500 mg/l is supported in the rulemaking in the belief that it is both appropriate and responsive to the requirement of Section 311 to identify those substances which "... present an imminent and substantial danger to the public health or welfare, including, but not limited to, fish, shellfish, ..."

3. <u>Other Selected Toxicity Criteria</u>

While not specifically mentioned in Section 311, aquatic plant life is of critical importance to aquatic fauna which is part of the "public welfare". Phytoplankton and periphyton are primary producers of energy in the aquatic food chain. Aquatic macrophyton play an

Figure IV-B

POLLUTANT CONCENTRATION ACHIEVABLE BY DISCHARGE
OVER SIX-HOURS VERSUS STREAM FLOW RATE



Using 96-hour LC50 data without further qualification, substantial harm can only be interpreted as exposure of the aquatic population to a concentration equal to the LC50 for 96 hours or more. However, condensation of this imminently dangerour quantity into a plug requiring less time to pass will result in still higher and potentially more damaging concentrations. A time of passage range must therefore be defined. Correlation of data on fish kills reveals that 95% have a duration of six hours or more (see Vol II reference 3, p. 105). Thus the appropriate range of interest is 6 to 96 hours (Vol. II, ref. 3, p 23, 103). To lend some perspective to the discussion damaging effects from a spill, consider Figure IV-B in which the concentration (ppm) of discharged material is plotted against flow rate (cfs) for capacity sizes representative of various transportation modes. The graph assumes uniform mixing in the receiving water within a 6-hour discharge time and illustrates the relationship of pollutant concentration, per pound of material discharged, to stream flow rate.

Assume that a 300 cfs stream is representative of a water body into which a tank truck or rail car could be accidentally discharged or that a 5,000 cfs water body is representative of one into which the contents of a chemical barge or tanker might be spilled. Figure IV-B then indicates that the resulting 6-hour concentration of a hazardous material would rarely exceed 1,000 ppm. Review and analysis of the literature indicates that the concentration of a given hazardous substance necessary to kill one-half of a test population in 6 hours is approximately or 96-hour period is widely accepted as the most meaningful test duration when considering acute effects.

The available data obviously must be adapted or interpreted to apply to a spill where the concentration of toxic material is not usually constant. During a spill, the substance enters the water as a large, concentrated slug and is diluted, or in the case of insolubles, dispersed, at a rate dependent on the type and size of the water body. For instance, in a flowing stream, dilution is proportional to the flow volume and therefore, the amount of turbulence. In the case of lakes and impoundments, the dispersion cannot be characterized by a unidirectional flow with rapid mixing. Rate of dilution is lower since horizontal dispersion is usually slower. If a thermocline is present it will also affect the rate of vertical dispersion.

Dilution rate is also dependent on the behavior of the material in the above cases. Floating substances will be subjected to prevailing wind drift while sinking materials will be affected by subsurface current regimes. Moreover, the combined effects of very slow flushing rates and limited areas in which aquatic organisms can migrate to avoid the pollutant generally result in a longer period of exposure.

Many of these same effects may also be seen in estuaries where the halocline, low freshwater flushing rates, and tidal cycles act to decrease the dilution rate below that of free flowing rivers carrying comparable dilution volumes.

American Public Health Association advocates the LC50 as the standard measure of toxicity to be determined in bioassay work [12]. Reliance on anything other than the median lethality concentration would necessitate the use of data not frequently reported in the open literature and would lack the value carried by an accepted standard for measuring relative toxicity.

Natural populations typically oscillate as a result of interactive forces in the environment. It is uncertain that contamination to the LC10 or LC20 levels would produce fluctuations with any greater impact than those natuaral oscillations, whereas there is little doubt that a 50% loss would be substantial. It is also important to note that laboratory bioassay results may not be directly proportional to effects in the field. The potential for variances in water quality and other factors to alter the effects of a spill reemphasizes the fact that damage cannot be predicted in any but relative terms. Consequently, the best measure of potential damage is a widely acceptable relative index of toxicity such as the LC50.

In order to firmly establish what consititutes substantial harm, the time interval for which aquatic organisms are exposed to a pollutant must be specified, in addition to specification of the magnitude and type of effects considered. This matter is discussed in detail in reference 3, pages II-23 through 27, where it is pointed out that the four-day or been the most frequently observed environmental impact of chemical spills. The death of an important organism is clearly substantial harm, while sublethal effects arising from an acute discharge may or may not be substantial, depending upon their level and duration. Additionally, sublethal effects have been studied for only a few substances and generally accepted standard testing procedures have not been agreed upon. This question is discussed in more detail in Volume II of reference 3, beginning on page 20. The general conclusion reached was that lethality should be recognized as the toxic effect of prime interest in regulations to implement Section 311.

Having concluded that attention is best focused on lethality to aquatic life, it is necessary to specify the magnitude at which the effects become substantial. This specification is required because individuals within a given species will differ in their ability to withstand toxic agents. The variance in toxic response is one of normal distribution about a median response level. This means that the death of the first fish in a given population may not signal impending expiration for the remaining individuals In fact, the pollutant concentrations where the first death occurred in a fish population employed for toxicological research have been reported to differ by a factor of two to three from those at which the last death occurred. While several data points are generated during the bioassay analysis (10-100 percent mortality levels) only the 50% mortality level -LC50 -is typically reported in the literature. Indeed, the known to be toxic to any life form under any possible condition. The criteria chosen and the basis for them are explained below.

The concept of imminent and substantial danger applies to both public health or public welfare, including fish, shellfish and wildlife. A material which is acutely toxic to a life form specified, or to one having close relation to public health or welfare, is the type of hazard which Congress intended to eliminate. The degree of danger presented by the exposure of an organism to a particular substance is dependent on many factors including the concentration of the substance, the age and general health of the target organism, the amount and kind of pre-existing environmental stress, and the duration of the exposure. (Of all the variables involved, the concentration of substance, the test species involved, and the duration of exposure are generally available from the literature.)

2. Aquatic Toxicity

a. Magnitude of Effects

Data on the effects of various pollutant levels to aquatic life have been collected for a variety of substances and are reported in terms of the TLm or LC50. (The median tolerance limit, TLm, is that concentration capable of inducing a given effect in 50% of the sample population in the time specified, often 96 hours. The LC50 represents the median lethal concentration in a specified time interval.)

Fish kills and other signs of distress in the aquatic community have history. Rejected because, taken alone, the spill potential concept does not address the "... substantial danger..." concept of Section 311.

A number of materials on the list published August 22, 1974 (39 FR 30466) were eliminated from the final list even though they meet the toxicological selection criteria discussed in Section C, 4 below. They were rejected for designation because they were judged to have a low potential for spillage. (The concept of "spill potential" is discussed at greater length in Section C, 5. of this chapter.)

C. Rationale and Basis for Proposed Toxicity Selection Criteria

1. Introduction

Section 311(b)(2)(A) states that hazardous substance regulations should list "... elements and compounds which ... present an imminent and substantial danger to the public health or welfare ...". Specifying all possible combinations of chemical compounds toxic to any life form at any concentration level under all environmental conditions is obviously impossible and also runs counter to the "... substantial danger ..." provision. Consequently decisions must be made, at least implicitly, as to what constitutes imminent and substantial harm to public health or welfare. These decisions constitute criteria for selection of various materials from the much larger set of all elements or compounds lists. Rejected because lists include explosives, compressed gases, and other substances which do not necessarily constitute a significant water pollution threat.

- Use of historical records of accidents involving chemicals. Rejected because no current reporting network provides sufficient information or breadth of coverage to insure a representative data base upon which a decision can be made.

- Base listing on open-ended classification such as inorganic acids, pesticides, and salts. Rejected because it does not specify the "elements and compounds" designation requirement of Section 311 nor recognize wide variances in toxicological effects within generic groups.

- Expand selection criteria to include carcinogenic, mutagenic, teratogenic, bioaccumulative, nutrient, high oxygen demand, and radioactive substances. Rejected because of limited information on short-term exposure effects, lack of accepted test procedures, and difficulty in relating short-term exposures, as found in spill situations, to the chronic exposure data.

- Base listing solely on a rating of potential for discharge ("spill potential") with evaluation of factors such as production quantity, mode of transport, handling or storage practices and past spill this potential selection criterion has not been utilized in the present proposal. Instead, bioconcentrative properties are evaluated separately and used in adjusting rates of penalty providing added incentive to prevent spillage of these materials. (For further discussion of bioconcentration, see Section D of this chapter.)

Exertion of biochemical oxygen demand (BOD) and biostimulation are also associated largely with chronic or continuous discharges but can conceivably result from acute spills. The critical BOD level is mainly a function of the site of the spill since dispersive characteristics, nutrients, microorganism and ambient dissolved oxygen (DO) are factors in determining the development of DO-related problems. Similarly, acute stress arising from the release of biostimulants will depend on the existing nutrient balance in the receiving water and other site specific variables. For water bodies in general any attempt to forecast harm resulting from spills of materials posing the hazards of increased BOD or biostimulation would be excessively probabilistic in nature. Further discussion of the above criteria, as well as genetic and eutrophic effects may be found in Section D of this chapter.

The following alternatives for the selection of hazardous substances were also considered but rejected prior to publication of an Advance Notice of Proposed Rulemaking (39 FR 30466) in August 1974:

- Utilization of Department of Transportation hazardous material brief in duration and not easily defined as substantial harm in the context of nonwithdrawal use. Toxicity via skin absorption and propensity to cause skin and eye irritation can lead to substantial harm. However, little quantitative data are available on the threshold levels at which these effects occur, hence critical concentrations cannot be identified for most substances. Further, these effects are usually the result of direct contact with pure materials or concentrated solutions rather than contact with more typical relatively dilute aqueous solutions which characterize spill situations.

D. Summary of Rejected Criteria and Alternative Approaches

Many different criteria and approaches were considered in the development of these regulations. Those which have been defered to a lower priority, for the present, are summarized below.

Bioconcentration is a hazard associated with a number of relatively persistent materials. Damage caused by bioconcentration has been noted in instances which were related to continuous discharges. A heavy diet of aquatic life containing some bioconcentrative materials over a prolonged period can cause harm in higher life forms. However, bioconcentration is to a degree reversible, given sufficient time and cessation of exposure, because mechanisms for excretion, degradation or other inactivation are known to exist for many such materials. The probability of demonstrable, substantial harm occurring from bioconcentration as a result of a spill is thought to be quite low. Consequently, The concentration levels at which these effects become significant, i.e., represent "...an imminent and substantial danger to public health or welfare...", are thus the possible thresholds for designation of materials as hazardous. The threshhold levels between effects associated with nonwithdrawal and withdrawal uses often differ by orders of magnitude. Only a single framework can be employed in establishing a set of consistent criteria for all water uses. Factors bearing on the selection of a single framework include:

- The greater availability of data on levels of harm for nonwithdrawal uses vs. those available for withdrawal uses;
- The higher degree of protection afforded withdrawal uses as a result of various levels of pre-treatment and water quality monitoring such as water treatment plants for municipal and industrial supplies;
- The fact that present civil law is better suited for recovery of damages to withdrawal use waters than to nonwithdrawal uses because of the greater ease in demonstrating damages; and
- The added difficulty in assessing probable harm to withdrawal uses a priori as a result of additional probabilistic factors (e.g., location of intake, degree of pretreatment).

All of these points suggest the use of the nonwithdrawal framework for setting thresholds. The effects which can impare nonwithdrawal uses differ greatly in significance. Color and odor may occur at low levels, but the reduction in amenities which may result is typically

3. Water Uses

There is no single, definite quantity of pollutant which results in harm at all locations and at all times. Rather, the harm caused by introduction of any pollutant into water is a continuous function of receiving water characteristics and depends on the concentration of pollutant in the water body, with the overall damage resulting related to the previous uses of that water, as has been pointed out in some detail in Chapter I. In summary, damage can be separated into that associated with either withdrawal uses or nonwithdrawal uses.

Uses common to the first category include potable water supply, irrigation, and industrial water supply which may be adversely affected by individual substances characterized by oral toxicity to humans and livestock, taste and odor phytotoxicity, corrosivity, and flammability. Uses common to the second category, including navigation, recreation, commercial and sports fishing, and aesthetics, are threatened by substances which are characterized by toxicity to aquatic life; susceptibility to bioconcentration or the ability to taint fish flesh; toxicity via skin absorption; propensity to cause skin and eye irritation; exertion of biochemical oxygen demand; biostimulation; and odor, color, or other properties which lead to a reduction in amenities.

For example, kerosene contains as a major constituent straight and branched aliphatic hydrocarbon isomers with carbon numbers mostly in the range of C_{11} to C_{16}. They form three or more members of a homologous series differing by a CH_2 group, and therefore, kerosene qualifies as an oil. Vegetable oil is an edible oil generally composed of mixtures of triglycerides. Because vegetable oils contain isomers of triglycerides composed of three or more saturated and unsaturated straight-chain fatty acids differing by two CH_2 groups in length, they qualify as an oil.

Subject to these criteria, PCB's and toxaphene do not qualify as oils. Both PCBs and toxaphene are composed of a multitude of isomers, but the homologous series increment consists of a Cl atom, instead of a fixed carbon-containing increment. However, a mixture of benzene, toluene and isomers of xylene satisfies both criteria to qualify as oil.

2. Navigable Waters

The basic definition of "navigable waters" can be found in proposed 40 CFR Part 116. Further clarification of questions concerning navigable waters of the United States, and of authority of various federal agencies over them, may be found in FWPCA Section 502(7); in Executive Order #11735 dated August 3, 1973; in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 1510); and in the Regional Contingency Plans published by the ten EPA Regions.

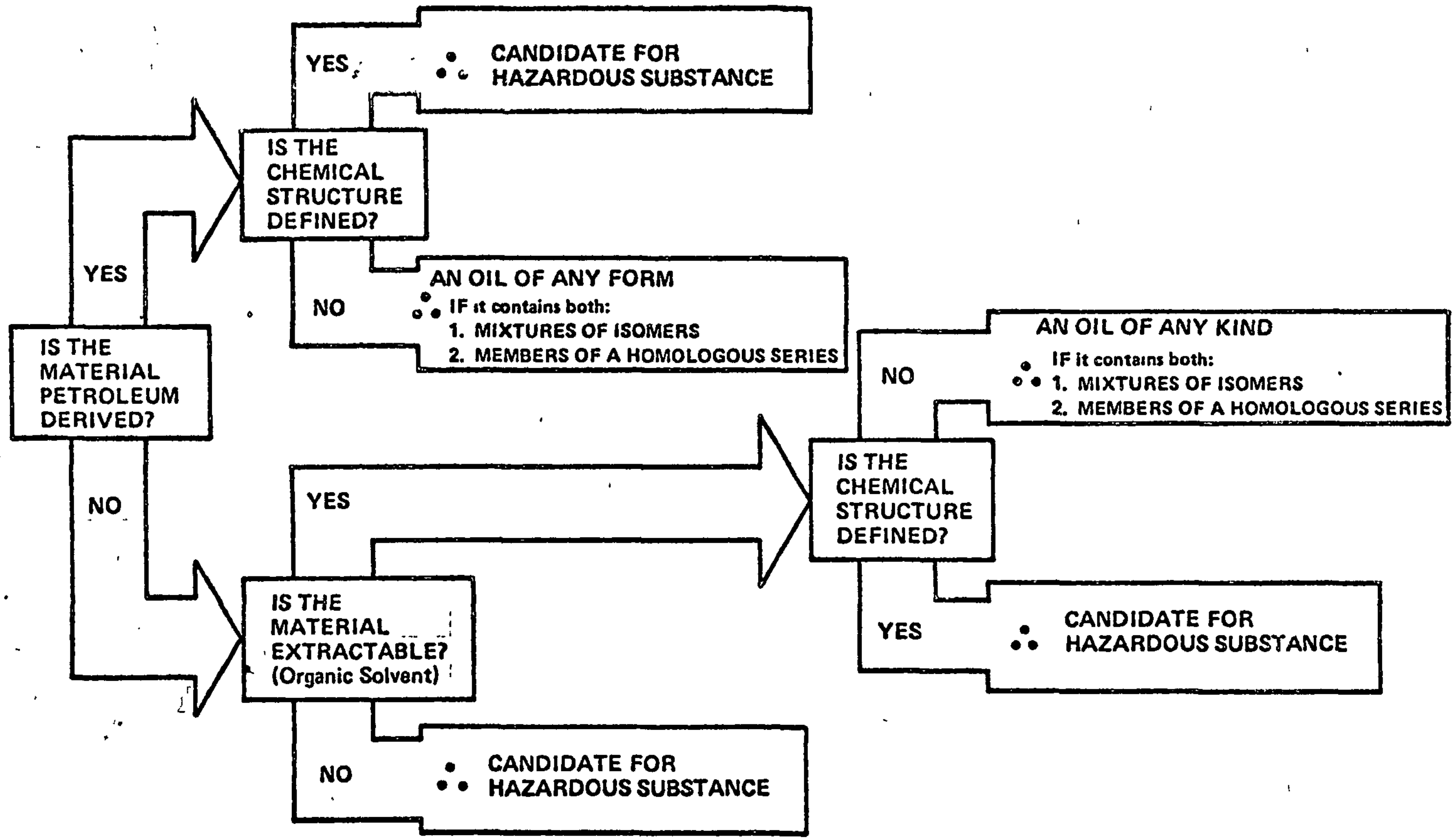
from the preceeding member by a fixed increment of certain constituents. For example, CH_3OH (methanol), C_2H_5OH (ethanol), C_3H_7OH (propanol) and C_4H_9OH (butanol) form an homologous series where each sucessive member differs from the preceeding member by the increment CH_2.

If the material does not fulfill both of the above requirements, then it does not qualify as an oil but becomes a candidate for hazardous substance designation. The criteria must be applied together but do not forbid the separate designation of isomers or homologs of an oil as potential hazardous substances.

The major categories of oils are recognized as (1) petroleum, mineral or hydrocarbon oils derived from crude petroleum, (2) mixed fatty acids and fatty oils derived from vegetable or animal fats or similar materials, and (3) essential oils derived from plants, usually not esters but more often terpene hydrocarbons. Materials in category (1) are members of a homologous series in which each successive member has one more CH_2 group in its molecule than the preceding member. Fats are composed of fatty acids which are long-chain aliphatic acids, both saturated and unsaturated. Members of category (2) differ from each other by two CH_2 groups. Compounds of category (3) contain carbon atoms in multiples of five so related to each other as to allow dissection of their structures into isoprene-like fragments. Oils of all three categories possess a multiplicity of isomers.

Figure IV-A

RATIONALE FOR DISTINGUISHING BETWEEN OILS AND MATERIALS THAT MAY BE HAZARDOUS SUBSTANCES



in determining whether a discharger may be subject to civil penalties in addition to clean-up liabilities under the hazardous substances regulations, or only be subject to clean-up liabilities under the oil provisions of the law.

Further guidelines proposed by Crump-Wiesner and Jennings[2] in 1975 contain additional considerations, paraphrased below, for use in those cases where the previous criteria did not to provide sufficient distinction between oils and other complex materials. For instance, no specific chemical structure can be written to characterize multi-component substances such as PCB's, toxaphene, or mixtures of organic compounds. The analysis must be carried further for these substances, as explained below and illustrated in Figure IV-A.

If the chemical structure is not defined, a material would qualify as an oil if it conforms to both of the following criteria:

1. contains mixtures of isomers
2. contains three or more members of a homologous series which differ by a fixed carbon-containing increment

An isomer is defined as a molecule having the same number and kind of atoms as another molecule, but differing from it in respect to atomic arrangement or configuration. A homologous series is a series of organic compounds in which each successive member differs

(EPA Report #440/9-75-009) contains the "hazard profile sheets" for each substance being considered a hazardous substance and provides the basic data used by EPA in selecting the list of elements and compounds.

B. General Considerations

1. Oils versus Non-oils

Subsection 311(b)(2)(A) provides that:

> "The Administrator shall develop, promulgate and revise as may be appropriate, regulations designating as hazardous substances, other than oil as defined in this section, such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States or adjoining shorelines or the waters of the contiguous zone, present an imminent and substantial danger to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, shorelines and beaches."

One significant question arising from the wording of this passage, is how to discriminate between oils and non-oils. A concise approach has evolved to supplement definitions found in the legislation. According to a rationale proposed by Thompson[1] in 1971, the distinction between a potential hazardous substance and an oil is made on the basis of whether the substance is soluble in an organic solvent such as chloroform or carbon tetrachloride and whether it possesses a defined chemical structure. If the chemical structure is not defined, then the substance is a candidate for designation as a hazardous substance, other than oil, under the same section. The differentiation is important because oils are, by law, removable whereas hazardous substances may be determined to be nonremovable. Nonremovability is the basic factor

CHAPTER IV

DESIGNATION OF HAZARDOUS SUBSTANCES

A. Introduction

Explosive growth of the chemical industry in the past few decades has been accompanied by a corresponding increase in the quantity and frequency of shipment of hazardous substances by all modes of transport. Each year more than 500 new commercial chemicals are developed. Each year approximately two billion tons of hazardous substances which could cause a pollution problem are manufactured and entered into commerce. Growing concern over these risks on the part of the Federal government, private industry and the general public resulted in several safety-related legislative acts including the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). This chapter is primarily concerned with a portion of Section 311 in the 1972 Amendments which requires promulgation of regulations designating specific elements and compounds, other than oil, as hazardous substances.

Prior to detailed discussion of the "selection criteria" used in compiling the proposed list of designated hazardous substances some topics of background interest should be covered. The following section deals with these considerations in a manner complementing the discussions found in Chapter III of EPA Report #440/9-75-005-b. While a certain amount of repetition is necessary for clarity, neither this chapter nor the referenced chapter is intended to stand alone as full coverage of all topics. In addition, the supplement to this Development Document

REFERENCES TO CHAPTER III

1. Report of the Committee on Public Works, United States House of Representatives, House Report No. 92-911, pp. 117-118, March 11, 1972.'

2. Report of the Committee on Public Works, United States Senate, Senate Report No. 92-414, pp. 65, 67, October 20, 1971.

3. Conference Report (to accompany S. 2770), Senate Report No. 92-1236, pp. 133-134, September 28, 1972.

(10) Legislative Interests

- House Public Works Committee
- Interstate Legislative Committee on Lake Erie
- Illinois State Commerce Commission

(11) Miscellaneous groups and Individuals-at-Large

On August 22, 1974, the Advance Notice of Proposed Rulemaking for Designation and Determination of Removability was published in the Federal Register. In this notice, the public was encouraged to supply information and comments on the proposal. Eighty-four organizations and individuals responded. These comments were analyzed and appropriate changes are reflected and discussed in the proposed rulemaking package.

in making this evaluation include: 1) past spill history; 2) annual production; 3) use and distribution patterns; 4) value of the substance.

5. <u>Spill Potential</u>

When historical data are not available on spills of a given hazardous substance the ability to predict the number of spills expected in a fixed time interval is clearly of interest to the Agency. The great variety of potentially hazardous materials leads to a desire to focus on the smaller subset of those having a "reasonable" potential for being discharged, i.e., spilled into a water body. Two parameters related its care in its handling and therefore to the number of spills likely for a given substance ("spill potential") are its cost and the quantity produced.

In the interest of discovering and quantifying any such relationship, cost and production data were assembled for those materials voluntarily reported spilled during 1972 and 1973 through the Office of Hazardous Materials Spill Information Retrieval System (OHM-SIRS) a computerized reporting network, through a similar information retrieval system operated by DOT and through EPA fish kill reports. Possible correlations were then sought through a large variety of graphs relating production or cost and the number of spills reported for a given substance.

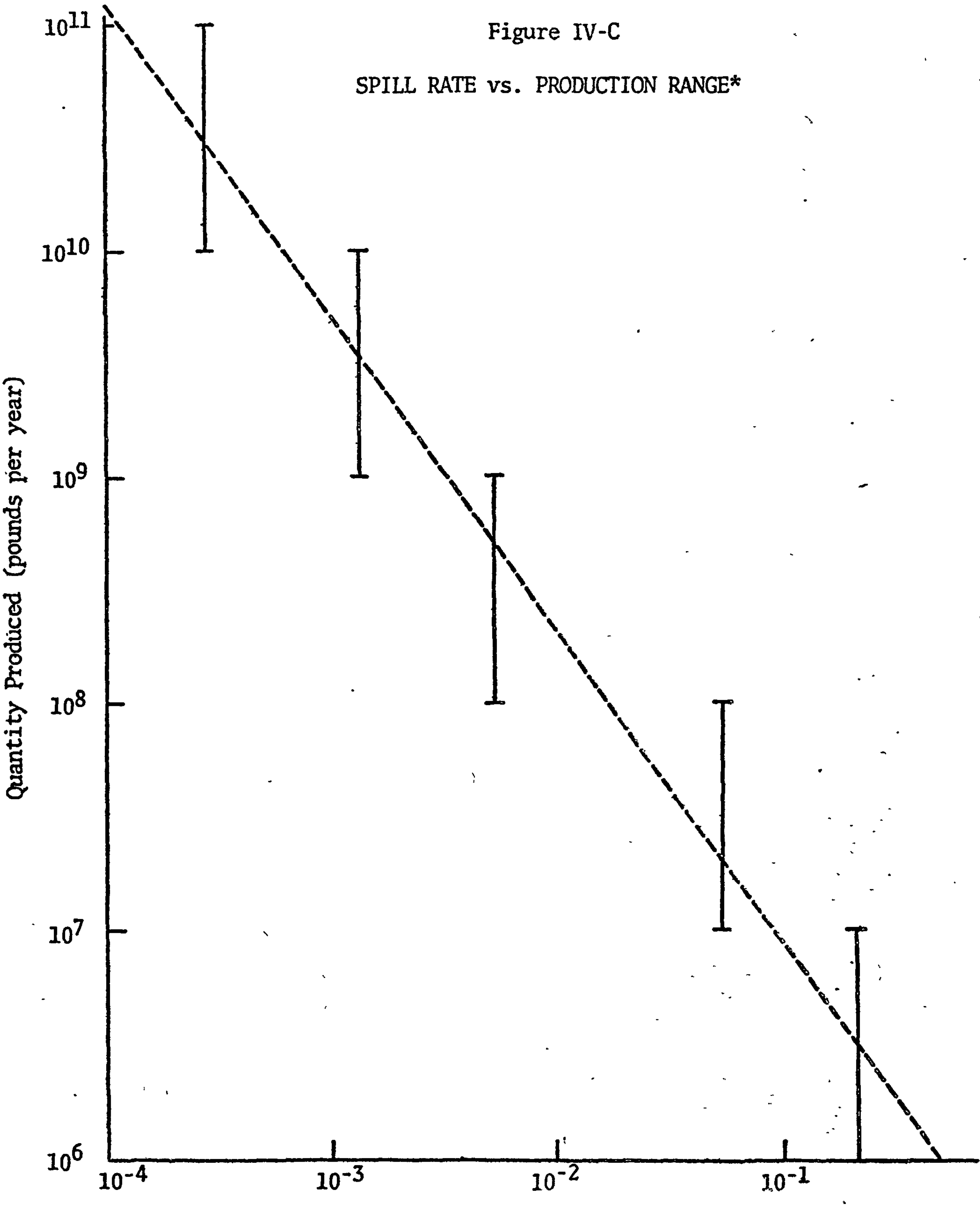
The most significant correlation arises from a plot of the logarithm of production <u>range</u> vs. the logarithm of the number of spill events per million pounds of production. According to Figure IV-C, for a material produced at the rate of 1,000,000 pounds per year, one spill will be reported for each 2,000,000 pounds produced. For a material produced at the rate of 10,000,000,000 pounds per year, one spill will be reported for each 17,000,000 pounds produced. The rate at which spills occur decreases as production volume increases, even though the overall number of spills for a high volume material exceeds the number of spills recorded for a low production volume material. The slope of the straight line found in Figure IV-C equals approximately -2×10^{4} pounds per spill event. (Of the various spill data sources, OHM-SIRS information appears the most reliable and was used separately for the graph, Figure IV-C.)

At present, the spill reports reaching OHM-SIRS or similar net works are voluntary in nature or result from fortuitous discovery of spills by parties other than the discharger. Consequently, those spills presently recorded doubtless represent only a small fraction of the total. More exact determination of the fraction reported must follow finalization of 40 CFR Parts 116 through 118, because only then does reporting of discharges in excess of a "harmful quantity" become compulsory.

Table IV-1 below lists those chemicals from the designation list of proposed 40 CFR Part 116 on which production quantity information is available but for which no spills have been reported through the

Figure IV-C

SPILL RATE vs. PRODUCTION RANGE*



*Using spill data from the Oil and Hazardous Materials Spill Information Retrieval System (OHM-SIRS) for the years 1972 and 1973.

OHM-SIRS network. The purpose of the Table IV-1 is to indicate predictions possible based on the preceding graphical scheme of Figure IV-C.

TABLE IV-1

Materials from Proposed 40 CFR Part 116 With Verified Production Quantities but no OHM/SIRS Spill Information

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
acetaldehyde	1.45×10^{9}	2.43×10^{-3}	3.5
acetic anhydride	2.24×10^{9}	1.75×10^{-3}	3.9
acetone cyanohydrin	5.40×10^{6}	1.20×10^{-1}	0.65
acrolein	5.5×10^{7}	2.55×10^{-2}	1.4
aldrin	1.05×10^{7}	8.50×10^{-2}	0.89
allyl chloride	1.84×10^{8}	1.06×10^{-2}	2.0
aluminum sulfate	1.50×10^{9}	2.38×10^{-3}	3.6
ammonium acetate	1.03×10^{6}	4.50×10^{-1}	0.46
ammonium chloride	5.32×10^{7}	2.63×10^{-2}	1.4
ammonium sulfate	4.16×10^{9}	1.13×10^{-3}	4.7
amyl acetate	1.1×10^{7}	8.20×10^{-2}	0.90

TABLE IV-1 (Continued)

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
aniline	4.10×10^{8}	6.00×10^{-3}	2.5
arsenic trioxide	1.60×10^{7}	6.25×10^{-2}	1.0
benzoic acid	1.55×10^{8}	1.22×10^{-2}	1.9
benzoyl chloride	3.4×10^{7}	3.60×10^{-2}	1.2
benzyl chloride	8.04×10^{7}	1.93×10^{-2}	1.6
beryllium chloride	1.70×10^{7}	6.00×10^{-2}	1.0
boric acid	1.40×10^{8}	1.30×10^{-2}	1.8
butyl acetate	9.57×10^{7}	1.70×10^{-2}	1.6
butylamine	2.62×10^{7}	4.40×10^{-2}	1.2
calcium hypochlorite	8.06×10^{7}	1.93×10^{-2}	1.6
captan	1.3×10^{7}	7.30×10^{-2}	0.95
chlorobenzene	4.85×10^{8}	5.30×10^{-3}	2.6
chloroform	2.35×10^{8}	9.00×10^{-3}	2.1
cupric sulfate	8.67×10^{7}	1.83×10^{-2}	1.6
hydrogen cyanide	2.72×10^{8}	8.10×10^{-3}	2.2

TABLE IV-1 (Continued)

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
sodium cyanide	4.5×10^{7}	3.05×10^{-2}	1.4
DDT	6.0×10^{7}	2.40×10^{-2}	1.4
dicamba	6.0×10^{6}	1.27×10^{-1}	0.76
diethylamine	8.8×10^{6}	9.60×10^{-2}	0.84
sulfton	8×10^{5}	1.02×10^{-1}	0.82
diuron	6×10^{6}	1.27×10^{-1}	0.76
ethion	3×10^{6}	2.10×10^{-1}	0.63
ethylenediammine	6.21×10^{7}	2.33×10^{-2}	1.4
aluminum fluoride	2.64×10^{8}	8.20×10^{-3}	2.2
sodium fluoride	1.38×10^{7}	7.00×10^{-2}	0.97
formic acid	3.19×10^{7}	3.80×10^{-2}	1.2
fumaric acid	5.14×10^{7}	2.60×10^{-2}	1.3
hydroquinone	1.23×10^{7}	7.60×10^{-2}	0.93
kelthane	4.0×10^{6}	1.70×10^{-1}	0.68
lindane	1×10^{6}	4.65×10^{-1}	0.46

TABLE IV-1 (Continued)

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
malathion	3.5×10^{7}	3.55×10^{-2}	1.2
maleic anhydride	2.29×10^{8}	9.20×10^{-3}	2.1
monoethylamine	2.81×10^{7}	4.20×10^{-2}	1.2
monomethylamine	2.87×10^{7}	4.10×10^{-2}	1.2
naled	2×10^{6}	2.80×10^{-1}	0.56
naphthenic acid	1.7×10^{6}	3.18×10^{-1}	0.54
nickel sulfate	4.08×10^{7}	3.15×10^{-2}	1.3
nitrobenzene	5.51×10^{8}	4.90×10^{-3}	2.7
nitrophenol	3.36×10^{7}	3.65×10^{-2}	1.2
pentachlorophenol	4.7×10^{7}	2.85×10^{-2}	1.3
phosgene	6.37×10^{8}	4.20×10^{-3}	2.7
phosphorous	1.19×10^{9}	2.80×10^{-3}	3.3
phosphorous oxychloride	6.68×10^{7}	2.23×10^{-2}	1.5
phosphorous pentasulfide	1.25×10^{8}	1.42×10^{-2}	1.8
phoshporous trichloride	1.25×10^{8}	1.42×10^{-2}	1.8

TABLE IV-1 (Continued)

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
quinoline	2.7×10^{6}	2.27×10^{-1}	0.61
resorcinol	2.6×10^{7}	4.40×10^{-2}	1.1
sodium	3.21×10^{8}	7.20×10^{-3}	2.3
sodium borate	1.05×10^{9}	3.05×10^{-3}	3.2
sodium hydrosulfide	9.9×10^{7}	1.67×10^{-2}	1.7
sodium methylate	5.2×10^{6}	1.42×10^{-1}	0.74
sodium phosphate, dibasic	4.16×10^{7}	3.13×10^{-2}	1.3
sodium phosphate, monobasic	5.26×10^{7}	2.55×10^{-2}	1.3
sodium silicate	1.32×10^{9}	2.58×10^{-3}	3.4
sodium sulfide	1.75×10^{8}	1.11×10^{-2}	1.9
2,4,5-T (acid)	4.9×10^{6}	1.46×10^{-1}	0.72
tannic acid	4.0×10^{7}	3.20×10^{-2}	1.3
tetraethyl lead	3.02×10^{8}	7.50×10^{-3}	2.3
toxaphene	5.0×10^{7}	2.70×10^{-2}	1.4
trichlorophenol	2.8×10^{7}	4.20×10^{-2}	1.2

TABLE IV-1 (Continued)

Material	Production Quantity (lb)	# Spills/Yr /Million lb	Predicted # Spills/Yr
trimethylamine	2.55×10^{7}	4.5×10^{-2}	1.1
xylenol	1.46×10^{7}	6.7×10^{-2}	0.98
zinc sulfate	8.94×10^{7}	1.80×10^{-2}	1.6

After publication of an Advance Notice of Proposed Rulemaking which included a tentative designation list, (Federal Register, Vol. 39, No. 164, Part IV, pp. 30466-30471, August 22, 1974), several public comments were received concerning expression of the concepts of "research quantities" and spill potential in general. As a result, these concepts have been reexamined and clarified.

Identification of a single, specific production quantity indicative of wide commercial usage, versus exclusively research-related use, proves very troublesome. It now appears more appropriate to consider research quantity as one of several factors involved in the overall evaluation of spill potential. (In the Advance Notice, exclusively research related use was originally suggested as an independent reason for eliminating a substance from further consideration before consideration of toxicity.)

Few data were available concerning the mode of transportation, handling practices and storage practices for many substances. Therefore, these considerations are no longer included in the assessment of potential for discharge.

Factors currently proposed (40 CFR Part 116) in determining spill potential are:

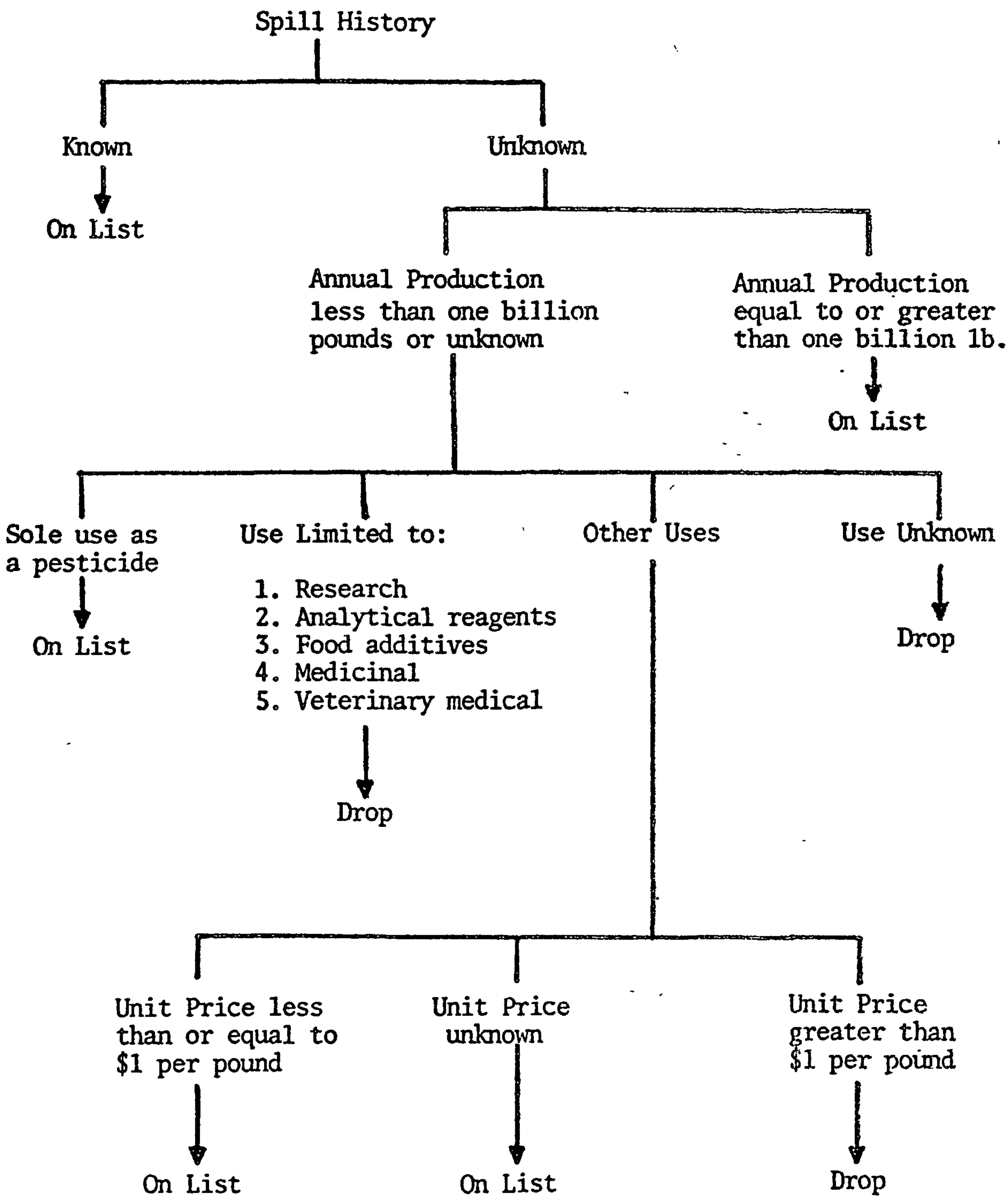
1. Past history of spillage
2. Production quantity
3. Use and distribution patterns
4. Value of the substance

A flow diagram found in Figure IV-D illustrates the order in which the factors mentioned above are considered in the overall assessment of spill potential. Further explanation is provided below.

Spill records presently available are checked for candidate substances meeting at least one lethality criterion. Those substances having a previous history of spillage are maintained as proposed hazardous substances. Because the reporting of spills of substances other than oil is not yet required, the spillage of many substances has undoubtedly gone unreported. Consequently, those spills presently recorded do not represent an inclusive representation of all substances which have a reasonable potential for discharge and additional factors must be considered.

Records of spills accumulated by EPA and DOT show that the materials spilled most frequently are, in general, the ones that are most abundant in commerce. That is, a distinction may be made between heavy usage bulk chemicals and other less widely used and distributed

Figure IV-D - SPILL POTENTIAL



chemicals. An analysis of production quantities, usage, and selling price indicates that chemicals produced in excess of one billion pounds annually are commonly used in highly diversified products and processes. As such, they are handled and transported in large quantities and multiple locations. Such chemicals also have a typically low selling price and could therefore receive a lower priority of handling concern. Accordingly, candidate substances which fall into this category are judged to have a relatively high spill potential and are proposed for designation as hazardous substances (40 CFR Part 116) within the meaning of Section 311.

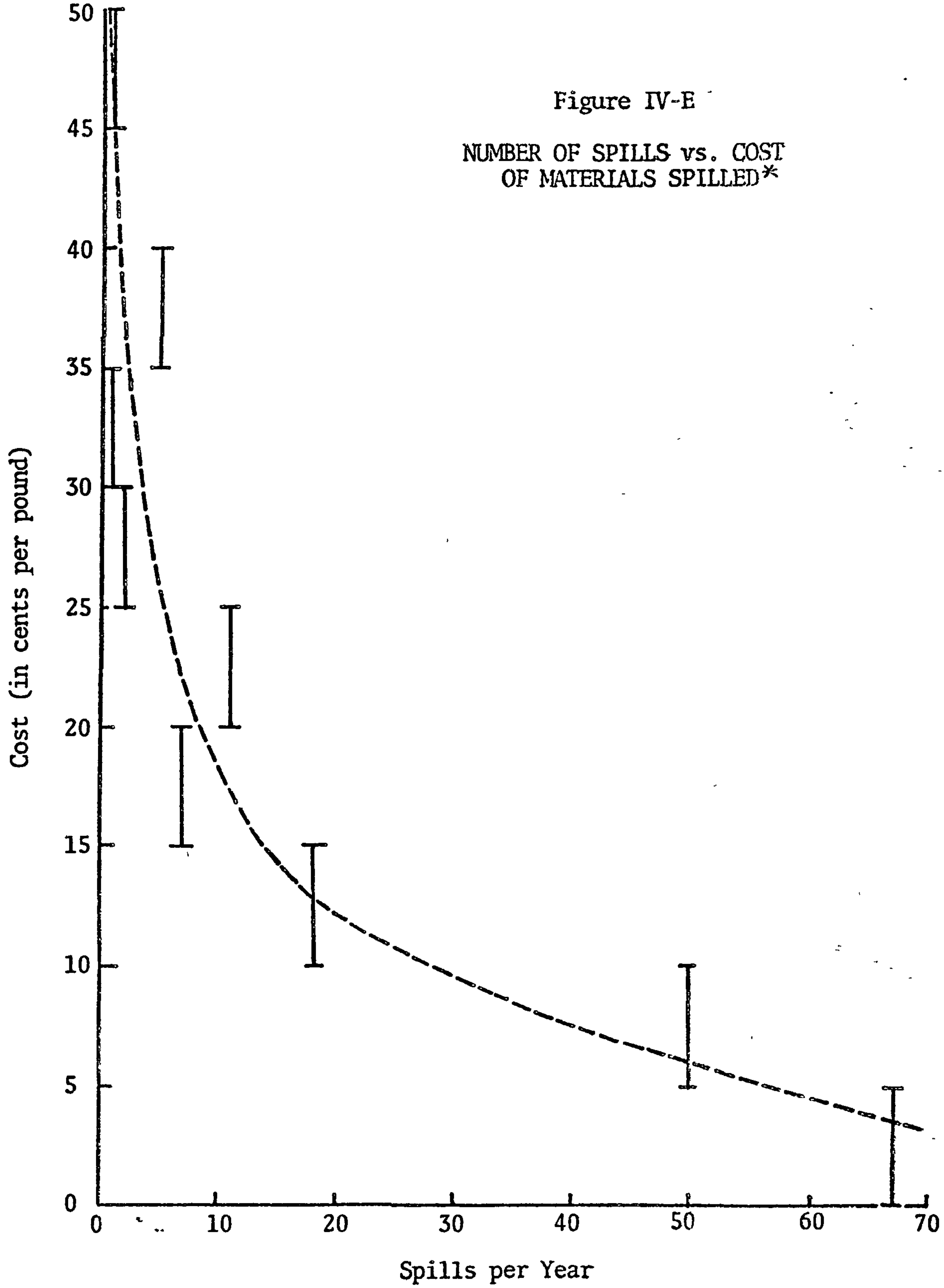
Materials which are produced in quantities less than one billion pounds annually or for which annual production is not known, are further examined for use and distribution patterns, and unit price. Substances with usages limited to areas such as research, medicinals, food additives, or analytical reagents are not further considered for designation at this time. These materials are subject to limited production and are less frequently stored or transported in bulk. Such substances are generally of high purity and are relatively high-priced. As such, they are subject to careful handling which makes spillage much less likely.

Substances known to have uses other than those mentioned in the preceeding paragraph, but which have a high commercial market value, are also considered to pose a limited spill risk. Additional safeguards in the manufacture, handling, and processing of such valuable substances appear to minimize the possibility of spillage. Spill data gathered during 1973 through the OHM-SIRS reporting system is plotted versus cost in Figure IV-E. The graph clearly indicates that the number of spills reported for high-priced materials is far smaller than the number for low-priced materials. While this graph does not correct for the influence of production quantity, it supports the use of a cost cutoff value as a reflection of potential for spillage. This approximation simplifies the regulation by shortening the list while maintaining a high level of environmental protection. The cost cutoff chosen for use at this time is one dollar per pound.

Substances for which no definite use can be established, other than an assumed but undocumented research-related use, are eliminated from further consideration at this time. Receipt of documentation on the uses of such materials may lead to reconsideration of their spill potential in the future.

Because of their intentional use and distribution in the environment, chemicals used primarily as pesticides are believed to have a high hazard even for low probability of discharge to the water and are maintained as candidate substances regardless of production volume or selling price.

As an example of the general process used to evaluate a substance for designation as hazardous, consider the compound sulfuric acid. Since its toxicological properties are well documented and meet the aquatic toxicological selection criterion, the potential for spillage of



*Using spill data collected through the OHM-SIRS reporting system during the year 1973.

this chemical is examined.

Sulfuric acid is the highest volume product in the chemical industry, with 59,000,000,000 pounds produced in 1971. Further, its production and use are steadily increasing. From the order of consideration shown in Figure IV-D, the fact that sulfuric acid is produced in quantities exceeding 1,000,000,000 pounds per is year taken as sufficient indication that this chemical is likely to be spilled. Consequently, this substance is listed in proposed 40 CFR Part 116. (Other data are available to support this decision. Department of Transportation and Environmental Protection Agency records show a continual increase in accidents involving sulfuric acid through the years 1971, 1972 and 1973. While production volume is considered the decisive factor in this example, the large number of manufacturers and distributers, as well as the low cost of the commodity are contributive factors.)

An example of a material that does not qualify as a hazardous substance because of low spill potential, using Figure IV-D, is ammonium gluconate. This compound was tentatively included in the Advance Notice because of toxic properties of the ammonium ion. Subsequent analysis reveals that production figures are not available, that the chemical has only limited distribution and use as an emulsifier in the food industry, and that it has no record of past spillage. The analysis results in an evaluation of low spill potential and this substance is not designated in proposed 40 CFR Part 116.

Early efforts at evaluating data which lead to designation of elements and compounds suggested the use of a priority ranking. This alternative was considered but rejected because of the incomplete data base and because of the changing priorities which may result from new products being manufactured and new markets being created. Attention has been maintained of these priority lists as the selection criteria were developed[14].

b. Materials Deleted Because of Low Potential for Discharge

A number of other substances listed in the August 22, 1974 Advance Notice shown in Table IV-2 appear to have little probability for discharge following the revised logic found in Figure IV-D. They are therefore deleted from the designation list of proposed 40 CFR Part 116. Receipt of persuasive evidence to the contrary during the proposed rule comment period would permit reconsideration of this deletion.

TABLE IV-2

Materials Deleted Because of Low Potential for Discharge

Ammonium Ferrocyanide
Ammonium Formate
Ammonium Gluconate
Ammonium Malybdate
Antimony Triiodide
Arsenic Tribromide
Arsenic Trifluoride
Arsenic Triiodide
Beryllium Hydroxide
Beryllium Phosphate
Beryllium Sulfate
Brucine
Cadmium Fluoborate
Cadmium Nitrate
Cadmium Sulfate
Catechol
Chromous Carbonate
Chromous Oxalate
Cobaltous Acetate
Cobaltous Chloride
Cobaltous Citrate
Cobaltous Iodide
Cobaltous Nitrate
Cobaltous Perchlorate
Cobaltous Succinate
Cobaltous Sulfate
Cupric Acetylacetonate
Cupric Bromide
Cupric Gluconate
Cuprous Iodide
Ferric Glycerophosphate
Ferric Phosphate
Ferrous Oxalate
Hydroquinone
Lead Bromide
Lithium Fluoride
Mercuric Ammonium Chloride
Mercuric Bromide
Mercuric Chloride
Mercuric Iodide
Mercuric Oxide
Mercurous Chloride
Mercurous Iodide
Molybdic Trioxide
Nickel Acetate
Nickel Bromide
Nickel Fluoride
Nickel Iodide
Nickel Perchlorate
Phosphorous Pentafluoride
Pyrogallic Acid
Selenic Acid
Selenium Oxychloride
Tannic Acid
Vanadium Oxytrichloride
Zinc Ammonium Sulfate
Zinc Permanganate
Zinc Propionate
Zirconium Ammonium Fluoride

D. Selection Criteria Considered and Why Rejected at Present

As summarized in part D of Section II of this chapter, several other criteria were considered. These are discussed below to clarify the intent of the Agency and to allow more efficient comment by the the public.

1. Bioconcentration

The terms "bioconcentration", "bioaccumulation", and "biomagnification" are all used to refer to the phenomenon by which living organisms incorporate an element or compound to a body level exceeding the level of environmental exposure. The three terms are defined by Kneip and Lauer[4] as follows:

Bioconcentration refers to the ability of an organism or a population of many organisms of the same trophic level to concentrate a substance from an aquatic system.

Bioaccumulation refers to the ability of an organism to not only concentrate, but to continue to concentrate essentially throughout its active metabolic lifetime, such that the "concentration factor", if calculated, would be continuously increasing during its lifetime.

Biomagnification is the term which should be used when a substance is found to exist at successively higher concentrations with increasing trophic levels in ecosystem food chains.

Polikarpov[5] has defined the concentration factor as the ratio of the concentration of a material in a biological species to the concentration of the material in the water or the preceding link in the food chain.

With this definition of the concentration factor, materials which bioconcentrate, bioaccumulate, or biomagnify can be defined as those substances which have the ability to display a concentration factor. For the purpose of designating substances as hazardous, this definition is adequate since the effects or the potential to produce damage vary only in the degree of effect and number of trophic levels affected and are independent of the route of exposure or mechanism of uptake. The term bioconcentration will be used since the definition is the most general and is inclusive of the other two. The general terminology is valid for addressing materials since an initial concentration must precede accumulation or magnification. Simply stated, an organism exposed to a concentration of bioconcentrative material will, in time, display a higher tissue level of the material. This definition intentionally excludes cumulative effects which may be observed when irreversible damage is inflicted by a toxic material that is not retained by the organism but is detoxified, metabolized, or excreted.

For a large percentage of toxic materials, the affected organism has a metabolic capability by which sublethal doses are excreted or detoxified. In the case of bioconcentrative substances, the detoxification-excretion mechanism is slow and often incomplete with the observed concentration occurring in specific tissues and organs or generally distributed in all body cells.

The bioconcentrative materials fall into two groups and can be classified according to their retention mechanism.

One group is the heavy metals such as mercury, cadmium, and lead which have a high affinity for sulfhydryl functional groups, disulfide bonds, amino acids, purines, and porphyrins found distributed in all tissues. The metals can, therefore, act at a variety of biochemical sites. Sulfhydryls and disulfide are important elements in maintaining the tertiary structure of many structural proteins and enzymes. In specific enzymes, the sulfhydryls have a direct catalytic or binding function at the active site. In vitro experimentation has shown that soluble forms of heavy metals are potent, irreversible inhibitors of most enzymes. The mode of action is usually that of formation of strong metallosulfur bonds with the sulfhydryls and disulfides or, in the case of some metallo-enzymes, substitution of the metal moiety. Direct enzyme inactivation results when the reactive sulfhydryl is at the active site. Protein denaturation occurs when the sulfhydryls and disulfides involved in maintaining tertiary structure are modified by association with the metal ion. In either case, the inactivated or denatured protein becomes non-functional. The result can be partial or total blockage of a metabolic pathway or control mechanism or the loss of structural integrity at the cellular or sub-cellular level[6-8].

Normal excretion of an absorbed material requires solubilization and transport to an excretory organ. In the case of bioconcentrated heavy metals such as mercury, excretion occurs at only very slow rates. The slow excretion rate coupled with a relatively active uptake mechanism results in observed concentration factors. For mercury, aquatic life concentration factors have been calculated to vary between 1×10^2 and 1×10^4 depending on the organism[4].

The persistent organic materials typified by DDT, toxaphene, and endrin are the second class of bioconcentrative materials. Their mechansim of retention and effects is much different from the heavy metals. A universal feature of these materials is their high solubility in non-polar solvents as opposed to their extremely low water solubility. The solubility characteristics account for that portion of the bioconcentration problem dealing with initial uptake and retention. The net effect is that of partitioning between the more polar nature of body fluids in the case of oral ingestion, or water in the case of direct sorbtion and the apolar nature of fatty tissue. As a result of the partitioning, very low concentrations in the blood or water eventually result in large concentrations in fatty tissues or lipid cellular fractions. Concentration factors for various chlorinated hydrocarbons are found to range between 1×10^2 and 4×10^5 depending on the material and trophic level evaluated (reference 4).

Most proteins or lipids, particularly the metallic micronutrients, have significant concentration factors at some trophic level. Since these data would qualify required nutrients as bioconcentrative substances, only those elements and compounds for which no nutritional requirements has been generally established could reasonably be selected by the bioconcentration criterion. In any event, evaluating even the small amount of bioconcentration data available is a difficult task since no standard bioassay or testing procedure has been adopted by which the concentration potential of a material can be consistently assessed. However, and effect such as bioaccumulation is typically noted after lengthy or lifetime exposure of test populations. Such chronic, long term exposures cannot presently be reconciled with the acute nature of spill discharges which are the concern of Section 311.

In summary, the lack of information, lack of standardization of available information and continuing related controversy about synergistic/antagnistic effects of multiple pollutants have resulted in a decision to exclude bioconcentration as a selection criterion at this time.

2. Genetic Effects

Genetic effects, as used here applies to a broad range of more specific effects observed involving malfunctions of the genetic process either in mitosis or meiosis. These effects are commonly referred to as carcinogenesis, teratogenesis, and mutagenesis. When the effects are chemically induced, current thinking in some quarters is that the inducing agent casuses a chemical modification of DNA nucleotides. A few chemicals are suspected of producing genetic effects based on casual relationships established either in the laboratory or with observation of exposed populations.

Some efforts have been made to bioassay for carcinogenic activity using test animals or tissue cultures. Most of these assays involve particularly sensitive strains of animals or cultures. Exposure routes are usually direct, rather than waterborne, and are continuous for long periods of time. The extrapolation of this chronic data to the problem of acute spills into water appears tenuous at this time.

An alternate approach involves the gathering of circumstantial evidence. Following exposure to the suspected genetic agent, plant or animal cells are examined for "chromosome aberrations". Chromosome aberrations can be loosely defined as gross alterations in the quaternary structure of the chromosomes. The assayed effect is considered circumstantial because the production of the aberrations is not always associated with an observed whole-body genetic effect. In addition, many of the structural alterations are readily reversible, presumably by nucleic acid repiar mechanisms.

The problems in extrapolating and quantifying the scarce data that are available are further complicated by existence of another school of thought on the cause and mechanism of genetic malfunction. Many studies have linked certain defined malignant tumor induction to viral agents. This seems quite plausible in light of the well defined mechanism by which viruses utilize the host cell genetic machinery to reproduce. A combination of the two approaches has produced a theory that the chemical agent either predisposes or sensitizes the host cell to virus infection.

In summary, while genetic effects caused by spills should be further investigated because of their danger potential, lack of adequate definition and quantification of the cause-effect relationship precludes their inclusion as a basis for designating materials as hazardous substances at this time.

3. Eutrophication Considerations

Concern has been expressed that a large spill-type discharge of nutrients into an impoundment has the potential to create eutrophic conditions and thus present an imminent and substantial danger to aquatic life.

Carbon, nitrogen, and phosphorus added singly or in combination to water from lakes of nine different fertility levels resulted in maximum standing crops of an introduced test algae directly proportional only to phosphorous levels and had no obvious correlation with carbon or nitrogen[9,10]. (Such laboratory data were substantiated when the diversion of sewage from Lake Washington decreased phosphorus input by 72%, nitrate by 20% and carbon by 25%. A concomitant decrease in algae biomass followed the same pattern as phosphorus to a total of 80% decrease.)

Studies on Lake Erie show a total annual pollutant biochemical oxygen demand input with a carbon equivalent of 75,000 tons. In contrast, the lake bicarbonates (20-25 ppm carbon) equal 10-12.5 million tons of carbon or about 150 times the amount from an entire year's input of sewage. At peak growing season, the biomass of 4.9 million tons contains 1.8 million tons of carbon, a value far exceeding the amount potentially controllable in pollutant inputs. Obviously, carbon available in bicarbonates, not to mention the additional free CO_2 from the atmosphere and from microbiological decomposition of organics, far exceeds the demands of algae production. The ratio of carbon in bicarbonates to the lake's total phosphorus is 800:1. If the carbon/phosphorus ratio in algae is about 40 (Table IV-3), then there is about 20 times more bicarbonate carbon available than is required to completely deplete the water of phosphorous. Similarly, Lake Erie has a 6-fold surplus of nitrogen, yielding a nitrogen/phosphorus ratio of seven. These calculations show that it is phosphorus and not carbon which is the growth limiting nutrient.

TABLE IV-3

Elemental Composition - Freshwater Algae

C = 49.51-70.17

O = 17.40-33.20

H = 6.57-10.26

N = 1.39-10.98

P = 1.35-2.76

Based on the preceding calculations, the probability of an isolated spill-type discharge of phosphorus-containing nutrient in sufficient quantity to produce eutrophic danger levels would seem remote. However, one must keep in mind that nutrients are continually cycled, particularly in water bodies with slow flushing rates such as lakes.

Because of the phoshporus and nitrogen cycles, the input of nutrients is an additive phenomenon. Since many of our nation's lakes are near the dangerous level already, one should consider whether a spill could possibly trigger a disasterous algal bloom, particularly in smaller lakes. Shagawa Lake, in Minnesota, has a surface area of 10.68×10^6 square meters and a mean depth of 6.7 meters. Calculation shows that the critical loading rate of 0.16 g/meter^2/year could be reached for a lake of this size with a 3,800 pound discharge of pure phosphorus, or 18,000 pounds of Na_2HPO_4. Considering the additive effect, it is possible that a truck or rail car capacity spill of phosphate could promote an algal bloom.

A somewhat larger lake such as Oneida in New York with a mean depth of 6.8 meters and a surface area of 2.067×10^8 square meters would be endangered by a 423,000 pound spill of nutrient phosphate. This example would seem significant in that the New York State Barge Canal system traverses the lake.

However, the potential environmental danger posed by spills of phosphorus or compounds containing phosphorus has been addressed, though in a different fashion, by the proposed regulatory package. Pure phosphorus, phosphoric acid and the common sodium salts of phosphoric acid have been selected for designation because they also exhibit toxic effects from acute exposure on selected aquatic species. Moreover, the "harmful quantities", or minimum quantity for compulsory notification and civil penalty purposes, determined for the phosphorous-containing materials mentioned are in all cases no greater than 500 pounds. These include a harmful quantity of one pound for pure phosphorus, to be contrasted with the 3,800 pound discharge calculated to result in algal bloom on Shagawa Lake and with the 18,000 pounds of sodium phosphate, dibasic, calculated to produce an algal bloom in Shagawa Lake.

Finally, since phosphorus has been shown to be the growth limiting nutrient in eutrophication, designation of the common or important phosphorous-containing materials brings the general eutrophication phenomenon under regulatory control. While the level and effectiveness of control will be undergoing continuous review, there does not now appear to be a need for a separate selection criterion based on eutrophication phenomena.

4. Biochemical Oxygen Demand

Dissolved oxygen is essential to the well being of much of the life in the aquatic environment. Oxygen consumption by direct oxidation of spilled chemicals or indirectly, as a result of biochemical utilization stimulated by a spilled chemical, is thus of concern. The following discussion illustrates the complexities which might be encountered in using a fixed level of biochemical oxygen demand (BOD) as a selection criterion for designating a substance as hazardous under Section 311.

a. Effects of Low Levels of Dissolved Oxygen

A number of interesting passages from a standard text by McKee and Wolf[11] provide some appreciation of the complexity of problems involving oxygen demand. (Numbered references to original literature in the text have been deleted for clarity. For these, see reference 11 pp. 180-181.)

> "The content of dissolved oxygen in water at equilibrium with a normal atmosphere is a function of the temperature and salinity of the water, the ability of water to hold oxygen decreasing with increases in temperature or dissolved solids...
>
> "There is a great deal of literature pertaining to the minimum dissolved oxygen concentration necessary to sustain

healthy aquatic life, especially fish, and the concentration below which fish will be killed by short-term exposure... No general statement can be made to give the dissolved oxygen concentration required to support fish life, owing to the fact that the oxygen requirements of fish vary with the species and age of the fish, with prior acclimatization, with temperature, with concentration of other substances in the water, and with several other factors...

"The lethal effect of low concentrations of dissolved oxygen appears to be increased by the presence of toxic substances, such as excessive dissolved carbon dioxide, ammonia, cyanides, zinc, lead, copper, or cresols. With so many factors influencing the effect of oxygen deficiency, it is difficult to estimate the minimum safe concentration at which fish will be unharmed under natural conditions...

"Several factors aside from the deoxygenating effects of pollutants influence the concentration of dissolved oxygen in surface waters. There is a diurnal variation owing to the photosynthetic action of algae during daylight hours and their respiration at night. Indeed, heavy fish mortalities have arisen from the oxygen demand caused by the decomposition of algae. There is also a variation of oxygen with the depth of water, especially in lakes and stagnant ponds. For this reason, fish may avoid the deeper, cooler waters and be forced to remain in shallow warm areas. Dissolved oxygen concentrations near the bottom muds of lakes and sluggish rivers may approach zero...

"The Aquatic Life Advisory Committee of ORSANCO [Ohio River Valley Water Sanitation Commission] has recommended that the minimum permissible oxygen concentration for a well-rounded warm-water fish population be as follows: The dissolved oxygen content of warm-water fish habitats shall be not less than 5 mg/l during at least 16 hours for any 24-hour period. It may be less than 5 mg/l for a period not to exceed 8 hours within any 24-hour period, but at no time shall the oxygen content be less than 3 mg/l. To sustain a coarse fish population, the dissolved oxygen concentration may be less than 5 mg/l for a period of not more than 8 hours out of any 24-hour period, but at no time shall the concentration be lower than 2 mg/l...

"Oysters show considerable resistance to oxygen deficiencies, according to Mitchell. Only when exposed for more than a week to very low concentrations of dissolved oxygen were oysters killed, and hence a temporary decrease in available oxygen is not considered by Mitchell to be a significant factor to oyster culture...

"Summary. On the basis of the available information described above, it is not feasible to attempt to suggest an optimum dissolved oxygen content of water for domestic, industrial, stock and wildlife, or recreational uses. For fish and other aquatic life, the recommendations of the Aquatic Life Advisory Committee of ORSANCO (as quoted above) appear to be logical."

This summary by experts in the area quoted illustrates the lack of a clear-cut, unchallengeable cutoff in BOD such as is desirable for regulations as widely applicable as those proposed under Section 311. In particular, choice of the type of deleterious effect which is most appropriate for a given purpose is frequently a source of misunderstanding. This problem is discussed in Section C, 2, a and Section D, 4, b below.

b. Significance and Margin of Error in BOD Testing

McKee and Wolf found the ORSANCO recommendations plausible but not irrefutable. There are still other fundamental difficulties concerning the significance and margin of error resulting from conventional BOD analyses. These are illustrated in the following passages from reference 12, Standard Methods for the Examination of Water and Wastewater, 13th ed., p. 489

"... The biochemical oxygen demand (BOD) determination described herein constitutes an empirical test, in which standardized laboratory procedures are used to determine the relative oxygen requirements of wastewaters, effluents and polluted waters. The test has its widest application in measuring waste loadings to treatment plants and in evaluating the efficiency (BOD removal) of such treatment systems. Comparison of BOD values cannot be made unless the results have been obtained under identical test conditions...

"The test is of limited value in measuring the actual oxygen demand of surface waters, and the extrapolation of test results to actual stream oxygen demands is highly questionable, since the laboratory environment does not reproduce stream conditions, particularly as related to temperature, sunlight, biological population, water movement and oxygen concentration...

"Complete stabilization of a given waste may require a period of incubation too long for practical purposes. For this reason, the 5-day period has been accepted as standard. For certain industrial wastes, however, it may be advisable to determine the oxidation curve obtained. Conversion of data from one incubation period to another can only be made if such special studies are carried out. Studies in recent years have shown that the exponential rate of carbonaceous oxidation, k, at 20 C rarely has a value of 0.1, although it may vary from less than one-half to more than twice this value. This fact usually makes it impossible to calculate the ultimate carbonaceous demand, L, of a sample from 5-day BOD values unless the k value has been determined on the sewage, wastewater or stream under consideration. It appears from recent work that the exponential interpretation of BOD rate curves is a gross oversimplification; the analyst should not be surprised if a good exponential fit is not obtained...

"There is no standard against which the accuracy of the BOD test can be measured. To obtain precision data, a glucose-glutamic acid mixture was analyzed by 34 laboratories, with each laboratory using its own seed material (settled stale sewage). The geometric mean of all results was 184 mg/l and the standard deviation of that mean was ± 31 mg/l (17%). The precision obtained by a single analyst in his own laboratory was ± 11 mg/l (5%) at a BOD of 218 mg/l."

Note that even in the case of an artificial standard, which is much better characterized and well-behaved than a real sample, the spread of values obtained from replicate tests is wide. This alone suggests that setting a single cutoff value could open the door to equivocation on enforcement actions, assuming such a criterion would withstand previous judicial review.

Overall, many questions remain unanswered relative to the significance of BOD testing in surface waters and concerning precision and accuracy of standardized BOD tests. Consequently, a selection criterion for designation of hazardous substances based on BOD is not appropriate at this time.

It should be recognized that this view is, in fact, compatible with the dissolved oxygen water quality criteria stated in reference 13, since the latter are aimed at chronic, longer-term situations and also at different levels of effect on aquatic species. The following quote from reference 13, pp. 131-132, illustrates this difference in basic outlook which, quite logically, leads to different answers.

> "...in evaluating criteria, it is not important to know how long an animal can resist death by asphyxiation at low dissolved oxygen concentrations. Instead, data on the oxygen requirements for egg development, for newly hatched larvae, for normal growth and activity, and for completing all stages of the reproductive cycle are pertinent. Upon review of the available research, one fact becomes clear: any reduction of dissolved oxygen can reduce the efficiency of oxygen uptake by aquatic animals and hence reduce their ability to meet the demands of their environment. There is evidently no concentration level or percentage of saturation to which the oxygen content of natural waters can be reduced without causing or risking some adverse effects on the reproduction, growth, and consequently, the production of fishes inhabiting those waters.
>
> Accordingly, no single, arbitrary recommendation can be set for dissolved oxygen concentrations that will be favorable for all kinds of waters, or even one kind of fish in a single kind of water. Any reduction in oxygen may be harmful by affecting fish production and the potential yield of a fishery.
>
> The selection of a level of protection is a socioeconomic decision, not a biological one. Once the level of protection is selected, appropriate scientific recommendations may be derived from the criteria presented in this discussion...."
>
> "...Despite the statements in previous paragraphs that there is no single oxygen concentration which is favorable to all species and ecosystems, it is obvious that there are, nevertheless, very low oxygen concentrations that are unfavorable to almost all aquatic organisms.

Therefore, a floor of 4 mg/l is recommended except in situations where the natural level of dissolved oxygen is less than 4 mg/l in which case no further depression is desirable. The value of 4 mg/l has been selected because there is evidence of subacute or chronic damage to several fish below this concentration...."

In contrast, the mandate of Section 311 is establishment, before the fact, of general standards applying to spills which will protect natural waters from the acute, short-term effects of such spills. What constitutes substantial harm under Section 311, i.e. lethality versus various sublethal effects, was discussed earlier (Section C, 2, a). It was concluded that the effect level most appropriate to spill situations was direct lethality to a substantial fraction of the population of an appropriately sensitive aquatic species.

5. Radioactive Materials

Abnormal levels of radioactivity in water may be deleterous to human health through direct consumption and through consumption of agricultural or aquatic life that has accumulated radioactivity from water. Surface and ground waters vary considerably in radioactive background levels, with the higher levels arising from natural sources generally associated with deep well waters and springs.

Radioactive materials must be dealt with by dilution, with water or stable isotopes, or by storage, since radioactivity cannot be neutralized or cancelled by known chemical or physical methods.

The great number of radioactive isotopes known differ considerably in the danger they represent due to variations in rate of decay and the types of particles or radiation given off. The biological effects of radiation are classified as somatic and genetic. Genetic effects, possibly affecting an individual's decendants, are obviously chronic in nature. Somatic effects may be either chronic or acute. The primary focus of regulations concerning spills of hazardous substances is on acute effects since first, a spill is implicitly an acute event. Second, long-term discharges are dealt with under other sections of the law, as listed in the "applicability" section of proposed 40 CFR 118 and proposed 40 CFR 119.

The effects of acute radiation exposure are reasonably well understood but levels of exposure necessary to produce acute effects (much higher than of concern for typical chronic water pollution control-type purposes) are already regulated by the Nuclear Regulatory Commission.

Extensive discussions were held with the EPA Office of Radiation Programs (ORP) and, through them, the Nuclear Regulatory Commission relative to criteria for discharges of radioactive materials. In addition to the objections to Section 311 regulation of radioactive materials mentioned above, no agreement was reached relative to criteria applicable under generalized environmental conditions such as are implicit in the toxicity selection criteria. The NRC insistence on specific location-dependent decisions as to what constitutes imminent and substantial danger calls for a different approach to notification and response than is appropriate for nationally applicable regulations for spills of other hazardous substances.

Due to the existing public awareness of possible hazards of radioactive material spills and present extensive regulation of their availability, handling and transport it has been decided not to include a selection criterion based on radioactivity at this time.

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CHAPTER V

DETERMINATION OF ACTUAL REMOVABILITY

Section 311 of the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251 et seq.) requires the Environmental Protection Agency to promulgate regulations to control the spill-discharge of chemicals. Section 311(b)(2)(B)(i) states:

> "The Administrator shall include in any designation under subparagraph (A) of the subsection a determination whether any such designated hazardous substance can actually be removed."

A variety of circumstances can influence the physical removability of a substance from the water in any particular situation. Removal could theoretically be possible if notification is prompt, if the weather is calm enough to allow filtering, or if the spill can be contained by a dike. However, the same substances spilled under different circumstances or in different quantities could be removed only partially or not at all.

The economic incentive for spill prevention found in the Act is based upon removal liabilities, thus implying that oil or oil-like substances are actually removable. Most substances proposed for designation do not have properties like crude oil, i.e. they do not form a dense mass on the surface enabling physical removal under certain conditions. Those few which do bear a limited resemblance to oils are generally handled in a manner similar to gasoline (defined as oil for the purposes of Section 311, in accord with the oil vs. non-oil discussion of Chapter IV). It is generally recognized that gasoline is difficult to remove, i.e., may not be actually removable in many situations. Due to the danger of fire or explosion, it is frequently considered better to allow such materials to evaporate or otherwise dissipate rather than bring in spark-producing equipment (such as pump motors).

Oil spills are primarily a surface phenomenon. Except for a small amount of initial dissolution or emulsification in the water column, oil generally floats. The visibility and floatation properties of oils facilitate detection as well as its actual removal after a spill. In contrast, the majority of designated substances, other than oils, do not have physical or chemical qualities which facilitate detection or advance determination concerning removability vs. nonremovability. The solubility of many of the inorganic salts on the designation list precludes maintanence of a discrete surface mass when they are spilled, as would be the case for oil.

Although oil has certain toxic effects on aquatic life, localization of oil to the surface tends to restrict the extent of its harmful effects. Its coating action, as on waterfowl feathers, fish gills, and beaches constitutes a large proportion of its deleterious effect. The higher solubility of a considerable number of the materials listed in proposed 40 CFR Part 116 means that their effect is not confined to coating.

The legislative requirement for advance determination of actual removability to be made as a part of designation, in essence, restricts the technical basis for the removability determination to data on physical or chemical properties of the substance. The properties which are indicative of the behavior of a substance in an aqueous system include solubility, specific gravity, viscosity, surface tension, hydrolytic reactions, ability to form colloids, melting point, boiling point, and vapor pressure.

The need for a determination in advance, precluding field investigations, also limits the decision alternatives to "yes" or "no", rather than to degrees of removability. A decision matrix was constructed to insure systematic consideration of available data on physical and chemical properties (Figure V-A). The terms used are discussed in the Legend to Figure V-A, which follows. The terms and matrix are constructed so as to be compatible with the final decision that oils are actually removabe (included in the text of Section 311).

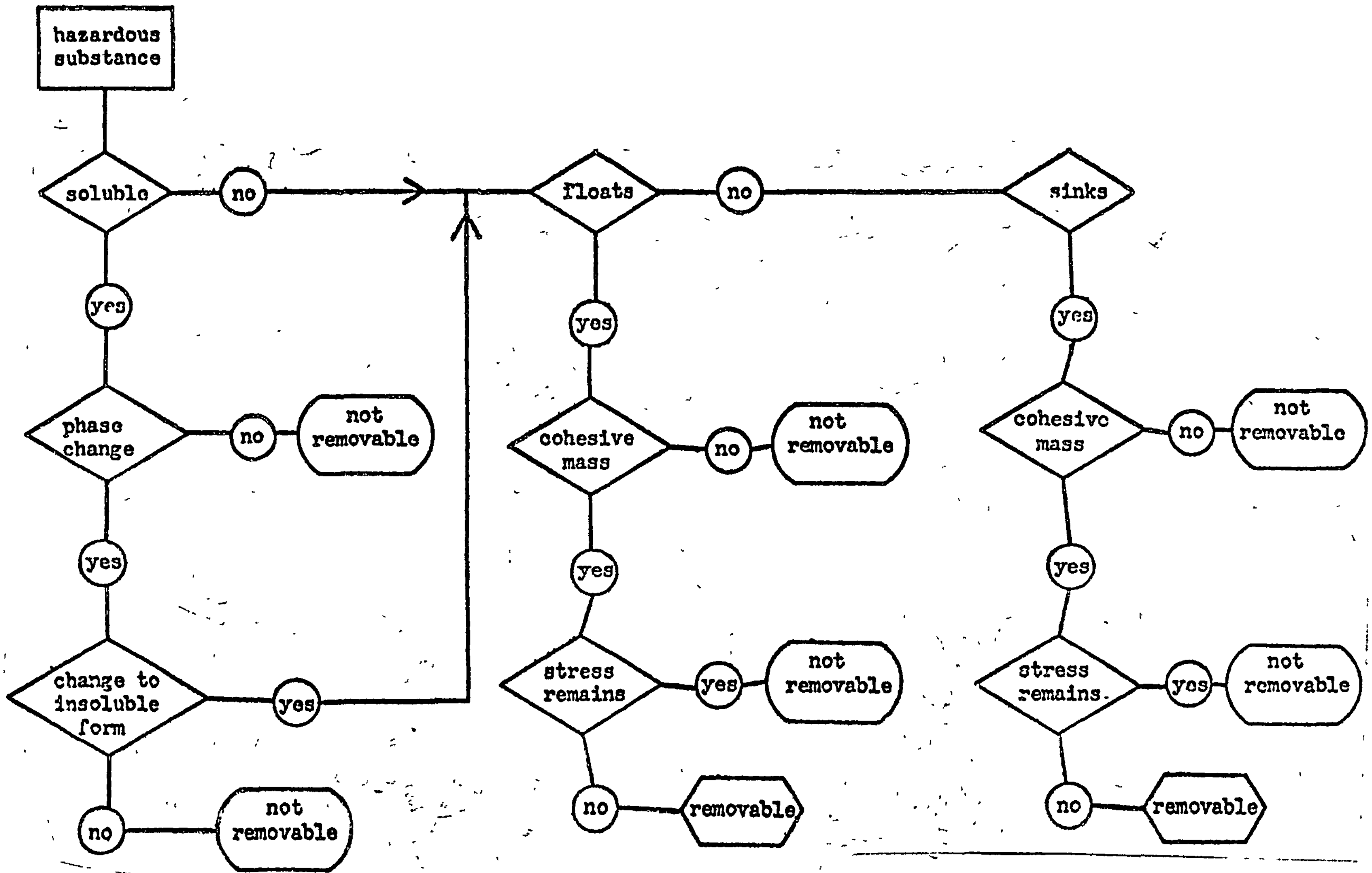

Figure V-A

REMOVABILITY DETERMINATION MATRIX

LEGEND TO FIGURE V-A

Solubility

To be considered as an insoluble substance, the material must be no more soluble than crude oil. Although crude oils vary greatly in their solubility, and initial decision value of 1,000 mg/l may be assigned. The solubility decision point thus screens out many salts as well as polar organic compounds. Solubility data are generally quite abundant.

Phase Change

This consideration is designed to permit evaluation of materials which are initially solubilized, but react to form insoluble derivatives. Those substances which do so are further considered. Data utilized in the decision are hydrolysis reactions and concentrations of other ionic species in natural waters.

Floats

Insoluble materials are next examined for specific gravity (density). Materials which are less dense than water (sp. gr. = 1.0) are considered to be floaters and oil-like in their behavior if they have a specific gravity of less than 1.0. Specific gravity data are generally available.

Cohesive Mass

Floating materials can spread over the surface of the water at different thicknesses. Controling physical properties appear to be viscosity and interfacial surface tension with the water. Unfortunately, viscosity data are limited and interfacial surface tension data even more rare. Some representatives viscosity values are shown in Table V-1.

TABLE V-1

Physical Properties of Removability

Chemical	Viscosity (in centipoise)	Temperature (degrees C.)
Benzene	0.65	20
Ethylbenzene	0.70	17
Cyclohexane	1.02	17
Carbon disulfide	0.36	-
Carbon Tetrachloride	0.739	40
Dichlorobenzene	1.2	-
Diamylamine	0.6	-
Xylene	0.7	20

Although some interfacial surface tension values were found for pure compounds, no comparative value could be found for crude oil. In addition, the degree of influence of the surface tension in determining the cohesiveness and removability of a surface film is, as yet, indeterminant. The tabulated values can be compared to the viscosity of light South Louisiana crude oil which has been reported as 3.84 - 4.32 centipoise at 40 degrees Centigrade. Thus, the spreading rates of all example substances appear to be 3.7 to 7.0 times that of the light crude oil.

Sinks

Sinking materials are described by a specific gravity value greater than 1.0. The evaluation of "cohesive mass" in the case of sinking materials is subject to the same arguments and data limitations as found in the preceeding paragraph.

Stress Remains

Another intrinsic property of each substance which must be considered in determining actual removability is aquatic toxicity. This property must be evaluated in the final decision because no removal technique will be 100% effective in recovering a discharge material. Less than complete removal of highly toxic or bioaccumulative substances will result in continuing, residual stress on the aquatic environment. Although removal actions would be of definite value in reducing the impact, a determination that such substances are "actually removable" would be inappropriate.

The local conditions surrounding a particular discharge are of considerable importance to removability determination. However, due to the need for a decision in advance, data relating to this would have to be replaced by assumptions based on a conceptualized water body, assuming there were enough physical data available to make the key evaluation, that of "cohesive mass" for each substance, as described above. The limited viscosity data suggest, but are too incomplete to prove, that several chemicals sharing some properties with crude oils, such as volatility and low solubility, probably are not nearly as cohesive as most crude oils. This cohesiveness is a prime factor in making most crude oils removable. Since data limitations make a conclusive, final, "cohesive mass" evaluation impossible for most of the designated substances, there is little point in extrapolating another order of magnitude by proposing a series of conceptualized water bodies. In summary, no chemical currently proposed for designation as a hazardous substance is "actually removable" in a clear and unequivocal manner on the basis of currently available physical and chemical data. That is to say, all proposed hazardous substances, other than oil, are deemed nonremovable.

Section 311(b)(2)(B)(iii) provides two penalty catagories for spills of nonremovable hazardous substances:

> "... the owner or operator of any vessel, onshore facility, or offshore facility, from which there is discharged any hazardous substance determined not removable under clause (i) of this subparagraph shall be liable, subject to the defenses to liability provided in subsection (f) of this section, to the United States for either one or the other of the following penalties, the determination which shall be in the discretion of the Administrator:
>
> "aa) a penalty in such amount as the Administrator shall establish, based on the toxicity, degradability, an dispersal characteristics of the substance, but not less than $500 nor more than $5,000; or
>
> " bb) a penalty determined by the number of units discharged multiplied by the amount established for such unit under clause (iv) of this subparagraph, but such penalty shall not be more than $5,000,000 in the case of a discharge from a vessel and $500,000 in the case of a discharge from an onshore or offshore facility."

The determination that all designated substances are nonremovable gives the Administrator full latitude in assessing lower penalties where spills occur in spite of the exercise of adequate caution and prevention procedures. Conscientious post-spill mitigation efforts could also be considered in arriving at penalty reduction. On the other hand, maximum penalties can be assessed if proper precautionary steps are not taken. These assessments will be made in those incidents where the Administrator can show gross negligence on the part of the discharger.

CHAPTER VI

DETERMINATION OF HARMFUL QUANTITY AND RATES OF PENALTY

A. General Considerations

Pollution resulting from the spillage of oil and hazardous materials has emerged as a major national problem. Estimates have been made that 15,000 such spills occur annually in the navigable waters of the United States, of which more than 3,000 involve non-oil materials[1]. These spills range in size from small quantities to millions of gallons and threaten many important waterways. Due to the present lack of compulsory spill reporting, the full magnitude of the problem of hazardous substance spills is not known, as was discussed in Chapter I.

Congress enacted Section 311 of the Federal Water Pollution Control Act Amendments of 1972 in an attempt to remedy this situation. Specifically, Section 311(b)(2)(B)(iv) provides for establishment of rates of penalty per "... unit of measurement based on the usual trade practice..." for spills of nonremovable hazardous substances, and Section 311(b)(4) requires determination of a quantity of hazardous substance which "... may be harmful to the public health or welfare...". [(Spills of a "harmful quantity" or more must be reported to the U.S. Coast Guard to avoid criminal penalties under Section 311(b)(5)).] Each of these subsections of the Act represents an attempt to reach the goal of better spill prevention measures, the primary defense against damage resulting from hazardous substance spills[2]. The two regulations and their basis are discussed together because of their interdependence.

Two prerequisite regulations have been published in the Federal Register[3] as Advanced Notices of Proposed Rulemaking. These deal with the designation of hazardous materials and the tentative determination of their actual removability.

The Agency undertook development of at least four different approaches which could be used to derive harmful quantities and rates of penalty. This effort was initially undertaken by EPA staff and later supplemented by a contract study. The outcome of this program will be reported following a discussion of the major issues.

Close examination of Sections 311(b)(2)(B)(iv), 311(b)(4) and related subsections reveals two major areas of concern in fulfilling legislative mandates. These areas are, (1) determination of "... a unit of measurement based upon the usual trade practice..." and (2), a priori determination of harm defined in the law as "... those quantities of oil and any hazardous substance the discharge of which, at such times, locations, circumstances and conditions, will be harmful to the public health or welfare of the United States, including but not limited to, shellfish, wildlife, and public and private property, shorelines and beaches...". A more manageable problem, also discussed in more detail below, involves how to deal with mixtures and solutions of designated hazardous substances.

An integral part of the penalty structure outlined in Section 311 is the designation of a unit of measurement. Rates of penalty are then bounded in the range of $100-§1,000 per unit of measurement. On the surface, this framework simplifies the task of selecting a unit of measurement common to each hazardous substance. However, for the vast majority of hazardous substances there is no common unit of measurement. The Agency had discussed this with the American Pharmaceutical Institute and the Manufacturing Chemists Association who generally concur. Materials are shipped in a variety of containers which span a wide range of sizes. Also, plant operators may construct reactors, storage tanks and other vessels of any desired size.

A unit of measurement for transportation related spill sources derived from the average shipment size and annual shipping patterns would be subject to fluctuation with changing markets. More importantly, for many substances bulk shipments represent most of the total volume shipped. Many bulk shipments including bulk vessel sizes, are regulated by the Department of Transportation. Consequently, DOT regulation and policy changes could abruptly alter the size of a statistically derived unit of measurement and thus the rate of penalty. (A case in point is the recent shift from small package shipments of parathion to the granting of an exemption permitting tank truck shipment.) It can be said with some certainty that unlike oil (where the 42 gal barrel is a unit common to the trade, i.e. oil industry) hazardous substances do not lend themselves to this type of quantification.

Due to these conceptual difficulties, a different approach was adopted concerning common features of hazardous substances. In essence, their common feature is the capacity to cause environmental damage. The minimum quantity of each substance causing substantial harm is thus a common unit and the "harmful quantity" determined for each has been defined as its unit of measurement. That unit would be common to any trade involved in the production, distribution or use of the substance which has a spill or must design and operate a program to protect the environment from spills of those quantities.

The amount of harm resulting from discharging any pollutant into water is dependent upon the concentration of pollutant in the receiving water and on the physical, chemical and biological characteristics of the water prior to the spill. A priori determination of "harmful quantities" as mandated by Section 311(b)(4) requires probabilistic evaluation of damage or harm to representative water bodies. This was done for oil in 40 CFR Part 110. That regulation is unique for oil and takes advantage of receiving water standards as well as oil's physical characteristics. There simply is no clear scientifically defensible threshold such that spillage of more than a given amount of a hazardous substance constitutes harm at all times and locations while lesser amounts of the contaminant are totally harmless at all times and locations.

For purposes of the work reported here and in the proposed regulations based on this work, the concentration where harm is considered probable and substantial is taken as that concentration causing death of 50% of a population of an aquatic species of median sensitivity within

96 hours (96 hr LC50). The considerations leading to this choice are outlined in Section B below and discussed in detail in reference 4.

Section 311 is very specific in its instruction to designate elements and compounds as hazardous substances. This has led to the development of methods for defining harmful quantities based on pure compound characteristics. The presence of additional materials in a mixture may affect toxicity through synergism, antagonism, addition or other interactive mechanisms. For these mixtures individual bioassays would be required to specify meaningful toxic levels. Such an approach is obviously not practicable since it is not feasible to designate harmful quantities for all conceivable mixtures. Consequently, the approach proposed for dealing with spills of mixtures or solutions is to assume that damages are additive based on the rates for individual constituents. For a mixture or solution of substance X, substance Y and substance Z, etc., the weight of substance X spilled is divided by the harmful quantity of pure substance X, the weight of substance Y spilled is divided by the harmful quantity of pure substance Y, and so forth. Next the fractions derived in this fashion are added. If the total equals or exceeds one, then the harmful quantity of the mixture or solution has been equaled or exceeded in the spill.

The methods set forth in this document and the proposed regulations based on them are intended to deal with spill conditions in a way that leads to encouraging notification of hazardous substance spills and facilitating equitable enforcement. These intermediate goals are intended to lead to the overall program goal of spill prevention.

Several technical alternatives were developed and considered for defining harmful quantities and establishing penalty rates. In each alternative, substances were characterized toxicologically, primarily on the basis of selected bioassay data representative of the hazard posed by the substance when spilled into the aquatic environment, e.g. 96 hour LC50.

Using the bioassay data as a starting point, four individual methodologies were completed or developed under EPA contract #68-01-2268. The final report is listed as reference 4. Each methodology has three identifiable segments: (1) a mechanism for deriving harmful quantities, (2) a rationale for the base rate of penalty, and (3) a scaling function to vary rates of penalty on the basis of the chemical and physical (hence dispersal) properties of individual materials. Also, each method has been designed in modular fashion to allow the formation of hybrid combinations from preferred segments. Each of the four basic methodologies is summarized below. Summaries of two additional hybrid methods synthesized from segments of the basic four then follow. Complete descriptions of the four basic methodologies may be found in reference 4, and the hybrids will be described in detail in a later section.

The first "basic" approach, the Resource Value Methodology, defines substantial harm as $5,000 worth of environmental damage. That is, harm is deemed substantial when water with a recreation and societal value in excess of $5,000 is degraded to levels impairing its value for those uses. The $5,000 value is selected from section 311(b)(6) where that value is used as the upper limit of a civil penalty for having discharged a harmful quantity. Base rates of penalty are set at the value of the damage potentially resulting from a spill of a given material. Penalties are varied on the basis of the probable duration of adverse impacts and the physical-chemical properties which enhance or restrict movement of the material in the environment.

The second approach, the IMCO Methodology, employs the same basic definition of substantial harm and rationale for base rates of penalty as the Resource Value Methodology, but focuses on four groups of hazardous materials rather than the more than three hundred individual materials. Each of the four groups or categories is defined in accordance with the Intergovernmental Maritime Consultative Organization (IMCO) system for noxious substance classification*. Toxicological data representative of each category as a whole is employed to derive harmful quantities for all members of the category. Penalties are varied over one order of magnitude through use of adjustment factors designed to reflect the ability of a material to spread in the environment.

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*"1973 IMCO Conference on Marine Pollution from Ships", hearing before the committee on Commerce, U.S. Senate, serial No. 93-52 November 14, 1973, USGPO.

The third approach offered, the Unit of Measurement Methodology, defines substantial harm for an IMCO grouping of materials indirectly through selection of a unit of measurement which is sufficiently large to be associated with probable harm in the event of a spill. The smallest bulk unit is defined as the harmful quantity for the most toxic IMCO group. Similar quantities are selected for the remaining groups of materials through comparison of their relative toxicities and then rounded to the nearest actual container size. Penalties are varied on the basis of the persistence and physical properties of individual materials.

The final approach, the DOHM Methodology, defines substantial harm by developing an idealized plug-flow stream model and employing a flow rate selected from statistical data on stream flow in the United States. The base rate of penalty is equated to the estimated cost of prevention (the expenditure, per gallon spilled, which would have prevented the spill from occurring). Quantitative operators are employed to vary the rate of penalty by a factor of two as a function of toxicity, degradability, and toxicity-to-solubility ratio.

In one hybrid, referred to as the Resource Value/Unit of Measurement Combination Methodology, the determination of harmful quantity is made in a manner similar to that proposed under the Resource Value Method. However, a substantial harm threshold value of $100 was selected to correspond with the Congressional limits of $100-$1,000 per unit of measurement. This substantially reduces the "harmful quantities" for a given material over those in the contractor reported Resource Value Method. At the same time it is recognized that much larger quantities of a material are needed to raise concentrations of hazardous materials to the critical level in a given body of water because of the dynamics of dispersion. Hence, a "locational factor" derived from a mathematical water body model is applied to adjust the harmful quantity to a more realistic basis than the "instantaneous mixing to the critical concentration" assumption originally employed in the contractor reported Resource Value Method.

A further adjustment is made in the rate of penalty to reflect the duration of harm caused by spillage of a particular hazardous substance and to reflect dispersal properties of a given material based on its physical/chemical properties. These adjustments allow the material with a maximum value from the product of these two factors to be assigned a rate of $1,000/HQ while that with a minimum value is assigned a rate of $100/HQ. The rates for all materials between these two extremes are interpolated linearly.

The method finally chosen for use in harmful quantity and rate of penalty regulations was the second hybrid, an IMCO/Unit of Measurement combination methodology. In general, hazardous materials are profiled and categorized in the same fashion as in the IMCO method described above. The smallest common commercial unit or container size (one pound/454 grams) was then defined as the harmful quantity and unit of measurement for all materials in the most toxic category. Other categories were thereafter assigned harmful quantities on a proportional basis. If the upper aquatic toxicity limit of a category was ten times higher than the preceding category, then the harmful quantity was set as ten times larger, and so forth. The base penalty rate was set as $1,000 per unit of measurement. This penalty rate is reduced by up to one order of magnitude by use of a physical/chemical/dispersal adjustment factor so that the final penalty rates of each catagory fall within the range of $100-$1,000 per unit of measurement in accordance with Section 311(b)(2)(B)(iv) of the Act.

B. Choice of Toxicological Data Base

1. Acute Versus Chronic Toxicity

Acute toxicity data appear most appropriate as a baseline for use in studying the effects of hazardous material spills. Spills are primarily an acute phenomenon and consequently should be represented by acute toxicity relationships. Since 96 hours has been widely accepted in aquatic biological investigations as the threshold of acute exposure times, bioassays whose results are expressed as 96-hour LC50s appear most appropriate for work addressing acute spills. More detailed discussions of acute versus chronic effects are available[4-6].

2. Receptor Species

The selection of a given species for a priority listing of preferred species is necessitated by the variance in sensitivity displayed among species of the same trophic level, genus, or family. Several investigators have found 3-4 fold differences in response between species when tested under identical conditions with the same toxicant. Other data suggest orders of magnitude difference for some substances. The relative order of sensitivity between species also differs with the substance tested.

It has been suggested that due to to their abundance and relative importance, freshwater species should be selected from the following families. Centrachidae (sunfish, bass, crappie); Salmonidae (trout, char, salmon); Cyprinidae (true minnow) excluding carp and goldfish; and Catostomidae (suckers). The obvious choice for any given situation would be the species common to the water body of interest. Unfortunately, there is no species common to all waters of the United States. Consequently, it was determined that a median sensitive species should be employed to be representative of the important species found in different environments throughout the country.

With this in mind, the bioassay data were reviewed to establish a priority list of freshwater species. Input data for critical concentrations can then be selected giving preference to the high priority species. On the basis of this review, Lepomis macrochirus (bluegill sunfish) was selected as the priority freshwater species. These members of the

Centrachidae family typically display a median level of sensitivity. They are widespread throughout the United States and are important both for their recreational fishing value and as a food source for larger, predatory sport fishes. Bluegills are easily kept and reared and therefore are commonly used in laboratory work. Consequently, bioassay data on this species are prevalent. Lower priority species were ranked according to their prevalence in the United States, and the availability of bioassay data. When only limited data were available, acute toxicity levels for other species were accepted.

Fewer options are available when selecting critical concentrations for marine waters. Bioassay data on marine organisms are quite limited. Oysters and other economically important species are given top priority for marine waters. Abundance and importance in estuarine systems are the primary criteria here rather than sensitivity since a lack of data prevents selection of a median sensitive receptor.

3. Other Considerations

It is known that critical concentrations may also change with other parameters such as temperature, pH, dissolved oxygen, and hardness. While investigators often employ different test conditions or do not report test conditions at all, an attempt has been made to select bioassay data obtained under similar conditions to ensure comparability.

The effect of variations in test conditions also differs with the substance of interest. For many industrial organic compounds potential differences arise from variations in temperature, turbidity, and dissolved oxygen content, among other factors. For inorganic materials such as cyanide and ammonia, pH can be especially important. With heavy metals, hardness and organic chelate content become very important in addition to the factors mentioned previously because of the potential precipitation and subsequent removal from solution of the toxic agent.

Because variations in water quality are site specific, a middle ground was necessary to indicate when the potential harm could be substantial for most natural waters. A set of preferences were set up for use whenever multiple data points were available. When data were available on species with similar sensitivity, highest priority was given to test results in waters similar to conditions existing in most natural waters. The pH range favored was 6.5-8.0 while hard water was given priority over soft water. In most cases, no other specifications were necessary since use of the 96-hour TLm for bluegill or fathead minnows severely limited the number of alternative data points.

In summary, median sensitivity species, bluegill and fathead minnow have been selected as representative of important species found in different freshwater environments around the country. Since very little salt water bioassay data are available, data on oysters and other economically important species are favored for marine waters.

It should be noted that the preference for data on median sensitive species, when available, represents a change in emphasis from the criteria used for deciding whether a substance was to be designated as hazardous in proposed 40 CFR Part 116. There the term "... appropriately sensitive ..." species was used so as to enable designation of materials as hazardous if firm toxicological data exist for other species but none happens to be available on bluegill or fathead minnow. Since the effort here is not to select materials but to attempt an evaluation of harm throughout the nation, median sensitive receptor data are preferred in all cases but in its absence bioassay data on other species may be acceptable.

C. Detailed Description of Hybrid Methodologies

1. Resource Value/Unit of Measurement Combination

a. Description of Method

The determination of harmful quantity is made in a manner similar to that proposed under the Resource Value Method. However, a substantial harm threshold value of $100 was selected to fall within the Congressional limits of $100-1000 per unit of measurement. (The substantial harm threshold in the contractor developed Resource Value Method was $5,000). Reduction of the harm threshold therefore substantially reduces the "harmful quantity" for a given material over that in the contractor developed Resource Value Method. This reduction was thought to be desireable by the Agency operating elements to facilitate more rapid and complete notification of spills.

It is recognized that much larger quantities of a material are needed to raise concentrations of spilled hazardous materials to the critical level in a given body of water than are indicated by the worst case assumption of "instantaneous mixing to the critical concentration" because of the dynamics of dispersion in any real water body. For the purpose of penalties and the determination of units of measure based on the harmful quantity it was determined that these quantities should be raised. Hence, a "locational factor" derived from a mathematical water body model is applied to adjust the harmful quantity to a more realistic harm basis[4]. When used in the following equation the locational factor increases harmful quantities in lakes and the coastal zone to approximately four times the base value and increases harmful quantities in rivers and estuaries to approximately twenty times the base value.

By this hybrid method, the harmful quantity is now defined as:

$$HQ = \left\{ \frac{\frac{\$100}{Vwb} \times CC_x}{LOC_{wb}} \right\}$$

where:

HQ = Harmful quantity
Vwb = Value of the water body type of interest
CC_x = Critical concentration of compound x
Loc_{wb} = Locational factor for the water body type

However, since the rate of penalty set by Congress is defined as \$100-1000 per unit of measurement (defined as the harmful quantity in this method), a further adjustment is made in the rate of penalty to reflect the duration of harm caused by spillage of a particular hazardous substance (Anf factor) and to reflect dispersal properties of a given material based on its physical/chemical properties (Disp factor). That is to say, the material with a maximum value for the product of (Anf x Disp) is assigned a rate of \$1000/HQ while that with a minimum value is assigned a rate of \$100/HQ. All points between these extremes are interpolated linearly.

The factors and their products can be characterized as presented below:

	Anf	Disp	p = Anf x Disp
Maximum	.25	1.35	.3375
Minimum	.06	.27	.0162

Thus, if we define,

$$ROP = mp + b$$

Where,

ROP = rate of penalty
m = slope of relation
p = Anf x Disp
b = intercept of relation

Solution of simultaneous equations,

$$1000 = .3375m + b$$
$$100 = .0162m + b$$

reveals that m = 2801 and b = 54.7. This means that the rate of penalty can be described as

$$ROP = 2801 + 54.7$$

(Detailed explanations of the locational factor, annuity factor (Anf) and dispersibility factor (Disp) are found in subsections b, c, and d respectively.)

The two simultaneous linear equations quantify the idea that the more persistent a hazardous substance is in the environment, the longer that material degrades the public domain, and therefore the higher the rate of penalty which should be exacted for a spill. Secondly, the physical/chemical properties of some materials are of a nature which causes more environmental damage per threshold value-worth of water, than do others. These more damaging characteristics thus also warrant a higher rate of penalty, as quantified above. The final results, as shown in Figure VI-A, is a continuous gradation in rate of penalty from $1,000 per harmful quantity for the most damaging and persistent materials to a minimum of $100 per harmful quantity for the least damaging and least persistent.

b. Locational Factor

i. General

The volume of water included with a given isoconcentration surface as a result of a spill of a miscible substance expands to a maximum and then declines as dispersion continues. (In this case the concentration of interest is the "critical concentration" for each specific hazardous substance. However, to avoid repeating detailed calculations on each material, a general scheme involving the ratio of actual to worst case [maximum] volume has been devised.) A model has been developed based on the mathematical techniques of Wnek and Fochtman[7]. This model permits consideration of such water body parameters as current

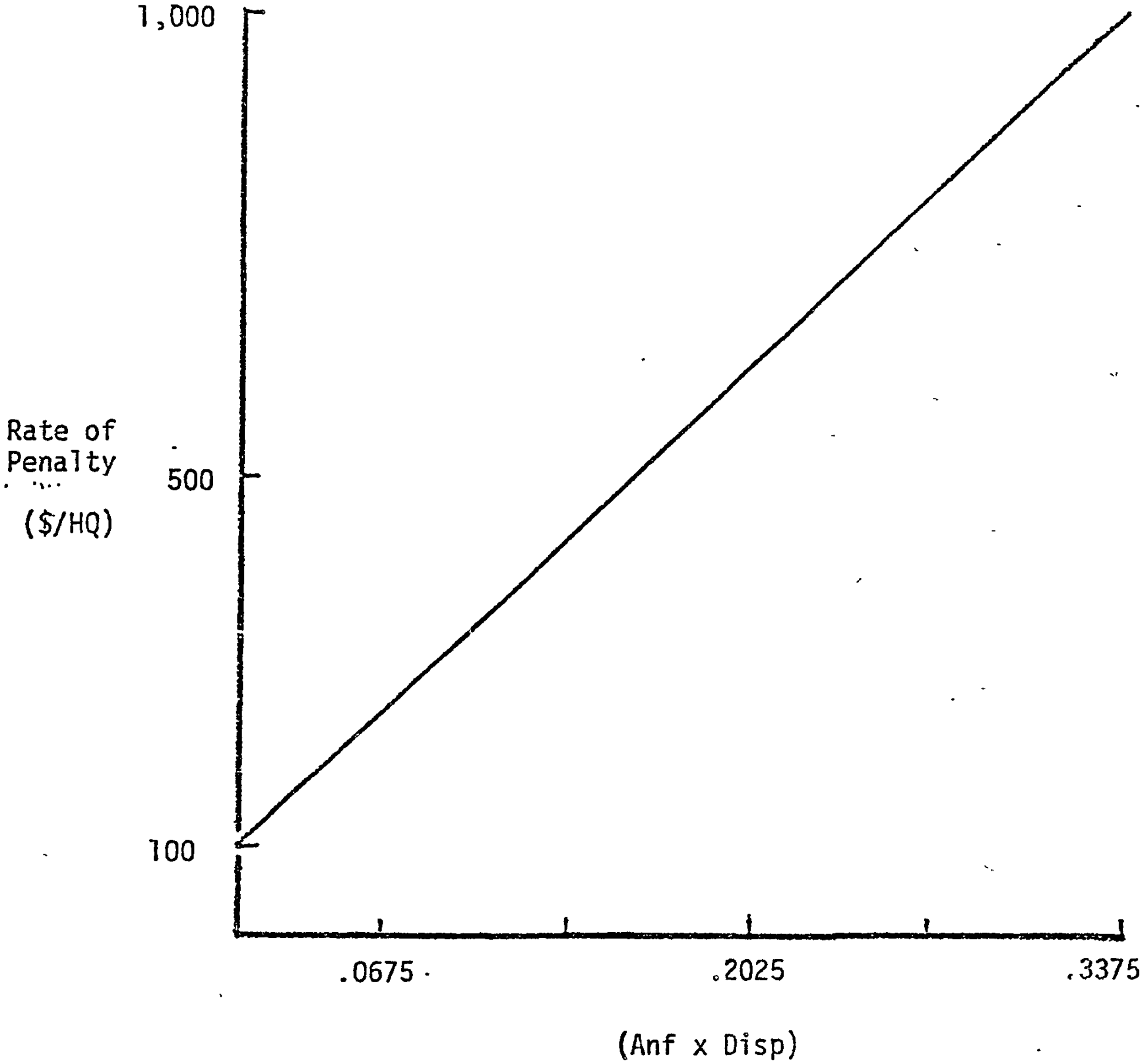

Figure VI-A Rates of Penalty as a Function of Adjustment Factors velocity, depth, angle of bottom slope near shore, non-constant dispersion coefficients, thermobars, and haloclines, as appropriate.

Further details concerning modifications and the results of a large number of computer calculations using this model are tabulated in reference 4. Comments below are directed to interpretation of these results.

Tabulated results from the hydrodynamic models, shown in reference 4 indicate that wide variation in such parameters as pollutant critical concentration, water depth, and angle of descent of the shore lead to relatively small variations in the locational factor for any single water body type. This fact, plus the accuracy to be expected in mathematical modeling and recognition that the geometry of many water bodies is not well characterized, led to the selection of a single locational factor value to represent each type of water body. The values selected are as follows: rivers and estuaries, locational factor (Loc) = 0.36; lakes and coastal zones, Loc = 0.18. The exact basis for each choice will be detailed below.

While the lower limit of aquatic toxicity necessary to qualify a substance for inclusion on the list of hazardous substances is an LC50 less than or equal to 500 ppm, the majority of the materials listed fall in a much lower range (7 materials between 250 and 500 ppm, 20 materials between 250 and 100 ppm). This finding, plus the relative insensitivity of locational factors to concentration mentioned earlier, has led to the choice of the single concentration level of LC50 = 100 ppm for further consideration. (Examples of the degree of approximation involved are seen in the following series of average Loc factors at various concentrations: for lakes with angles of descent of 10 degrees to 45 degrees and depths of 10 to 200 feet, Loc (50 ppm) = 0.143 versus Loc (100 ppm) = 0.180; for the coastal zone with currents of 0.2 to 0.5 knots and depths of 100 to 500 feet, Loc (25 ppm) = 0.162, Loc (50 ppm) = 0.169 and Loc (100 ppm) = 0.176; for rivers, Loc (50 ppm) = 0.0271 versus Loc (100 ppm) = 0.0359.)

ii. Lakes

In arriving at a final single locational factor for lakes, some data from reference 4, Table D-1, p. III-146, was excluded. In particular the 1,000 foot depth column appears unrepresentative. Only at isolated points in Lakes Michigan, Superior, Tahoe, and the like, do freshwater lake depths equal or exceed 1,000 feet. In comparison with the total freshwater volume of the country, such locations represent a far smaller proportion of the total than the 17% of the total data represented by the 1,000 foot depth line in the table. Similarly, the sixty degree angle of decent row in the reference 4 table is not representative of the majority of freshwater lakes and three of six entries are incomplete. Consequently, the 1,000 foot depth also was excluded. The five degree angle of descent row was excluded primarily due to suspicions raised concerning the efficiency of the model at this combination of parameters because the Loc factor is apparently invariant at depths greater than ten feet. Average

Loc (100 ppm) values calculated from the remaining data equal 0.1802, or approximately 0.18.

iii. Coastal Zone

The data of reference 4, Table D-2, p. III-147, a quite reasonable and well-represented range of currents and depths found in the twelve mile zone. Depths within twelve miles of the Pacific coast, the Hawaiian Islands and Alaska appear to justify retention of the 1,000 foot column. All data in Table D-2 of reference 4 were used in calculating an average Loc (100 ppm) = 0.188, or approximately 0.19.

iv. Rivers and Estuaries

Personal communication with the authors of reference 4, revealed that use of the mathematical model of Appendix D, p. III-135 for estuaries, with various amendments, yields results either virtually identical to those of the coastal zone or virtually identical to those for rivers, depending on the choice of parameters for a given computer run. In either case the authors were faced with more unknowns than equations. Consequently, unless a great deal of additional work is to be undertaken, choice between these two extremes must be based on external considerations. Since many of the prime characteristics of estuaries are attributable to flow and definite, channelized currents, the results for rivers were tentatively adopted.

The model and amendments used to represent rivers in Table D-3, p. III-160 of reference 4, result in an overall trend toward lower locational factors with increase in flow rate. The values do not decrease monotonically. The more representative single value, in the absence of further information, would seem to be that obtained by simply averaging Loc (100 ppm) values calculated from all data presented. This average is equal to 0.036. (As a matter of interest, since only the Mississippi and a couple of other rivers exceed a median flow rate of 10,000 cubic feet per second, the average Loc (100 ppm) for the range of flows from 100 to 10,000 cubic feet per second was also calculated and found to equal 0.036.)

v. Conclusion

The most straightforward approach to locational factors appears to be the use of the value, to two significant figures, of Loc = 0.18 for lakes and the coastal zone and Loc = 0.036 for rivers and estuaries.

c. Annuity Factor (Anf)

In many cases spills will devalue a water body for only a finite period of time. Use of an annuity factor alone is intended to give a penalty representing the value (interest) lost to society if the resource were considered an investment yielding six percent interest per year, or, more precisely, an annuity which at six percent per annum over infinite time, equals the present worth of the resource.

Individual potentially hazardous substances were assigned to more general material classifications, as shown in the left-hand column of Table VI-1. The average time span for recovery from a spill of each class of material was then estimated.

TABLE VI-1

IMPACT PERIODS ASSIGNED TO MATERIAL CLASSIFICATIONS IN DERIVING THE Anf FACTOR (PERIODS GIVEN IN YEARS)

Material Classification	Water Body Type Lake	River	Estuary	Coastal
Organic - Degradable	2	1	3	1
Persistent	2	1	4	2
Bioconcentrative	5	3	5	2
Inorganic - Bioconcentrative	5	2	5	2
Nonbioconcentrative	2	1	3	1

No material is credited with an impact duration of less than one year. While acute lethality may be exhibited in hours, repopulation, particularly at higher trophic levels, takes far longer. Similarly, a minimum impact period of three years has been assigned for estuaries where non-mobile shellfish species require the extra time to reach maturity.

Using annuity tables, present worth factors can be associated with the impact periods defined above, at 6%. The "P" factor is then derived by the ratio of the present worth factor for a finite period of years to present the worth factor for 100 years or essentially an infinite period of time (16.7). Further details are found in reference 4, p. II-52.

Annuity factors associated with the selected impact periods are shown in Table VI-2. The impact periods and Anf factors differ in some respects from the values found in the corresponding tables of the BNW draft final contractor report. These alterations reflect reconsideration of the impact periods assigned to certain material categories by personnel of the Hazardous Substances Branch, EPA. The basic differences between the two versions are seen in the "bioconcentrative" and "organic, persistent" categories. In the view of the Agency, certain inactivating mechanisms exist which, in effect, remove a large portion of the substances in the categories mentioned from recirculation in a given ecosystem. Perhaps the leading example of this is the phenomenon of inactivation by adsorption on bottom sediments of a water body.

TABLE VI-2

Impact Periods/Anf Factors

Material Classification	Water Body Type			
	Lake	River	Estuary	Coastal
Organic - Degradable	0.11	0.06	0.16	0.06
Persistent	0.16	0.06	0.21	0.11
Bioconcentrative	0.25	0.16	0.25	0.11
Inorganic - Bioconcentrative	0.25	0.16	0.25	0.11
Nonbioconcentrative	0.11	0.06	0.16	0.06

d. Dispersibility Factor (Disp)

The second adjustment factor, Disp, must consider physical/chemical properties of the material such as specific gravity, solubility, and volatility, as well as the resources which could be damaged in a given type of water body. In order to assign factors the materials were classified based on their predicted response to spillage in water. A panel of scientists and experiences field operators was then asked to assign factors for spillage of each classification of material into each type of water body. The inquiry procedure is given in reference 4. Miscible substances were identified with a Disp of 1.0 to act as the base comparator for the four water types. Other classifications were then rated on the basis of their tendency to spread more or less than a miscible substance and to affect the most critical sector of the host environment.

For the purpose of the classification process, the definitions given in Table VI-3 were used.

TABLE VI-3

Dispersibility Factor Class Definition

miscible - liquid substances which can freely mix with water in any proportion

mixer - solid substances which have a solubility greater than 1,000 grams of solute per 1,000 grams of water

precipitators - salts which dissociate or hydrolyze in water with subsequent precipitation of a toxic ion

insoluble volatile floaters - materials lighter than water with a vapor pressure greater than 10 mm Hg and a solubility of less than 1,000 ppm or materials with solubility less than 10,000 ppm and vapor pressure greater than 100 mm Hg

insoluble nonvolatile floaters - materials lighter than water with a vapor pressure less than 10 mm Hg and solubility less than 1,000 ppm (solubility of less than 1 gram of solute per 1,000 grams of solution)

soluble floaters - materials lighter than water and of a solubility greater than 1,000 ppm (solubility greater than i gram of solute per 1,000 grams of solution) soluble sinkers - materials heavier than water and of a solubility greater than 1,000 ppm (solubility greater than 1 gram of solute per 1,000 grams of solution)

insoluble sinkers - materials heavier than water and of a solubility less than 1,000 ppm (solubility less than 1 gram of solute per 1,000 grams of solution)

The results of the panel's independent scoring are tabulated in Table VI-4.

TABLE VI-4

RELATIVE "Disp" FACTORS FOR VARIOUS WATER BODY TYPES

	Water Body Types			
	Lake	River	Estuary	Coastal
Miscible	1.0	1.0	1.0	1.0
Mixer	0.84	0.80	0.84	0.78
Precipitator	0.73	0.71	1.3	0.55
Insoluble Volatile Floater	0.31	0.31	0.27	0.35
Insoluble Nonvolatile Floater	0.74	0.62	0 60	0 94
Insoluble Floater	0.86	0.86	0.82	0.86
Insoluble Sinker	0.59	0.58	1.35	0.43
Soluble Sinker	0.83	0.85	1.05	0.59

Several specific interpretations arise from Table VI-4. In general, miscible substances were felt to have the maximum potential for spreading in the vulnerable parts of the environment. The three exceptions were sinking and precipating materials in estuaries where shellfish are a major factor in the value of the resource. Floating substances received somewhat higher ratings than sinkers in coastal waters because of the surface transport processes which would bring spills into the beach and estuarine zone.

e. Specific Example of Method

Consider the case of a spill of 2,000 pounds of aniline into a river. The data necessary to calculate the harmful quantity of this material under these circumstances is listed below.

$CC = 11$ ppm (= 11 milligrams per liter)

$V_{wb} = \$200$ per acre-foot

$Loc_{wb} = 0.036$

$$HQ = \frac{\frac{\$100}{\$200/\text{acre-ft}} \times 11\ \text{mg/l} \times Z}{0.036}$$

where Z is a units conversion factor,

$$Z = (1233\ \text{cu. meters/acre-ft})(10\ \text{liters/cu. meter}) \times (10^{-6}\ \text{kilograms/milligram})$$

$HQ = 19$ kilograms (42 pounds)

Since aniline is a nonpersistent organic compound, its Anf factor = 0.06 and Disp factor = 0.85. The product, "p", then equals 0.051. This value is then inserted into the following equation:

$$\text{ROP (per HQ)} = [2801p + 54.7] = \$198$$

$$\text{or, ROP (per lb)} + [\$198/42\ \text{lb}] = \$4.70$$

The final penalty for the spill would then be 2,000 x \$4.70 = \$9400.

f. Strengths and Weaknesses of Method

A particularly attractive feature of this method is the graduation of rates of penalty throughout the range of $100 to $1000 per harmful quantity. Also, this method gives more explicit consideration to the combination of hazardus substance persistence in the environment and dispersibility based on physical/chemical characteristics versus dispersion based on mixing properties of a given type of water body.

The method shares the problem of a questionable data base concerning the value of water with all other methods drawing on the Resource Value Method. Another possible ground for objection is the potential difficulty in explaining to the nongraphically or nonmathematicallly oriented the carefully designed, quantitative scheme for spreading rates of penalty throughout the range mandated by Congress. Finally, some question arises as to whether the data base (value of water, correction factors) justifies the relative sophistication of the method used to spread the rates of penalty.

g. Basis for Rejection of Method

The prime difficulty with the method and reason for its rejection is the reliance on water value data carried over from the Resource Value Method.

2. IMCO/Unit of Measurement Combination Method

a. Description of Method

The IMCO/UM Combination Method has been chosen for determination of harmful quantities and rates of penalty and therefore, was explained in considerable detail in the notice of proposed rulemaking published in the Federal Register which this technical document supports (proposed 40 CFR Parts 116 through 119). However, additional details are useful concerning derivation of the P/C/D (physical/chemical/dispersal) adjustment factor. Also, in the interests of clarity, modifications made in the basic IMCO system are recounted below:

i. Since the basic IMCO system (done in 1971) is designed more for a marine environment than fresh water, hazardous materials already categorized must be reexamined in terms of fresh and salt water hazard potential and the latest available data.

ii. Materials not previously considered by IMCO must be categorized.

iii. Small modifications must be made to further clarify "additional factors in the hazard profile" and to descretely handle multiple hazards. To this end, the guidelines for catergorization have been modified to read as found in Table VI-5.

TABLE VI-5

EPA GUIDELINES FOR CATEGORIZING HAZARDOUS SUBSTANCES*

Category A includes substances which are:

a. bioaccumulated and liable to produce a hazard to aquatic life or human health (Rating +), or

b. highly toxic to aquatic life (Rating 4), or

c. moderately toxic to aquatic life (Rating 3) and also liable to produce tainting of sea food (Rating T), or

d. bioaccumulated with a short retention of the order of one week or less (Rating Z) while also being moderately toxic to aquatic life (Rating 3) and causing severe reduction of amenities (Rating XXX).

Category B includes substances which are:

a. bioaccumulated with a short retention of the order of one week or less (Rating Z), or

b. liable to produce tainting of sea food (Rating T), or

c. moderately toxic to aquatic life (Rating 3).

Category C includes substances which:

a. are practically nontoxic to aquatic life (Rating 1), or

b. are highly hazardous to human health (oral intake), (Rating 4), or

c. cause deposits blanketing the seafloor with a high biochemical oxygen demand (Rating BOD) and produce moderate reduction of amenities, or

d. are moderately hazardous to human health (oral intake), (Rating 3), and also cause a slight reduction of amenities (Rating X).

*The terms used in the categorization are completely defined in context in reference 4 and in the Senate-Commerce Committee Hearing Report Serial No. 93-52, November 1973.

iv. The final necessary modification arises due to the concept of harmful quantity of Section 311(b)(4) which is not found in the basic IMCO system. A mechanism must be devised for deriving a consistent set of harmful quantities based on quantitative differentiation between categories. To this end, aquatic toxicity (96-hr. LC50) was selected since it is the only criterion common to all categories in the the basic IMCO system and is the only one which permits a quantitative comparison of categories. Otherwise, subjective evaluation between different hazard potentials becomes necessary (e.g. bioaccumulation vs. reduction of amenities).

The smallest container normally used in common commerce for a typical category A material, say an inorganic cyanide, is a one pound (454 gram) bottle. Consequently, this amount has been chosen as the "harmful quantity" of all category A materials. Other categories are thereafter assigned harmful quantities on a proportional basis (Table VI-6). Basically, if the upper aquatic toxicity limit of a category is ten times higher than the preceding category, then the harmful quantity is set as ten times larger, and so forth.

TABLE VI-6

EPA CATEGORIES FOR HARMFUL QUANTITY (HQ) DETERMINATION

Category	Representative Range	Harmful Quantity lb(kg)
A	LC50* < 1 ppm	1.0 (0.454)
B	1 ppm ≤ LC50 < 10 ppm	10 (4.54)
C	10 ppm ≤ LC50 < 100 ppm	100 (45.4)
D**	100 ppm ≤ LC50 ≤ 500 ppm	500 (227)

*LC50 means that concentration of material which is lethal to one-half of the test population of aquatic animals upon continuous exposure for 96 hours or less.

**The basic IMCO criterion for Category D aquatic toxicity is 96 hr. LC50 values of 100-1,000 ppm. The selection criteria for materials considered in this effort eliminated any material with a 96-hr. LC50 in excess of 500 ppm. Thus, the representative toxicity range for Category D materials has been changed to 100-500 ppm.

It is important to note that only those portions of the basic IMCO methodology which relate to hazard profiling and categorization for determination of harmful quantities have been retained. The extensions of the original IMCO system pertaining to differentiation between four types of water bodies, as shown in reference 4, was not retained in the hybrid IMCO/UM approach. Also, the approach in reference 4 made use of a Resource Value Method for finding rates of penalty while the IMCO/UM combination equates the concepts of harmful quantity and unit of measurement for this purpose.

c. Other Modifications to Contractor Report (ref. 4)

In addition to the changes made in the basic IMCO system as mentioned in the preceeding section, it will be found that certain differences exist between the IMCO categories assigned to some materials in reference 4 and those appearing in the proposed regulations. Although the report served as a basis for the derivation of EPA categories, the data base for each material was reexamined by the Agency prior to establishing the regulatory categories. The reasons for variations between the two categorization operations are as follows.

i. Certain unpublished data were made available directly to the contractor and where these data differed from published data to the degree that a category variation was indicated, the Agency preferred to use the published information. Those substances are:

Allyl alcohol
Allyl chloride
Calcium dodecylbenzenesulfonate
Isopropanolamine dodecylbenzenesulfonate
Sodium dodecylbenzenesulfonate
Triethanolamine dodecylbenzenesulfonate

ii. According to the IMCO guidelines for categorization, materials which are known to bioaccumulate and create a hazard to humans or aquatic life are placed in Category A. The contract report reflects the determination that salts of arsenic, lead, and selenium were bioaccumulative materials. However, examination of information does not support the finding that these substances have been known to affect either man or aquatic life by reason of bioaccumulation processes through the aquatic ecosystem. Harmful quantities and penalty rate categories for these were therefore established on the basis of aquatic toxicity.

iii. In some cases, the available data base supported different categories for fresh and salt water based on bioassays with species from both. Because the proposed rules do not differentiate between the two, it was necessary to select one category. In these cases the agency selected a category based on an evaluation of the relative soundness or preponderance of data. Those substances are:

dichlobenil
diquat
Hydrochloric acid
Hydrofluoric acid
Methyl parathion
Phosgene
Phosphorous oxychloride
Phosphorous trichloride
Fluoride salts
2,4,5-T acid

iv. Four substances were apparently categorized incorrectly in the contract report. Based on the same data, the following materials were placed in alternate categories.

Butyric acid
Monoethylamine
Monomethylamine
Naphthalene

v. Because the categorization process requires that a single data point be used to indicate the degree of aquatic toxicity, it was sometimes necessary to select one of several available bioassay studies. In these cases, agency categories reflect a preference for one particular study over that chosen by the contractor. In general, EPA categories reflect a preference for turbid or hard water condition bioassays over the test species preference used by the contractor. Substance recategorized on this basis are:

Ammonia and Ammonia salts
Chromium salts
Sodium hydrosulfide
Strychnine
Sulfur monochloride
2,4,5-T esters
Tetraethylpyrophosphate
Trichlorofon

c. <u>Approach for Determination of Rates of Penalty</u>

Section 311(b)(2)(B)(iv) of the Act requires the Administrator to establish "a unit of measurement based upon the usual trade practice" for each designated substance. A rate of penalty is then to be established for each such unit of measurement in order to compute civil penalties under Section 311(b)(2)(B)(iii)(bb) of the Act. Agency study and discussions with industry have not revealed such units common to trade practice. A common unit of measurement for the manufacturer is frequently different from that of the user of the same material. The price of many chemicals is also based upon the quantity purchased, resulting for instance, in differing costs per pound for one pound versus ton lots.

Transporters of chemicals frequently employ units different from those of either manufacturer or user. Such units also vary depending upon the mode of transport employed. Waterborne commerce frequently utilizes tons while highway and rail carriers use 1,000 pound units, tons, or gallons. As a consequence, the Agency proposes that the units employed be multiples of simple mass units (kilograms and pounds). Also, in the absence of any common units of measurement, the smallest normally used common commercial unit of one pound (0.454 kg) is adopted as the "unit of measurement for materials in the most toxic EPA category and is assigned a base penalty rate of $1,000 per unit. Other EPA categories are assigned a larger unit of measurement found as a direct proportion between the upper aquatic toxicity limit of the less toxic category and the upper aquatic toxicity limit of category A substances. The aquatic toxicity ranges for various hazard categories and the units of measurement derived from the appropriate rates are found in Table VI-7.

TABLE VI-7

U NITS OF MEASUREMENT (UM) AND BASE RATES OF PENALTY

EPA Category	UM = HQ lb (kg)	Representative Range	Maximum Rate of Penalty ($/lb)
A	1 (.454)	LC50*$<$1 ppm	1000
B	10 (4.54)	1 ppm $\leq$ LC50 $<$ 10 ppm	100
C	100 (45.4)	10 ppm $\leq$ LC50 $<$ 100 ppm	10
D**	500 (227)	100 ppm $\leq$ LC50 $\leq$ 500 ppm	2

The modified IMCO system provides a "worst case" assessment of the hazards associated with various materials. Consequently, reduction of initial penalty rates by up to one order of magnitude is proposed by use of a physical/chemical/dispersal adjustment factor so that the final rates fall within the legislatively mandated range of $100 to $1,000 per unit of measurement.

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*LC50 means that concentration of material which is lethal to one-half of the test population of aquatic animals upon continuous exposure for 96 hours or less.

**The basic IMCO criterion for Category D aquatic toxicity is 96 hour LC50 values of 100-1000ppm. The selection criteria for materials considered in this study climinated any material with a 96 hour LC50 in excess of 500 ppm. Thus, the representative toxicity range for Category D materials has been changed to 100-500 ppm.

The physical/chemical/dispersal (P/C/D) classification scheme uses the class definitions and ratings proposed in reference 4 for adjustments to rates of penalty under the Resource Value Method rather than a similar version used in that reference by extending the IMCO system. (The latter used different definitions [13 categories instead of 8] and a different panel of experts.)

Since the approach finally adopted in determining harmful quantities of hazardous materials does not distinguish between the four water body types (reference 4, Volume II, Table IV-5, p. 50), the values within each "material classification" were averaged over all four types of water bodies. These averages were then arranged in ascending order by a panel of experts to reflect the relative severity of environmental damage attributed to each category. Finally, the eight categories were assigned decimal factors (0.1 to 1.0) spreading the range specified in Section 311 (b)(2)(B)(iv). Naturally, the most damaging materials are assigned the highest rate of penalty, the next most damaging the second highest rate, and so forth.

TABLE VI-8

PHYSICAL/CHEMICAL/DISPERSAL (P/C/D) ADJUSTMENT FACTORS

Material Classification	P/C/D Category	Rank	P/C/D Factor
Insoluble Volatile Floater	IVF	1	0.10
Insoluble Nonvolatile Floater	INF	2	0.23
Insoluble Sinker	IS	3	0.36
Soluble Mixer	SM	4	0.49
Precipitator	P	5	0.62
Soluble Sinker	SS	6	0.75
Soluble Floater	SF	7	0.88
Miscible	M	8	1.0

Legend:

IVF (insoluble volatile floaters) - materials lighter than water with a vapor pressure greater than 10 mm Hg and a solubility of less than 1,000 ppm or materials with vapor pressure greater than 100 mm Hg and solubility less than 10,000 ppm.

INF (insoluble nonvolatile floaters) - materials lighter than water with a vapor pressure less than 10 mm Hg and solubility less than 1,000 ppm (i.e. solubility of less than 1 gram of solute per 1,000 grams of solution).

IS (insoluble sinker) - materials heavier than water and of solubility less than 1,000 ppm (solubility of less than 1 gram of solute per 1,000 grams of solution).

SM (soluble mixer) - solid substances which have a solubility greater than 1,000 grams of solute per 1,000 grams of water.

P (precipitators) - salts which dissociate or hydrolyze in water with subsequent precipitation of toxic ion.

SS (soluble sinker) - materials heavier than water and of solubility greater than 1,000 ppm (solubility of greater than 1 gram of solute per 100 grams of solution.)

SF (soluble floater) - materials lighter than water and of a solubility greater than 1,000 ppm (solubility of a greater than 1 gram of solute per 1,000 grams of solution).

M (miscible) - liquid substances which can freely mix with water in any proportion.

In summary, the final rates of penalty, in dollars per unit of measurement arising from all possible combinations of toxic category and P/C/D factor are seen in Table VI-9 below.

TABLE VI-9

FINAL RATES OF PENALTY
(in $/Unit of Measurement)

	P/C/D Classes								
EPA Category	IVF	INF	IS	SM	P	SS	SF	M	Unit of Measurement (lb)
A	100	230	360	490	620	750	880	100	1
B	100	230	360	490	620	750	880	100	10
C	100	230	360	490	620	750	880	100	100
D	100	230	360	490	620	750	880	100	500

For convenience, Table VI-10 shows the final rates of penalty, in dollars per pound, for all combinations of toxic category and P/C/D factor.

TABLE VI-10

FINAL RATES OF PENALTY (in $/lb)

EPA Category	P/C/D Classes IVF	INF	IS	SM	P	SS	SF	M
A	100	230	360	490	620	750	880	1000
B	10	23	36	49	62	75	88	100
C	1.0	2.4	3.6	4.9	6.2	7.5	8.8	10
D	.20	.46	.72	.98	1.2	1.5	1.8	2.0

Prevention and mitigation of the effect of spills are the long-term goals of this proposed rule. The harmful effects of spills may be reduced in many cases by such actions as warnings to affected water users, spill containment, spill treatment, appropriate final disposal of debris from a spill or clean-up operation, environmental restoration and monitoring of hazardous substance levels. Details and further suggestions may be found in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 1510). In particular, the "General Pattern of Response Actions" has been specified in 40 CFR Part 1510.53. For those materials considered to be hazardous, disposal will require special precautions in addition to guidelines published as 40 CFR Part 24. Complete documentation of spill response activities and plans for prevention of similar occurrences in the future would be most protective of the long-term interests of both the private sector and the public.

d. <u>Discretionary Choice of Civil Penalty System</u>

Section 311(b)(2)(B)(iii) provides two civil penalty systems to discourage the discharge of non-removable hazardous substances. The decision on which penalty system should be applied was left to the discretion of the Administrator.

Concern has been expressed that the potential economic impact of penalties which might be assessed under Section 311(b)(2)(B)(iii)(bb) could be so great that major transportation modal shifts might occur, along with changes in plant siting. The Agency has no evidence at this time which would suggest that these changes are necessary or desirable. Consultation with the Department of Transportation has suggested that available transportation expertise is being utilized but that remedial civil penalties would enhance the protection of the environment.

It is proposed that the Administrator's discretion in regard to penalties for spills of nonremovable hazardous substances be used to control economic impact while providing strong incentive for mitigation of spill threats to public health or welfare, based upon the following principles:

i. Economic incentive in the form of penalties will motivate additional care for prevention of discharges;

ii. Economic incentives in the form of penalties will motivate additional action to mitigate damages resulting from discharges;

iii. Penalties should be assessed for nonremovable hazardous substances (40 CFR Part 117) discharged in amounts equal to or greater than harmful quantities (40 CFR Part 118);

iv. Penalties should normally be assessed in the range of $500 to $5,000 on an individual discharge incident basis;

v. When assessing civil penalties, the substances' properties as well as the extent of action taken by the discharger to prevent or mitigate damage will be considered;

vi. The higher penalty system as provided in 311(b)(2)(B)(iii)(bb) will be used only when the Agency can show gross negligence on the part of the discharger;

vii. If the (bb) penalty calculates to be less than $5,000 then the (aa) penalty of $500 to $5,000 per discharge will be used;

viii. Case-by-case assessment of the discharger actions provides the most equitable penalty basis while ensuring the greatest motivation for protection of the environment.

e. Examples of Penalty Determination

i. Assume 2,000 lb. of acetic acid is spilled and that in the judgement of the responsible Federal Officer, the discharger displayed gross negligence by refusing to take mitigating actions. Therefore the civil penalty assessed for the spill is determined by the proposed penalty rate multiplied by the number of units discharged. Referring to the accompanying rates of penalty table in Part 119.5, the material is found to be in Category C. In this category, the unit of measurement is 100 pounds. The base rate of penalty is, therefore, \$1,000/100 lbs. Since the P/C/D adjustment factor for acetic acid is 1.0, the final penalty rate is \$1,000/100 lbs or \$10/lb. The final penalty for this spill would be \$10/lb x 2,000 lbs = \$20,000.

ii. Assume 10,000 lb of calcium oxide is spilled, but that in this case the responsible Federal Officer finds the discharger's attempts to mitigate effects of the spill adequate for the conditions present. Consequently, the penalty recommended to be assessed will fall in the range of \$500 to \$5,000 per discharge, based on the factors mentioned previously. (By way of contrast, the penalty which <u>might</u> have been assessed in case of inadequate response or mitigation by the discharger is calculated as follows. Referring to the table of Part 119.5 one finds the material belongs to Category D with a P C/D factor of 0.49. The base rate of penalty is \$1,000/UM or \$2/lb. The adjusted rate of penalty would have been 0.49 x \$2/lb = \$0.98/lb and the final penalty would have been \$0.98/lb x 10,000 lb = \$9,800.)

iii. Assume 500 lb of a solution containing 50% by weight sodium hydroxide and 50% by weight water is spilled. Further, assume that the Administrator determines that gross negligence was the cause of the spill. Only half of the total poundage spilled is a designated hazardous substance. Effectively, 250 lb have been spilled. Sodium hydroxide is a member of Category C (UM= HQ = 100 lb). The P C/D class of the material is "SS", for which the adjustment factor is 0.75. Therefore, the rate of penalty is 0.75 x $1,000/UM = $750/UM or 0.75 x $10/lb = $7.50/lb and the penalty would equal $7.50/lb x 250 lb = $1,875. However, for those spills in quantities leading to a total penalty of less than $5,000 under the penalty rate scheme of 311(b)(2)(B)(iii)(bb), the Administrator will assess a penalty in the range of $500 to $5,000 per spill event according to the guidelines given earlier.

f. Strengths and Weaknesses of the Method

The method outlined above is considered the most satisfactory alternative among the six considered. Principally, it does not rely on the inadequate data base presently available for the valuation of water used in the general Resource Value Method penalty rate determination. The IMCO/UM combination method does possess the virtue of being compatible with an international convention. Also, this method satisfies the penalty rate requirements of Section 311(b)(2)(B)(iv). Finally, while certain assumptions are required, e.g., HQ = UM and that one pound of a category A material is capable of substantial harm to the environment, these assumptions are clearly delined and the number of assumptions is minimized. Thereafter, the structure of the method is internally consistent and rational. On presentation of convincing evidence, the underlying assumptions could be altered without overturning the entire structure.

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CHAPTER VII

ECONOMIC IMPACT OF HAZARDOUS SUBSTANCE REGULATIONS

A. Introduction

The Assistant Administrator for Planning and Management, in a memorandum dated February 24, 1975, outlined the requirements for inflationary impact statements in accordance with Executive Order 11821 and OMB Circular No. A-107. This chapter presents an analysis of the expected areas of economic impact and quantitates as much as possible, the magnitude of costs associated with the proposed hazardous substance regulations. The data on which this analysis is based are the best currently available. The hazardous substance regulations involve:

1. Designation of Hazardous Substances
2. Determination of Actual Removability
3. Establishment of Harmful Quantities
4. Determination of Rates of Penalty.

There appear to be three areas of cost impact; one of which is directly associated with the regulations and two of which are indirect and incremental increases over current expenditures. The direct costs are civil penalties to be assessed by the EPA and Coast Guard. The indirect and incremental costs are those associated with spill prevention and increased spill response, clean-up, and damage mitigation. These latter cost impact areas may be more appropriately considered in detail as they relate to removal and prevention regulations to be published separately from the regulations noted above. However, the promulgation of the subject regulations does create incentive for potential dischargers to expend funds in these areas and also increases the

the need to promulgate hazardous substance spill prevention guidelines. (Prevention regulations have been promulgated for oil as 40 CFR Part 112 to control non-transportation related facilities). Only the incentives of spill prevention costs are considered in this document, rather than the actual cost impact of that future regulation.

These indirect impact areas will be approached as an incremental cost increases over existing industry expenditures. Because the current level of expenditure in these areas cannot be isolated in any given industry, it is impossible to identify incremental cost of these impact areas across the total regulated industry. The analysis, therefore, assumes what could be called a "worst case" situation and estimates reasonable maximal values for the cost of spill response and prevention with current levels of expenditure only qualitatively factored into the estimate.

The number of spills occurring annually is basic to the derivation of cost estimates. Data relative to hazardous substances spillage are limited because there is no required reporting of discharges until such time that the substances are designated and their harmful quantities are established. The data base used here spans two and one half years of spill records which were voluntarily reported or fortuitously discovered. This may be inconsistent with spill reports as noted in Chapter I. However, to get a relative assessment of the cost factors involved, the analysis on this data base is thought to be sufficient. During this period, 174 incidents involving entry of a proposed hazardous substances into a surface water body in excess of the proposed harmful quantity were recorded. (1) The average is, therefore, 70 spills per year. Due to the nature of spill reporting, it is assumed that these records account for only 10% of actual discharges resulting in a predicted spill rate of 700 per year. The estimate of 10% is drawn from the oil spill reporting experience under the same section of law in which mandatory reporting requirements produced 10 fold increase over the previously voluntary reporting level. This same data base is used in the analysis to derive average spill size, spill distribution, and typical damage mitigation costs which are later discussed. Additional usage is made of the analogous oil spill data available from nearly five years of compulsory reporting to the Federal Government.

The analysis of direct penalty costs is based on the idea that the Agency intends to use the higher rate of penalty [311(b)(2)(B)(iii)(bb)] only when it can be shown that the spill resulted from gross negligence or that the discharger was grossly negligent in mitigating the spill. This criterion for applying the potentially high penalties has a significant effect in controlling the magnitude of civil penalties. Because of the difficult test of law in determining gross negligence the analysis assumes few penalty actions under the higher, (bb) penalty option.

In regard to the cost of prevention, the program could closely parallel the Oil Spill Prevention Program currently being implemented on a national basis (2). This program, for non-transporation related facilities, operates from a Spill Prevention Containment and Countermeasure Plan (SPCC). To assist in understanding the possible impacts, data from the oil spill prevention program have been considered. It should be noted, however, that the hazardous substance spill prevention program is not developed and may not necessarily involve the same costs or procedures as the oil spill program.

Damage mitigation costs are regarded as liabilities and as such are insurable risks. These costs will add, in some cases, to the liabilities currently carried by chemical producers, handlers, and transporters. Personal injury and property damage liability is an accepted "cost of business" with chemical handlers. In many cases, existing insurance coverage will suffice for normal environmental damage mitigation expense incurred by the insured from spill. For example, the insurance which vessels now carry for oil spill clean-up liability or for accident casualties will cover hazardous substances spills with little or no incremental increase in premiums (3).

When considering the economic impacts, it should be recognized that the prevention, mitigation, and penalty costs are not necessarily additive. The owner or operator has a certain degree of freedom to decide if added prevention costs for his operation are warranted in light of post spill costs potentially assesseable. He may elect to withstand the mitigation and penalty costs rather than invest in upgrading his facility until such time as promulgation of prevention regulations require it.

B. Civil Penalties

Briefly, the methodology employed in estimating the magnitude of civil penalties which may be assessed by the EPA revolves around the estimated number of spills per year (700), the frequency with which the penalty will be assessed using Section 311(b)(2)(B)(iii)(aa) ($500-$5,000/spill) or Section 311(b)(2)(B)(iii)(bb) (penalty rate in dollars per unit times units discharged), and the probable magnitude of penalty under each option.

In order to use the (bb) penalty option, the Agency must establish the quantity of substance discharged. The data base reveals that in 27% of the recorded incidents, it was not possible to estimate the quantity actually reaching a surface water body. In these cases, fire, evaporation, or ground sorption accounted for a significant reduction in the amount of pollutant actually entering the water. Applying the 27% figure to the total predicted number of spills (700) results in 189 spills for which enforcement actions using the (bb) penalty rate option would be tenuous. Thus, enforcement of a civil penalty would require use of the (aa) option ($500-$5,000) which may be assessed on a per discharge basis regardless of quantity discharged. The level of penalty assessment within the statutory range is to be based at least upon the toxicity, degradability, and dispersal characteristics of the substance. Assuming an (aa) penalty equal to the average of the statutory range results in the value of $2,750/spill. Thus, the total anticipated (aa) penalty for spills of unknown volume is equal to 189 x $2,750 = $520,000/year.

According to the above calculation, there remain 511 spills per year which will be known volume and potentially subject to penalties under the (bb) clause utilizing the rate of penalty schedule. Because gross negligence has been selected (see chapter on harmful quantities and penalty rates) as the discriminator between the (aa) and (bb) penalty options a conservative estimate is to assume that the Agency will enforce and apply the penalty rate under (bb) in no more than 1% of the spills. This assumption results in a remainder of 506 spills/year which will be assessed a civil penalty under the (aa) option. The average penalty ($2,750) multiplied by the predicted spills (506) yields an anticipated penalty cost of $1,391,500/year for spills of known volume in which gross negligence was not a factor. Therefore, the total civil penalty estimated to be assessed under (aa) would be $1,922,500 per year.

From the above calculations, there remain a predicted 4.75 or 5 spills per year in which gross negligence will be a factor and a penalty assessment under the (bb) clause will be made. A concern expressed by the transportation industry, particularly the water mode, is that the maximum penalty under the (bb) option of $5,000,000 will be used and result in financial ruin. The data base shows 16% of all spills occur from vessels. Taking 16% of the 5 remaining spills results in a prediction of 0.80 spills/year from vessels subject to the penalty rate. Additional analysis of spill records indicates that in only 5% of the spill incidents was sufficient quantity discharged such that the penalty computed by the proposed rate schedule exceeded the statutory limit of $5,000,000 for vessels and $500,000 for other sources. Thus, 5% of 0.80 results in an estimated 0.04 spills/year from vessels which year from vessels which will result in a $5,000,000 penalty. In other words, the barging industry could anticipate a $5,000,000 penalty once in every 25 years or an average of $200,000 per year. Of the remaining 4.2 spills per year, 5% or 0.21 will result in a maximum penalty for sources other than vessels. Thus, the maximum penalty of $500,000 for facilities will be anticipated once every five years, resulting in an average annual impact of $100,000/year. Therefore, the total penalty arising from assessment of the maximum (bb) penalty should be $300,000 per year.

Additional information is required on the probable size of spills if a total penalty is to be predicted based on assessment of (bb) penalties which, individually, are less than the maximum. The American Petroleum Institute has provided (4) data demonstrating the relationship between number of spill events and spill volume for oils reported during the calendar years 1972 through 1974. Spills of less than 1,000 gallons represent 83% of the number of spills, yet account for only 5% of the volume of oil spilled. In strong contrast, spills of greater than 10,000 gallons represent only 4% of the number of spills, yet account for 78% of the volume of oil spilled. Finally, spills of oil between 1,000 and 10,000 gallons represent 13% of the number of spills, and account for 17% of the volume spilled.

Since this data base represents 12,725 spills over the full three-year period, with a total spillage of 35,838,482 gallons, it provides a substantial, though far from unequivocal, base from which to extrapolate. We shall assume the same percentage distribution applies to hazardous material spills. Then, to determine the cost of penalties for those spills subject to less than maximum (bb) penalties, we shall assume the following three penalty levels:

Frequency	Penalty level	Assumed Penalty Level: Vessels	Assumed Penalty Level: Facilities and Other
83%	Minimal	$5,000	$5,000
13%	Average	$1,000,000	$100,000
4%	Large (but less than the maximum)	$2,500,000	$250,000

Thus, the remaining 4.75 spills per year are predicted to occur in the following penalty groups:

0.83 x 4.74 = 4.0 at minimal penalty level
0.13 x 4.74 = 0.6 at average penalty level
0.04 x 4.75 = 0.2 at large penalty level.

Because penalties are dependent on the source of the spill, the previously cited analysis of vessels and other sources of spills require that most of 16% and 84% respectively must be considered.

Penalty Level	Number of Vessel Spills	Number of Spills From Other Sources
Minimal	0.16 x 4.0 = 0.64	0.84 x 4.0 = 3.36
Average	0.16 x 0.6 = 0.10	0.84 x 0.6 = 0.50
Large	0.16 x 0.2 = 0.03	0.84 x 0.2 = 0.17

Predicted penalties may then be calculated using the previously assumed penalty levels.

Penalty Level	Vessel Spills	Number of Spills	Penalty $/Yr
Minimal	5,000	0.64	3,200
Average	1,000,000	0.10	100,000
Large	2,500,000	0.03	75,000
			$178,200

Penalty Level	Other Than Vessels	Number of Spills	Penalty $/Yr
Minimal	5,000	3.36	16,800
Average	100,000	0.50	50,000
Large	250,000	0.17	42,500
			109,300

Thus, total (bb) penalties less than maximum = $248,100/year. The total predicted civil penalties by EPA is a summation of the above values.

It will be recalled that the values in Table VII-1 are based on the following assumptions:

- 700 enforceable spills/year
- Enforcement of gross negligence in 1% of cases

Key values derived from existing data are:

- 27% of spills will involve unknown quantities
- 16% of spills are from vessels
- 5% of spills will exceed maximum (bb) penalty
- 83% of spills are in a minimal penalty range
- 13% of spills are in an average penalty range
- 4% of spills are in a large penalty range

TABLE VII - 1

SUMMARY OF ESTIMATED PENALTIES

Penalty under (aa)		
1. Unknown spill volume		520,000
2. Gross negligence not a factor		1,391,500
	total (aa) penalty	1,911,500
Penalty under (bb) - gross negligence		
1. Maximum penalty assessed		
a. Vessels		200,000
b. Other		100,000
	total maximum penalties	300,000
2. Less than maximum		
a. Vessels		178,200
b. Other		109,300
	total less than maximum	287,500
	total (bb) penalties	$587,500
	total (aa) and (bb) penalties	2,499,000/year

In addition to the EPA civil penalties, the Coast Guard has authority to assess a civil penalty of up to $5,000 for discharges in excess of the harmful quantity [Section 311(b)(6)]. If successful enforcement for all of the predicted 700 spills is assumed, along with an average penalty of $2,500, the estimated total civil penalty is $1,750,000/year.

Although Section 311(b)(5) provides for penalties in the case of failure to notify the Government of discharges in excess of the harmful quantity, these are of a criminal nature and are not included in this analysis.

Thus, the estimated total civil penalties from the three subparts approximate 4.25 million dollars per year as a potential consequence of the proposed regulations.

C. Cost of Spill Response: Clean-up and Damage Mitigation Liabilities

This portion of the analysis deals with the first of the indirect costs and is based on three factors: first, a projection of the number of spills per year of hazardous materials that reach water, (700), second, a projection of the average spill size; and third, the cost of clean-up and mitigation, based on known costs for specific spills, for several categories of hazardous materials. This analysis is done recognizing the determination that all hazardous substances have been proposed as being not actually removable. Details are given in the chapter on the determination of removability.

The first factor required for the analysis is the number of spills per year. The estimate of 700 derived in the preceeding section is used here without further development.

The second factor dealing with the average spill size was obtained by grouping the 174 reported spills into ranges of 50 pound increments and plotting the frequency of spillage as a function of the spill size within the 50 pound increments. The resulting curve closely approximates a normal Gaussian distribution with a mean most probable spill size of 7,500 pounds.

The third factor, dealing with typical response costs, is the most tenuous of the values. Limited experience with documented cost figures is the primary weakness in developing these estimates. In order to conveniently handle the large number of chemicals, and because there are a limited number of spill clean-up techniques, three categories were devised based on physical-chemical properties and the corresponding clean-up techniques applicable to each cateogry. The basic categories are soluble materials, insoluble floaters, and insoluble sinkers or precipitators. The soluble materials may require neutralization or sorbtion; harmful effects of the "oil-like" substances (insoluble floaters) may be ameliorated by existing oil spill techniques; and the harmful effects of sinkers may be ameliorated by dredging or suction pumping.

Analysis of 74 spill records for the calendar year 1974 results in a spill frequency for the three categories.

Category	Number in Category (n=74)	Percentage of Total
Solubles	49	66
Insoluble floaters	23	31
Insoluble sinkers	2	3

Applying this frequency distribution to the predicted annual spill rate of 700 yields the following predicted spill frequency for each category:

Category	Percentage of Total	Projected Spills Per Year Per Category (n=700)
Solubles	66	462
Insoluble floaters	31	217
Insoluble sinkers	3	21

Finally, actual case histories are utilized to determine typical response and clean-up costs for each category.

1. Soluble Substances

Analysis of 19 different acid spills that entered water during the year 1974, taken from the OHM-SIRS data bank, revealed that common basic substances were frequently used to neutralize the spills. Commonly used bases included caustic soda, sodium carbonate, and lime. Recent issues of the Chemical Marketing Reporter indicate an average price of about $.10 per pound for bulk quantities of these materials. As a first approximation, it can be assumed that the neutralization will be a one to one relation i. e., 100 pounds of acid will require 100 pounds of base. Thus, the cost of mitigating an acid or base spill is approximately $.10 per pound in terms of material required. The actual cost of mitigation will, of course, be significantly greater, but actual figures for a spill of this type are not available. In lieu of actual cost numbers, a reasonable approximation is that raw material costs constitute 10% of the total clean-up expenses. Thus, the approximated cost of mitigating a spill of a soluble acid or base is $1.00 per pound.

Soluble chemicals which cannot be neutralized constitute the remainder of the soluble category. Although actually documented cases of clean-up are minimal, mitigation by use of ion exchange or carbon sorbtion is feasible.

In June 1973, a Western Maryland Railway freight train derailed west of Cumberland, Maryland. Eleven freight cars were involved, including three tank cars carrying liquid carbolic acid (phenol). Two of the tank cars ruptured after derailment, spilling 25,000 gallons of phenol onto a hillside sloping down from the tracks and toward Jennings Run, a feeder stream to the Potomac River. The two tank cars contained a total of 193,000 pounds of phenol, however, 17,000 pounds of phenol remained in the cars after the derailment and rupture. Of the remaining 176,000 pounds of phenol, 166,000 pounds was absorbed into the hillside leaving 10,000 pounds of phenol which flowed into the waters of Jennings Run. Efforts to mitigate the spill consisted of construction of a granular activated carbon filtration unit through which leachate from the contaminated soil passed before discharge into Jennings Run. The unit operated for several months, effectively removing phenol from the leachate. Biodegradation occurring in the contaminated soil during the time period also helped in removal of the phenol. Expenditures by the railroad totaled $80,000 resulting in a clean-up cost of $0.45 per pound of phenol spilled. An obvious problem in the above analysis is that expenditures for a response effort of this sort are not directly related to the size of the spill. Thus, the derived value per pound spilled is a function of the spill size. In this case, the cost of constructing the filtration unit was the major expense and because of the magnitude of the spill, the cost per pound figure is probably less than one would predict for the more typical size spill. Assuming the more typical spill would involve only one tank car rather than the two in this case, the cost of mitigation increases to $0.90 per pound since the basic cost of constructing and operating the charcoal filtration unit would be the same. Because the value is nearly that of the previous estimate for acids and bases, a value of $1.00 per pound for Category A substances will be used for computational purposes.

2. Floaters - Oil-Like Substances (Less Dense then Water with Limited Solubility)

Analysis of 26 different oil spills from transport vessels during the years 1972-1974 revealed that the average cost of clean-up for these 26 spills was $6.70 per gallon, or $0.84 per pound of oil spilled. The amount spilled ranged from 1430 gallons to 7.4 million gallons, and the cost per gallon of clean-up in individual cases ranged from $0.14 to $9.52 per gallon, or from $0.02 to $1.19 per pound. While it was generally true that as the volume of oil spilled increased, the cost per gallon of clean-up decreased (in 6 of 7 cases where the volume spilled was over one million gallons, the cost per gallon of clean-up was under $1.00), this was not always the case. Factors such as terrain or accessibility to spill site; weather, including such elements as cold temperatures and wind; high water, current or wave action; natural or floating obstructions and debris in the water; and the availability of clean-up equipment and personnel all influence the efficiency and cost of clean-up operations.

The average cost of clean-up per gallon of oil spilled is supported almost precisely by another case not included in the analysis above. A tanker casualty in the Delaware River spilled 294,000 gallons of No. 6 fuel oil (Bunker C) into the water. Clean-up costs amounted to $1,975,000, which included machinery rental and purchase, disposable material purchase, disposal of the collected oils, and restocking of destroyed wildlife. The cost per gallon of clean-up was $6.72, or $0.84 per pound. While not all spills of materials in this category can be successfully mitigated by oil spill clean-up techniques, a certain, but as yet indeterminate, number of spills will occur at such times and locations that booms, skimmers, and adsorbents will be effective. The average cost of $0.84 per pound will be utilized for floating substances.

3. Insoluble Sinking Substances

The use of dredging or suction pumping to mitigate spills of chemicals which precipitate or sink to the bottom of a water course has been demonstrated on several occasions. In 1970, a highway accident involving a chemical tank truck resulted in the discharge of dimethyl sulfate into a slow moving roadside stream. Nearly complete recovery of the material was achieved by vacuum pumping the chemical from below the surface of the water.

In September 1974, an electrical transformer was being loaded by the Department of the Army onto a barge in the Duwamish Waterway near Seattle, Washington, for shipment to an Air Force base in Alaska. During the process of loading, a support member failed and the transformer dropped onto the dock, cracking open in the process. As a result, approximately 265 gallons of PCB's spilled onto the dock and into the waterway, contaminating both the water and the adjacent harbor area. Spill clean-up was accomplished by vacuum dredging and carbon filtration of contaminated sediments and water. Although the total cost of the spill response effort was $148,183, many of the contributory costs can be subtracted due to the atypical nature of the response effort at the Federal level. The primary item which can be subtracted is the labor cost of divers totalling $73,849. Because of the experimental nature of the response effort, divers rather than remote control devices were utilized to control vacuum dredge lines. Such would not be the case in a "typical" damage mitigation effort. In addition, travel expenses of EPA, State, and Coast Guard personnel totalling $13,178 are included and are considered excess of the expected Federal response to routine clean-up efforts. A more typical expenditure would be half of the above amount. Thus, the expenditure expected for similar spills would total $67,745 for 265 gallons. Since the specific gravity of PCB's is approximately 1.38, the value becomes $67,745 per 3053 pounds or $22 per pound. Thus, the expected cost for response to spills of insoluble sinking materials is $22 per pound.

Utilizing the average spill size, predicted number of spills, and anticipated cost of clean-up or damage mitigation, the following figures are derived in Table VII-2.

Table VII-2
Cost of Clean up of Hazardous Substances

Cagetory	Average Spill Size (pounds)	Predicted Spills/Yr	Cost of Clean-up ($/lb)	Annual Cost (millions of dollars)
Solubles	7500	462	1.00	3.465
Floaters	7500	217	0.84	1.367
Sinkers	7500	21	22.00	3.465
			Total:	8.297

It must be pointed out that the above analysis is on a worst case basis. The basic assumption is that all of the 700 predicted spills will result in response/clean-up actions. It is certain that many spills will not be amenable to such treatment and that appropriate response activity may consist only of warning downstream water users and cursory monitoring of pollutant levels to assure no long-term exposure. Furthermore, case histories exist which show that response to chemical accidents is an ongoing activity with many producers and handlers. Thus, regulations requiring response activities will in all probability not carry the degree of impactiveness predicted above. The projected 8.297 million dollars expenditure for response assumes no current level of expenditure for chemical clean-up. A more accurate estimate would be some percentage of the projected $8.297 million effort. Since the actual incremental increase is presently indeterminate, the figure cited above is again a worst case estimate.

D. Spill Prevention

Because implementing regulations have not yet been developed, the anticipated costs associated with spill prevention are indirect impacts and extremely speculative at this time.

The owner or operator of a hazardous material handling or manufacturing facility need not actually spend any monies on spill prevention equipment or techniques. He may decide that mitigation of damages resulting from a spill is more economical than spill prevention expenditures, based on his analysis of the odds of a spill occurring. The trade-off decision is his until prevention regulations are promulgated.

A capital discount approach provides a rough estimate of the maximum amount of funds that would be spent solely to avoid penalties and mitigation. Assuming that capital expenditure for spill prevention are 100% effecitve, that equipment has a 20-year life, and that from previous analysis that civil penalties and mitigation total costs remain less than $12, 550, 000 annually, the maximum capital expenditures would be $12. 550, 000 divided by the cost of capital to the industry. A study of the cost of capital for a number of industries was performed for EPA - Economic Analysis Division (5). The cost of capital to the chemical industry for the years 1975 through 1977 was found to be 14%. Thus, at a 14% discount factor, the maximum capital expenditure for spill prevention is approximately 78. 5 million dollars.

It should be noted that the The Coast Guard has responsibility for generation of prevention regulations to cover transportation-related spills of oil. To date, those regulations have not been issued. It appears reasonable to assume that the Coast Guard will also be given responsibility for generation of prevention regulations to cover transportation related spills of hazardous materials. However, because of existing authorities concerning the transportation of chemicals, there is some question whether the Coast Guard would choose to move forward on prevention regulations for hazardous materials relative to transportation sources in the near future.

E. Cost of Insurance

Discussion with various members of the insurance industry, trade organizations, and Federal agencies has revealed wide variation in the extent of insurance coverage for hazardous material spills for fixed facilities and transportation stock. The trucking industry is the only transportation mode that requires minimum insurance levels to be carried. The Interstate Commerce Commission requires a minimum coverage of $50,000 for property damage and $100,000/$300,000 for personal liability. These requirements are for third party damage protection (6).

However, the coverage within the industry varies. It is estimated that there are 16,000 truck lines; of these about 100 lines carry large "umbrella" insurance policies that range between one and five million dollars. Another 1,000 truck lines carry property damage insurance between $100,000 and $1,000,000 and are assumed to carry correspondingly large coverage for personal liability. The remaining 15,000 truck lines carry the minimum insurance levels required by the ICC.

The insurance coverage for hazardous material spills in the trucking industry, as presently contituted, will cover mitigation expenses to prevent further property losses. However, environmental mitigation expenses, in and of themselves, may not be recognized by these insurers as necessary or valid expenses.

There are no Federal requirements for minimum insurance coverage for the railroad industry for hazardous material spills. Generally, railroads cover their own damage claims. However, some lines do carry special insurance policies to cover catastrophic accidents and fires. Insurance levels for this type of situation may be for $25,000,000 total coverage, with a $1-2 million deductible clause written into the policy. Accident liability for the railroad industry is thus covered either by the railroad line directly or through a large catastrophe policy with a substantial deductible clause written in. However, as presently constituted, it is not likely that a large catastrophe policy would cover environmental mitigation expenses(7).

Insurance coverage for vessel transportation of hazardous materials appears to be different from that for the railroad or trucking industries. Present insurance policies for vessels transporting hazardous materials are indemnity policies whereby the insurance underwriter indemnifies the vessel owner or operator for all costs the owner or operator must pay to cover all liabilities. Most current vessel insurance policies cover all liabilities encountered, regardless of whether the substance causing the problem was designated a hazardous substance or not. Thus, existing insurance for vessels transporting hazardous materials includes all accidents resulting in pollution incidents and the resulting mitigation expenditures (3).

Insurance coverage for hazardous material spills at fixed facilities appears to be generally similar to that for railroad lines, although there are some exceptions. The largest chemical and petro-chemical production facilities either totally self-insure themselves (that is, carry sufficient funds in a floating reserve to cover any pollution incidents), or self-insure themselves up to a certain limit, such as $1,000,000 or $5,000,000, and buy insurance coverage for catastrophic events causing liabilities beyond that point. On the other hand, some smaller chemical production facilities purchase large insurance policies to cover any damages or claims resulting from hazardous material spills.

It should be noted, however, that no insurance company will underwrite a production facility or transportation mode that causes a pollution incident by knowingly allowing the release (or spill) of a hazardous material. It has been indicated to this Agency that it is insurance industry policy not to write insurance to cover fines or penalties that a policy holder may sustain because of concern that insuring fines or penalties is neither legal, nor in the public interest.

Thus, from the examples cited above it seems evident that insurance coverage can generally be obtained in the hazardous material industry for both property damage and personal liability. However, coverage for expenditures for environmental mitigation may pose a problem which may be overcome through education and experience. We believe it is in the interest of both the insurance companies and the public to offer such coverage, and intend to press for inclusion of such coverage in policies to be written in the future if it is not so included already.

F. Price Impacts

Economic data were collected for about 150 of the most significant hazardous substances involved. In 1972, total sales for these substances was approximately $4 billion. The manner in which the costs identified above will affect the prices of specific chemicals is unknown. In terms of all hazardous chemicals, spreading the annual costs over total volume yields a price increase of less than 0.3%.

G. Energy Impacts

No significant energy impacts are expected. Minor amounts of energy are expected in most clean-up responses. Spill prevention technology is varied but not expected to entail intensive energy impacts.

REFERENCES TO CHAPTER VII

1. R. Sanford, "Statistical tabulation and evaluation of OHM-SIRS polluting substance spills", Memorandum to Record, Files of Hazardous Substances Branch, CSD, OWPS, OWHM, EPA, Wash., D.C., April 2, 1975

2. "Oil Pollution Prevention, Non-Transportation Related Onshore and Offshore Facilities" 40 CFR Part 112, or Federal Register, Vol. 38, No. 237, Part II, p. 34164

3. A. L. Jennings, Report on telephone call to Mr. Drew, Federal Maritime Commission Re: Insurance for vessels under Section 311, Memorandum to Record, Files of Hazardous Substances Banch, CSD, OWPS, OWHM, EPA, Wash., D.C., July 29, 1975

4. Private comunication, American Petroleum Institute to T. Charleton, Oil and Special Materials Control Division, OWPO, OWHM, EPA, Wash., D.C.

5. G. Pogue, "Estimation of the Cost of Capitol for Major U. S. Industries", Contract report for Economic Analysis Division, Office of Planning and Evaluation, EPA, 1975

6. C. H. Thompson, "Insurance Coverage of Motor Carriers for Spill Clean-up Liability", Memorandum to Record, Files of Hazardous Substances Branch, CSD, OWPS, OWHM, EPA, Wash., D.C., July 17, 1975

7. L. R. Williams, "Insurance Coverage" [of railroads, according to Assoc. of Am. Railroads], Memorandum to Record, Files of Hazardous Substances Branch, CSD, OWPS, OWHM, EPA, Wash., D.C., July 21, 1975

CHAPTER VIII

RECOMMENDATIONS

A. Introduction

Having invested tens of man years in the development of regulations on chemical spills, this branch has observed several problem areas which are only partially solved by the proposed regulations. The purpose of this chapter is to offer the recommendations of the Hazardous Substances Branch staff concerning resolution of these problems, if a resolution appears possible. As such, this section can be likened to a contract study in which observations and recommendations are presented without regard to existing Federal or state legislative authority, to current technical limitations or to the proposed regulatory approach. This section must, by design, be viewed as the product of the Hazardous Substance Branch and does not necessarily represent the views of the Agency as a whole.

B. Environmental Protection Agency

Although the proposed list of hazardous substances contains over three hundred chemicals, it is considered only an initial list with the criteria for designation as the vehicle for additional listings. Work should continue on adding priority chemical substances to the list. To assist in this effort, Federal and state agencies should forward reports of all accidental discharges of chemicals to the program office in order to assemble an improved data base on spill frequency for materials not currently listed. Agency laboratories should utilize spill hazard frequency reports as justification for deriving toxicological data for those unlisted substances so that addition of chemicals to the list may be made on the basis of solid, standardized, modern data. This will require greater cooperation and coordination between regulatory offices and the research arm of the Agency than is currently in evidence.

The regulations themselves, when promulgated, will require Environmental Protection Agency and Coast Guard personnel to respond to spill incidents in the field. Additional training will be mandatory for both agencies. The chemical spill situation is unique and few response personnel are adequately trained at present along the lines of public health considerations and personal safety. Such training should constitute a major program emphasis. In addition, the enforcement of Section 311 provisions will require training and guidance from Headquarters.

The proposed differentiation between available penalties based upon gross negligence of the discharger will require the development of guidelines to both EPA and Coast Guard On-scene Coordinators and enforcement personnel. In addition, hearing procedures relevant to the assessment of civil penalties must be consistent from Region to Region. It is recommended that either guidance or training be offered to enforcement personnel charged with conduct of the hearing.

The National Oil and Hazardous Substances Pollution Contingency Plan, as currently drafted, is inadequate for dealing with hazardous chemical spills. It is, in effect, an oil contingency plan and therefore needs extensive updating and expansion to adequately deal with hazardous substances and implement the regulations following final promulgation.

It is recommended that the Agency initiate studies to develop chemical spill prevention regulations at the earliest possible time. since the general problem of chemical spills is obviously best dealt with by preventing their occurence in the first place. The rapid promulgations of spill prevention regulations will clear up much of the confusion and concern regarding what the Federal Government expects of potential dischargers along the lines of spill prevention expenditures and liabilities.

With regard to response activities, the removal regulations for hazardous substances required under Section 311(j)(1)(A) should be developed in the near future, drawing upon current spill response and damage mitigation technology. Furthermore, EPA Research and Development should examine methods of damage mitigation to improve the technological data base.

C. Industry

As structured, the regulations attempt to induce industry to prevent spillage and to respond to spill events when they do occur. Although the bulk of industry is attuned to these needs at present, emphasis on protection of environmental health may deserve increased priority. Thoughts should be directed toward additional operator training as well as toward individual corporate contingency plans and identification of spill response team members specializing in environmental protection.

D. States

State agencies have become increasingly concerned over the problem of chemical spills and are in the process of instituting their own regulations to deal with the situation. Industry and the Federal Government share a concern that proliferation of regulations differing from State to State might overburden interstate commerce of hazardous chemicals. It is therefore recommended that states support the Federal effort, with the objective being a consistent set of regulations designed to address spills of these chemicals from the standpoint of both prevention and response. One of the principal problems with state authority in the area is that states have, quite justifiably, addressed all media instead of just water. The need for Federal legislation to correct this difficulty is discussed below.

E. Legislative

Controlling a chemical pollutant problem should not be limited to one medium such as air, land or water only. The crux of the spill control problem is prevention, which can cover all accidental releases regardless of media, and response, which can likewise be developed for all media. A legislative framework designed to prevent hazardous chemical releases and to protect public and environmental health after their release should be designed without regard to media. In addition, the current framework of spill control relies heavily on economic disincentives for spills in water. Greater administrative discretion in the assessment of penalties should be incorporated into any amended legislation. At the same time, requirements and liabilities for restoration of the damaged environment should be included. Since unpolluted or relatively unpolluted portions of the environment are valued as a resource, the rapid return of that resource to its pre-spill condition should be the primary concern of any legislative spill control program.

F. International

The regulations implementing Section 311 currently are consistent with international activities in terms of the scientific grouping and analysis of chemical hazards. Such consistency should be maintained in future endeavors and activities such as the Great Lakes Water Quality Agreement, the Ocean Dumping Convention, the Marine Pollution Convention at IMCO and others.

APPENDIX

SPILL DATA

This Appendix is a tabulation of data on accidents available from the Oil and Hazardous Materials Spill Information Retrieval System (OHM-SIRS) computerized files. The interval covered is from August 1970 through July 1975. The listing follows that found in a computer printout from OHM-SIRS and is chronological, except for approximately 50 entries found at the end of 1974. OHM-SIRS file entries which do not name the substance spilled, or which do not adequately describe the substance in some other fashion, have been omitted from this Appendix.

While the column headings are largely self-explanatory, a few comments are required. When no entry is found in the "waters affected" column, this means that none of the material involved is thought to have reached navigable waters. Reports of known damages are listed but blanks in this column do not necessarily mean that no damage resulted since field personnel frequently have no time to estimate damage in the heat of emergency situations. Field assessments performed as part of emergency response measures are always difficult and often tend to underestimate the total environmental impact of spills.

Conclusions drawn from the data in this Appendix should also be tempered with the realization that specific accident reports were voluntary and are often incomplete due to lack of standardization among these cooperative parties or individuals. Moreover, due to the voluntary nature of the reports, there is reason to believe that only a small fraction (10-20% ?) of all such spills were reported.

A considerable number of substances in this Appendix are not found on the proposed designation list published on December 30, 1975 as Proposed 40 CFR Part 116. Inclusion of the full range of properly identified materials, whether currently proposed or not, is appropriate since this appendix consists of raw data. The analyses and summaries of Chapters I and VII were derived from these data, taking into consideration only the materials designated in Proposed 40 CFR Part 116, spilled in excess of the "harmful quantities" specified in Proposed 40 CFR Part 118 and in accordance with the penalties possible under rates of penalty published in Proposed 40 CFR Part 119.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/14/70	Portland, Ore.	Boiler Wash Waste Caustic Soda & TOC-3	Company Plant	Unknown	Willamette River	Phillips Petroleum Corp.	
8/21/70	Edmore, Mich.	Plating Waste	Plant which manufactures electrical parts	Unknown	Pine River	General Electric	
8/22/70	Portland, Ore.	Alkaline Solution	M/V Santa Eliana	Unknown	Willamette River	Prudential Grace Line	
9/2/70	Chicago, Ill	Iron, Pickel Liquor	Onshore Facility	Red Discoloration of River	Calumet River	Interlake Steel	
9/21/70	Staffordsville, Va.	2-4 Toluene Di-Isocyanate	11000 gallons/ MOBA Chemical Truck	Unknown	Big Walker Creek	MOBA Chemical	
9/21/70	Portland, Ore.	Lime, Rock Washing Wastes	Pipeline Refuse Dumping	Unknown	Willamette River	Ash Grove Cement Co.	
9/24/70	Union Town, Ky.	Ethylbenzene	50 gallons/barge	Unknown		Cardinal Carrier Co.	
10/8/70	Mississippi River, La.	Toluene	5000 gallons/ onshore facility	Unknown	Mississippi River	Geigy Chemical Co.	
10/9/70	Wyandotte, Mich.	Mercury	Plant	Unknown	Mercury Pond near Detroit River	Wyandotte Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
10/10/70	Salem, Va.	Ethyl Benzene	2000 gallons/ Onshore Tank	Fish kill of 13,280 of various species	Roanoke River	Koppers Plant	
10/28/70	Baltimore, Md.	Molasses	Cargo Ship	Unknown		M. V. Asterus & Pacific Mollasses Co.	Estimated 40,000 gallons retained in conduits. Amount of loss thru drain undetermined.
10/29/70	Portland, Ore.	Blue-green dye & paper fibers	Plant drain	Unknown	Willamette River	Molded Container Corp.	
11/9/70	Rabbit Island, La.	Ethyl Hexanol	60072 gallons/ Barges	No visible damage to wildlife		Union Carbide Co.	
11/16/70	Blair, Nebraska	Ammonia	168000 gallons/ Barge	Unknown		Gulf Chemical Co.	
11/19/70	Portland, Ore.	Thick White Lacquer Substance	42 gallons/Ship Loading Barrels of Substance	Unknown	Willamette River	States Steamship Co.	
11/30/70	New Martinsville W. Va.	Benzene	Onshore Facility	Unknown		Mobay Chemical Co.	
12/2/70	Detroit, Mich	Salt Pile, Earth Slide	20,000 tons/ Dockside	Interfered with traffic in navigation channel. Temporary shutdown of water intakes	Rouge River	Detroit Bulk Rock Co.	
12/6/70	Leroy-Genessee County, N.Y.	Trichloroethylene	35,000 gallons/ tank cars	Contaminated wells-taste, odor		Lehigh Valley Railroad	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/9/70	River Mile #571 Desoto	Carbon Black Toluene	25,000 gallons/ barge 145,600 gallons/ barge	Unknown	Mississippi River		Tow boat and barges aground
12/9/70	Redstone Arsenal, Ala.	Chromium	140# in 9000 gallon waste	Unknown	Tennessee River		Majority Chromium waste controlled and treated i industrial lagoon
12/10/70	Gulf of Mexico-250 miles south Mississippi River Mouth	Sugar	40,000 tons/ Alessandria ship	Unknown	Gulf of Mexico & Mississippi River	Strachan Shipping Co.	Sugar spilled at site of collision and enroute to shipyard for repairs at Grammercy, La.
12/30/70	Detroit, Mich.	Suspended solids	18 MGD/500mg/l for 2 days	Unknown	Detroit River	Great Lakes Steel	
1/6/71	Tacoma, Wash.	White Tallow Effluent	Fore Terminal Sump Discharge	Unknown	Puget Sound, Fore Terminal-Port of Tacoma	Fore Terminal Co.	
1/11/71	Alameda/Berkeley Cal.	Sulphuric Acid	Pipeline	Unknown	San Francisco Bay, Berkeley Aquatic Parks	Colgate Palmolive Co.	
1/11/71	Marin/Sausalito Cal.	Photo Chemicals	An individual	Unknown	San Francisco Bay	Unknown	
1/14/71	Alameda, Cal.	White Substance	Storm Sewer	Unknown	San Francisco Bay	Big "B" Lumberteria	
1/15/71	Alameda/Hayward Cal.	Tomato Juice	600 gallons/ Hayward Airport	Unknown	San Francisco Bay	Hunts-Wesson Foods	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/1/71	San Francisco Bay, Cal.	Weed Killer	126 gallons	Unknown	San Francisco Bay	Atlantic-Richfield Co.	
2/2/71	Portland, Ore.	Paint	M/V Freemantle Star	Unknown	Willamette River	Blue Star Line, London, Overseas Shipping Co.	
2/2/71	Portland, Ore.	Cailey Garbage and Refuse	M/V Lodestone	Unknown	Willamette River	Lodestone Shipping Co.	
2/10/71	Ashkum, Ill.	Antifreeze	15000 gallons/ Train Tank Car			Wyandotte Chemical Co.	
2/10/71	Marion, Ill.	Diethyl Sulfate	4000 gallons/ Tank truck	One dead muskrat-Several distressed fish. No significant changes to water supply noted.		Canco Co.	Spilled material entered ditch which flows to Crab Orchard Creek - a tributary to Crab Orchard Lake.
2/10/71	San Francisco Bay, Cal.	Paint and Paint Stripping Chemicals	S.S. Monarch	Unknown	San Francisco Bay	Unknown	
2/21/71	Cary, Miss.	Ammonia	Tank Car			Unknown	Railroad officials report one tank car of ammonia damaged during recent tornadoes but no product was lost. The damage was fixed in terms of leaking hazardous materials.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
3/3/71	Emeryville, Cal.	Chemical	Unknown	Unknown	Temescal Creek	Unknown	
3/9/71	Seattle, Wash.	Paint	Onshore Facility	None	Puget Sound, Elliott Bay Lockheed Shipyard	Shipyard Employee	
3/22/71	Portland, Ore.	Sandy Wash & Oily Wastes	Sand & Gravel Operation	Unknown	Willamette River	Pacific Building Materials Co.	
3/23/71	Richmond, Cal.	Acidic Pollution	Onshore Facility	Unknown	San Francisco Bay	United Chemical Co.	
3/25/71	Cook County/ Bedford Park, Ill.	Toluene	No.2 Port Compartment of barge	Unknown	Chicago Sanitary and Ship Canal	Canal Barge Lines, Inc.	
3/30/71	Portland, Ore.	Concrete mix and oil	Wash & storm drains from plant	Unknown	Willamette River	Willamette Hi Grade Concrete Co.	
4/4/71	Contra Costa Cal.		Outfall	Unknown	Coyote Creek	Unknown	
4/6/71	San Fran Bay Cal.	Kerosene Detergent Cosmoline	Pier 24	Unknown	San Francisco Bay	Kal Auto Transport	
4/14/71	New York Slough Cal.	Chlorine Gas	Unknown	Unknown	San Francisco Bay	Dow Chemical Co.	
4/15/71	Alameda, Cal.	Molasses	Mollasses Barge	Unknown	San Francisco Bay Oakland Estuary	Unknown	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	U.S. AREA
4/21/71	Dubuque, Iowa	Refuse	City Dump	Unknown	Mississippi River	City of Dubuque	
4/28/71	Cincinnati, Ohio	Molasses/water mixture	30gallons/barge	Unknown	Ohio River	River Transportation Co.	
4/29/71	Mobile, Ala.	Resi-dual Creosote	Unknown	Unknown		Republic Creosote Co.	
4/30/71	Los Angeles, Cal.	Zinc Cyanide	1000 gallons/ Flat Bed Truck	Stream & Bay monitored for effects-No injuries to people & no fish kills sighted.	Balona Creek - Santa Monica Bay	Royal Manor House-ware Co.	
5/2/71	Bee Lake, Miss.	Vinyl Chloride, Tetraethyl lead, & liquid sugar	RR Tank Cars	Soil in creek showed trace of lead. Soil Chem-ically decon-taminated.	Tcherro Creek	I C Railroad	
5/6/71	Roanoke, Va.	Emulsion type cleaner	250 gallons/ N&W Railroad	Unknown	Lick Run	N and W Railroad	
5/7/71	Meridian, Miss.	Isopropyl alco-hol	2 gallons/RR cars	No fish kill		Southern Railway	
5/8/71	St. Lawrence Co., N.Y.	Tank Lining debris	Vessel	Unknown	St. Lawrence Seaway	Unknown	
5/12/71	Wood Co., W.Va.	Sulfuric Acid	200 gallons/ onshore storage tank	No visible damage	Ohio River	Marbon Chemical Co.	
5/15/71	Conneautville, Pa.	Nitrogenous liquid fertilizer	500 gal/tank farm	About 200,000 fish of various types killed	Glessman Feed Mill		

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/17/71	Morehead City, N.C.	Agricultural liquid nitrogen	4600 gallons/ tank truck	Will start process of eutrophication which could do long range damage.	Bogue Sound	Plymouth Fertilizer Co.	Truck was parked over storm sewer-two blocks from Bogue Sound-fertilizer ran into sound.
5/18/71	New Boston, Ohio	Blast furnace waste water	Factory	Unknown	Ohio River	Empire-Detroit Steel Corp.	
5/18/71	Chicago, Ill.	Rust	Tow Barge	Unknown	Chicago Sanitary and Ship Canal	Commonwealth Edison	
5/19/71	Lemont, Ill.	Oily, Rusty colored liquid, water soluble	Tow Barge	Unknown	Chicago Sanitary and Ship Canal	Unknown	
5/19/71	Alameda, Cal.	Methyl Ethyl Ketone	Plant	Unknown	San Francisco Bay		
5/19/71	Marietta, Ohio	Epichlorohydrin	600 gallons/ Chemical plant	No damage reported		Union Carbide Co.	
5/24/71	Joliett, Ill.	Sulfuric Acid	4300 gallons/ onshore facility	Unknown	Des Plaines River	Blockson Works	
5/25/71	Triadelphia, W.Va.	Iron floc	Disturbed deposit of iron floc	No damage noted	Wheeling Creek	State Road Commission	
5/28/71	Raleigh, N.C.	Sulfuric acid	250 gallons/tank truck	Unknown		Axton-Cross Co.	
5/28/71	Belle, W. Va.	Methanol	30000 gallons/ storage tank	No visible damage	Kanawha River	E. I. Dupont Belle Plant	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/29/71	Brownwood, Tex.	Brandy Alcohol	5873 gallons/ Tank-truck trailer	A few fish killed-stream devoid of dissolved oxygen in much of impounded volume.	Pecan Bayou	Younger Brothers Inc.	
6/2/71	Portsmouth, Ohio	Endrin	Individual	About 3400 fish were killed	Shawnee Lake	Individual	
6/3/71	Picayune, Miss.	Epoxy	Onshore facility	Unknown	Hobolochitto Creek	Crosby Chemical	
6/4/71	Portland Ore.	Oil, Sawdust, caustic soda, etc. samples	Shore facility	Unknown		Linnton Plywood Assoc.	
6/7/71	Roanoke, Va.	Methoxychlor waste	Onshore facility	Unknown	Little Piney Creek	Calabama Chemical Co.	
6/11/71	Roanoke, Va.	Tannery Discharge	Tannery	Large red area in river		Tannery	
6/14/71	Waterville, Ohio	Sodium Hydroxide	750 gallons/ Fiberglass plant	Unknown	Maumee River	Johns Manville Fiberglass Inc.	
6/15/71	Portland, Ore.	Paint	Vessel	Unknown	Kingsley Lumber dock	Argo Shipping Corp.	
6/16/71	Oakland, Cal.	Sulfur substance	Unknown	Unknown	San Francisco Bay	Union Carbide Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/17/71	Louisville, Ky.	Concentrated sulphuric acid	Tank	Unknown		Ralston-Purina Plant	
6/20/71	Farmville, N.C.	DDT, Parathion, Aldrin , Chlordane	Warehouse	Plant life in swampy area dead	Neuse River	Royster Co.	
6/24/71	Imperial, Cal.	Parathion & Thimet & uniden-tified herbicides	1000 gallons/ Warehouse	No unusual number of dead fish	New River	Bisco Flying Co.	
6/24/71	Lorain, Ohio	foam, fuel oil water mixture	48576 gallons/ vessel	Unknown	Black River	American Ship Building Yard	
6/24/71	Jackson, Miss.	Cotton defoliant	Truck	Unknown	Pearl River	Unknown	
7/1/71	Ketchikan, Alaska	Caustic soda	Caustic tank	Unknown	Geteway Borough	Standard Oil Co.	
7/8/71	New Orleans, La.	Ethyl Parathion	28 gallons/barge	None reported	New Orleans Harbor	Ciehl S/S Co.	
7/9/71	Natrium, W.Va.	Phenol	2700 gallons/ surge tank	5000 dead fish	Ohio River	Mobay Chemical Co.	
7/10/71	Natrium, W.Va.	Phenol	recycle tank	Unknown	Ohio River	Mobay Chemical	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/13/71	Saltville, Va.	Chlorine	Holding ponds	15,000 dead fish	Holston River	Olin-Mathieson Co.	
7/19/71	Fairfax, S.C.	Methyl Parathion & Toxaphene	225 gallons/tank	Unknown	Stream & 2 ponds	Unknown	
7/19/71	Shreveport, La.	Toxaphene	3000 gallons/ RR tank car	No apparent damage		Unknown	
7/20/71	Kelly AFB, Tex.	Phenolic Substance	Unknown	No visible damage	Leon Creek	U.S. Air Force	
7/23/71	Crestwood, Mo.	Sulfuric acid	1200 gallons	Unknown	Gravois Creek	Sapo Elixir Chemical Co.	
7/26/71	Johnson City, S.C.	Benelate	Peach Orchard	fish kill	Johnson City Reservior	Cecil Young	
7/27/71	Norwalk, Conn.	Nitro-benzene, Propylalcohol, Toluene	Chemical plant	Chemical saturation as deep as 36 in. along shoreline-No marine life north of Rte. 95 bridge.	Norwalk Harbor	King Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/28/71	Beaumont, Tex.	Acrylonitrile	630 gallons/barge	Unknown	DuPont docks	Union Carbide Co.	
7/28/71	Michigan	Caustic soda	Storage tank	Unknown	Tittabawassee River	Dow Chemical Co.	
7/29/71	Moundsville, W.Va.	Caustic	Chemical plant	Unknown	Ohio River	Allied Chemical Corp.	
7/30/71	Wheeling W.VA.	Phenol	Unknown	Unknown	Unknown	Unknown	
8/10/71	Rapid City, S.D.	Chromic acid	Unknown	5,000 estimated non-game fish killed	Rapid Creek	Unknown	
8/13/71	Maryville, Tenn.	Acid	RR cars	Unknown	Little Tenn. River	L & N Railroad	
8/14/71	Elizabethtown, Ky.	Sulphuric acid	12000 gallons/ RR tank car	Unknown		Ill.-Central Railroad	
8/18/71	Punxsutawney, Pa.	Copper Cyanide	Pipeline	100 to 200 fish killed	Mahoning Creek	Crestline Inc.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/19/71	Hazel Township, Pa.	Fluoride-Beryllium	Lagoon spill	Both creeks highly acid streams-Black Creek has no aquatic life,	Black Creek & Hazel Creek	Kawecki-Berylco	
8/24/71	Baton Rouge, La	Phenyl Ethylene	300 gallons/ pump hose on barge	Unknown	Mississippi River	Casmar Co.	
8/25/71	Carville, La.	Phenyl Ethylene	Barge	Unknown	Mississippi River	Cos-Mar Co.	
8/26/71	Sistersville, W. Va.	Toluene	112 gallons/ chemical plant	Unknown	Ohio River	Union Carbide Corp.	
8/26/71	Corpus Christi, Tex.	Xylene	Vessel	No apparent damage		Cabins Tanker Inc.	
8/29/71	Chattanooga, Tenn	Believed to be Chlorophenol	Unknown	Taste & odors in drinking water	Tennessee River	Unknown	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/31/71	Berks/Birdsboro, Pa.	Nitric & sulfuric acid	6000 gallons/ Ruptured RR tank car	5000 fish killed	Hay Creek	DuPont, Inc.	
8/31/71	Beaver, Pa.	Organics & dead algae	Apparent discharge into Raccoon Creek	Much dead algae	Racoon Creek & Ohio River	Unknown	
9/1/71	Troy, Ohio	Toxic Discharge	Packing Co.	Estimate 200 fish killed	Great Miami River	Dinner Bell Packing Co.	
9/1/71	Calumet City, Ill.	Fertilizer-granite	barge	Unknown	Calumet River	Victor Welding	
9/1/71	Seattle, Wash.	Tectyl	Onshore facility	Unknown	Harbor Island	Lockheed Shipbuilding & Construction	
9/2/71	Longview, Wash.	Alumina	Onshore facility	Unknown	Columbia River	Reynolds Metal Co.	
9/3/71	Colorado	Zinc	Mill waste settling pond	Hundreds of fish killed- Water supplies affected.	Willow Creek	Emperius Mill	
9/3/71	Galveston, Tex.	Zinc oxide- Zinc metal ash	Derrick	Unknown	Ship Channel	Gulf Central Co.	
9/5/71	Texas & Tenn.	Xylene	Barge	Unknown	Intercoastal waterway & Tenn. River	Unknown	
9/7/71	Kent, Wash.	Methyl alcohol	RR tank car	Small fish kill	Mill Creek	Borden Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
9/9/71	Brunswick, Md.	Formaldehyde	4000 gallons/ Tank truck	Unknown		E. I. DuPont	
9/14/71	Dorsey, Md.	Vinylidene chloride	10080 gallons/ Tank car	Unknown		Dow Chemical Co.	
9/15/71	Painville, Ohio	Creosote	Pumping equipment	Unknown	Lake Erie & Grand River	GAF Corp.	
9/16/71	Painville, Ohio	Industrial waste discharge	Plant	Unknown	Lake Erie & Grand River	Industrial Rayon Corp	
9/16/71	Durham, N.C.	Trichloroethylene	1848 gallons/ Tank trailor	Unknown		South Chemical Co.	
9/17/71	Louisville, Miss.	Phenolic compound	400 gallons/failure of reactor	Unknown	Hughes Creek	Georgia Pacific Chemical Plant	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
9/20/71	Houston, Tex.	Xylene	1050 gallons/ tank farm	Unknown	Houston Ship Channel	Shell Oil Co.	No reported damages to wildlife or environment.
9/21/71	Charleston, S.C.	Chlordane	Drums	Unknown		Sea-Land Services Corp.	
9/24/71	Pasadena, Tex.	Spent caustic soda	Barge	Unknown	Houston Ship Channel	Champion Paper Co.	Barge raised and cargo transferred to onshore storage tanks. Cargo hat[illegible] covers remained tight during incident. Channel pH in vicinity did not exceed 8.
9/28/71	Corpus Christi, Tex.	Collected waste mixture with pH of 12	42000 gallons/ waste pit	No apparent damage to wildlife & environment	Corpus Christi Channel & Nueces River	Nueces Vacuum Service Co.	
9/29/71	Greenville, Tex.	Concentrated Sulphuric acid	3300 gallons/ tank truck	None evident	Hale Creek, tributary to Lake Tawakoni, Tex.	Allied Chemical Co.	Solution in diked area converted to alkaline an[illegible] will be retained by dike[illegible] until sufficient rainfall runoff causes dikes to w[illegible] out. This will facilitate additional dilution.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
9/30/71	Eastlake, Ohio	Chrome	700 gallons/ Process tank	Unknown	Drainage ditch	Lubrichrome, Inc.	City of Eastlake respond to cleanup.
9/30/71	Carville, La.	Phenyl ethylene	20000 gallons/ Onshore pipeline	Unknown	Mississippi River	Cos-Mar Co.	
9/30/71	Harrison, Ind.	Aqueous suspension - chicken manure	11072 gallons/ septic tank	Massive fish kill	Tippecanoe River	William Tinkey Farm	Estimate that 500,000 to 1,000,000 fish were kill
9/30/71	West Yellowstone Montana	Ammonium phosphate	4750 gallons/ Truck & trailer	No important damage		U.S. Hatch Trucking - Stauffer Chemical Co.	
10/2/71	Ontario, Canada	Hexane	17000 gallons/ storage pipeline	Unknown	St. Clair River	Polymer Corp. Ltd.	
10/4/71	Chester, Pa.	Hexamethylene diamine	300 gallons/tank	Estimated 500 fish killed	Beaver Creek	Liquid Nitrogen Products Co.	
10/8/71	South Point, Ohio	Ammonium Nitrate solution	12856 gallons/ storage tank	Unknown	Ohio River	Allied Chemical Co.	
10/10/71	Houston, Tex.	Vinyl chloride, butadiene, acetone & other chemicals	RR tank cars	One dead, 33 persons injured		Missouri Pacific RR	
10/14/71	Roanoke, Va.	Styrene monomer	Tank truck	No fish kill	Roanoke River	Unknown	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
10/16/71	Emporia, Va.	Acetone, Paper mill waste, Cooking oil, & Gasoline	Freight train	Unknown		Seaboard Coast Line RR	
10/18/71	Wilmington, N.C.	Methanol	2000 gallons/tanker	None	Cary Creek	Associated Petroleum Carriers	
10/18/71	DeSoto, Kan.	Butyl acetate	1100 gallons	Unknown	Kill Creek	Sunflowers Ord.	
10/18/71	Lawrence, Mo.	Ammonia	Unknown	Unknown		Atlas Chemical Co.	
10/19/71	Warren, Ohio	Acid rinse water	Industrial sewer line	Unknown	Mahoning River	Wheeling Pittsburgh Steel Co.	
10/19/71	New Jersey	White effluent	Onshore facility	Unknown	Delaware River	Unknown	
10/19/71	Pennsylvania	Red effluent	Onshore facility	Unknown	Delaware River	Unknown	
10/19/71	Wilmett, Ill	Lake sediment, carbon, alum, algae	Water treatment plant	Unknown	Wilmette Harbor	Wilmette Water Treatment Plant	
10/21/71	Great Bend, Pa.	Methyl ethyl ketone & acetate	Tank truck	Truck driver killed		Krajack Co.	
10/21/71	New Jersey	Red effluent	Onshore facility	Unknown	Delaware River	Unknown	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
10/26/71	Latrobe, Pa.	Zinc oxide	Truck	None	Loyalhanna Creek	Unknown	
10/26/71	Harrison, Ind.	Methanol	44640 gallons/ barge	No dead or distressed fish observed	Ohio River	Old Man River Towing Service	
10/27/71	Houston, Tex.	Xylene	Barge	Unknown	Houston Ship Channel	Charter International Oil Co.	
10/27/71	Washington, W. Va.	Acrylonitrile	Storage tank	Unknown	Ohio River	Marbon Chemical Co.	
10/28/71	Portland, Ore.	Caustic soda	2400 gallons/ onshore pipes	Unknown	Willamette River	Pennwalt Chemical Corp.	
11/2/71	Evendale, Ohio	Plating wastes	21,000 gallons/ plant	Unknown	Mill Creek	Micro Mechanical Finishing Co.	Mill Creek is primarily a storm drain. No fish known to inhabit affected portion of creek.
11/2/71	Oklahoma	Salt water from production wells	12,600 gallons/ storage tank	Unknown	Unnamed Creek	Gulf Oil Co.	
11/2/71	New Jersey	Red effluent	Onshore facility	Unknown	Delaware River	Unknown	
11/4/71	Tennessee	Caustic soda	3600,000 gallons/ barge	None	Cumberland River	Herbert Towing Co. & E.I. DuPont	
11/4/71	Baltimore, Md.	arsenic acid	Trailer truck	None visible	Baltimore Harbor	Allied Chemical Co.	
11/6/71	Cincinnati, Ohio	Methyl Alcohol	2500 gallons/ tank truck	Unknown	U.S. Route 75	Refiners Transport & Terminal Inc.	
11/8/71	West Virginia	Nitric Acid	Company plant	None visible	Ohio River	Mobay Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/9/71	West Virginia	Dioctylphthalate-flexol Plasticizer	890 gallons/ pipeline	Unknown	Kanawha River	Union Carbide Co.	
11/9/71	Easton, Pa.	Cleaning solvent	Sump of wells & pipeline from it to 4 above-ground tanks	Unknown	Bushkill Creek	Pfizer Inc.	
11/9/71	McConnelsville, Ohio	Copper Sulfate	3350 gallons/ storage tank	None	Muskingum River	Gould Foils Division	
11/9/71	Addyston, Ohio	Hydrogen sulfide	Drainage system	None	Ohio River	Monsanto Chemical Co.	
11/9/71	Addyston, Ohio	Sulfuric acid & other chemical wastes	Outfall from pit	Unknown	Ohio River	Monsanto Chemical Co.	
11/9/71	Plymouth, Ill.	Oily ester	Two railroad cars	Unknown	Flour Creek & LeMoine River	Burlington and Northern Railroad	
11/11/71	Point Pleasant, W. Va.	Vinyl resin	Settling lagoon	Unknown	Ohio River	Pantasote Co.	
11/11/71	Chicago, Ill.	Fertilizer	6529 gallons, barge	Unknown	Calumet River	Chotin Transportation, Inc.	
11/12/71	Indianapolis, Indianha	Sulfur Chloride	31072 gallons, railroad tank car	Unknown	Tributaries of White River	Penn Central Railroad	
11/14/71	Boone, N. Carolina	Methylene Chloride	Plant	Unknown	New River	IRC Div. of TRW Corp.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/16/71	Midland, Pa.	5% Sulphuric acid	5400 gallons, pickling tank	Unknown	Ohio River	Crucible Steel	Acid flowed through sewer into river.
11/16/71	Parkersburg, W. Va.	Sulphuric acid	Pipeline	Unknown	Little Kanawha River	FMC Corp.	
11/17/71	Winona, Minn.	Molasses	15,000 gallons, barge	Unknown	Mississippi River	Bargco and Co.	
11/17/71	Wyoming	Reservoir sediments	Reservoir	Fish kill below Willwood Dam.	Shoshone River past Willwood Dam	Willwood Diversion Co.	
11/17/71	Gillette, Wyoming	Propane	1000 gallons, tank truck	Unknown	Inland	A&V Gas Service	
11/18/71	Boston, Mass.	Possibly hydrogen sulfide	Unknown	Massive fish kill	Boston Harbor & Charles River	Unknown	
11/24/71	Downington, Pa.	Coconut soap of Diethyl amide	3000 gallons/ tank truck	Unknown		Textilana Neise Inc.	
11/25/71	Eldorada, Tex.	Butane & propane	Pipeline	Unknown		Phillips Pipeline Co.	
11/26/71	Riverton, Wym.	Concentrated sulfuric acid	Tank truck	Unknown	Wind River	Neuman Transport Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/2/71	New Jersey	Red effluent	Onshore facility	Unknown	Delaware River	Unknown	
12/3/71	Thomasville, Ga.	Sulphuric acid	RR cars	Unknown		Southern Railroad	
12/3/71	Fort Meade, Fla.	Phosphate	Waste storage pond	Phosphate slime seem on vegeta-tion-75lb. dead tarpon observed.	Peace River	Cities Services Oil Co.	Visual damage severe for 75 miles upstream from Punta Gorda.
12/4/71	Northeast of Cleveland, Ohio.	Fatty substance	Sewer discharge line	Unknown	Grand River	Uniroyal	
12/6/71	Baton Rouge, La.	Styrene "tar"	Storage pond	No apparent damage to wildlife or environment.	Baton Rouge Harbor	Foster Grant Co.	
12/7/71	Henrietta, N.Y.	Chlorine	Sewage treatment plant	Estimated 3000 fish killed	Barge Canal	Village of Henrietta	
12/7/71	Hempstead, Tex.	Chemical waste mixture	1500 gallons/ tank truck	Unknown	Tributary to Brazos River	Ted True	
12/8/71	Wheatfield, Ind.	"Anti-knock" chemical	RR tank car	Unknown		Unknown	
12/9/71	Kenton, Ohio	Phenol & lagoon wastes	Lagoon	No apparent fish kill	Scioto River	Hooker and Durez Plastics Co.	Marion Water Co. shut off intake because of phenol at point of intake. Alternate intake on Little Scioto River was prevented by a concurrent spill of fuel oil. Taste & odor problems resulted.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/9/71	Cincinnati, Ohio	Dimethylamine	14400 gallons/ RR tank car	None visible	Mill Creek	Proctor & Gamble Co.	
12/9/71	Westminster, Mass.	Methyl ethyl ketone	RR tank car	Unknown		Boston & Maine R.R.	
12/10/71	Near Ripple Meade, Va.	Sulfuric acid	Tank car	Unknown	New River	Norfolk & Western R.R.	
12/11/71	Corbin, La.	Chlorine, liquid phosphate fertilizer, lube oil, vinyl acetate	RR tank cars	Unknown		Illinois Central R.R.	3-mile radius of sparsely populated area evacuated due to chlorine leak.
12/13/71	Lea, New Mexico	Salt water	6300 gallons/ on-land heater treater	Unknown		Amerada Hess Corp.	Leak repaired. Surface restored.
12/13/71	New Orleans, La.	Tetraethyl lead	Dock loading facility	None apparent	Near Mississippi River	Nashville Avenue Wharf & Ethyl Corp.	
12/14/71	Nashville, Tenn.	Ethyl acrylate	Truck	None		Matlack Truck carrying Rohm & Haas product	
12/15/71	Chicago, Ill.	Isopropanol	1000gallons/ tank barge	Unknown	Calumet River	Unknown	Product unrecoverable in water-readily mixes with water.
12/16/71	Newcastle, Del.	Acetone	45000 gallons/ tank truck	Unknown		Reliance Universal	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/20/71	Wayne, Ind.	Cadmium oxide	5000 gallons/truck	Unknown	Whitewater River	Unknown	
12/20/71	Fayetteville, N.C.	Phenol	22000 gallons/ pressure storage tank		Cape Fear River	Borden Chemical Co.	
12/23/71	Lake Charles, La.	Components in a Perchloroethylene reactor	Reactor plant	3-4 plant personnel killed	Lake Charles	P P G Industry	
12/23/71	New Jersey	Red effluent	Onshore facility	Unknown	Delaware River	Unknown	
12/26/71	Mansfield, Tex.	Anti-knock compound & insecticide	RR tank cars	Unknown		Southern Pacific RR	
12/27/71	Helena, Mon.	2-4-D, Stoddard or equivalent & emulsifier	Unknown	2 fish kills-Destroyed feeding area for migrant birds.	Lake Helena	Bureau of Reclamation	
12/29/71	Pittsburgh, Pa.	Isooctyl alcohol	Barge	Unknown	Ohio River	U. S. Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/2/72	Near Marsailles Illinois	Vinyl acetate	B&O tank car	Unknown		Rock Island	
1/4/72	Berkeley, Cal.	Sulphuric acid	Truck	Unknown	Storm drain	Unknown	
1/4/72	Cleveland, Ohio	Zinc chloride solution	Onshore facility	No visible damage	Cuyahoga River	E. I. DuPont	
1/5/72	Pittsburgh, Pa.	Toluene	Tank truck	Unknown	Allegheny River	Pennzoil United Inc.	
1/8/72	Plaquemine, La.	Vinyl chloride	Compressor unit	No apparent damage to wild-life or envir-onment. However, 5 plant personnel injured.	Near Mississippi River	Goodyear Chemical Co.	
1/11/72	Alexandria, Va.	Chlorosulfuric acid and sodium	Tractor trailer	Driver injured & taken to hospi-tal.		Hendden Tractor Trailer	
1/11/72	Perry, Ind.	Ethanol	168 gallons/tank on barge	Unknown	Ohio River	Union Carbide Co.	Leak stopped by pumping part of contents of damaged tank compartment to adjacent compartment so that level dropped.
1/14/72	Hamilton, Ohio	Concentrated nitric acid	8000 gallons/ RR tank car	None visible		B&O Railroad/National Lead Co.	
1/14/72	Berkeley, Cal.	Pesticide	Unknown	Unknown		Gring Pest Control	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/16/72	Garland, Utah	Lime	Waste lime pond	Some rough fish were killed.	Malad River	Utah-Idaho Sugar Co.	Water of river used for irrigation.
1/16/72	Hamilton, ~~Cin.~~ Ohio	Molasses	2000 gallons/barge	Unknown	Ohio River	Bargco Inc.	
1/16/72	Colorado	Mixture of Hydroflouric & Chromic acids	Settling pond	No reported fish kill	Brush Creek & South Platte River	Martin-Marietta Co.	
1/18/72	Loveland, Colo.	Recirculated clarified water	Water discharge system	Unknown	Big Thompson River	Great Western Sugar Co.	
1/18/72	Massachusetts	Tetraethyl lead	Vessel	Unknown	Atlantic Ocean	DuPont Chemical Co.	Explosion danger-Empty dru had gasoline & tetraethyl lead residue-toxic, poison and explosive
1/19/72	Belle, W. Va.	Methanol	2000 gallons/ storage tank	Unknown	Simmons Creek	DuPont Chemical Corp.	
1/20/72	North of Richmond, Va.	Acrylonitrile	Truck	Small fish kill	Tributary to North Anna River	Glosen Motor Lines	
1/20/72	Institute,W.Va.	Isobutyl methyl ketone	46667 gallons/barge	Unknown	Kanawha River	Union Carbide Co.	
1/20/72	Baton Rouge,La.	Caustic soda	55996 gallons/barge	Unknown	Mississippi River	Allied Chemical Co.	
1/20/72	Chicago, Ill.	Styrene monomer	Unknown	Unknown	Chicago Sanitary & Ship Canal	Unknown	
1/22/72	Franklin, Pa.	Cleaning solvent	Tank wagon	Unknown	Race Run	Mooney Chemical Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	PRIMARY RESPONSIBLE	REMARKS
1/23/72	Clarksfield, Ohio	Hydrochloric acid	RR tank car	None visible	Vermillion River	N & W Railroad Co.	
1/26/72	Nitro, W.Va.	Caustic soda	Barge	Unknown	Kanawha River	FMC Corp.	
1/27/72	Ovid, Colo.	Plant process discharge, BOD & solids	13728 gallons/ Plant outfall	Water quality in river affected	South Platte River	Great Western Sugar Co.	
3/3/72	South of Baton Rouge, La.	Debutanized 30% aromatic concentrate (Benzene, xylene, byproducts of ethylene)	26460 gallons/ cargo line	Unknown	Mississippi River	Allied Chemical Co.	
3/3/72	Baltimore, Md.	Alkyd resin solution	Chemical plant	Unknown	Curtis Creek	Hancy's Products Chemical Corp.	
3/16/72	Veronon, Ky.	Sulfur dichloride	3000 gallons/ RR tank car	Unknown	Eagle Creek	Louisville & Nashville Railroad	
3/17/72	Near New Orleans La.	Styrene	Barge	None	Mississippi River	Unknown	
3/19/72	Louisville, Ky.	Chlorine	192000 gallons/ barge	Unknown	McAlpine Dam	Unknown	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
3/20/72	Theodore, Ala.	Arsenical pesticide	Unknown	Steer which died showed traces of arsenic. Horse exhibited symptoms of arsenic poisoning. 2 cows & 1 horse died.	Tributary to Mobile Bay	Cisco Chemical Co.	
3/22/72	Greenfield, Ind.	Natural latex with 2% ammonia	4000 gallons/ tank truck	Unknown		Stein, Hall & Co.	
3/23/72	Walton, Ind.	Anhydrous ammonia	16000 gallons/ pipeline	Several thousand dead fish	Rock Creek	De Haven Soils Service	
3/30/72	Yorkville, Ohio	Sodium bichromate	In-plant tank	Unknown	Ohio River	Wheeling-Pittsburgh Steel Co.	
3/31/72	Willock, Pa.	Methyl chloride, Methylene chloride, Caustic soda, & acid	RR tank	Unknown	Streets Run	B & O Railroad	
4/1/72	Geismer, La.	Liquid nitrogen fertilizer	1680000 gallons/ barge	Unknown	Mississippi River	Allied Chemical Co.	
4/1/72	Evandale, Ohio	Methyl parathion	Truck-tractor	14 persons hospitalized		Hayward Chemical Co.	
4/2/72	Denver, Colo.	Cobaltous naphthenate	Trucking Co.	Unknown	South Platte River	P.I.E. Trucking Co.	Material spilled is a flammable material, wi hazardous vapor & dang skin contact.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/5/72	Dallas, Tex.	Potassium bromate	Plant	8 employees killed	Trinity River & Daniels Creek	Pennwalt Co.	Much of the potassium bromate was estimated to have been consumed during 3 violent explosions and subsequent fire.
4/8/72	New Orleans, La.	Arsenic trioxide	Dry cargo ship	No measurable damage to environment.	Piety Street Wharf	Unknown	
4/8/72	Belle, W. Va.	Spent ethylene glycol	165000 gallons/ tank	Unknown	Kanawha River	DuPont, Inc.	
4/11/72	Dixmoor, Ill.	Acid, base	Storage tank	None	Little Calumet River	Haag Laboratories	
4/11/72	Cleveland, Ohio	Iron oxide solids	Steel Mill, wastes from electric furnace operations	Discoloration of river for short distance downstream.	Cuyahoga River	J and L Steel Co.	
4/12/72	Radford, Va.	Acid wastes	Waste treatment plants	Unknown	New River	Radford Arsenal	
4/12/72	Baltimore, Md.	Unknown (probably sodium sulfide solution)	8000 gallons/ storage tank	Unknown	Baltimore Harbor	FMC Corp.	
4/14/72	Denver, Colo.	Arsenic tetrachloride	Metal can	Unknown	Sand Creek	Consolidated Freightways	
4/15/72	Radford, Va.	Acid water	Acid neutralization system	Unknown	New River	Radford Army Ammunition Plant	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/19/72	Portland, Ore.	Oil & rust colored preservative	Ship dismantling operation	Unknown	Willamette River	American Ship Dismantling Co.	
4/19/72	Fairfield, Con.	Acrylic resins	1000 gallons/ tank truck	Unknown		Unknown	
4/20/72	Willow Grove, Pa.	High detergents	Washing of aircraft	Heavy fish kill	Park Creek	U. S. Naval Air Station	
4/24/72	Memphis, Tenn.	Antifreeze	RR tank car	Unknown		Continental Oil Co.	
4/27/72	Baltimore, Md.	Insecticide (Kepone) powder form	Storm drain	Unknown	Storm drain	Unknown	
4/30/72	Quincy, Mass.	Soap suds	Unknown	Unknown	Boston Harbor	Proctor & Gamble	
5/5/72	Antioch, Cal.	Hydrochloric acid	Unknown	Unknown		Imperial West Co.	
5/14/72	Stockholm, Wisc.	Anhydrous ammonia, Oil, Chemicakersin, Ammoniun nitrate phosphate	RR cars	Unknown		Burlington Northern Railway	
5/14/72	West Lafayette, Ohio	Phosphorus, Pentasulfide (P_2S_5) Vinyl chloride, Acrylonitrile	RR cars	P_2S_5 burned 1 mile radius evacuated		Penn Central	
6/1/72	West Virginia	Tetralin	Cooling water/ sewer	Unknown	Kanawha River	Union Carbide	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/1/72	Dallas, Tex.	Ethylene	RR. tank car	17 people injured		Texas-Pacific Railroad Co.	
6/5/72	Painesville, Ohio	Sodium hypochlorite	Onshore pipeline	Estimated 150,000 fish killed	Grand River	Diamond Shamrock, Inc.	
6/5/72	Baltimore, Md.	Unknown yellow pungent liquid	Outfall	Unknown	Stonehouse Cove	FMC Corp.	A fish kill was observed in vicinity but Md. Dept. of Water Resources felt it unrelated.
6/6/72	Branford, Conn.	Iron oxide mixed with mild based sulfate	Outfall	Unknown	Long Island Sound	Atlantic Wire Co.	
6/6/72	Martins Ferry, Ohio	Lime floc material	Steel Mill effluent	Unknown	Ohio River	Wheeling-Pittsburg Steel	
6/6/72	Schodack, N.Y.	Formaldehyde	5000 gallons/tank truck	Unknown	Muitzes Kill	P.B. Mutrie Motor Transportation, Inc.	
6/7/72	Perth Amboy, N.J.	Styrene	3780 gallons/ storage tank	Unknown	Arthur Kill	Zinchem, Inc.	Spill reached Arthur Kill via storm sewers.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/15/72	Addison, Ohio	Styrene Polymer	Storm drain	No danger to downstream users	Ohio River	Monsanto Chemical Co.	
6/15/72	Baltimore, Md.	Paint thinner	2000 gallons/ Underground storage tank	Unknown	Bethlehem Steel Ship Yard		
6/16/72	Denver, Colo.	Wastes (Cyanide, Radioactive, sludge, oil)	Refinery wastes & other industrial wastes are brought to hazardous land-fill, in addition to solid wastes.	Cattle grazing at ranch below landfill found dead.	Murphy Creek	Denver Landfill Site	
6/19/72	Renville, N.D.	Mercury treated grain	Farmer had dumped treated seed beside road.	Unknown		Unknown	
6/23/72	Valley Forge, Pa.	Nitrocellulose, pigments & lead compounds, MEK, Iso-alcohol, Ethyl alcohol, Methanol, Aluminum Stearate.	38500 gallons/ drums	Unknown	Schuylkill River	American Laquer & Solvent Co.	Hurricane Agnes
6/23/72	Cleveland, Ohio	Blast furnace effluent	Blast furnace clarifier	Unknown	Cuyahoga River	Republic Steel Corp.	
6/26/72	Englewood, Colo.	Suspect Hydro-chloric acid	Plating solution waste	South Platte River deteri-oration	South Platte River	Thomas Plating Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/26/72	Greeley, Colo.	Anhydrous ammonia	Farmland drain ditch to river	Several thousand fish killed	Cache La Poudee River	Unknown farm or farms	
6/27/72.	Denver, Colo.	Sulfuric acid	Storage tank	Estimated few thousand fish killed	South Platte River	Allied Chemical Co.	
6/27/72	Mount Savage, Md.	Phenol	23000 gallons/ tank car	Vegetation turned brown	Jennings Run to Wills Creek	Western Maryland RR	
6/28/72	Pennsylvania	Hazardous substances	Stray drums from storage area - multiple sources.	Unknown	Schuylkill River	Unknown	Hurricane Agnes
6/30/72	North Gate, North Dakota	Unknown - pesticide suspected	Unknown	20-25 thousand fish killed.	Des Lacs River	Unknown	
7/5/72	Commerce City, Colo.	Soil organic binder	Storage tank	Unknown	Near Sand Creek	Riff Oil Co.	The material was used as a filler on roads prior to asphalt.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/16/72	Denver, Colo.	Vinegar (10% acetic acid)	Storage tank	Unknown	South Platte River	Spear Vinegar Co.	
7/20/72	Ironton, Mo.	Chicken manure	Chicken brooder plant	Virtually total fish kill-Creek in a septic condition for 1-2 miles.	Stouts Creek	Unknown	
7/24/72	Golden, Colo.	Fertilizer	Trucks	Unknown	Ralston Creek	Coor's Brewery	
7/24/72	Denver, Colo.	Sugar production waste	Aeration pond	1/3 drop in aeration of production water	South Platte River	Great Western Sugar Co.	
7/26/72	Riverside, Cal.	Mesityl Oxide	RR tank car	3 persons overcome by fumes		Southern Pacific Railroad	
7/28/72	Oil City, Pa.	Aqua ammonia	Drums	Unknown	Allegheny River	Wolf's Head Oil Refining Co.	
7/31/72	Jefferson, Colo.	2% suspension Dibromomethane	Spray tank on truck	Unknown	Bear Creek	Forest Service	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/1/72	Wilson Lock and Dam	Styrene	Small amount/ Barge leak	Unknown	Tennessee River	Unknown	Barge offloaded at Chattanooga, Tenn.
8/7/72	Institute, W.Va.	Ethyl Butyraldehyde	3000 gallons/ Chemical plant	Unknown	Kanawha River	Union Carbide	Personnel negligence in loading barge
8/8/72	Los Angeles, Cal.	Ketones, alcohols & jet fuel additives	Chemical storage tank farm fire	No fish kill observed	Los Angeles Harbor	General American Trans. Co.	Fill pipe of tank farm snagged by truck causing leak and eventual fire.
8/8/72	Vaughn, N.M.	Toxaphene	385 gallons/ Overturned truck	None reported	None	Helena Chemical Co.	
8/9/72	Denver, Colo.	Nitric acid	1 gallon/Bulk storage tank line	None	None	Martin Marietta	
8/11/72	Rawlins, Wyo.	Sulfuric acid	4800 gallons/ truck overturned	Surface contamination on highway property	None	Neuman Transit Co.	
8/12/72	Institute, W.Va.	Methyl ethyl pyridine	50 gallons/ plant spill	Unknown	Kanawha River	Union Carbide	
8/16/72	Columbus Grove, Ohio	Ammonium hydroxide	1500 gallons/ leaking line	Fish kill	Cranberry Creek	Schumacher Soil Service	
8/22/72	Chester, Pa.	Ethylene	Tank truck	Unknown		Unknown	Traffic accident.
8/22/72	Casper, Wyo.	Soybean oil replacement (Alkyd resin)	10-12000 gallons/ Storage tank & RR tank car	Unknown	None	Jorgenson Paint Co.	Wrong valve left open on storage tank - overflowed.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/24/72	Haskell County, Texas	Toxaphene	165 gallons/ ruptured drums	None reported	None	Helena Chemical Co.	Truck-auto collision ruptured drums
8/26/72	Longmont, Colo.	Cyanide	Unknown	Large fish kill	St. Vrain River		
8/26/72	Monticello, Miss.	Guthion	194 lbs/Agricultural spraying operation	Huge fish kill	Pearl River		
10/1/72	Radford, Va.	Probably sodium sulfate	TNT plant	Unknown	New River	Radford Army Ammunition plant	Red color in cooling wate[illegible] effluent.
10/8/72	River Mile 214	Acrylonitrile	35 gallons/barge went aground	Unknown	Tennessee River	Inland Oil Transportation Co.	
10/10/72	Radford, Va.	Probably Sodium sulphate	TNT plant		Stroubles Creek to New River	Radford Army Ammunition Depot	Pink color in cooling wat[illegible] effluent.
10/17/72	New Martinsville, W. Va.	Polyether	1000 gallons/ plant		Ohio River Mile 121	Mobay Chemical Co.	
10/17/72	Newton Falls, Ohio	Chromic acid	13000 gallons/ plant	Unknown	Mahoning River	North American Rockwell	Bayonet heater broke, blowing acid out top of t[illegible]
10/20/72	Fayetteville, N. C.	Xylene	2000 gallons/ overfilled tank	Unknown	Cape Fear River		
10/31/72	Newark, N.J.	Sulfuric acid	1-5000 gallons/ tank car overflowed	1 man injured		Essex Chemical Corp.	
10/31/72	Waynesville, N.C.	Sulfuric acid	40-50 gallons/ tank truck leaking valve	50-60,000 stock of state trout hatchery	Small Stream, Richland Creek	Caustic Soda Transportation Co.	pH dropped to 2.53

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/1/72	Hammond, Ind.	Sulfuric acid	Leaking tank car	High SO_3 in air 93ppm- evacuate nearby area.	None	Indiana Harbor Belt RR	
11/8/72	Steubenville, Ohio	Blast furnace scrubber water	About 10,000 gallons	Unknown	Ohio River	Wheeling-Pittsburgh Steel	Blast furnace water clarifier breakdown.
11/9/72	Farmville, N.C.	Urea-formaldehyde	714 gallons	Unknown	Contentnia Creek	International Paper Co.	
11/9/72	Albany, Cal.	Glue	Tank truck	Unknown		Adhesives Products	Driver washing out tank of water soluble glue
11/10/72	Emeryville, Cal.	Lime	Unknown	Unknown		Fiberboard	Company spilled lime on property - Danger of washing off.
11/10/72	Jamestown, Col.	Mine water & solids	Unknown	Unknown	James Creek	Allied Chemical	
11/11/72	Newark, Cal.	Acid material	Unknown	Unknown		Jones Hamilton Co.	Acid material leaches from company property everytime it rains.
11/11/72	Greeley, Col.	Feeder molasses	2000 gallons	Unknown	Poudre River - Trip to South Platte River	Great Western Sugar	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/14/72	Hickory, N.C.	Glyoxal	100 gallons/tank truck overturn	Unknown	Clark Creek	Chemical Leaman Tank Line	
11/16/72	Taylorsville, Ill.	Ammonium phosphate, potassium chloride	Tank cars leaking	Unknown	Flat Branch Creek	B & O Railroad	Derailment
11/19/72	Houston, Tex.	Merox	300 gallons/ No. 1 spillway	Unknown	Houston Ship Channel	Crown Petroleum Co.	
11/20/72	LeFlore County, Okla.	Ammonium nitrate	3 barges involved	Unknown	Arkansas River	Unknown	Barges got loose
11/20/72	Institute, W.Va.	Benzene	Less than 200 gal/ tank barge leak	Unknown	Kanawha River	Union Carbide	
11/21/72	Lexington, Ky.	Toluene	2000 gallons/ truck wreck	Unknown	Elkhorn Creek		
11/22/72	Chicago, Ill.	Toluene	Barge leak	Unknown	Chicago Sanitary & Ship Canal	Union Oil	
11/25/72	Cabin Creek, W. Va.	(1)Methyl amyl acetate (2)Sodium hydroxide (3)Carbon tetrachloride	(1)3468 gallons (2)1400 gallons (3)300 gallons	Unknown	Cabin Creek	C & O Railroad	Train derailment.
11/26/72	Uravan, Col.	Acid	Plant	Unknown	San Miguel River	Union Carbide	Operator erroneously diverted flow to river.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/28/72	Washington, W.Va.	Latex	1000 gallons/ plant line broke	Unknown	Ohio River	Marbon Chemical Co.	
11/28/72	Durham, N.C.	Methylene chloride	1000 gallons/tank truck overturn	Unknown	None	Union Oil	
11/28/72	Lordstown TNP, Trumbull County, Ohio	White Phosphorus	Tank car derailed but intact	None		B & O Railroad	
12/1/72	North Carolina	Sulfuric acid	100 gallons/tank truck accident				Acid contained in roadside ditch, neutralized with lime and removed.
12/2/72	Salt Lake City, Utah	Hydrochloric acid	4-8000 gallons/ truck trailer tipped over	Unknown	Salt Lake Sewage Canal	Wasatch Chemical Co.	Stiff leg on trailer broke while being filled.
12/4/72	Tallahassee, Fla.	Ethylene glycol	20,000 gallons/ train wreck	None apparent	None	Seaboard Coastline RR	
12/4/72	Cincinnati, Ohio	Molasses			Ohio River	Werlin Corp.	Failure of tankerman to place blank flange on discharge hose.
12/5/72	Joliet, Ill.	Para-xylene	100 gallons/ barge overflow	Unknown	Des Plaines	Amoco Chemical	
12/8/72	Scotts Bluff, Neb.	Pesticides	Wharehouse fire			Stauffer Chemical	Contaminated debris disposal problem.
12/10/72	St. Paul, Minn.	Chromic and Sulfuric acids	500 gal/storage tank leak		Mississippi River	Univac Corp.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/12/72	Duff, Tenn.	Ortho-toluidine	About 200 gallons/ tank car derailment		None	L & N Railroad	
12/12/72	Pottstown, Pa.	Waste hydro-chloric acid	2300 gallons/tank truck accident	Unknown	Schuylkill River	Carpenter Steel Yard	
12/13/72	Baltimore, Md.	Acetone	250 gallons/tank truck leak (weld failure)			Matlack	
12/13/72	Iuka, Ill.	Glycerine; Hexane petroleum naphtha; Propylene glycol	Train derailment	Unknown	None	B & O Railroad	Fire consumed some of materials.
12/18/72	Ducktown, Tenn.	Sulfuric acid	3-6000 gallons/ tank truck over-turn	Unknown	Lake Ocoee	Cities Service	
12/18/72	Institute, W.Va.	Flexol plasti-cizer	500 gallons/tank overflow	Unknown	Kanawha River		
12/19/72	Morris, Ill.	Lasso pesticide	125 gallons/truck overturn	Unknown	None	Cardox Transport	
12/20/72	Luke, Md.	Chlorine	Tank car spill	20 people ex-posed - 3 hospitalized overnight	None	Westvaco Paper & Pulp	Tank car brakes not secu when car moved, it broke flanged connection.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/22/72	Edgewood, Md.	Sulfonic acid	20 gallons/tank truck accident	Unknown	Creek	Matlack Trucking Co.	
12/26/72	Russell, Mass.	Vinyl chloride	20,000 gallons/ RR tank car	Unknown	Westfield River	Penn Central	Tank car entered river following train wreck - No leakage.
1/3/73	Corpus Christi, Tex.	Vinyl acetate	About 500 bbls/ Barge sank. Some hatch covers were loose.	Few dead fish	Corpus Christi Ship Channel	Alamo Barge Lines	
1/3/73	So. Charleston, W. Va.	Isopropanol	2-3 gallons/tank barge	Unknown	Kanawha River	Union Carbide	
1/3/73	Heron, Mont.	Telone; Dichloropropene	15,000 gallons/ RR tank car	Unknown	Clark Fork River	Burlington Northern RR	
1/4/73	Harrod, Ohio	Pentane; Anhydrous ammonia	RR tank car, box-car derailment	1 fatality local air pollution problem		Erie-Lackawanna RR	Pentane tank car collided with tanks of Anhydrous ammonia stored along t[illegible] 1 of ammonia tanks rocketed into town causing fatality.
1/6/73	Hardin County, Tex.	Sulphuric acid	33,000 gallons/ storage tank overflowed	Unknown	Neches River	DuPont	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/7/73	Page, Okla.	Ethylene oxide	20,000 gallons/ tank car derailment	Town of 100 evacuated	None	Kansas City Southern RR	Vapor burned as it emerge from crack in tank car.
1/8/73	Ama, La.	Hexamethylene-diamine; Methyl ethyl ketone	RR tank cars derailed & leaking		Unknown	Missouri Pacific RR	
1/9/73	Elkhorn City, Ky.	Ammoniated fertilizer	29 tons/RR box-car overturned	Unknown	Levisa Fork	C&O Railroad	
1/9/73	Morgan City, La.	Chlorine	Runaway barge struck RR bridge & went aground	2500 people forced to evacuate during salvage operation	Atchafalaya River	Diamond Chemical Co.	No Chlorine lost.
1/10/73	Alexandria, Va.	Many types of solid & liquid pesticides	About 500 lbs/ Pesticide Whare-house fire.	Unknown	Potomac River	Herbert Bryan, Inc.	
1/11/73	Beltsville, Md.	Scotch whiskey	400 gallons/boxcar derailment		Indian Creek - Tributary to N.E. branch Anacostia River, Potomac River	B&O Division of Chessie	
1/12/73	Oklahoma County, Okla.	Methanol	Tank car over-turned	None apparent	None	Frisco RR Co.	
1/13/73	LaPlace, La.	Adiponitrile	Storage tank	Possibly some Minnows	Drainage canal to Lake Maurepas	DuPont	Adiponitrile contaminated water inadvertently re-leased from diked area.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/15/73	New Martinsville, W. Va.	Carbon disulfide	Explosion in plant storage tank	Unknown	Ohio River	PPG Industries	About 30 tons carbon disulfide may have reached river.
1/15/73	Midland, Pa.	Red oxide	Pump failure	Unknown	Ohio River	Crucible Steel	
1/17/73	Pryor, Okla.	Ammonium nitrate	Nitrogen plant explosion & fire	8 employees injured; $10 million damage	Pryor Creek - Grand River	Cherokee Nitrogen	Fire fighting run-off entered creek. Nitrate concentration about 40ppm.
1/18/73	Bellevue, Ohio	52% Caustic soda	8000 gallons/ leaking tank car	Unknown	None	N&W Railroad	Car ruptured during Humping operations.
1/19/73	Denver, Colo.	Weak sulfuric acid solution	8-10,000 gallons	None	South Platte River	Public Service Co.	Electrical failure caused scrubber wash to be dumped to sewer system.
1/20/73	Selma, Ind.	Methyl methacrylate	500 gallons/tank car derailment	Evacuated about 5000 people	None	Penn Central	
1/22/73	Youngstown, Ohio	Toluene	10,000 gallons/ tank car ruptured during shifting operations	Unknown		B&O Railroad	All material leaked out.
1/27/73	Jefferson Parish, La.	Caustic soda	1000 tons/barge aground but did not leak.	Unknown	Arkansas River	Plaquemine Barge Co.	
1/30/73	Chester, S.C.	Industrial alcohol	Unknown/tank car derailment-leaking from dome			Seaboard Coast Line Railroad	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/1/73	Loveland, Colorado	Recycle-water with high BOD	120,000 gallons of water		Big Thompson River	Great Western Sugar	
2/2/73	Mile 382 Miss. River	Meta-and paraxylene	Unknown/leaking barge		Mississippi River	Chotin Transportation Co.	
2/2/73	Winfield, W. Va.	2-ethyl hexanol	30-40,000 gal. leaking barge		Kanawha River	Union Carbide	
2/5/73	Downingtown, Pa.	60% sulfuric acid 40% nitric acid	7000 gallons tank car derailment	2000 people evacuated from homes	East Br. Brandywine Creek	Penn Central	
2/5/73	Middletown, Ohio	Paper mill wastewater	40,000 gallons pump failure	Unknown	Dicks Creek	Harding Jones Paper Co.	
2/6/73	Hammond, Ind.	Monoethanolamine	1 pint		Lake Michigan	Universal Oil Products	
2/7/73	Thornton, Ill.	Formaldehyde	150 gallons tank truck overturn		None	Rogerts Cartage	
2/8/73	Decatur, Ill.	Corn steep liquor	7300 gallons RR tank car leak during transfer		None	Barge to Railroad	RR notified state. State did not notif[y] US EPA
2/9/73	Troy, Ohio	Untreated packing house wastes	300-400,000 gal. explosion in treatment plant		Interstate stream Great Miami River	Dinner Bell Foods, Inc.	Ohio EPA granted Co[.] permission to disch[arge] waste to river.
2/12/73	Unity, Ohio	Sulfuric Acid	2000 gallons tank truck crash		Reservoir	Leaman Chemical Tank Lines	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/13/73	Kanawha River S. Charleston W. Va.	Cellosolve solvent	2-3 gallons leak in header line tank barge		River	Union Carbide Co.	
2/20/73	Dubach, La.	Methyl-acetylene propadiene & LPG	3 tank cars 20,000 gal. each train derailment		None	Rock Island Railroad	
2/20	Pecos, Texas	Carbonic acid, phenols, vinyl chloride	5 RR tank cars/ derailment		None	Texas Pacific Railroad	Fire followed derailment.
2/21/73	Taft, La.	Hexamethylene-diamine, adipic acid	6 RR tank cars/ collision		None	Texas Pacific Railroad	
2/23/73	Alberta, Va.	Liquor squeezings	40,000 pounds/ derailment		None	Seaboard Railroad	
2/24/73	Kremlin, Oklahoma	Methanol	20,000 gallons/ derailment		None	Rock Island Railroad	
3/1/73	Bartlesville, Oklahoma	Bis-cycyclo-hexenyl ethylene	200 gallons/ valve opened by mistake		Liza Creek	Phillips Petroleum Co.	
3/5/73	Kingston, Tennessee	PCB & chlorinated benzenes	2200 gallons/ leakage from tank truck	Unknown	Two Creeks	General Electric Moss Truck Co.	
3/5/73	Oglesby, Ga.	Caustic soda — 15,000 gallons Orthoxylene — 20,000 gallons Para-cymene — 10,000 gallons/ train derailment			Tributary to Broad River	Seaboard Coastline Railroad	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
3/9/73	Toledo, Ohio	Sodium chromate conc. 300-400 ppm	120-140,000 gal. valve malfunction cooling system		Otter Creek	Libby Owens Ford	
3/13/73	Salisbury, N.C.	Methyl acrylate	400 gallons/ tank truck turned over		Town Creek	Matlack Inc.	
3/22/73	Belleville, New Jersey	Molasses	100,000 gallons/ tank rupture		Storm Sewers	Universal Foods Corp.	
3/26/73	Geuga County Ohio	Burnt Lime	35,060 pounds/ overturned truck		Swamp draining to Baker Creek	A licensee of Matlack Inc.	
3/27/73	Wilmington, Delaware	Ketone	1 gallon/defective valve		Brandywine Creek	B&O Division Chessie System	
3/28/73	Wilmington, Delaware	Oleic acid	2000 gallons/ human error		Marsh about 1/2 mile from Delaware River	Atlas Chemical Div.	
4/1/73	Ironton, Ala.	Caustic soda anhydrous ammonia	UNK-Tank Cars containing 30,000 gallons soda & 90,000 gallons ammonia/train derailment		Ditch leading to Cahaba River/ Birmingham water supply	Southern Railroad	200 people evacuated f nearby trailer park, because of ammonia.
4/1/73	Mile 471 Tennessee River	Liquid ammonium nitrate	Unknown/underwater damage to barge while in a lock		Tennessee River	Brent Towing Co.	
4/3/73	Sistersville, W. Va.	Xylene	2000 gallons/pump failure in onshore industrial plant		Ohio River at mile 145.3	Union Carbide Co.	

	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/7/73	Exit 40 Interstate 83 Salem, Va.	Zinc chromate	550 pounds/truck overturned		Small amount diesel ran into unnamed creek	Roadway Express Inc.	
4/9/73	Radford, Va.	Sulfuric acid waste	66,000 gallons equipment failure		New River	Radford Army Ammo Plant, Radford	Neutralization by application of sod
4/10/73	Treasure Falls, Colorado	Mixed cleaning chemicals-amine sulfonates	Unknown-several drums leaking/ truck accident		San Juan River	RR Street Co. Gojo Distributors	
4/11/73	Ironton, Ala.	Ethylene glycol— acetic acid——— caustic soda——— anhydrous ammonia	4000 gallons small amount 20,000 gallons leaking into air (1 tank car)/ train derailment		Cahaba River	Southern Railroad	

On the following pages, chronology moves from the bottom of the page to the top.

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
10/12/73	Pittsburgh, Pennsylvania	PCB's	55 gallons - leak in 55 gal. shipping drum	-------	--------------	--------------	spilled material recovered & shipped for dispo sal
10/11/73	Bemidji, Minnesota	Sodium chlorate	100 pounds - rail car derailment	-------	--------------	Soo Line RR	100% physical pickup
10/10/73	Marked Tree, Arkansas	Naptha and propane	4 tank cars - railroad tank car derailment and rupture	-------	--------------	Frisco RR Company	1,000 persons evacuated
10/9/73	Corinth, North Carolina	Caustic soda	20,000 gallons - railroad tank car derailment & rupture	-------	--------------	Norfolk & Southern RR	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
9/18/73	Geismar, Louisiana	Caustic soda	250-350 tons - valve inadvertently left open at plant	-------	Mississippi River	Wyan Dotte Corp.	-------
9/17/73	Scranton, Pennsylvania	Sulfur dioxide	30,000 pounds - tank truck accident	stream affected for one-half mile	stream	Va. Chemical Co.	lrcal residents evacuated
9/17/73	Freeport, Texas	Phenol	16,750 gallons - 6 inch pipeline rupture	-------	private pond	Dow Chemical Co.	
9/17/73	Lafayette, Indiana	organic & inorganic solvents	3,350 gallons - teflon valve malfunction	-------	Wabash River	Eli Lilly Co.	-------
9/17/73	Dearborn, Michigan	formaldehyde & butyl alcohol	one tank car train derailment	-------	---------------	C&O Railroad	material recovered for disposal
9/17/73	West Salem, Ohio	Neodol 45	20,732 gallons - spilled material burried after train derailment one tank car rupture	fish kill after material leaked into creek	Muddy Fork Creek	Erie Lockawanna Railroad	2 ponds pumped dry and contractor instructed to clean up
9/14/73	Gulf of Mexico	Sodium cyanide & potassium cyanide	520 drums - 100 pound cyanide/drum lost in 2 ship collision	-------	Gulf of Mexico	M/J Persus & Ar/J Puebla	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
10/1/73	Dawson, Texas	Hydrochloric acid - 15%	1,000 gallons - automobile collided with tank truck fracturing valve	-------	--------------	Cardinal Chemical Company	Fire Dept washed acid into storm sewer
9/27/73	Radford, Virginia	Waste acid	quantity unknown - equipment failure at plant	-------	Stroubles Creek	Radford Army Ammunition Plant	-------
9/26/73	Greenwood, Mississippi	Vinyl chloride	quantity unknown - tank car after derailment	-------	--------------	Illinois Central RR	-------
9/20/73	Pennsboro, West Virginia	Vinyl chloride & cyclohexane	quantity unknown - train derailment	-------	--------------	B&O Railroad	-------
9/19/73	Aberdeen, Washington	Acetic acid	6,000 gallons - ruptured tank at Evans Harbor Mill	-------	Chehalis River	Evans Harbor Mill	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
10/7/73	Magna, Utah	Sulfuric acid 98%	28,000 gallons - pipe fatigue and failure at plant	-------	Great Salt Lake	Kennecott Copper	-------
10/6/73	Savannah, Georgia	Hydrochloric acid	1,200 gallons - equipment failure onshore nontransportation	-------	Savannah Harbor	---------------	-------
10/5/73	Ragland, Alabama	Phosphoric acid - 75%	40,000 gallons - railroad tank car derailment	-------	Swoosa River	Seaboard Coast Line Railroad	-------
10/4/73	Alvin, Texas	Formaldehyde Solution - 50%	240 gallons - tank truck collision broke off pump	-------	unnamed bayou	Robertson Tank	Partially contained in ditch by earthen dam
10/3/73	Price, Utah	Hydrochloric acid 35%	3,000 gallons - tank truck valve failure	-------	--------------	Conlin Dahlod Contractors	truck moved to landfill and drained
10/2/73	Houston, Texas	Furfural	630 gallons - pump failure at plant	-------	Sims Bayou	Petro-Tex Chemical	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
10/12/73	Pittsburgh, Pennsylvania	PCB's	55 gallons - leak in 55 gal. shipping drum	-------	--------------	--------------	spilled material recovered & shipped for dispo sal
10/11/73	Belmidji, Minnesota	Sodium chlorate	100 pounds - rail car derailment	-------	--------------	Soo Line RR	100% physical pickup
10/10/73	Marked Tree, Arkansas	Naptha and propane	4 tank cars - railroad tank car derailment and rupture	-------	--------------	Frisco RR Company	1,000 persons evacuated
10/9/73	Corinth, North Carolina	Caustic soda	20,000 gallons - railroad tank car derailment & rupture	-------	--------------	Norfolk & Southern RR	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
10/30/73	Rush, Kentucky	Acrylonitrile	80,000 gallons - railroad tank car derailment and rupture	Large fish kill	Little Sandy & tributaries	C&O Railroad	200-300 persons evacuated EPA & State authorities on scene
10/24/73	Midway, Florida	Anhydrous ammonia	20,000 gallons - railroad tank car derailment and rupture	-------	--------------	Seaboard Coastline Railroad	-------
10/22/73	Vanport, Pennsylvania	Diethylene benzene	quantity unknown	-------	Ohio River	Koppers Chemical Company	Citizens reported taste in water
10/17/73	East Liverpool, Ohio	Xylene	quantity unknown - barge collision and tank rupture	-------	Ohio River 41.4 miles	Chotin Towing Company	-------
10/16/73	Newark, Delaware	Xylene	100 gallons - tank truck tank rupture	-------	------------	Matlack, Inc.	-------
10/12/73	Maryann Township, Ohio	2-4-5-T weed killer	5 gallons - tank truck tank leak	soaked into ground	------------	Ohio Power Company	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
11/6/73	Rufus, Oregon	Phenolic resin	15,000 pounds - tank truck	-------	Columbia River	--------------	-------
11/3/73	Homimy, Ohlahoma	Oil well brine	quantity unknown - leak in salt water injection well	-------	Nicicola Creek	Union Oil Co.	salt tasted in creek up to 1 mi. below spill
11/1/73	Lima, Ohio	Sulfuric acid	10,000 gallons	fish kill for 20 miles	Ottawa River	Fulston Corp.	neutral-ized with limestone
11/1/73	Rantoul, Illinois	Acrylonitrile	8,000 pounds - leaking valve in tank car	-------	--------------	Illinois Central Railroad	leak absor-bed by road ballast
10/31/73	Yorkville, Ohio	Hydrochloric acid (conc.)	100 gallons - valve failure at plant	-------	Ohio River	Wheeling Pittsburgh Steel Corporation	-------
10/31/73	Newport, Tennessee	Biphenyl benzoate	2,000 gallons - truck overturned	-------	French Broad River	Tentatex Chemical Company	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
12/3/73	Ganada, Texas	Vinyl acetate	500 gallons - tank truck overturned and tank ruptured	-------	--------------	Robertson Tank Lines	-------
11/30/73	Charlotte, North Carolina	Latex	50 gallons - pipeline failure	-------	Mallard Creek	United Oil	-------
11/29/73	Savannah, Georgia	Liquid fertilizer	2,000 gallons - tank truck collision and tank rupture	-------	Savannah Harbor	M&M Transportation Company	-------
11/27/73	West Dale, West Virginia	Cyanide plating solution	2,500 gallons - line leak at plant	-------	Ohio River	Triangle Conduit & Cable Company	-------
11/20/73	Front Royal, Virginia	Sulfuric acid	1,000 gallons - equipment failure at plant	-------	South Fork & Shenandoah River	FMC Corporation	-------
11/20/73	Roanoke, Virginia	Radioactive wastewater	10,000 gallons - structural failure of setting tank	-------	Roanoke River	Babcox & Wilcox Co.	-------
11/13/73	Louisville, Kentucky	Toluene	400 gallons - tank truck tank rupture	-------	Ohio River & Paddy Creek	E.I. DuPont DeNemours	-------
11/12/73	Salt Lake City, Utah	Sodium hydroxide	50 pounds - equipment failure	-------	Jordan River Milk Creek	Phillips Petro. Co.	-------
11/10/73	Kingsport, Tennessee	Methylhexyl-ketone	8,000 gallons - manufacturing plant	-------	Holston River	Tennessee Eastman Company	-------
11/9/73	Rock Springs, Wyoming	Methanol	1,060 gallons - tank truck	-------	Green River	Desert Oil Co.	-------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
12/14/73	Maryann Township, Ohio	2-4-5-T weed killer	5 gallons - tank truck tank leak	soaked into ground	--------------	Ohio Power Co.	--------
12/12/73	Chambersburg, Pennsylvania	Chromium plating solution (approx. 79 ppm)	quantity unknown - personnel error in plant	-------	Couodguinet Creek	Letterkenny Army Depot	---------
12/12/73	Burlington, Illinois	Phosphoric acid	125,000 gallons - railway tank car suspension failure and tank rupture	small fish kill	Coon Creek	Illinois Central Railroad	---------
12/12/73	Greensboro, North Carolina	Ethyl alcohol	500 gallons - storage tank rupture	-------	Buffalo Creek	Charles Pfizer Co.	-------
12/9/73	Vinings, Georgia	Thionate	2,000 pounds - explosion in plant	-------	-------------	Vinings Chemical Corporation	-------
12/7/73	Edgemoor, Delaware	Titanium dioxide slurry	10,000 gallons - drain plug failure at plant	---------	Delaware River	E.I. DuPont	--------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
1/7/74	Atlanta, Georgia	Molasses	38,000 pounds - tank truck accident due to personnel error	-------	-------------	Fleet Transportation	-------
12/31/73	West Columbia, South Carolina	Sulfuric acid	10,000 gallons - railway tank car tank rupture	------	-------------	Southern Railroad	spill was contained
12/28/73	Sterling, Ohio	Fluoboric acid and 48-50% ammonium oxylate	unknown quantity - piggyback trailer not secured on railcar	---------	Chippewa Creek	B&O Railway Co.	------------
12/23/73	Mapleton, Illinois	Acrylonitrile	35 tons - railway tank car derailment and tank rupture	soaked into soil	----------	Toledo, Peoria, and Western Railroad	------------
12/17/73	Greenville, Mississippi	Orthoxylene	10 gallons - barge sprung a leak	-------	Ferguson Lake	Midland Enterprises	---------
12/15/73	Parowak, Utah	Caustic soda	500 gallons - tank truck collision and tank rupture	------	Sevier River	W.S. Hatch Trucking Company, Inc.	----------

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATER AFFECTED	CO. RESPONSIBLE	REMARKS
1/14/74	Helena, Montana	Stack Particulate	100 cubic yards - industrial plant	fish kill 4-6 miles estimated 1500-2000 fish/mi.	Prickly Pear Creek and Lake Helena	Kaiser Cement Company	-------
1/14/74	Horse Creek Wyoming	Vinyl Acetate, Phenol	quantity unknown railway tank car derailment and rupture	-------	Horse Creek and North Platte River	Colorado Southern Railroad	-------
1/14/74	Opal, Virginia	Sulfuric acid	75 gallons - tank truck overturned	-------	--------------	Lemmon Trucking Company	-------
1/14/74	White Haven Pennsylvania	Chlorine	unknown quantity railway tank car derailment and rupture	-------	--------------	Lehigh Valley Railroad	-------
1/10/74	New Martinsville, West Virginia	Hydrochloric acid (32%)	10 gallons - tank truck collision and tank rupture	-------	--------------	Mobay chemical Company	-------
1/9/74	Winnie, Texas	Phenolic waste	1,000 gallons - deliberate discharge from tank truck	-------	Galveston harbor and unnamed bayou	------------	500 gallons recovered

On the following pages, chronology moves from top of the page to the bottom.

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/1/74	Calhoun Falls, S.C.	Borax	35,000 lb		Savannah River	Atlantic Coastline R.R.	rail train wreck entere river
1/5/74	Boston, Mass.	Liquid Nitrogen			Boston Harbor	Ing. Barge Mass.	tank barge rupture - equipment failure
1/7/74	Atlanta, Ga.	Molasses	38,000 lb		None	Fleet Trans.	tank truck personnel error - wreck
1/14/74	Cincinnati, Ohio	Ethylenediamine	12,000/ind. plant personnel error	None	None	Emerg. Ind. Inc.	
1/14/74	McGregor, Texas	Vinyl Chloride, Naptha	319,120 lb 68,099 lb/ derailment		None	Santa Fe R.R.	
1/15/74	Hot Springs, N.C.	Terathatartic	20,000 lb railroad derailment		None	Southern R.R.	
1/15/74	Mansfield, Ohio	Sulfuric Acid	5,600 lb/ ind. plant personnel error, tank overflow			Detroit Steel	
1/15/74	Markland, Indiana	Valeraldehyde Propylaldehyde	400,000 lb/ barge collision		River in Ohio	Walker Towing Co.	
1/15/74	Hopewell, Va.	Sodium bisulfite	Unknown/ highway wreck				
1/16/74	Harrisberg, Pa.	Radioactive material					

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/17/74	Austin, Ohio	Acrylonitrile	Unknown/ derailment			B&O R.R.	
1/18/74	Old Hickory, Tenn.	Caustic soda	2,400 lb/ storage tank leaky valve		Cumberland R.	DuPont	
1/18/74	Lima, Ohio	Phenol	24,000 lb/ refinery - valve failure		Ottawa R.	Std. Oil of Ohio	
1/20/74	Denver, Colo.	D&R Spray Fumagant & Disinfectant [2-(hydroxymethyl) 2-nitro-1,3-propane]	8 lb/ highway - container rupture				
1/21/74	Meigs, Ga.	Sodium Hydroxide	Unknown/derailment			Seaboard Coastline R.R.	
1/22/74	Mt. Holly, N.C.	Perchlorethylene	8,100 lb spilled 4,000 lb entered river/break in transfer pipe		Catawba R.	Sou-Tex Chemical Co.	
1/25/74	Cass, Texas	Kraft Process soap stock (fatty acid)	14,600 lb/ derailment		Sulfur R.	Kansas City Southern R.R.	
1/26/74	Phila., Penn.	Ethyl alcohol (95%)	56,000 lb/ derailment			Reading R.R.	
1/26/74	Baton Rouge, La.	Hydrochloric Acid (20%)	3,600 lb/tank truck hose rupture		inland stream (unnamed)	Matlack, Inc.	
1/27/74	Washington, W.Va.	Liquid Latex	1,600 lb/ ind. plant pump failure		None	Borg Warner	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/30/74	West Virginia	Liquid Paraffin	8,000 lb/ tank barge structural failure		Kanawha R.	Union Carbide	
1/31/74	St. Louis, Mo.	Sodium Hydroxide	1,624,000 lb/ terminal - personnel error	None	Mississippi R.	Tri-City Terminal	
2/4/74	Duchesne, Utah	Phosphate	90,000 lb/ truck accident		Starvation Reservoir	U.S. Hatch Trucking Co.	
2/7/74	Jacksonville, Fla.	Camphene	1,000 lb/ tank car - personnel error (cleaning accident)		Moncief (stream)	Durkee Division of SCM Corporation	
2/10/74	Jacksonville, Fla.	Ammonia	40,000 lb/ chemical plant - vandalism		McCoy R.	Ashland Chemical Co.	
2/12/74	Copperhill, Tenn.	Sulfuric Acid (concentrated)	Unknown/tank car derailment				
2/12/74	Detroit, Mich.	Chlorine Hydrogen Peroxide	360,000 lb/ derailment	None		C&O R.R.	
2/12/74	Phila., Penn.	Methanol Toluene	4,000 lb/ ind. plant equipment failure		Delaware R.	Rohm & Haas Co.	
2/13/74	Taylors, S.C.	Latex	24,000 lb/ tank overflow - personnel error		Enoree R.	J.P. Stevens Co.	
2/13/74	Bessnner, Ala.	Ethylene glycol glycerine	28,000 lb/ tank overflow - personnel error		inland stream	Hercules, Inc.	
2/15/74	Balt., Md.	Alcohol	1,600 lb/ highway collision		Hubert Run	Seagrams Distillery	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/16/74	Morgan City, La.	Anhydrous ammonia	no spillage - barge collision		None	Southern Towing Co.	
2/17/74	Muscle Shools, Ala.	Unknown	Unknown/ effluent from treatment facility due to malfunction			Union Carbide	
2/18/74	Sueth, Utah	saltwater	Unknown/equipment failure	None	None	TEXACO Co.	
2/20/74	Chicago Heights, Ill.	Sodium Hydroxide	45,000 lbs	None	Thorn (inland creek)	Schneider Tank Lines, Inc.	
2/20/74	Nitro. W. Virginia	Sulfuric Acid	Unknown Quantity tank barge accident		Kanawha R.	Allied Chemical Co.	
2/22/74	Marsailles, Ill.	styrene	24,000 lbs tank truck overturn		Walbridge Creek	D & L Transport, Inc.	
2/28/74	Vandalia, Ohio	acrylonitrile	48,000 lbs md plant pump malfunction		Poplar Creek	General Motors	
3/3/74	Wright City, OK	wastewater glue	quantity unknown vandalism	None	None	Wayerhauser Co.	
3/3/74	New Haven, Conn	nitric acid	quantity unknown deliberate discharge		Branford River	Atlantic Wire Co.	
3/4/74	Latrobe, Pa.	mineral spirits	16,000 lbs valve failure		Saxon Creek	Matlack Inc.	
3/5/74	Kalamazoo, Mich.	methylene chloride	30,400 lbs tanktruck overturn		Portage Creek	Transport Services	
3/5/74	Washington Court House, Ohio	ammonia (28%)	112,000 lbs equipment failure of storage tank	None	None	Carter Flo-lizer	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
3/5/74	Farmington, N.M.	hydrochloric acid	40,000 lbs storage tank repture due to structure failure			Dowell Chemical Co.	
3/6/74	Wales, Fla.	sulfuric acid	unknown quantity truck-train collision with tankcar rupture		None	Seaboard Coastline R.R.	
3/7/74	McGregor, N.D.	injection salt water	160,000 lbs. pipeline corrosion	None	None	Hunt Oil Co.	
3/11/74	St. Vincent, Minn.	liquid nitrogen fertilizer	28,800 lbs truck accident	None	None	Dan Dugan Transport	
3/11/74	Plymouth, Mich.	pickle liquid	19,200 lbs personnel error	None	None	Wycoff Steel	
3/12-74	Columbus, Ga.	blue dye	Unknown quantity Unknown cause			Fieldcrest Mills	
3/13/74	Cokeville, Wyo.	sodium hydroxide	400 lbs truck overturn			W.S. Hatch, Co.	
3/14/74	Cody, Wyoming	crude and caustic water and phenols	unknown quantity refinery spill			Husky Oil Co.	
3/15/74	Wilmington, N.C.	liquid nitrogen	unknown quantity tanktruck accident		None	Cromartie Oil Co.	
3/15/74	Baltimore, MD	sulfuric acid	120 lbs storage tank leak		None	Bob Chrisholm	
3/17/74	Terre Haute, Ind.	vinyl chloride	unknown quantity derailment		None	Penn Central Transportation Co.	
3/18/74	Gilman, Col.	mine toilings	unknown quantity mining operation			Georgia Pacific Corp.	

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3/19/74	Port Westworth, Ga.	phenol formaldihyde	unknown quantity ind. plant discharge			Georgia Pacific Corp	
3/20/74	Geismar, Louisiana	sulfuric acid (70%)	7,200 lbs tankcar accident			Ill. Central Gulf R.R.	
3/21/74	Mineral, Ohio	ammonium nitrate soda ash	quantity unknown derailment		None	Balt. & Ohio R.R.	
3/21/74	Springdale, Ohio	ethylene glycol	108,000 lbs ind. plant-defect. valve		None	Avon Products Co.	
3/22/74	East Bridge, Mont.	dichloropropane	80,000 lbs. tankcar structural failure			Burlington Northern R.R.	
3/22/74	Statesville, N.C.	dimethylterephthalate	quantity unknown tankcar collision			Chemical Seaman Tank Lines	
3/24/74	Raceland, KY	liquid Phosphate fertilizer	96,000 lbs derailment			Chessie System	
3/24/74	McKenzie, N.D.	saltwater	126 gal injection line break			Texaco Co.	
3/26/74	Dallas, Texas	hydrochloric acid	1,500 gal spilled 750 gal entered H_2O valve stem broke		Trinity River	Arrow Chemical Co.	
3/28/74	Salem, Mass.	soapy solution	quanity unknown condenser failure			Salem Power Plant	
3/28/74	Wilmington, Del.	1-2 benzisocyazalone	100 lbs ind. plant		Delaware River	ICI American	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/1/74	Little America, Wyo.	phosphoric acid	1800 gal deliberate discharge		None	Hatch Co.	
4/1/74	Mitchell, S.D.	raw sewage	quantity unknown personnel error			Mitchell Sewage Treatment Plant	
4/2/74	Chicago, Ill	polyglycol and n-ethylmorphine	quantity unknown loose fittings			Lee Way Motor Freight, Inc.	
4/5/74	Baton Rouge, Louisiana	liquid rubber antioxident mixed alkylated diphenyl Paraphenoplene diaminus (39%) Mixed diphenyl amines (31%) Polymerized diphenyl paraphenylene diamines and hydroxydiphenyl amines (10%)	1870 gal incorrect valve handling on tankcar			Copolymer Rubber and Chemical	
4/7/74	Hammond, La.	octyl alcohol	6180 gal tank truck accident			Matlack Tank Lines	
4/8/74	Saginaw, Mich.	anhydrous ammonia	50,000 gal tankcar accident			Chessie System	
4/8/74	Fair Oaks, Georgia	terpentine, ink	1500 gal ind. dhop				
4/13/74	Hiedelburg, Miss.	salt water	4200 gal due to heavy rain, pipeline		Tallaltah River	Gulf Oil Co.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/13/74	Wylandville, Pa.	hydrochloric acid sodium hydroxide	Unknown quantity tankcar overturn			B & O R.R.	
4/15/74	Sherman, Texas	chromic acid	3000 gal spilled 2800 gal entered H_2O tank truck flange rupture		Chocktaw River	Texas Instruments Inc.	
4/15/74	New Martinsville, W.Va.	poly liquid resin	5500 gal tank truck accident			Matlack, Inc.	
4/15/75	Philadelphia, Pa.	vinyl chloride	unknown quantity tank accident			Penn Central R.R.	
4/16/74	Hazard, Ky.	ammonia	8,000 gal storage tank deliberate discharge	fish kill	pvt. pond	Ashland Oil, Inc.	
4/16/74	Wabash, Minn.	inorganic zinc coating (paint base)	quantity unknown highway accident source unknown				
4/16/74	Freeport, Ill.	ammonia (88%)	500 gal farm trailer tank overturn				
4/17/74	Kent, Ohio	iron ore sodium sulfite sodium sulfate	unknown quantity derailment			B & O R.R.	
4/17/74	Greenville, S.C.	radioactive material	unknown quantity onshore transport				
4/18/74	Three Forks, Wyo.	sulfuric acid	1200 gal tank truck overturn			Newman Transit Co.	
4/19/74	Saylor's Point, Penna.	sodium isthiate	50 gal tank truck collision			Matlack, Inc.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/20/74	Falls City, Texas	sodium chloriate	quantity unknown tank truck incorrect valve handline			Robertson Distributors System	
4/21/74	Norman, Minn.	anhydrous ammonia	20,000 lbs tank car leak			Burlington Northern	
4/22/74	St. Paul, Minn.	lignum	300 gal derailment			Soo Lines	
4/22/74	North Point, La.	dimitro weed killer (2-sec-butyl-4,6 dimitro-phenol)	130 gal tank truck accident				
4/23/74	Birthoud Falls, Col.	ethylene glycol	1500 gal truck accident			Ruan Transport	
4/23/74	Monessen, Pa.	ammonia liquor	100 gal ind plant equipment failure			Wheeling-Pittsburgh Steel	
4/24/74	Ingraham, Ill.	anhydrous ammonia	quantity unknown ind. plant casualty			Standard Oil Indiana	
4/24/74	Cleveland, Tenn.	sulfuric acid	quantity unknown acid cooler leak			Cities Service Co.	
4/24/74	Tuling, Texas	hydrochloric acid	10,000 gal stationary tank rupture			Darrel Knight Service Co.	
4/24/74	South Holand, Ill.	trichloroethene	1300 gal tank truck overturn			Barton Solvents, Inc.	
4/25/74	Falls City, Texas	sodium chlorate	quantity unknown tank truck, valve left open			Robertson Dist. System	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/25/74	Stillwater, Minn.	sodium hydroxide	2400 gal power plant personnel error		St. Croix River	Northern States Power Co.	
4/28/74	Eau Clair, Wis.	naptha resin	200 gal stationary tank overflow			Uni-Royal	
4/29/74	Roper, N.C.	thymid	500 lbs truck accident		Unnamed Stream	Scurlock Oil Co.	
4/30/74	Frederickstown, Ohio	red acrylic paint bore	10,000 gal ind. plant personnel error, tank overflow		North Branch Kokosind	J.B. Foote	
5/1/74	Beaumont, N.C.	dye	50 gal. plant storage, deliberate discharge			Grey Connelly	
5/1/74	Woodbine, Ill.	arachlor - 43%	200 gal truck accident			United Supplies	
5/2/74	Londonberry, Ohio	ethylene glycol	300 gal tank truck accident			Coastal Tank Lines	
5/2/74	Mundelein, Ill.	titanium tetra-chloride	4 drums spilled drum leak (equip. failure) from truck			TIM Freight Lines	
5/2/74	Edgemoor, Del.	ferric chloride (30%)	3500 gal ind. plant.		Delaware River	DuPont	
5/3/74	Fisher, Arkansas	benezene	unknown quantity derailment		small creek	Cotton Belt R.R.	
5/6/74	Ada, Minnesota	liquid fertilizer	4300 gal highway accident			Senex Transportation	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/6/74	Spencer, Indiana	ammonium nitrate	80 ton train overturn			Penn Central Transportation Co.	
5/9/74	Alexandria, Va.	hydrochloric acid	unknown quantity loose flanges (equip failure)			Dow chemical Co.	
5/10/74	Tennessee	sodium nitrate	3400 gal (cause not given)		Holston River	Holston Army Plant	
5/12/74	St. Thomas, Ill.	Prover 24 D CML2570 (herbicide)	1250 gal tank truck overturn (truck hit curbing)			Nalco Chemical Co.	
5/15/74	Edgemoor, Del.	titanium dioxide	unknown quantity ind. plant spill			Dupong Co.	
5/16/74	Woodlawn, N.C.	ketone mixture	4400 gal tank truck accident			Forshaw Chem Co.	
5/20/74	Fargo, N.D.	sugar beet plant lagoon effluent	unknown quantity ind. plant	BOD fish kill (740,411 to 740,430)	Red River	American Crystal Sugar Co.	
5/20/74	West Virginia	hydrochloric acid (33%)	quantity unknown ind. plant.			Allied Chemical Corp.	
5/20/74	Houston, Texas	organic waste	100 gal storage tank accident (natural course flooding)		unnamed drainage ditch	Ashland Chemical Co.	
5/23/74	Cincinnati, Ohio	Sulfuric Acid	160,000 gallons barge collision		Ohio River	Ashland Oil Co.	
5/24/74	Denver, Colo.	Vinyl paint	10 gallons ind. plant, personnel error			KWAL Paint Co.	
5/25/74	Cleveland, Ohio	Industrial waste	4,500,000 gallons ind. pland, equipment error		Cuspahoge River	DuPont	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/25/74	Romulus, Mich.	Acetic Acid	100 gallons/ tank car, structural failure			Chessie System R.R.	
5/25/74	Springfield, Tenn.	Toxaphene	200 gallons/ airplane discharge due to engine trouble, deliberate			Riggs Flying Service	
5/27/74	Chattanooga, Tenn.	Diisobutylamine	50 gallons/ storage tank overflow, personnel error		S. Chickamauga	Alco Chemical Co.	
5/28/74	Greenville, S.C.	Latex waste	500 gallons/ stationary tank rupture (structural failure)		Bushy Tops	Commercial Broad Loom	
5/28/74	Downers Grove, Ill.	Acid	Unknown/ind. plant, deliberate dumping into stream		Unnamed stream	Wescom, Inc.	
5/28/74	Greensboro, N.C.	normal Butyl Alcohol	452 gallons spilled, 45 gallons entered water/tank car equipment failure		North Buffalo R.	Pfiezer, Inc.	
5/30/74	Lenoir, N.C.	Lacquer thinner	540 gallons/storage tank hose rupture (equip. failure)		Tower R.	Singer Co.	
5/31/74	Rome, Ga.	Black liquor	8,000 gallons/tank car equipment failure		Smith Cabin R.	Georgia Craft Co.	
5/31/74	Church Hill, Tenn.	Sulfonated Detergent Compound	Unknown/tank truck accident			Mason Dixon Line	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/31/74	Radford, Va.	TNT	Unknown/explosion at plant			Radford Army Ammunition Plant	
6/1/74	Phila., Penn.	Phenol	10 gallons/tank truck loose valve (equipment failure			Matlack, Inc.	
6/2/74	Hinton W. Va.	Ethylene glycol	30,000 gallons/tank car overturn		New River	C&O R.R.	
6/4/74	Morristown, Pa.	Pickling Acid Waste	4,000 gallons/deliberate discharge				
6/4/74	Charlotte, N.C.	Vinyl Acetate	800 gallons/truck accident			Central Transport Co.	
6/4/74	Roland, Idaho	Sodium Hydroxide	16,000 gallons/derailment			Chicago Milwaukee R.R.	
6/5/74	Clarion, Pa.	Pocolene	25 gallons/ind. plant		Clarion Run	Owens Ill. Corp.	
6/6/74	Edgemore, Del.	Titanium Dioxide	500 pounds/ind. plant		Delaware R.	DuPont	
6/7/74	Moncure, N.C.	Liquid Nitrogen	300 gallons/tank being towed, rupture due to equipment failure			Mr. Henry Morton	
6/7/74	Covington, Va.	Polystyrene	Unknown/truck accident			Westvaco Co.	
6/10/74	Asheboro, N.C.	Urea formaldehyde resin	2,000 gallons/truck accident			Central Transport Co.	
6/11/74	Dayton, Ohio	Acrylonitrile	21,000 gallons/derailment			C&O R.R.	
6/11/74	Baton Rouge, La.	Styrene	3,000 gallons/tank truck accident		inland bayou	Texas Solvents Chem. Co.	
6/12/74	Bridgeport, Mich.	Pesticides Herbicides	Unknown/plant accident (fire)			Williams Co.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/12/74	Morre, Okla.	Phosphorous trichloride	6 - 8 drums (55 gal. ea.)/ derailment	30 people treated for smoke inhalation, 5,000 - 7,000 people evacuated from Moore		Santa Fe R.R.	
6/12/74	Wabash, Ind.	Trichloroethylene	100 gallons/ ind. plant, personnel error (incorrect valve handling)			General Tire & Rubber Co.	
6/13/74	Piqua, Ohio	Anhydrous ammonia	2,000 pounds/ ind. plant, equipment failure	10,000 fish killed	Great Miami	Val Decker Packing Co.	
6/14/74	Dermott, Texas	Cyclohexane	210,000 gallong/ derailment			Santa Fe R.R.	
6/15/74	Wixon, Mich.	Acetic Acid	5 gallons/tank car, line leack (equip. failure)			Chessie System R.R.	
6/17/74	Norfolk, Va.	Paint thinner	Unknown		Chesapeake & Albemarle Canal	Atlantic Yacht Basin	
6/18/74	Grapevine, Texas	Chromic Acid	500 gallons/ deliberate waste disposal from ind. plant		Unnamed Branch	Electro Coating, Inc.	
6/18/74	Marshallton, Del.	Phenol	75 gallons/ind. plant personnel error (incorrect valve handling)			Harvey Industries	
6/19/75	Pueblo, Colo.	Sodium Hydroxide	2,000 gallons spilled 50 gallons entered water/ ind. plant, tank overflow, (personnel error)		St. Charles R.	Public Service Co.	

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6/19/74	Charleston, W. Va.	Isopropyl Acetate	4,500 gallons/ tank truck collision		Kavawka R.	Reliance Trucking Co.	
6/20/74	Gateway, Colo.	Potassium hydroxide	3,000 gallons/ tank truck accident			Don Ward Trucking Co.	
6/20/74	Morton Grove, Ill.	Phosphorous chloride	8 gallons/ ind. plant storage tank structural failure			Regis Chemical Co.	
6/23/74	Melvin, Ohio	Sodium hydroxide (52%)	9,000 gallons/ tank car derailed		Todd Fork	B&O R.R.	
6/24/74	La Veta, Colo.	Liquid fertilizer	5,000 gallons/ tank truck, structural failure			Gibson Truck Lines	
6/28/74	Rutherfordton, N.C.	Toluene	3,500 gallong/ tank truck accident	Fish kill	inland stream	Infinger Transportation Co.	
6/28/74	Deniopolis, Ala.	Phenol-formal-dehyde	100,000 pounds/ plant boiler explosion			Bordon Chemical Co.	
6/29/74	Nacogdoches, Texas	Adipic acid hexamethylene - diamine tetraethyl lead fatty alcohol petroleum wax vinyl chloride toluene plastics tallow	Unknown/rail general cargo overturn			Southern Pacific R.R.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATER AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/30/74	Franklin Furnace, Ohio	Phosphoric Acid	28,000 gallons/ derailment			Norfolk & Western R.R.	
6/30/74	Darling, Miss.	Vinyl Chloride	Unknown/derailment			Illinois Central R.R.	
7/2/74	Florance Miss.	Lead Acid Fumes	Unknown/ind. plant			Con-Rex Oil Co.	
7/2/74	Donaldsonville, La.	Sulfuric Acid	17653 pounds spilled 1770 pounds entered water/tank truck hose rupture		Mississippi R.	Triad Chemical Co.	
7/3/74	New London, Conn.	Paint	Unknown/construction job, personnel error			Tangeni & Sons Paint Contractor	
7/5/74	Radcliff, Colo.	Acid	Unknown/ind. plant line leak			Amox Co.	
7/6/74	Kenton, Ohio	Phenol resin	200 pounds/ind. plant equipment failure, cooling jacket leak		Taylor Creek	Hooker Chemical Corp.	
7/8/74	Delta, Colo.	Pesticide	Unknown/crop dusting				
7/8/74	Peshtigo, Wis.	Black sulfite liquour	Unknown/ind. plant			Badger Paper Co.	
7/9/74	Greenville, S.C.	Acrylic latex	1500 gallons spilled 200 gallons entered water/storage tank overfilled, personnel error		Rudy R.	Charles S. Tanner Co.	
7/9/74	Tollansbee, W. Va.	Sulfuric Acid (66%)	100 gallons/ind. plant flanges not properly secured, personnel error		Ohio R.	Wheeling Pittsburgh Steel	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATER AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/9/74	Roseville, Minn.	Oxidizing material	55 gallons/ind. storage			Warner Construction Co.	
7/10/74	Colorado Springs, Colo.	Caldium Carbonate	Unknown/deliberate discharge from ind. plant			Calco	
7/10/74	Hopewell, Va.	Sulfuric Acid	Unknown/ind. plant equipment failure hose rupture			Allied Chemical Co.	
7/10/74	Le Seur, Minn.	Salt	65 tons/bulk storage tank rupture			Green Giant Co.	
7/10/74	Montgomery, Ala.	Formic Acid	Unknown/tank car rupture structural failure			Western R.R. of Ala.	
7/11/74	Shaw, Miss.	Ortho-dichloro-benzene Hydrocyanic Acid	Unknown/derailment			Illinois Central Gulf R.R.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/12/74	Ingleside, Texas	Chlorine	Small/Dupont	Unknown	Intercoastal Waterway, Gulf Coast	Dupont	Personnel Error Safety Relief Va Released Chlorin
7/14/74	Alliance, Ohio	Chlordane Malathion 2,4-D 2,4,5-T Oxychlor Chlorinol	Unknown/Storage Tank Onshore	$1 million	Berlin Res. Mahoning R.	Universal Coop Agriculture Chemical Plant	Lightening Struc Power Line Causi Fire
7/14/74	Alliance, Ohio	Pesticides Herbicides	Unknown/Onshore Storage	Unknown	Mahoning R.	Universal Coop Inc.	Fire in Chemical Plant. Air and Water Problem.
7/16/74	Old Hickory, Tenn.	Xylol	100 gal	Industrial Plant	Cumberland R.	E.I.Dupont Textile Fibers Dept.	Personnel Error Storage Unit Draining
7/17/74	Keystone, South Dakota	Herbicides Amdon & Amixol	Unknown/Highway Transportation Liquid Bulk Spill	Unknown	Inland R. Spring	Nalco Chemical Co., Chicago	Collinsion with Fixed Object
7/18/74	Carbondale, Colorado	Acid	Unknown/Fixed Facility Plant		Eagle River	New Jersey Zinc	Equipment Failur
7/18/74	Durango, Colorado	Pesticide Boytex	Unknown/Fixed Facility Industrial Plant		Lake Pastorian	Unknown	Deliberate Disch to Kill Mosquito

ATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
/18/74	Hodges Gardens, Louisiana	Light Aromatic for Benzene Extraction	Unknown/Highway Transportation Spill. Liquid Bulk.		Inland	Continental Oil Co. Houston, Texas	Collision with Other Car. Knocked Unloading Valve Off.
/20/74	Haylow, Ga.	Muriatic Acid	Unknown/Transportation Rail.	Unknown	Inland	Southern Railroad	Train Derailment.
/22/74	Saranac, Michigan	Chicken Manure	Unknown/Onshore Natural Phenomenon Heavy Rains.	Unknown	Lake Creek	Unknown	NH3 & BOD Killed Fish in Stream.
/22/74	Raleigh, N.C.	Soap	Unknown/Highway Transportation Spill	Unknown	Neuse R.	Malone Freight Line	Truck Accident.
/22/74	Holsopple, Pa.	Magnesium Ore	5,000 gal/Railroad Derailment	Unknown	Stoney Creek	B&O Railroad	None
/22/74	Kayford, West Va.	Coal Slurry	5,000 gal/Onshore Fixed Facility	Unknown	Fork Creek	Bethlehem Mines	Pipeline Break
/23/74	Denver, Colorado	Pesticide	Unknown/Fixed Onshore Industrial Plant	Unknown	Houston Park Lake	Wilhelm Tree Service	Natural Phenomenon Heavy Rains
/23/74	Nathrop, Colorado	Concentrated Chlorine Mixture	Unknown/Fixed Facility A Retail Outlet	Unknown	Chalk Creek	Mount Princeton Hotspring	Deliberate Discharg Killing 31,000 4" Trout
/24/74	Maryville, Tenn.	Nitric Acid	8,000 gal/Tank Truck on Highway	Unknown	Inland	Fleet Transportation Co.	Equipment Failure Gasket Leak
/25/74	Sterling, Colorado	Herbicide	Unknown/Onshore Fixed Facility Industrial	Unknown	Sterling Reservoir	North Sterling Irrigation Co.	Deliberate Discharge to Kill Weeds

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/25/74	San Antonio, Texas	Spent Cyanide Plating Solution	15 gal/Fixed Facility Engine Shop	Fish Kill	Leon Creek	U.S.A.F.	Equipment Failure
7/27/74	Uravan, Colorado	Soda Ash Soloution (30% Conc.)	40 gal/Onshore Transportation High Liquid Bulk.	Unknown	San Miguel R. Inland	Union Carbide	Personnel Error Tank Overflow
7/28/74	Sheboygan, Michigan	Dioctyl Phtalate	6,000 gal/Onshore Fixed Facility. Industrial Plant	Unknown	Lake Michigan	Vinyl Plastic Co.	Cause Equipment Failure
7/29/74	Kinsport, Tenn.	Industrial Waste BOD	100,000 pounds/ fixed facility	Unknown	Holston R.	Tennessee Eastman	High water caused wase pipeline to rupture
7/29/74	Cleveland, Ohio	Industrial Waste	500,000 gallons/ fixed facility ind. plant	Unknown	Cuyahoga R.	E.I. DuPont	Equipment Failure
7/29/74	Mode, Ill.	Polyvinyl Chloride	Unknown/Railroad	Unknown	Inland	Chicago& Eastern Illinois Railroad	car overturn
7/29/74	Willard, Ohio	Arsenic Acid (75%)	800 gallons/ Highway spill	Unknown	Inland	B&O R.R.	Rail tank car leak/ structural failure
7/29/74	Decateur, Ill.	Propane	9,000 gallons/ Railroad spill in water	Unknown	Inland	Norfolk & Western R.R.	Explosion
7/30/74	Cortez, Colo.	Salt Water	100 gallons/ fixed facility, oil well	Unknown	Dolores Creek	Southland Royalty Co.	Soaked in ground
7/30/74	Washington, W. Va.	Ammonium Hydroxide	Unknown/fixed facility, ind. plant	Unknown	Ohio R.	AMAX	Storage tank rup- ture
7/31/74	Gillette, Wy.	Salt Water	Unknown/fixed facility	Unknown	Little Powder R.	Cheveron Oil	Line ruptue sank into ground

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATER AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/31/74	Alcoa, Tenn.	Sulfuric Acid	15,000 gallons/ Highway transportation	Unknown	Inland	Highway Transportation Co.	Truck Accident
8/1/74	Fargo, N. Dakota	Anhydrous Ammonia	Unknown/Transportation/rail transfer	Unknown	Red R.	Burlington Northern R.R.	Equipment failure/ tank leak
8/2/74	Columbus, Ga.	Blue dye	Unknown/city sewer	Unknown	Chattahoochee R.	City	Sewer plugged causing overflow
8/2/74	Baltimore, Md.	Detergent	5 pounds/fixed facility/ind. plant	Unknown	Baltimore Harbor	Proctor & Gamble	Deliberate discharge
8/3/74	Briggsdale, Colo.	Salt Water	8400 gallons/ fixed installation	Unknown		Chevron Oil	Equipment failure internal corrosion
8/4/74	Kingsport, Tenn.	Aniline sulphate, Sulfuric Acid	13,000 pounds/ Industrial fixed facility	Unknown	South Fork Holston R.	Tennessee Eastman Co.	Sump was silted over causing overflow
8/5/74	Fairfield, Md.	Chrome	1600 gallons/ fixed facility industrial plant	Unknown	Patapsco R.	M&T Chemical Inc.	Storage tak rupture
8/6/74	St. Paul, Minn.	Toluene	2 gallons/fixed facility	Unknown	Mississippi R.	Detterman Welding & Tank Service	pipe leak
8/7/74	Columbus, Ga.	Toluene Xylene	6,000 gallons/ highway spill	Unknown	Standing Boy Creek	Marrietta Transport	Truck wreck
8/7/74	Radford, Va.	Sulfuric Acid	40,000 gallons/ fixed facility	Unknown	Inland River	Radford Valley Ammo. Plant	Structural Failure

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/8/74	Baltimore, Md.	Calcium oxide	unknown/fixed facility onshore industrial plant	unknown	Inland stream	Trestolite Gas Co.	None
8/9/74	Atlanta, Ga.	Toluene	110 gal. spilled 0 entered water/ Highway spill. Truck hose ruptured	unknown	Inland	Marietta Transport	
8/9/74	Cleveland, Ohio	Acetic acid 80%	45 gal./Railroad spill/storage drum leaks	unknown	Inland	B & O RR	
8/9/74	Radford, Va.	Crude	252 gal./none entered water/onshore pipeline spill/equipment failure	unknown	White Oak Creek	Eureka Pipeline	
8/11/74	Rico, Colorado	Cyanide	3,000 gal. spilled/ 3,000 gal entered water/Fixed facility Silver mine/holding pond washout	fish killed 10 miles of stream	Doloris Creek	Rico Argent Mine	
8/11/74	Williamstown W. Va.	Hydraulic fluid	1700 gal. spilled and entered water/dry cargo vessel offshore/cause was collision with a fixed object		Ohio R.	Union Mechling	
8/12/74	Philadelphia, Pa.	Caustic Soda	115 gal./Rail liquid bulk/cause personnel error	unknown	Delaware R.	B & O Railroad	
8/12/74	St. Mary Montana	Herbicide Montsanto Avadex BW 10% granular	2000 lbs. spilled but none entered water/Highway transportation dry bulk/Truck accident	unknown	St. Mary R. Co.	Wagoner Trucking	

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8/13/74	Denver Colorado	Purple dye	unknown/unknown	unknown	South Platte R.	unknown	
8/13/74	Nunn, Colorado	Salt water 11,500 mg/l	3,000 gals. spilled/ none entered water/ onshore fixed facility injection line broke	unknown	South Platte R.	Chevron Oil Co.	
8/14/74	Warm Springs, Georgia	Sulphuric Acid	3,000 gal. spilled/ none entered water/ cause onshore transportation/crash between truck and train	unknown	Inland	Chemical Lehman Tank Lines	
8/14/74	Denver, Colorado	Acrylic Acid	55 gal.none of which entered water/Source was highway transportation crash between a truck and a train	unknown	South Platte R.	Burlington Northern Transport	
8/14/74	Mile 46.0 Miss. River Illinois	Toluene	66,000 gal. spilled & entered Miss. River/ Source groundin of tow on Miss.R./Cause equipment failure due grounding	unknown	Miss. R.	T/B CBC 241	
8/14/74	Norfolk Virginia	Caustic Soda	1 gal. spilled, none of which entered water/ Onshore transportation/ Rail liquid bulk/cause was equipment failure	unknown	Elizabeth R.	Norfolk & Portsmouth Beltline R.R.	
8/14/74	Irving Texas	Propanol	500 gal. none of which entered.water/Fixed facility/transfer line/cause line ruptured	unknown	Inland	Drackett Inc.	

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8/20/74	Conshocken Pennsylvania	Oily pulp	unknown/fixed onshore facility/ industrial plant	unknown	Schuylkill R.	Allenwood Steel & paper Company	
8/20/74	Salt Lake City	Ferric Chloride	1,000 gal. none entered water/fixed facility onshore/ bulk storage tank/ transfer line parted	unknown	Jordan R.	Wasatch Chem.	
8/21/74	Moorville N.C.	Foam material	30 gal. spilled and entered water/fixed onshore facility/ industrial	unknown	Reeds Creek	Braymore MFG Co.	
8/21/74	Uravan Colorado	Sovent extraction liqueur	3,000 gal. spilled & entered water/fixed onshore facility/ processing plan/ tank rupture	unknown	San Miquil	Union Carbide	
8/21/74	Erie Pennsylvania	Sulfuric Acid	12,500 gal. spilled/ fixed facility/bulk storage onshore/tank rupture	unknown	Lake Erie	Pennsylvania Electric Co.	
8/21/74	Magna Utah	Slate Lime	100,000 lbs spilled into water/fixed facility/processing plant/bypass valve left open at treatment plant	unknown	Great Salt Lake	Kennecot Copper Company	
8/22/74	Eldred Pennsylvania	Unknown Caustic	unknown/onshore fixed facility/bulk storage/ equipment failure	unknown	Indian Creek	Suspected Pennzoil	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/22/74	Buffalo N. Y.	Toluene	400 gal. spilled 250 gal. entered water/fixed onshore facility/was washed into storm sewer to reduce fire hazard	unknown	Inland R.	Allied Chem.	
8/23/74	Fairfield Maryland	Light Gray Film unknown	unknown/onshore fixed facility	unknown	Curtis Cr.	Amoco Oil	
8/24/74	Oil Hickory Tennessee	DMT & Xylol	100 gal. spilled/ 20 gal. entered water	unknown	Cumberland River	Dupont	
8/24/74	Annville Pennsylvania	Turpentine	unknown/transportation/bulk rail/ wreck	unknown	Inland	Reading RR	
8/26/74	Philadelphia Pennsylvania	Amylase	1,200 gal. ind. plant, deliberate discharge into sewer	unknown	Inand	Publishers Industries Co.	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
8/27/74	Brighton, Utah	raw sewage	500 gal. drain hose of vault tank unattended personnel error		Big Cottonwood Creek	Mr. Gordon Jensen	
8/28/74	Rangely, Colorado	salt water	quantity unknown oil production activity, well head on fire			Chevron Oil Co.	
8/30/74	Finleyville, Penn.	Sodium hydroxide	1000 gal. derailment, deliberate discharge		inland river	Chessie System	
9/6/74	Alvin, Texas	brine water	quantity unknown from disposal well			Amco Chem. Co.	
9/9/74	Helena, Montana	phosphoric phosphate soln.	quantity unknown derailment			Burlington Northern RR	
9/10/74	Baltimore, Md	tolune-di-iso-cyanate	55 gal. drum rupture, personnel error			Chessie System	
9/11/74	Cumberland, Ohio	ammonium nitrate	quantity unknown derailment			B & O RR	
9/11/74	Crossett, Arkansas	phenol & formaldihyde resin	3000 gal. industrial plant, incorrect valve handling		Brushy Creek	Georgia Pacific Corp.	
9/13/74	Seattle, Washington	PCB	260 gal. transformer fell		Coastal Durvanish Waterway	U.S. Air Force	
9/13/74	Nacogdoches Texas	acid	unknown quantity ind. plant, natural phenomenon, heavy rain			Texas Farm Products Company	

DATE	LOCATION	MATERIAL	QUANTITY/SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
9/17/74	Englewood, Colorado	cyanide	unknown quantity, passed through treatment plant	small fish kill	South Platte	unknown	
9/18/74	Salt Lake Utah	blood	900 gal, truck accident			Intermountain	
9/18/74	Galena Park, Texas	C-7 C-9 alcohol	9000 gal., personnel error, incorrect valve, bulk storage		Panther Creek	Chem. Exchange Co.	
9/19/74	Winslow, Washington	pentachloro phenol 5% aromatic oils	500 gal., ind, plant			Wykoff Wood Treatment Plant	
9/21/74	Gillette, Wyoming	saltwater	1260 gal. ind, plant equipment failure			Chevron Oil Co.	
9/21/74	Grambling. La.	15% & 28% acid	1250 gal., truck overturn			Dowell Chem. Co.	
9/22/74	Swiekley Penn.	acid waste	quantity unknown, natural seepage at ind, plant			Mil Service, Inc.	
9/23/74	Bay City, Mich.	benzene	100-150 gal., vessel, personnel error, back pressure on transfer pump		Saginow R.	M/V Bow Rogen	
10/2/74	Magna, Utah	sulfuric acid	quantity unknown, copper smelter, break in acid line			Kennecott Copper	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
10/7/74	Minn. Knife River	paint	Quantity unknown personnel error during bridge construction			Duluth, Mesabe, Iron Range RR	
10/10/74	Ill., Zion	Anhydrous ammonia	90,000 lb. derailment			Chicago & Northwestern Transportation	
10/15/74	Virginia Radford	sulfuric acid	3,000 gal./ind. plant, structural failure, tank rupture		New River	Hercules Inc.	
10/16/74	Ind. E. Chicago	hydrochloric acid	quantity unknown, possibly deliberate			Youngstown Sheet & Tube	
10/17/74	Alaska Cape Omaney	area pellets anhydrous ammonia	4,500/9,000 tons barge sinking	some aquatic mortality & browning of trees in area	Snipe Bay	Collier Chem. Co.	
10/21/74	Ill., Roadhouse	dimithylamine	quantity unknown equip. failure (valve)			Ill. Central Gulf RR	
10/23/74	Utah Magna	sulfuric acid	quantity unknown equip. failure			Lemmocptt Copper Co.	
10/24/74	Minn. Rochester	fungicide Nalco-21	quantity unknown personnel error, hospital, flushing airconditioner		cascade	St. Marys Hosp.	
10/25/74	Ind. Lafayette	Traflan(herbicide)	500 gal./ind. plant, personnel error, tank overflow			Eli Lilly	
10/28/74	Minn. Duluth	paint	2 gal. deliberate discharge from vessel		Lake Superior	Vessel MV Atlantic Charity (owner unknown)	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
10/29/74	Marietta, Ohio	Phenol	800 gallons/ ind. plant, pump failure		Ohio R.	Union Carbide	
10/29/74	Littleton, Colo.	Nitric Acid (57%)	100 gallons/ tank truck, hose rupture			Moly Corp.	
10/29/74	Rangely, Colo.	Saltwater (1,000 ppm)	84,000 gallons/ ind. plant, equipment failure			Chevron Oil	
10/30/74	Charleston, W. Va.	Butyraldol Carbon Tetra- chloride	4,500 pounds/ ind. plant, condenser leak		Kanawaha R.	Union Carbide	
10/30/74	Lockport, Ill.	Xylene based substance	1,000 gallons/ warehouse, deliberate dis- charge		Des Plains R.	TPG Enterprises, Inc.	
10/30/74	Kiln, Miss.	Potassium Phosphorous Sodium	3,500 pounds/ leakage from buried container			Ingram Explosive Devices, Inc.	
11/5/74	Cincinnati, Ohio	Vinyl Acetate	7,000 gallons/ rail collision			C&O R.R.	
11/5/74	Dunkirk, N.Y.	Nitric Acid	600 gallons/ truck, flange failure				
11/6/74	Ponce de Leon, Fla.	Ammonium Nitrate Sulfuric Acid	Unknown/ derailment			L&N R.R.	
11/7/74	Magna, Utah	Smelter process water	72,000 gallons/ junction box overflow, equip. failure		Great Salt Lake	Kennicott Copper Co.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/8/74	Aneth, Utah	reinjection salt water	84,000 gallons/ oil well, equip. failure (line broke)			Texaco, Inc.	
11/8/74	Old Hickory, Tenn.	D.M.T. waste	Unknown/ind. plant, dike wall leak			DuPont	
11/9/74	Jackson Township, Ohio	Cresol oil	1,500 gallons/ tank truck rupture, equip. failure			Chem. Leaman Tank Lines	
11/10/74	Swamonoa, N.C.	Acetic Acid	4,000 gallons/ind. plant, storage tank rupturo			Beacon Mfg. Co.	
11/11/74	F. Collins, Colo.	Raw sewage	Unknown/waste treatment plant, line break		Cache La Poudre	City of Fort Collins	
11/11/74	Dearborn, Mich.	Propionic Acid	20 gallons/tank car, line leak			Chessie System	
11/12/74	Hopewell, Va.	Toluene	180 gallons/ind. plant		Grindall Creek	DuPont	
11/14/74	Denver, Colo.	Digested sewage sludge	280,000 gallons spilled 100,000 gallons entered water		S. Platte R.	Denver Metro Sewage Treatment Plant	
11/15/74	Harper, Ga.	Acetic Acid Hexamuthylene Diamine	15 gallons/ derailment			Southern R.R.	
11/16/74	Lodi, Ohio	Liquid Latex	51,000 gallons/ derailment			B&O R.R.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/16/74	Savannah, Ga.	Foam (unknown type)	Unknown		Savannah R.	Unknown	
11/16/74	Trion, Ga.	PCB C-10 oil	600,270 gallons/ truck accident			General Electric Co.	
11/19/74	Mansoy, S.C.	Acrylonitrile	10 gallons/tank car structural failure			Seaboard Coastline	
11/20/74	Chattanooga, Tenn.	Styrene	Unknown/non-transportation cause			Tennessee River Terminal	
11/22/74	Douglas, Wy.	Salt Water	Unknown/oil well equip. failure (retention dike seepage)			Texaco Oil Co.	
11/22/74	Smackover, Ark.	Nitric Acid	12,000 gallons/ derailment		Smackover Creek	Missouri Pacific R.R.	
11/23/74	Neola, Utah	Hydrochloric Acid (28%)	2,000 gallons spilled 1,000 gallons entered water/truck accident		Unita R.	B&J, Inc.	
11/26/74	Memphis, Tenn.	Sodium Hydroxide	1,000 gallons spilled 100 gallons entered water/storage tank rupture		Non Connahrl Creek	Valley Products Co.	
11/26/74	Aneth, Utah	Salt Water	33,600 gallons/oil well, equip. failure (plug rupture)			Texaco, Inc.	
11/28/74	Blackhawk, Colo.	Mill Tailings	Unknown/natural phenomenon (wash out)			Golden Gilpen Mine	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/1/74	Harlem, Montana	Mill Tailings	Unknown/natural phenomenon (heavy runoff)		Inland R.	Unknown	
12/2/74	Whitting, Ind.	Phenol	2,000 pounds/ ind. plant, pump failure		Lake Michigan	American Oil Co.	
12/3/74	Midland, Pa.	Phenol	Unknown/ind. plant		Ohio R.	Crucible Steel Corp.	
12/5/74	Wash., D.C.	Iodine-123	Unknown/airport personnel error (package crushed)			National Airport	
12/6/74	Munsing, Mich.	Butadiene Nitrile	500 gallons/ind. plant, line rupture			Kimberly Clark Corp.	
12/6/74	Radford, Va.	Toluene	Unknown/tank car valve failure			Radford Army Arsenal	
12/6/74	Arlington, Va.	Varsol	Unknown/non-transportation storage tank failure			Larry Buick Co.	
12/7/74	Munsing, Mich.	Butadiene Nitric Laytex	300 gallons/tank car line rupture		inland pond	Kimberly Clark Corp.	
12/9/74	Cleveland, Ohio	Toluene	5,000 gallons spilled 200 gallons entered water/bulk storage equip. failure		Aujahoga R.	Aujahoga Chem. Co.	
12/10/74	Goliad, Texas	Fatty Alcohol	13,675 gallons/ derailment			Southern Pacific R.R.	
12/12/74	Front Royal, Va.	Phosphorous Acid	Unknown/ind. plant personnel error			FMC Co.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
12/12/74	Old Fort, N.C.	Lacquer	1,000 gallons/ ind. plant, deliberate discharge		inland stream	Ethan Allen Furniture Co.	
12/13/74	Lake Whiting, Ind.	Phenol	2,200 pounds/ ind. plant equip. failure		Lake Michigan	Standard Oil	
12/14/74	Cincinnati, Ohio	Sodium Hydroxide Potassium Manganate	2,300 gallons/ind. plant, broken flange		Mill Creek	Emery Industries	
12/15/74	Bristol, Pa.	Unknown	1,800 gallons/ ind. plant, improper connection		Black Ditch Creek	3-M Company	
12/16/74	Odenville, Ala.	Telone	60 gallons/rail car leaking drums personnel error			Seaboard Coastline R.R.	
12/16/74	W.Va.	Ammonium Nitrate	2,000 pounds/ derailment			Western Maryland R.R.	
12/18/74	Salt Lake City, Utah	Sulfuric Acid	13,320 gallons/ tank car, incorrect switching			Union Pacific R.R.	
12/18/74	S. Carolina	Plastasol	200 gallons spilled 100 gallons entered water/ind. plant		Saluda R.	J.P. Stiphens	
12/24/74	Moab, Utah	Unknown	1,900 gallons/ oil production, personnel error		Colorado R.	Flying Diamond Corp.	
12/26/74	Ashtabula, Ohio	Monochlorobenzene (50%)	20 gallons/ind. plant, tank allowed to overflow		Fields Brook	Olin Corporation	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE
12/27/74	Highland Heights, Ohio	Sulfuric Acid (20%)	1500 gallons/ind. plant, valve failure		Euclid Creek	Grumman Corporation
12/30/74	St. Louis Park, Minn.	Various pesticides	30,000 pounds/ ind. plant			Androc Chem.

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/27/74	Springdale, Pa.	Paint	5 gallons/ storage tank, structural failure		Allegheny R.	PPG	
3/6/74	Mt. Savage, Md.	Grain corn	Unknown/ derailment			Western Md. R.R.	
3/20/74	Hayden, Colo.	Drilling mud	Unknown/storage lagoon, structural failure		Sage R.	Benson, Morton, & Greer Drilling Co.	
3/21/74	Portland, Maine.	Animal tallow	25 gallons		coastal port		
4/9/74	Mt. Storm, W. Va.	Molasses	Unknown/tank truck accident			Southern States Corp.	
4/11/74	Oologah, Oka.	Mils & wheat (feed grain)	Unknown/rail car derailment			Missouri Pacific R.R.	
4/21/74	Darby, Pa.	Grain corn	140,000 pounds/ derailment			B&O R.R.	
5/2/74	Cleveland, Ohio	Steel industrial wastewater	Unknown/ind. plant, rake in thickener jammed		Cujohoga	U.S. Steel	
5/2/74	Milwaukee, Wis.	Line tracing dye	Unknown/ind. plant, deliberate discharge		Industrial ditch	General Electric	
5/16/74	Frisco, Colo.	mud	Unknown/ind. plant, deliberate discharge		Ten Mile (inland stream)	Cumax Molybdenam	
10/3/74	Frisco, Colo.	mud & salt water	Unknown/truck, deliberate discharge		Ten Mile (inland stream)	Colorado State Highway Department	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
6/4/74	Plymouth, Mich.	corn syrup	8,000 gallons/ derailment			Chessie System	
6/4/74	Charleston, W. Va.	coal slurry	500 gallons/ mining operation, gasket failure		Ten Mile Fork (inland stream)	Bethlehem Mines	
6/6/74	Ellsworth, Pa.	coal slurry	3,000 gallons/ coal mine, line blockage		Pigeon Creek	Bethlehem Mines	
6/23/74	Defiance, Ohio	Freon	Unknown/derailment			B&O R.R.	
6/29/74	Cherryhill, N.C.	Calgon Cat Floc T	500 gallons/non-transportation, personnel error		Long (inland stream)	Lithium Corporation of America	
7/2/74	Jacksonville, Fla.	Sewage	Unknown		Broward R.	Anhauser Busch	
7/4/74	Epon, La.	liquified gas (natural gas)	420 gallons/ pipeline rupture		inland stream	Continental Oil Co.	
7/5/74	Warrenton, Ind.	salt brine	Unknown/oil drilling, equip. failure, corrosion			Melvin Drilling Co.	
7/5/74	Milwaukee, Wis.	water soluble black	300 gallons/bulk tank overflow, personnel error		inland stream	A.O. Smith Corporation	
7/9/74	Wheeling, Ind.	salt brine	630 gallons/oil production, equip. failure (corrosion)		Yellow Creek	Cherokee Drilling Co.	
7/11/74	Chillicothe, Ill.	molasses	800,000 gallons/ barge collision			Sioux City of New Orleans	
7/16/74	Detroit, Mich.,	Hydrochloric Acid	10 gallons/highway truck hose rupture			Midwest Chrome Process	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
7/19/74	Yorktown, Va.	Paint	Unknown/bridge construction personnel error		York R.	Burgess Bros. Painting	
7/28/74	Wash., D.C.	sewage	Unknown/personnel error	fish kill	Potomac	Blue Plains Plant	
7/30/74	Kayford, W. Va.	coal slurry	90,000 gallons/ ind. plant, line blockage		Cabin Creek	Bethlehem Mines	
7/31/74	Kayford, W. Va.	coal slurry	500 gallons/ind. plant, line blockage		Cabin Creek	Bethlehem Mines	
8/2/74	Connersville, Ind.	white porcelain sludge	55 gallons/ind. plant, personnel error			Philco Ford Co.	
8/3/74	Ratliff City, Oka.	salt water	3,150 gallons/non-transportation, injection line broke			Conoco	
8/14/74	Ratliff City, Oka.	salt water	1,260 gallons/ind. plant, equip. failure, corrosion		Caddo Creek	Continental Oil Co.	
8/19/74	McComb, Ohio	sugar	Unknown/ind. plant, fire	extensive fish kill	Portage R.	Food Packaging, Inc.	
8/26/74	St. Louis, Mo.	sewage	30 gallons/deliberate discharge		Mississippi R.	Sauget Waste Treatment Plant	
8/28/74	W. Va.	black water	800 gallons/ind. plant, pump failure		Cabin Creek	Bethlehem Mines	
8/29/74	Burlington, Vermont	molasses	200 gallons spilled 5 gallons entered water/ind. plant improper hose connection		Lake Champlain	A.D. Tease Grain Co.	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
9/20/74	Hartford City, Ind.	pulp water	2,000 gallons/ ind. plant, valve failure		Little Lick R.	3-M Company	
9/22/74	Baltimore, Md.	wheat	Unknown/railroad car overturn			Chessie System	
10/9/74	Milwaukee, Wis.	isopropyl alcohol	400 gallons/tank truck, incorrect valve handling			Ashland Chemical Co.	
10/15/74	Chicago, Ill.	red sediment	50 gallons/ind. plant		Calmet R.	Republic Steel	
11/7/74	Milwaukee, Wis.	coal dust	25 pounds/non-transportation, personnel error		Menomee R.	Hometown Coal Co.	
11/10/74	Cleveland, Ohio	industrial waste	18,000 pounds spilled 8,000 pounds entered water/equip. failure		Cujahoga	DuPont	
11/12/74	Farmington, Minn.	milk	6,000 pounds/leak in cooling system			Mid America Dairymen, Inc.	
11/12/74	Racine, Wis.	sand & water	20 gallons/ind. plant, equip. failure (pump)		Lake Michigan	J.S. Case	
11/19/74	Baltimore, Ohio	mill effluent	8,500 gallons/ ind. plant, valve leak		unnamed stream	Crown Fullerbach Corp.	
11/20/74	Waukegan, Ill.	brown substance	Unknown/ind. plant		Lake Michigan	U.S. Steel	
11/22/74	Porter, Ind.	dunnage	10 gallons/ foreign vessel deliberate discharge		Port Michigan	M.V. Veshva Kirti	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
11/25/74	Princeton, Ill.	sodium lauryl sulfate (shampoo base)	5,011 gallons/ truck accident			Transport Service Co.	
12/8/74	Minneapolis, Minn.	calcium sulfate	200 gallons/ ind. plant			Superior Plating Co.	
12/10/74	Old Hickory, Tenn.	organic material	400 pounds/ ind. plant, heavy rains		Cumberland R.	DuPont Textile Fibers Department	
12/12/74	Van, W. Va.	coal chaning water	500 gallons/ coal mine, line leak		West Fork of Pond Fork	Bethlehem Mines	
12/28/74	Wanamingo, Minn.	whey	40,000 pounds/ highway accident			Land O' Lakes	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
1/11/75	Buffalo River, Tenn.	Sulfuric Acid	9,000 gal truck accident		Buffalo River		
1/25/75	Susquehanna River, Pa.	Paint Thinner	40,000 gal capsizing		Susquehanna River		
1/28/75	Evitts Run, West Va.	Unknown	3,000 gal fire	None Reached Water	Evitts Run		
1/28/75	Wilmington, Delaware	Carbon Black	5,000 lbs	None Reached Water			
1/29/75	Beaver Dam, Maryland	Varsol	700 lbs	350 lbs Reached Water	Unknown		
1/30/75	Kanawha River, West Va.	Sulfuric Acid	100 lbs reached tank overflow		Kanawha River		
1/30/75	Piscataway Creek, Md.	Unknown	1,000 lbs improper hose connection	1,000 lbs Reached Water	Piscataway Creek		
2/10/75	Otter River, Virginia	Sodium Hydroxide	25,000 gal capsizing	25,000 gal Reached River	Otter River		
2/12/75	Claysville, Pa.	Styrene	1,600 lbs spilled vehicle collision	100 lbs Reached Water	Buffalo Creek		

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGE	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
2/14/75	Fishing Creek, West Va.	Coal	100,000 lbs. capsizing	100,000 lbs Reached Water	Fishing Creek		
2/20/75	Buskill Stream, Pa.	Iron Oxide	300 lbs	Unknown	Buskill Stream		
2/24/75	A Tributary in Va.	Polyester Resin	10 lbs spilled capsizing	0 lbs entered	Tributary		
2/25/75	Little Coal River, W.Va.	Black Coaling Water	6,500 lbs pump failure	Unknown	Little Coal River		
3/2/75	Fauquier Co., Va.	Unknown	50 lbs vandalism	Unknown	Broad Run	Vandals	
3/18/75	Van, West Va.	Black Water	200 gal explosion	200 gal Entered Water	West Fork of Pond Fork		
3/19/75	Curtiss Bay, Md.	Unknown	1,000 lbs spilled	Unknown	Curtiss Bay		
3/20/75	Wierton, West Va.	Hydrochloric Acid	500 lbs spilled collision	500 lbs Reached Water	Stream		
4/2/75	West Virginia	Black Water	500 gal	500 gal Reached Water	10 mile fork of CAB		
4/4/75	Piedmont, West Va.	Chlorine	180,000 lbs capsizing	0 Reached Water	Potomac		
4/18/75	Van, West Va.	Black Water	1,000 gal pipeline ruptured	1,000 gal Reached Water	West Fork of Pond River		

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
4/18/75	Baltimore Harbor	Fatty Alcohol	20,781 gal vandalism	20,781 gal Entered Water	Baltimore Harbor	Vandalism	
4/21/75	Van, West Va.	Black Water	800 gals pipeline rupture	Unknown	West Fork of Pond Fork		
4/22/75	Bluestone R., Va.	Liquid Ammonia	1 lb	Unknown	Bluestone R.		
5/2/75	Indiana	Sodium Hydroxide	1 gal tank overflow	Fish Kill	Little Laughery Creek		
5/6/75	Farina, Indiana	Fertilizer	6,000 gal corrosion pipeline	Unknown	Stream	Williams Pipe-Line Co. PO Box 9339 Tulsa, Oklahoma 74107	
5/6/75	Indiana	F8253 starter	750 gal improper hose connection	750 gal Reached Water - Fish Kill	Center Run		
5/11/75	Maryland	Ammonia	Unknown Quantity tank leak	Unknown	Unknown		
5/14/75	Lemont, Illinois	Unknown	500 gal (defective valves in tank truck)	Unknown	Tributary		
5/19/75	Etna Green, Indiana	Liquid Fertilizer	1,000 gal capsizing	Unknown	None	Custer Grain Co. Garrett, Indiana 46738	

DATE	LOCATION	MATERIAL	QUANTITY/ SOURCE	DAMAGES	WATERS AFFECTED	COMPANY RESPONSIBLE	REMARKS
5/26/75	Essex, Md.	Roofing Tar	1 gal	Unknown 1 gal Reached Water	Hopkins Creek	Mr.Jerome North 305 Sassafras Rd Essex, Md. 21221	
5/29/75	Pennsylvania	Fertilizer 32% N	49,000 lbs capsizing	Unknown 0 lbs Reached Water	Tributary		
6/1/75	West Virginia	Phosphorus Trichloride	170 gal on shore trans.	85 gal Reached Water	Monongahela River		
6/5/75	Baltimore, Md.	Nitric Acid	13 gal leak	1 gal Reached Water	Chesapeake Bay		
6/5/75	Salisbury, Md.	Asphalt	1,500 gal	1,500 gal Reached Water	Wicomica River	Vandalism	
6/11/75	Rockville, Md.	Chloride	1,000 gal seal on truck leaked	Unknown	Unknown		
7/3/75	Baltimore Harbor, Md.	Hydrochloric Acid	55 gal drum leaked	Unknown	Baltimore Harbor		
7/16/75	Delaware River	Unknown	500 gal pipeline flange leak	Unknown 500 gal Reached Water	Delaware River		
7/25/75	Kayford, West Va.	Black Water	3,000 gal heavy rains	Unknown	White Oak Creek		
7/29/75	Roanoke, Virginia	Laquer Thinner	4,000 gal capsizing truck accident	4,000 gal Reached Water	Roanoke River		
8/6/75	Eddystone, Pa.	Ilmenite (Fe-Ti ore)	165 lbs derailment	0 lbs Reached Water	None		