Analysis of U.S. Oil Spillage

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Executive Summary

As shown in Figure A, total petroleum industry spillage has decreased consistently over the last 40 years. Seventy-seven percent less oil is spilling since the 1970s and 46% less since the previous decade.

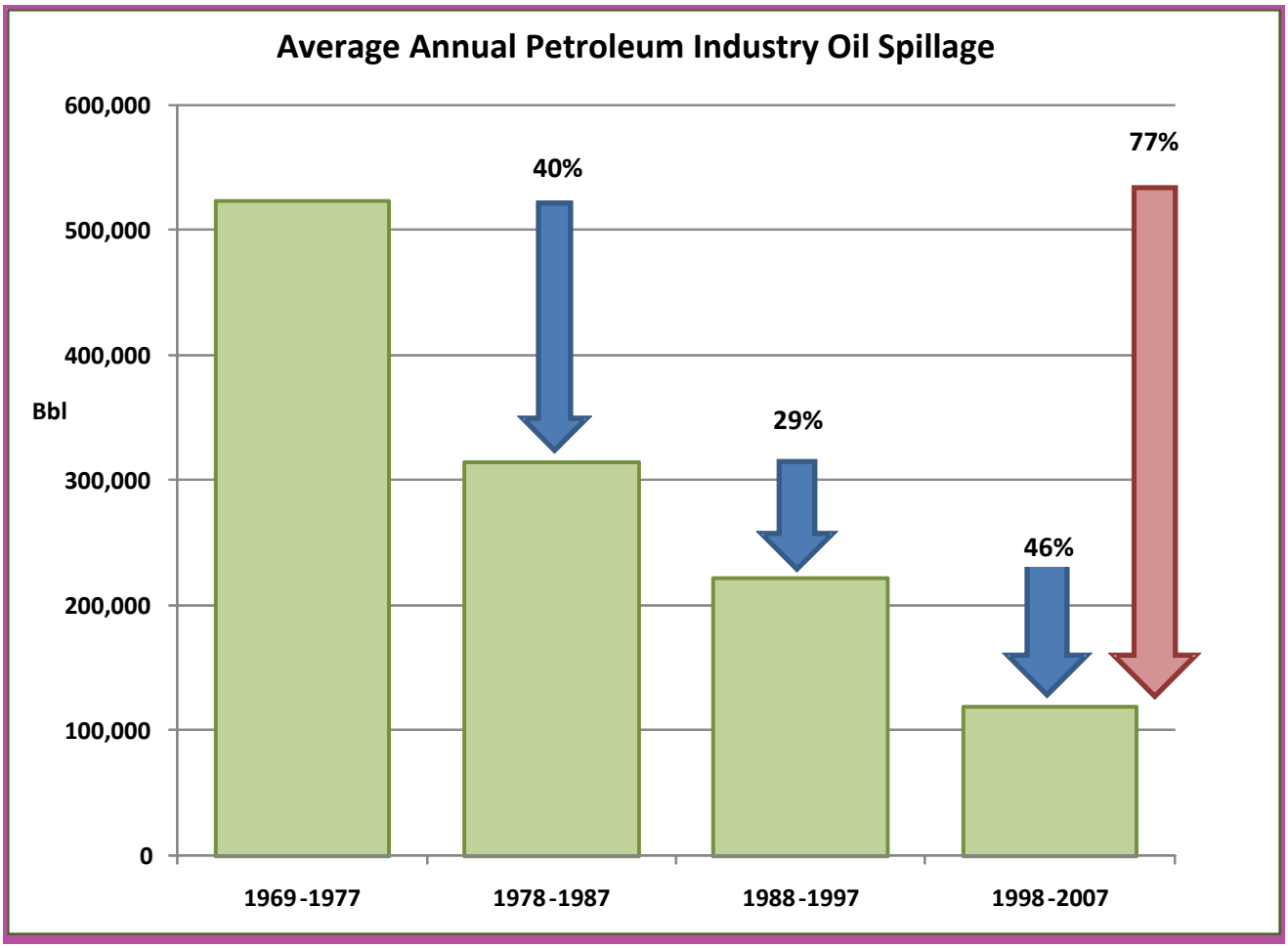

Figure A: Average Annual Oil Spillage from Petroleum Industry Sources by Decade

Average annual oil spillage from petroleum industry sources, including: spillage related to oil exploration and production platforms and offshore pipelines; spillage from coastal and inland pipelines, spillage from oil transport by tank vessels, railroads, and tanker trucks; spillage from oil refineries; and spillage at gas stations.

In the last decade, on average, 2.017 billion barrels of crude oil were produced domestically, and 4.082 billion barrels of crude oil and petroleum products were imported annually. *For each barrel of crude oil either domestically produced or imported from foreign sources, 0.00003barrels spilled from all sources – of which 60.8%, or 0.00002 barrels, spilled from petroleum industry sources.*

In the last decade, an average of 7.3 billion barrels[1] of oil were "consumed" each year in the U.S. Oil consumption can be viewed as a measure of the amount of oil that is transported, stored, and handled each year. *In the last decade, for every barrel of oil "consumed" in the U.S., 0.000027 barrels[2] spilled from all sources and 0.000016 barrels spilled from petroleum industry sources.*

In the Upstream sector, oil spillage from offshore platforms has decreased by 30% from the previous decade and by 95% since the 1970s. Overall average annual oil spillage from offshore exploration and production

[1] Based on Energy Information Administration data.
[2] This is the equivalent of 3/1000th of an ounce for every gallon of oil consumed.

activities has decreased by 61% from the previous decade and 87% from the 1970s. On the basis of unit production, oil spillage has decreased by 71% since the previous decade and 87% from the 1970s. Had the rate of spillage from 1969-1970 continued, an additional 516,000 barrels of oil would have spilled.

In the Marine sector, oil spillage from tankers has decreased by 91%, and from tank barges by 76% since the previous decade. Spillage from tank vessels (tankers and tank barges combined) per unit oil transported has decreased by 71% from the last decade.

In the Pipeline sector, oil spillage has decreased 35% since the previous decade, with even greater reductions in pipeline rights-of-way.

In the Refining sector, oil spillage from refineries has decreased by 19% from the last decade, and 27% when taken on the basis of per-unit oil processing or throughput.

In the Downstream sector, oil spillage from petroleum industry gas stations and truck stops has been reduced by nearly 48% from the previous decade.

For the last decade, production-related spillage was less than 0.9% of the amount released from natural seeps. Total spillage from all sources was less than 11% of the amount released in natural seeps. In other words, over nine times as much oil was released from natural seeps as was spilled from all sources.

Overall, petroleum industry-related spillage represented 60.8% of total spillage from all sources (including non-industry sources related to oil consumption and usage) during the last decade. Over the last decade, total petroleum industry spillage was 10.6% of the amount released in natural seeps. Natural seeps released nearly nine times as much oil as the total of petroleum industry spillage.

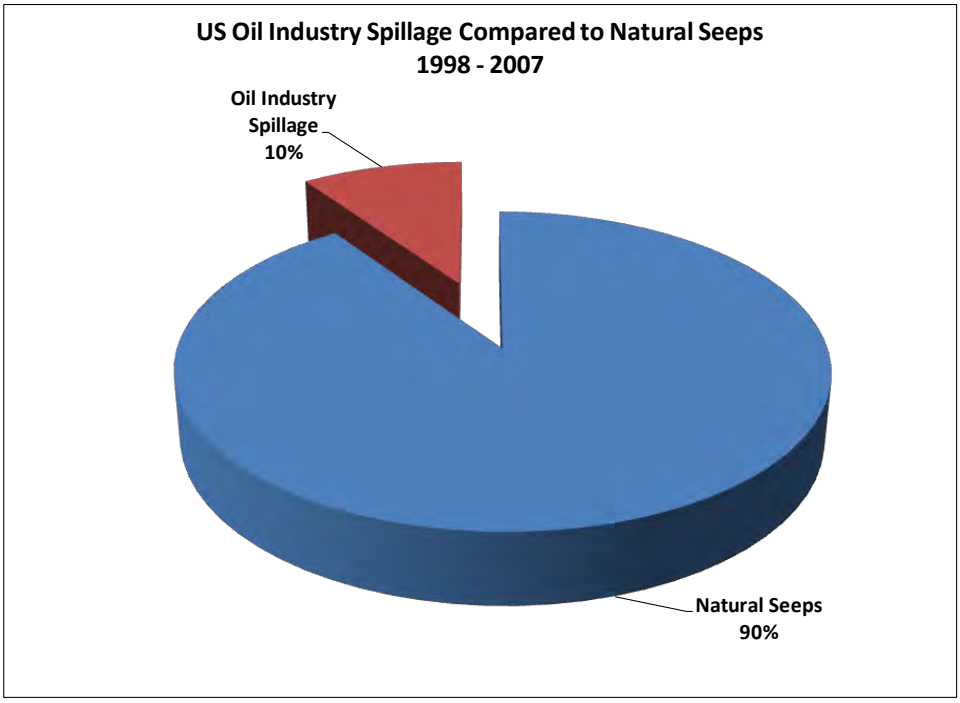

Figure B: U.S. Oil Industry Spillage Compared to Natural Seeps

Introduction

Public awareness and concern about oil spills has been high over the last two decades. Periodically, public distress heightens with media coverage of incidents in the U.S., such as the *M/V Cosco Busan* spill[3] in San Francisco Bay, or even with events outside the U.S., such as the Prestige spill off the coast of France. Potential plans for opening U.S. offshore and Arctic regions for oil exploration and production have again caused great concern. The best approach to rationally evaluating the merits of these concerns is to look at the facts.

Having just passed the fortieth anniversary of the Santa Barbara well blowout that was a major impetus for the environmental movement in the U.S., and just after the twentieth anniversary of the *Exxon Valdez* spill on 24 March 2009, there is a great deal of *good news* with regard to oil spills. Despite the publicity of the recent *Cosco Busan* spill, spill rates are down across the board. The implementation of prevention-oriented regulations and voluntary industry initiatives has combined to reduce spillage dramatically. *But these facts do not often reach the level of public awareness.*

The analyses in this report examine oil spillage and other oil inputs into U.S. waters from all angles – from the spills of greatest public concern, those from the oil industry's tankers and offshore production platforms, to the spills attributable to public consumers – from leaking automotive oils, which input more than oil into U.S. waterways annually than the *Exxon Valdez* spill did. The spillage from all industry and consumer sources is put into perspective with natural seepage of oil in offshore and coastal waters, which adds the equivalent of 11 Santa Barbara well blowouts worth of oil to U.S. marine waters annually. Legally-permitted operational oil inputs from refinery effluents and offshore produced water are also analyzed.

These data analyses will provide factual scientific perspectives for rational decision-making and public education.

Note: Key terms of reference and definitions of "waterways", as applied in this report, are presented in the Appendices.

Note: Table data are rounded to produce whole figures; any apparent arithmetic errors in sums are the result of such rounding.

[3] The container vessel Cosco Busan spilled bunker fuel after a collision with a bridge. This vessel carried oil as fuel and for operations only. It was not an oil tanker and not a petroleum industry source. This spill appears under the "consumption of oil" as a non-tank vessel in these analyses.

Natural Oil in the Environment: Seeps

The U.S. has proved oil reserves[4] of about 21.32 to 30.46 billion barrels.[5] Some of this crude oil is naturally discharged each year from "natural seeps", natural springs from which liquid and gaseous hydrocarbons (hydrogen-carbon compounds) leak out of the ground. Oil seeps are fed by natural underground accumulations of oil and natural gas (U.S. Geological Service).[6] Oil from U.S. sub-marine (and inland subterranean) oil reservoirs comes to the surface each year, as it has for millions of years due to geological processes (Figure 1).

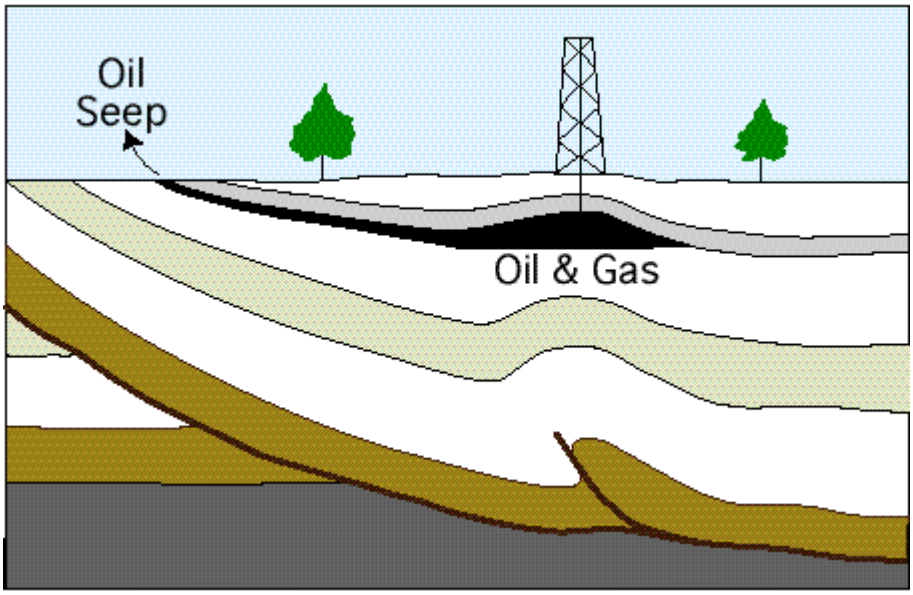

Figure 1: Seepage of oil to surface

Oil and gas seeps are natural springs where liquid and gaseous hydrocarbons (hydrogen-carbon compounds) leak out of the ground. Whereas freshwater springs are fed by underground pools of water, oil and gas seeps are fed by natural underground accumulations of oil and natural gas (U.S. Geological Service diagram).

Natural discharges of petroleum from submarine seeps have been recorded throughout history going back to the writings of Herodotus[7] and Marco Polo.[8] Archaeological studies have shown that products of oil seeps were used by Native American groups living in California - including the Yokuts, Chumash, Achomawi, and Maidu tribes - well before the arrival of European settlers.[9]

In recent times, the locations of natural seeps have been used for exploration purposes to determine feasible locations for oil extraction. The magnitude of natural seeps is such that, according to prominent geologists, Kvenvolden and Cooper (2003), "*natural oil seeps may be the single most important source of oil that enters the ocean, exceeding each of the various sources of crude oil that enters the ocean through its exploitation by humankind.*" Worldwide, natural seepage totals from about 4.2 million barrels to as much as 14 million barrels annually. In U.S. waters, natural seeps are also the largest source of oil inputs.

[4] Proved oil reserves are estimated quantities that analysis of geologic and engineering data demonstrates with reasonable certainty are recoverable under existing economic and operating conditions.
[5] *BP Statistical Review 2008* estimates 30.46 billion barrels (for year end 2007); *Oil & Gas Journal* estimates 21.317 billion barrels (1 January 2009).
[6] http://geomaps.wr.usgs.gov/seeps.
[7] Lees 1950.
[8] Levorson 1954.
[9] Hodgson 1987.

Each year an estimated 1,123,000 barrels of crude oil[10] seeps from geologic formations below the seafloor into U.S. waters, mainly in the Gulf of Mexico and off southern California. This estimate is detailed in Table 1.

Table 1: Natural Seepage of Oil in U.S. Waters			
U.S. Region	**Estimated Annual Barrels of Seepage (NRC 2003)**		
	Low	**High**	**"Best Estimate"**
Alaska	2,520	8,400	2,800
Pacific Ocean (South California)	119,000	140,000	140,000
Gulf of Mexico	560,000	1,400,000	980,000
Total	**681,520**	**1,548,400**	**1,122,800**

Figure 2 shows reported oil seeps in the Gulf of Mexico. Figures 3 and 4 show reported oil seeps off southern California. Figure 5 shows reported oil seeps off Alaska.

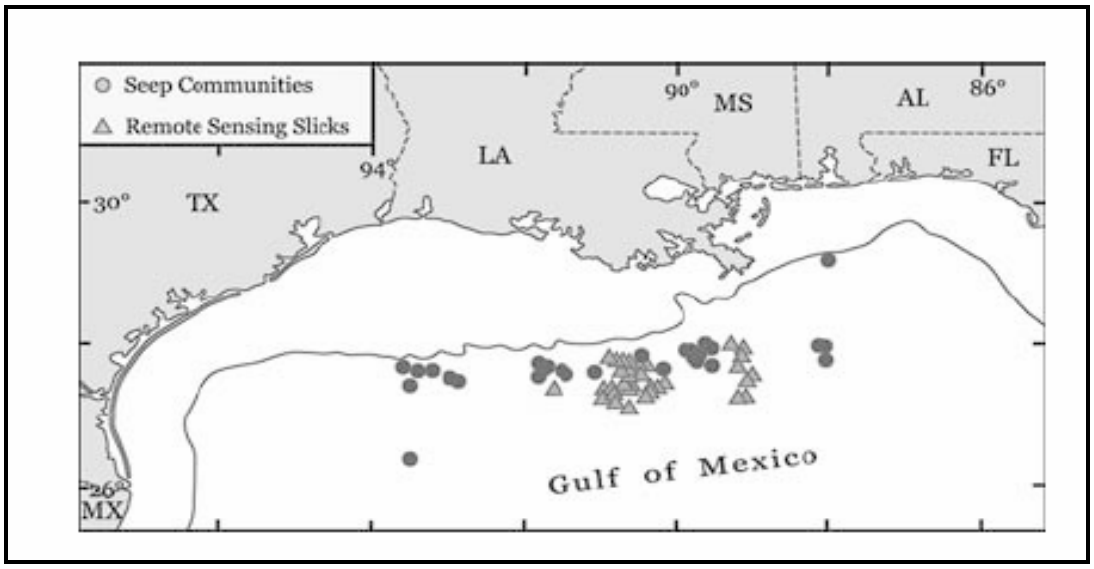

Figure 2: Reported Oil Seeps in the Gulf of Mexico[11]

A number of natural seeps have been identified in the Gulf of Mexico off of Louisiana and Texas.

While regional assessments of natural seepage have been conducted in some locations, particularly nearshore in California,[12] the Indian Ocean,[13] and in the U.S. Gulf of Mexico,[14] the most comprehensive worldwide assessment of natural seepage is still the study conducted by Wilson et al. (1974). Even the two more recent international assessments of oil inputs into the sea[15] relied heavily on the estimates of natural oil seepage conducted by Wilson et al. (1974), having found no more recent comprehensive studies.

Assessments for natural oil seepage involve few actual measurements, though certain seep locations along the southern California Pacific coast have been studied to some extent. Natural seep studies have also included identification of hydrothermically-sourced hydrocarbons (especially polycyclic aromatic hydrocarbons) in sediments. The most well-known studies have relied on estimation methodologies based on field data, observations, and various basic assumptions.

[10] Estimates based on analyses in NRC 2003.
[11] Kvenvolden and Cooper 2003.
[12] Allen et al. 1970; Hornafius et al. 1999; Kvenvolden and Simoneit. 1990.
[13] Chernova et al. 2001; Gupta et al. 1980; Venkatesan et al. 2003.
[14] MacDonald, 1998.
[15] GESAMP 2007; NRC 2003.

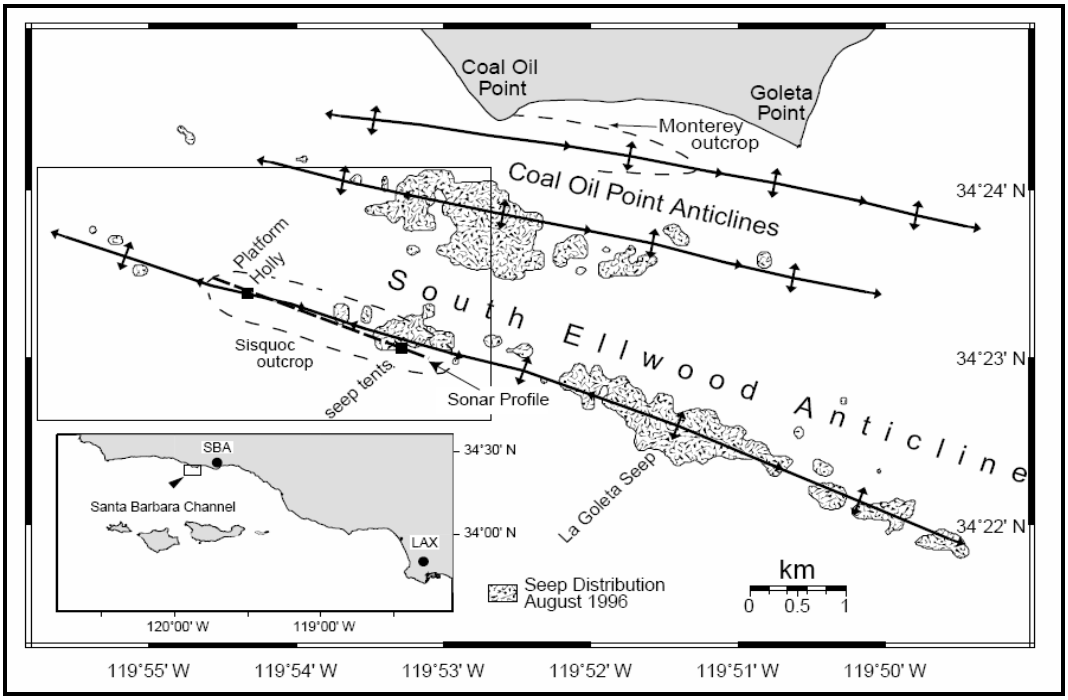

Figure 3: Oil seeps off Santa Barbara, California[16]

Perhaps the most studied oil seeps in the world are those off the coast of Santa Barbara, California.

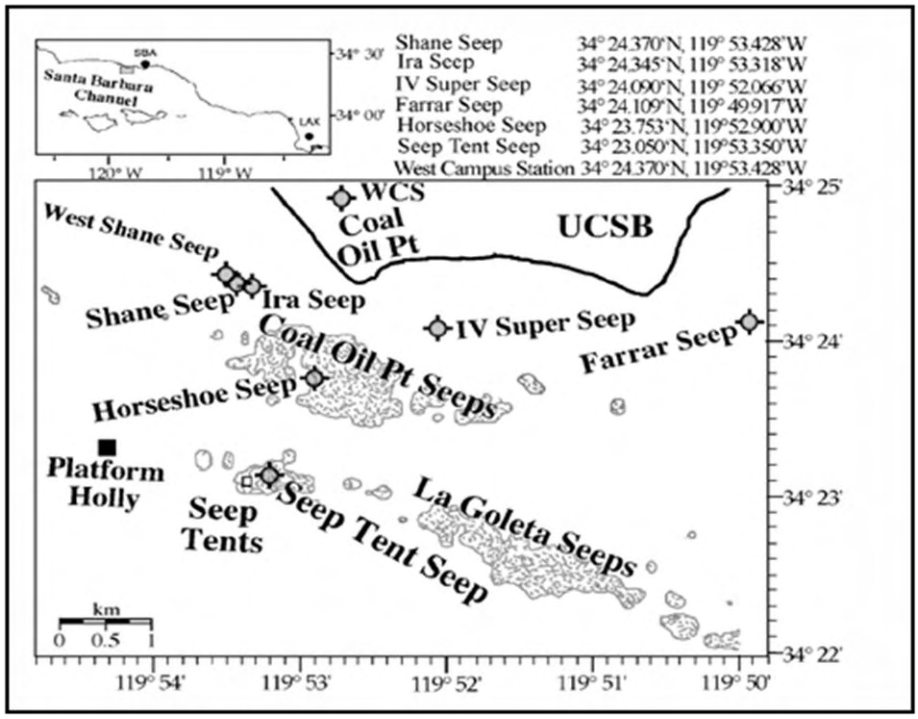

Figure 4: Detail of oil seeps off Coal Oil Point, California[17]

The oil seeps off of Coal Point have been the source of many oil slicks and continuous oiling and tar ball deposition on California shorelines.

[16] Quigley et al. 1999.
[17] Leifer et al. 2003.

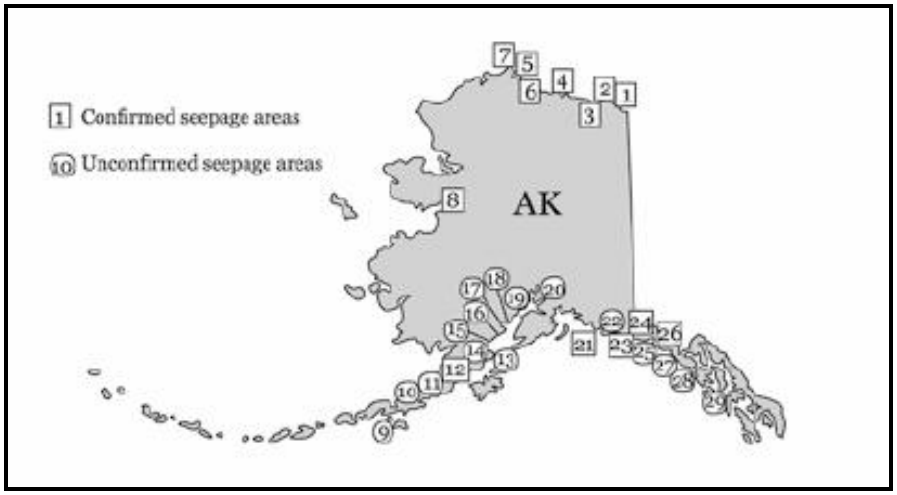

Figure 5: Oil seepage areas around Alaska[18]

Oil seeps in and around Alaska have been reported.

Wilson et al. (1974) estimated that total *worldwide* natural seepage ranged from 1.4 to 42.0 x 10^6 barrels annually, with the best estimate being 0.6 x 10^6 tonnes 4.2 x 10^6 barrels, based largely on observations of seepage rates off California and western Canada. Estimates of the areas of ocean with natural seeps are shown in the table below. Estimates of seepage rates by ocean are shown in Tables 2 and 3.

Table 2: Seepage-prone Areas of the World's Oceans[19]

Ocean	Number of 1,000-Square Kilometers		
	High-Potential Seepage	**Moderate-Potential Seepage**	**Low-Potential Seepage**
Pacific	1,943	9,285	4,244
Atlantic	1,303	10,363	11,248
Indian	496	7,928	3,010
Arctic	0	5,636	2,456
Southern	0	486	458
Total	**3,741**	**33,697**	**21,416**

Table 3: Summary of World Seepage Rates[20]

Ocean	Estimated Oil Seepage (bbl per year)[21]		
	Case I, P_{16}[22]	**Case II, $P_{1.0}$[23]**	**Case III, $P_{0.3}$[24]**
Pacific	19,810,000	1,883,000	482,300
Atlantic	14,420,000	1,372,000	352,800
Indian	6,510,000	619,500	159,600
Arctic	1,498,000	16,100	36,400
Southern	131,600	121,800	3,157
Total	**42,369,600**	**4,012,400**	**1,034,257**

Wilson et al. (1974) based their estimates on five basic assumptions:

- More seeps exist in offshore basins than have been observed;

[18] Based on Becker and Manen 1988, as presented in Kvenvolden and Cooper 2003.
[19] Based on Wilson et al. 1974
[20] Based on Wilson et al. 1974
[21] Three probability levels were examined.
[22] Probability percentile 16 with a worldwide estimate of 42 x 10^6 bbl annually, likely a high estimate.
[23] Probability percentile 1.0 with a worldwide estimate of 4.2 x 10^6 bbl annually
[24] Probability percentile 0.3 with a worldwide estimate of 1.4 x 10^6 bbl annually, likely a minimal estimate.

- Factors that determine seepage rate in a particular area are related to general geological structural type and the stage of sedimentary basin evolution;
- Seepage is dependent on the area of exposed rock rather than on rock volume;
- Most marine seeps are clustered at continental margins; and
- Seepage rates are log-normally distributed.

Kvenvolden and Harbaugh (1983) concluded that the minimal worldwide estimate (1.4×10^6 barrels annually) from the Wilson et al. (1974) study is most likely to be correct and that an error margin of an order of magnitude above and below this value should be applied (i.e., 0.14×10^6 to 14.0×10^6 barrels annually). Their theory was based on a reduced value for the assumed and known oil resources that would be available for seepage.

NRC 2003 presented a worldwide estimate of natural seepage into the marine environment of between 0.14×10^6 to 14.0×10^6 barrels annually, with a "best estimate" of 4.2 million barrels. These estimates[25] were made based on the Kvenvolden and Harbaugh (1983) reassessment of the estimates made by Wilson et al. (1974), as well as an acceptance of the original estimates of Wilson et al. (1974), resulting from a "new appreciation" for the magnitude of natural seepage, particularly in the Gulf of Mexico. Relying largely on the Wilson et al. (1974) and Kvenvolden and Harbaugh (1983) studies, the 2007 GESAMP also included an estimate of the range of natural seepage as 0.14×10^6 to 14.0×10^6 barrels annually.

With the technology available today a more comprehensive assessment of natural seepage, or at least a verification of the Wilson et al. (1974) study or the Kvenvolden and Harbaugh (1983) re-evaluation of that study, is theoretically possible. Due to the considerable resources that might be required to conduct this on a global or even regional scale, the most likely funding would, however, come from industry sources interested in exploration of any areas that contain potentially high levels of oil rather than for the purpose of assessing impacts to the world's oceans. Figure 6 shows areas of oil seepage potential in and around the U.S.

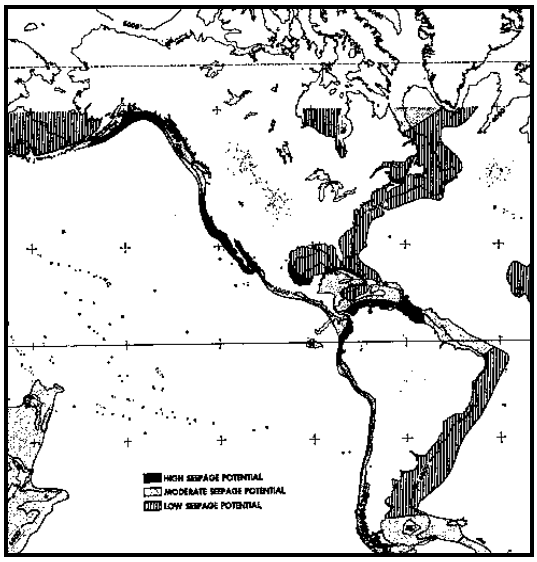

Figure 6: Oil Seepage Potential[26]

This figure shows the potential for natural oil seepage in and around U.S. waters.

[25] The Oil in the Sea III natural seep estimates were made by Dr. Keith Kvenvolden, one of the co-authors of the Kvenvolden and Harbaugh (1983) reassessment.

[26] Wilson, R.D., P.H. Monaghan, A. Osanik, L.C. Price, and M.A. Rogers. 1974. Natural marine oil seepage. *Science* Vol. 184 (4,139): pp. 857 – 865.

Spillage from Offshore Oil Exploration and Production Activities

Areas in which natural seeps occur have provided opportunities for oil exploration and production. During the last decade (1998 – 2007), an estimated 1,273 barrels of crude oil spilled from offshore platforms into federal and state waters of the U.S. each year. An additional 2,614 bbl spilled annually from offshore pipelines, for a total of 3,887 bbl per year. This represents a nearly 66 percent reduction in spillage from the previous decade, and an 87 percent reduction in spillage since the 1970s.[27]

Spills from Platforms

Oil spillage from offshore platforms in U.S. Outer Continental Shelf (OCS) and state waters is shown in Figure 7 for 1969 – 2007 and Figure 8 for the last decade.

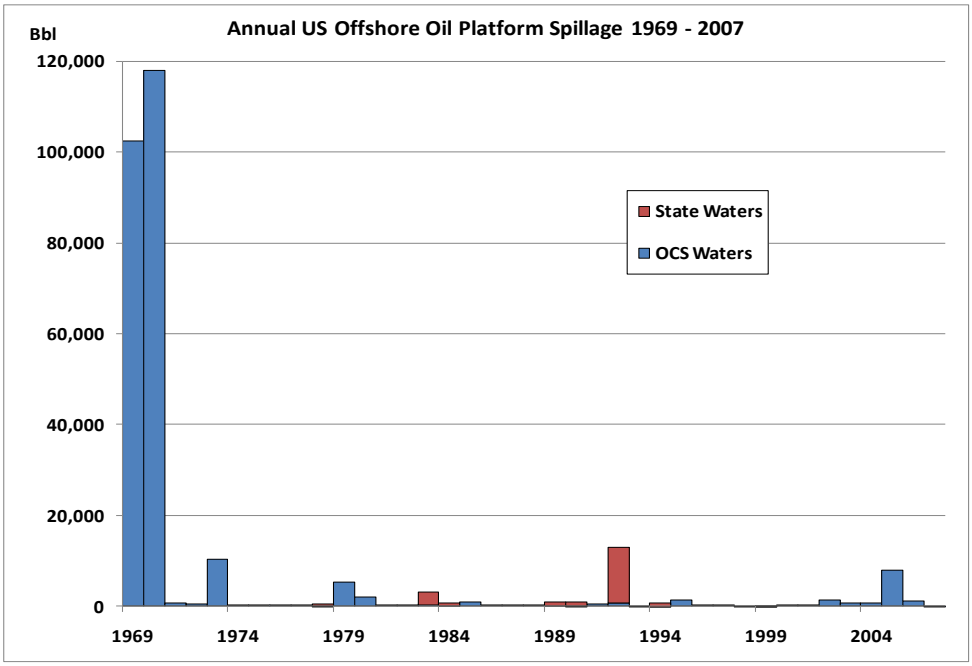

Figure 7: Annual U.S. Offshore Oil Platform Spillage 1969-2007

This graph of oil spillage from offshore oil platforms shows spillage in both state and OCS waters. Since 1971 spillage from platforms has been very low.

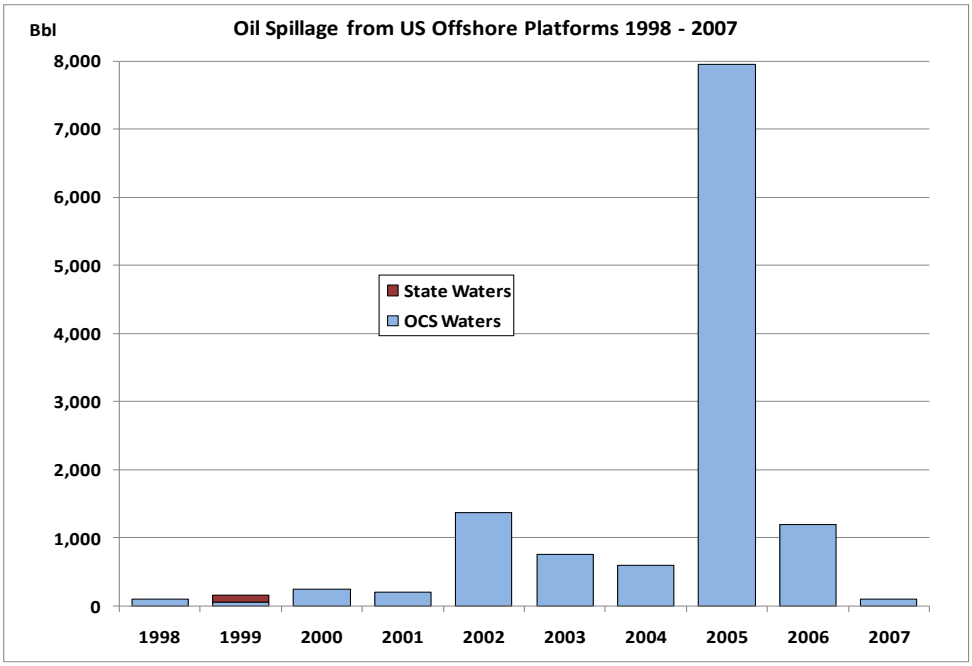

Figure 8: Annual Oil Spillage from U.S. Offshore Platforms 1998 – 2007

In 2005, there was some platform spillage associated with hurricane damage. Note that even the 2005 spill volumes are only 8 percent of the volumes of 1969 and 1970.

[27] 1969 – 1977.

Average platform spillage by decade is shown in Figure 9. There has been a 30% reduction in annual spillage since the last decade and a 95% reduction since the 1970s.

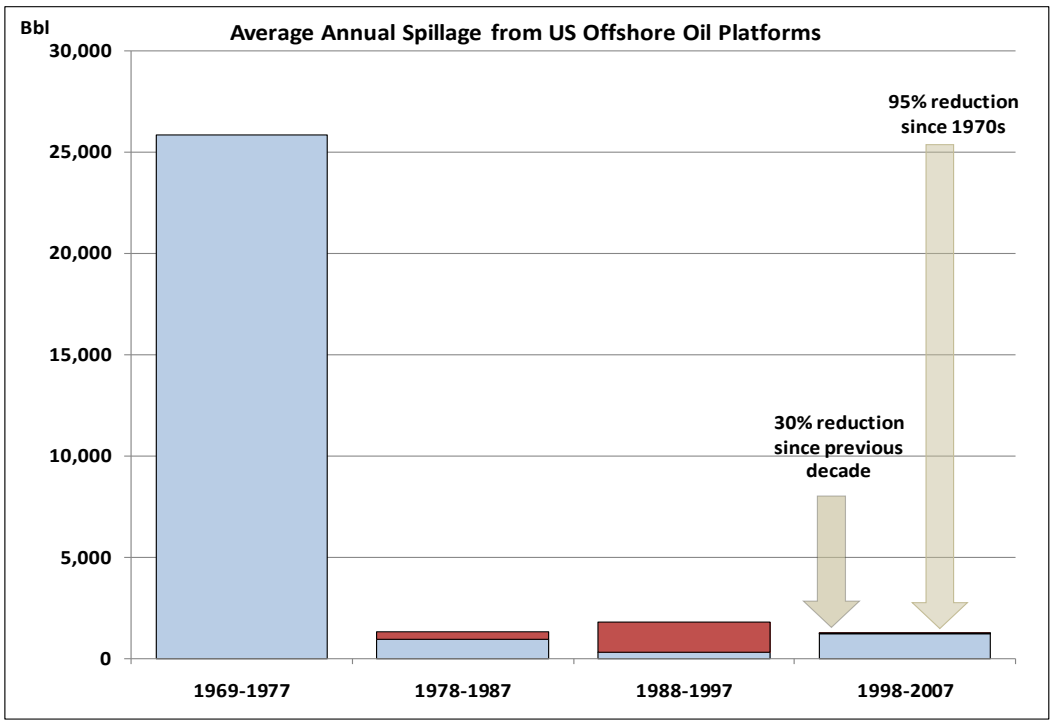

Figure 9: Annual Average Spillage from U.S. Offshore Platforms – Reductions by Decade

Average annual spillage from offshore platforms has reduced significantly. There is a 95% reduction since the 1970s and a 30% reduction since the previous decade.

Table 4 shows the numbers of incidents and volume spilled from offshore oil platforms by year. Table 5 gives the same annual results broken down by oil type. Table 6 gives the annual results broken down by location. The data are dominated by large crude spills in 1969 and 1970.

Table 4: Oil Spills from U.S. Offshore Oil Platforms

Year	Number (1 bbl or more)	OCS (bbl)	State Waters (bbl)	Total (bbl)
1969	2	102,500	0	**102,500**
1970	2	118,095	0	**118,095**
1971	121	736	0	**736**
1972	86	418	0	**418**
1973	77	10,289	0	**10,289**
1974	38	267	0	**267**
1975	29	118	0	**118**
1976	25	129	0	**129**
1977	29	169	0	**169**
1978	26	104	524	**628**
1979	38	5,168	0	**5,168**
1980	29	2,042	0	**2,042**
1981	26	296	0	**296**
1982	26	115	0	**115**
1983	40	421	2,810	**3,225**
1984	25	126	690	**816**
1985	36	876	0	**876**
1986	20	141	0	**141**
1987	20	134	0	**134**
1988	15	252	0	**252**
1989	14	125	810	**935**
1990	17	65	953	**1,018**
1991	15	414	0	**414**

Table 4: Oil Spills from U.S. Offshore Oil Platforms				
Year	**Number (1 bbl or more)**	**OCS (bbl)**	**State Waters (bbl)**	**Total (bbl)**
1992	16	746	12,262	**13,008**
1993	6	35	0	**35**
1994	14	0	740	**740**
1995	15	1,390	0	**1,390**
1996	17	231	0	**231**
1997	9	114	0	**114**
1998	15	108	0	**108**
1999	9	56	107	**163**
2000	10	252	0	**252**
2001	11	203	0	**203**
2002	23	1,377	0	**1,377**
2003	9	761	0	**761**
2004	18	603	0	**603**
2005	57	7,963	0	**7,963**
2006	32	1,193	0	**1,193**
2007	18	109	0	**109**
Total	**1,035**	**258,139**	**18,896**	**277,029**
Average 1969-1977	**45**	**25,858**	**0**	**25,858**
Average 1978-1987	**29**	**942**	**402**	**1,344**
Average 1988-1997	**14**	**337**	**1,477**	**1,814**
Average 1998-2007	**20**	**1,262**	**11**	**1,273**
Average 1969-2007	**27**	**6,619**	**485**	**7,103**

Table 5: Oil Spillage (bbl) from U.S. Offshore Oil Platforms by Oil Type					
Year	**Crude**	**Diesel**	**Condensate**	**Other Oil**	**Total Platform**
1969	102,500	0	0	0	**102,500**
1970	118,095	0	0	0	**118,095**
1971	670	13	15	38	**736**
1972	379	10	6	23	**418**
1973	10,260	9	0	20	**10,289**
1974	258	5	0	4	**267**
1975	108	7	0	3	**118**
1976	115	3	3	8	**129**
1977	154	11	4	0	**169**
1978	620	3	5	0	**628**
1979	146	1,513	3,500	9	**5,168**
1980	1,529	504	4	5	**2,042**
1981	217	39	0	40	**296**
1982	52	17	3	43	**115**
1983	3,087	105	11	22	**3,225**
1984	810	3	0	3	**816**
1985	90	755	0	32	**876**
1986	48	0	0	93	**141**
1987	58	8	0	68	**134**
1988	86	6	10	151	**252**
1989	607	297	0	31	**935**
1990	574	27	413	4	**1,018**
1991	393	8	2	11	**414**
1992	13,007	0	1	0	**13,008**
1993	32	3	0	0	**35**
1994	87	0	602	51	**740**
1995	876	4	510	0	**1,390**
1996	121	17	22	72	**231**
1997	44	29	20	22	**114**
1998	60	29	0	19	**108**

Table 5: Oil Spillage (bbl) from U.S. Offshore Oil Platforms by Oil Type					
Year	**Crude**	**Diesel**	**Condensate**	**Other Oil**	**Total Platform**
1999	31	107	19	5	**163**
2000	244	2	3	3	**252**
2001	153	45	0	4	**203**
2002	74	1,273	3	27	**1,377**
2003	50	707	1	3	**761**
2004	449	114	22	18	**603**
2005	3,618	3,655	599	91	**7,963**
2006	369	65	734	24	**1,193**
2007	80	2	6	21	**109**
Total	**260,148**	**9,395**	**6,518**	**968**	**277,029**
Average 1969-1977	**25,838**	**6**	**3**	**11**	**25,858**
Average 1978-1987	**666**	**295**	**352**	**32**	**1,344**
Average 1988-1997	**1,583**	**39**	**158**	**34**	**1,814**
Average 1998-2007	**513**	**600**	**139**	**22**	**1,273**
Average 1969-2007	**6,671**	**241**	**167**	**25**	**7,103**

Table 6: Oil Spillage (bbl) from U.S. Offshore Oil Platforms by Region				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
1969	2,500	100,000	0	**102,500**
1970	118,095	0	0	**118,095**
1971	736	0	0	**736**
1972	418	0	0	**418**
1973	10,289	0	0	**10,289**
1974	267	0	0	**267**
1975	118	0	0	**118**
1976	129	0	0	**129**
1977	165	4	0	**169**
1978	108	524	0	**632**
1979	5,168	0	0	**5,168**
1980	2,037	5	0	**2,042**
1981	245	51	0	**296**
1982	93	3	20	**116**
1983	3,225	0	0	**3,231**
1984	782	34	0	**816**
1985	871	5	0	**876**
1986	130	11	0	**141**
1987	123	11	0	**134**
1988	247	0	0	**247**
1989	406	5	524	**935**
1990	1,017	1	0	**1,018**
1991	413	1	0	**414**
1992	13,008	0	0	**13,008**
1993	35	0	0	**35**
1994	729	11	0	**740**
1995	1,390	0	0	**1,390**
1996	226	5	0	**231**
1997	114	0	0	**114**
1998	105	0	4	**109**
1999	163	0	0	**163**
2000	252	0	0	**252**
2001	203	0	0	**203**
2002	1,377	0	0	**1,377**
2003	761	0	0	**761**
2004	603	0	0	**603**
2005	7,963	0	0	**7,963**

Table 6: Oil Spillage (bbl) from U.S. Offshore Oil Platforms by Region				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
2006	1,193	0	0	**1,193**
2007	109	0	0	**109**
Total	**175,812**	**100,670**	**548**	**277,036**
Average 1969-1977	**14,746**	**11,112**	**0**	**25,858**
Average 1978-1987	**1,278**	**64**	**2**	**1,345**
Average 1988-1997	**1,759**	**2**	**52**	**1,813**
Average 1998-2007	**1,273**	**0**	**0**	**1,273**
Average 1969-2007	**4,508**	**2,581**	**14**	**7,104**

Spills from Offshore Pipelines

Annual oil spillage from pipelines[28] connected to offshore platforms is shown in Figure 10 and Table 7. Average annual spillage by decade is shown in Figure 11. There has been a 68% reduction in offshore pipeline spillage since the previous decade. Spillage by region and by oil type is shown in Tables 8 and 9. Nearly 85% of the spillage is crude oil. Of the total offshore pipeline spillage, 96% is in the Gulf of Mexico.

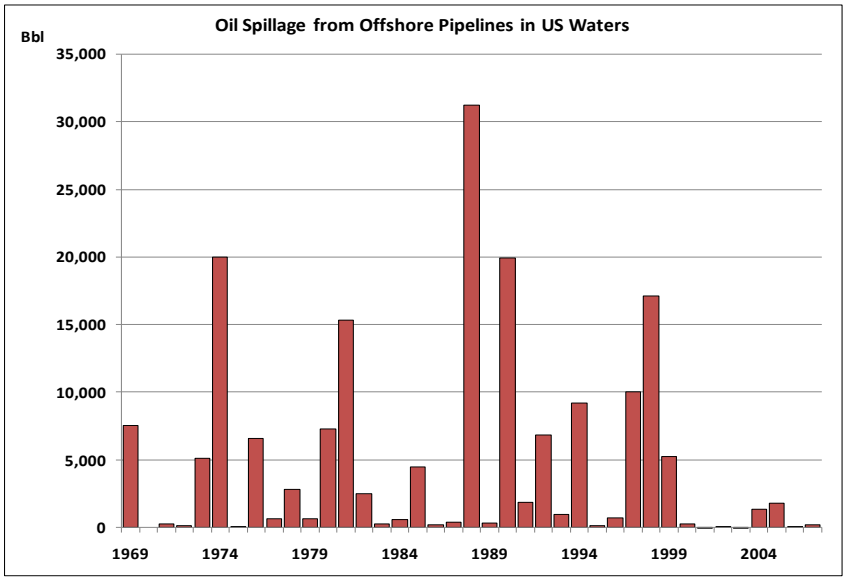

Figure 10: Annual Oil Spillage from Offshore Pipelines 1969 – 2007.

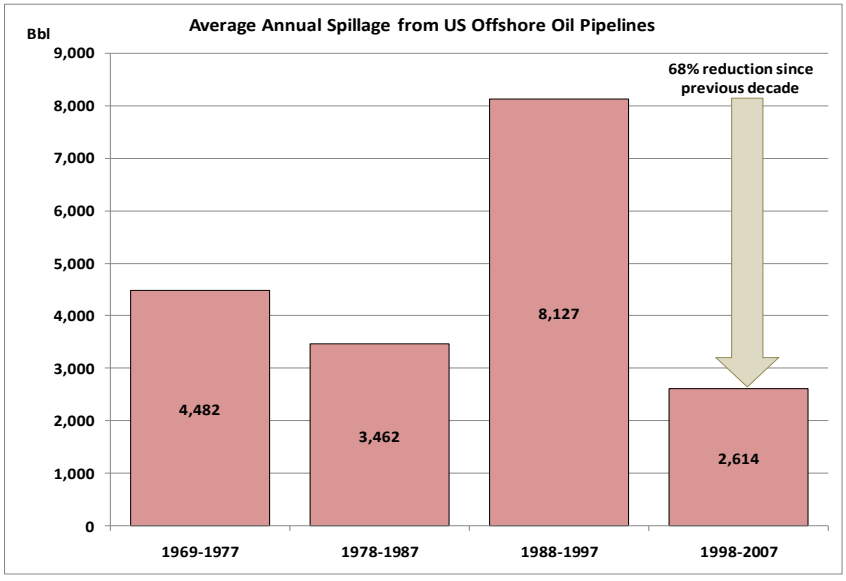

Figure 11: Average Annual Oil Spillage from Offshore Pipelines by Decade

There has been a 68% reduction in spillage from offshore pipelines in the last decade.

[28] This category includes pipelines that bring oil from offshore facilities to the coast, but does *not* include inland pipelines that transport crude oil to refineries or refined products from refineries to storage terminals or other locations.

Table 7: Oil Spills from U.S. Offshore Oil Pipelines		
Year	**Number of Incidents (1 bbl or more)**	**Volume (bbl)**
1969	1	**7,524**
1970	0	**0**
1971	29	**258**
1972	22	**126**
1973	29	**5,119**
1974	19	**20,003**
1975	17	**51**
1976	9	**6,617**
1977	13	**637**
1978	12	**2,821**
1979	17	**646**
1980	13	**7,262**
1981	12	**15,367**
1982	5	**2,536**
1983	8	**269**
1984	5	**586**
1985	13	**4,513**
1986	9	**195**
1987	4	**421**
1988	12	**31,204**
1989	9	**358**
1990	24	**19,937**
1991	17	**1,894**
1992	20	**6,815**
1993	12	**942**
1994	6	**9,184**
1995	7	**156**
1996	8	**746**
1997	20	**10,028**
1998	18	**17,099**
1999	10	**5,259**
2000	6	**246**
2001	6	**31**
2002	5	**42**
2003	1	**15**
2004	27	**1,373**
2005	55	**1,788**
2006	3	**94**
2007	3	**193**
Total	**506**	**182,355**
Average 1969-1977	**15**	**4,482**
Average 1978-1987	**10**	**3,462**
Average 1988-1997	**14**	**8,126**
Average 1998-2007	**13**	**2,614**
Average 1969-2007	**13**	**4,676**

Table 8: Oil Spillage (bbl) from U.S. Offshore Oil Pipelines by Region				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
1969	7,524	0	0	**7,524**
1970	0	0	0	**0**
1971	258	0	0	**258**
1972	126	0	0	**126**
1973	5,119	0	0	**5,119**
1974	20,003	0	0	**20,003**
1975	51	0	0	**51**
1976	6,617	0	0	**6,617**
1977	637	0	0	**637**
1978	2,821	0	0	**2,821**
1979	51	595	0	**646**
1980	3,762	0	3,500	**7,262**
1981	15,367	0	0	**15,367**
1982	2,536	0	0	**2,536**
1983	269	0	0	**269**
1984	586	0	0	**586**
1985	4,275	0	238	**4,513**
1986	195	0	0	**195**
1987	421	0	0	**421**
1988	31,204	0	0	**31,204**
1989	355	3	0	**358**
1990	19,935	0	2	**19,937**
1991	1,841	53	0	**1,894**
1992	6,060	350	405	**6,815**
1993	911	31	0	**942**
1994	9,184	0	0	**9,184**
1995	156	0	0	**156**
1996	279	467	0	**746**
1997	9,028	1,000	0	**10,028**
1998	17,099	0	0	**17,099**
1999	5,258	1	0	**5,259**
2000	246	0	0	**246**
2001	22	9	0	**31**
2002	42	0	0	**42**
2003	15	0	0	**15**
2004	1,373	0	0	**1,373**
2005	1,788	0	0	**1,788**
2006	94	0	0	**94**
2007	193	0	0	**193**
Total	**175,701**	**2,509**	**4,145**	**182,355**
Average 1969-1977	**4,482**	**0**	**0**	**4,482**
Average 1978-1987	**3,028**	**60**	**374**	**3,462**
Average 1988-1997	**7,895**	**190**	**41**	**8,126**
Average 1998-2007	**2,613**	**1**	**0**	**2,614**
Average 1969-2007	**4,505**	**64**	**106**	**4,676**

Table 9: Oil Spillage (bbl) from U.S. Offshore Oil Pipelines by Oil Type					
Year	**Crude**	**Diesel**	**Condensate**	**Other Oil**	**Total Pipelines**
1969	7,524	0	0	0	**7,524**
1970	0	0	0	0	**0**
1971	253	0	5	0	**258**
1972	126	0	0	0	**126**
1973	5,119	0	0	0	**5,119**
1974	19,998	0	5	0	**20,003**
1975	51	0	0	0	**51**
1976	6,618	0	0	0	**6,617**
1977	637	0	0	0	**637**
1978	2,821	0	0	0	**2,821**
1979	646	0	0	0	**646**
1980	7,261	0	1	0	**7,262**
1981	14,638	714	15	0	**15,367**
1982	2,534	0	3	0	**2,536**
1983	270	0	0	0	**269**
1984	581	0	5	0	**586**
1985	914	0	3	3,596	**4,513**
1986	191	5	0	0	**195**
1987	421	0	0	0	**421**
1988	31,203	0	0	1	**31,204**
1989	351	2	4	1	**358**
1990	5,226	286	14,426	0	**19,937**
1991	1,787	0	12	95	**1,894**
1992	4,930	1,881	3	1	**6,815**
1993	703	238	1	0	**942**
1994	4,645	7	4,533	0	**9,184**
1995	152	0	4	0	**156**
1996	746	0	1	0	**746**
1997	9,779	0	8	241	**10,028**
1998	15,764	100	1,220	14	**17,099**
1999	5,253	0	0	6	**5,259**
2000	241	0	5	0	**246**
2001	14	0	8	9	**31**
2002	12	0	40	0	**42**
2003	15	0	0	0	**15**
2004	1,348	0	25	0	**1,373**
2005	1,751	0	37	0	**1,788**
2006	87	0	7	0	**94**
2007	193	0	0	0	**193**
Total	**154,802**	**3,233**	**20,370**	**3,964**	**182,355**
Average 1969-1977	**4,481**	**0**	**1**	**0**	**4,482**
Average 1978-1987	**3,028**	**72**	**3**	**360**	**3,462**
Average 1988-1997	**5,952**	**241**	**1,899**	**34**	**8,126**
Average 1998-2007	**2,468**	**10**	**134**	**3**	**2,614**
Average 1969-2007	**3,969**	**83**	**522**	**102**	**4,676**

Total Offshore Exploration and Production Spillage

Offshore oil exploration and production spillage was combined to include spills from offshore platforms and pipelines, as well as spillage from offshore supply vessels servicing the platforms, as shown in Table 10. The same data are broken down by oil type and region in Tables 11 and 12, respectively.

Table 10: Annual Oil Spillage (bbl) from U.S. Offshore Oil Exploration and Production

Year	Platform	Pipeline	Offshore Vessels	Total
1969	102,500	7,524	0	**110,024**
1970	118,095	0	0	**118,095**
1971	736	258	59	**1,053**
1972	418	126	38	**582**
1973	10,289	5,119	376	**15,784**
1974	267	20,003	45	**20,315**
1975	118	51	210	**379**
1976	129	6,618	64	**6,810**
1977	169	637	63	**869**
1978	628	2,821	107	**3,556**
1979	5,168	646	301	**6,115**
1980	2,042	7,262	403	**9,707**
1981	296	15,367	33	**15,695**
1982	115	2,536	545	**3,196**
1983	3,225	270	468	**3,962**
1984	816	586	37	**1,439**
1985	876	4,512	810	**6,199**
1986	141	196	23	**359**
1987	134	421	0	**555**
1988	252	31,203	30	**31,486**
1989	935	358	0	**1,293**
1990	1,018	19,938	54	**21,009**
1991	414	1,894	23	**2,332**
1992	13,008	6,815	3	**19,826**
1993	35	942	0	**977**
1994	740	9,185	169	**10,093**
1995	1,390	156	109	**1,655**
1996	231	747	44	**1,022**
1997	114	10,029	44	**10,187**
1998	108	17,100	34	**17,241**
1999	163	5,259	70	**5,492**
2000	252	246	0	**498**
2001	203	22	0	**224**
2002	1,377	51	0	**1,429**
2003	761	15	0	**776**
2004	603	1,373	0	**1,976**
2005	7,963	1,788	0	**9,751**
2006	1,193	94	0	**1,286**
2007	109	193	0	**302**
Total	**277,031**	**182,361**	**4,162**	**463,549**
Average 1969-1977	**25,858**	**4,482**	**95**	**30,435**
Average 1978-1987	**1,344**	**3,462**	**273**	**5,078**
Average 1988-1997	**1,814**	**8,127**	**48**	**9,988**
Average 1998-2007	**1,273**	**2,614**	**10**	**3,898**
Average 1969-2007	**7,103**	**4,676**	**107**	**11,886**

Table 11: Oil Spillage (bbl) from U.S. Offshore Oil Exploration and Production by Oil Type					
Year	**Crude**	**Diesel**	**Condensate**	**Other Oil[29]**	**Total All Oil Types**
1969	110,024	0	0	0	**110,024**
1970	118,095	0	0	0	**118,095**
1971	979	16	20	38	**1,053**
1972	521	21	6	35	**583**
1973	15,396	368	0	20	**15,784**
1974	20,259	47	5	4	**20,315**
1975	160	211	0	3	**374**
1976	6,748	108	3	8	**6,866**
1977	791	67	4	7	**869**
1978	3,445	102	5	4	**3,556**
1979	797	1,809	3,500	9	**6,115**
1980	8,790	935	5	10	**9,740**
1981	14,855	781	15	45	**15,696**
1982	2,591	547	6	53	**3,196**
1983	3,369	501	11	82	**3,962**
1984	1,395	21	5	18	**1,439**
1985	1,004	1,487	69	3,640	**6,199**
1986	243	24	0	98	**364**
1987	479	8	0	68	**555**
1988	31,314	6	15	152	**31,486**
1989	958	299	4	32	**1,293**
1990	5,803	339	14,839	4	**20,984**
1991	2,180	8	14	106	**2,308**
1992	17,937	1,881	4	4	**19,826**
1993	735	241	1	0	**977**
1994	4,732	166	5,135	61	**10,093**
1995	1,028	107	520	0	**1,655**
1996	867	61	23	72	**1,021**
1997	9,823	66	28	270	**10,186**
1998	15,824	129	1,223	46	**17,223**
1999	5,284	141	19	47	**5,492**
2000	485	2	8	3	**498**
2001	167	45	8	13	**234**
2002	86	1,273	43	27	**1,419**
2003	65	707	1	3	**776**
2004	1,797	114	47	18	**1,976**
2005	5,369	3,655	636	91	**9,751**
2006	456	65	741	24	**1,287**
2007	273	2	6	21	**302**
Total	**415,124**	**16,360**	**26,969**	**5,136**	**463,572**
Average 1969-1977	**30,330**	**93**	**4**	**13**	**30,440**
Average 1978-1987	**3,697**	**622**	**362**	**403**	**5,082**
Average 1988-1997	**7,538**	**317**	**2,058**	**70**	**9,983**
Average 1998-2007	**2,981**	**613**	**273**	**29**	**3,896**
Average 1969-2007	**10,644**	**419**	**692**	**132**	**11,886**

[29] Other oils include: jet fuel, mineral oil, lubricating oil (lube), hydraulic oil, gasoline, waste oil, oil-based drilling muds, and other miscellaneous or unknown oils.

Table 12: Oil Spillage (bbl) from U.S. Offshore Oil Exploration and Production by Region				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
1969	10,024	100,000	0	**110,024**
1970	118,095	0	0	**118,095**
1971	1,053	0	0	**1,053**
1972	582	0	0	**582**
1973	15,784	0	0	**15,784**
1974	20,315	0	0	**20,315**
1975	379	0	0	**379**
1976	6,810	0	0	**6,810**
1977	865	4	0	**869**
1978	3,036	524	0	**3,560**
1979	5,520	595	0	**6,115**
1980	6,202	5	3,500	**9,707**
1981	15,645	51	0	**15,696**
1982	3,174	3	20	**3,197**
1983	3,962	0	0	**3,962**
1984	1,403	34	2	**1,439**
1985	5,956	5	238	**6,199**
1986	348	11	0	**359**
1987	544	11	0	**555**
1988	31,481	0	0	**31,481**
1989	761	8	524	**1,293**
1990	21,006	1	2	**21,009**
1991	2,277	54	0	**2,331**
1992	19,071	350	405	**19,826**
1993	946	31	0	**977**
1994	10,082	11	0	**10,093**
1995	1,655	0	0	**1,655**
1996	549	472	0	**1,021**
1997	9,186	1,000	0	**10,186**
1998	17,238	0	4	**17,242**
1999	5,491	1	0	**5,492**
2000	498	0	0	**498**
2001	225	9	0	**234**
2002	1,419	0	0	**1,419**
2003	776	0	0	**776**
2004	1,976	0	0	**1,976**
2005	9,751	0	0	**9,751**
2006	1,287	0	0	**1,287**
2007	302	0	0	**302**
Total	**355,674**	**103,180**	**4,695**	**463,549**
Average 1969-1977	**19,323**	**11,112**	**0**	**30,435**
Average 1978-1987	**4,579**	**124**	**376**	**5,079**
Average 1988-1997	**9,701**	**193**	**93**	**9,987**
Average 1998-2007	**3,896**	**1**	**0**	**3,898**
Average 1969-2007	**9,120**	**2,646**	**120**	**11,886**

Figure 12 shows the annual spillage of combined offshore exploration and production sources. Figure 13 shows total offshore spillage by decade. There has been a 61% reduction in total spillage since the last decade and an 87% reduction since the 1970s. Offshore oil exploration and production spillage data for the past decade only are shown in Tables 13 – 16.

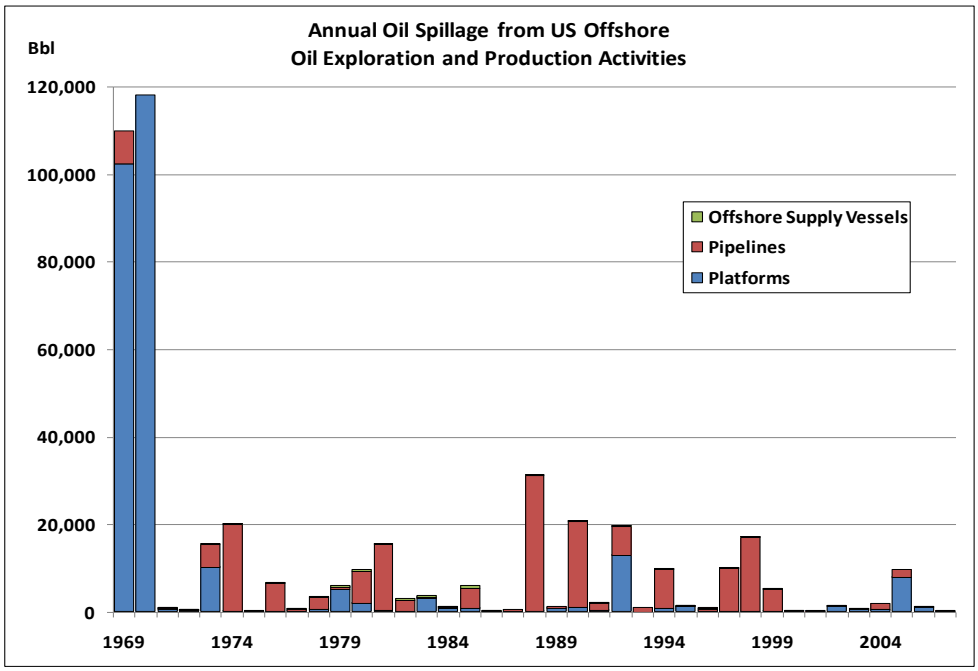

Figure 12: Annual Oil Spillage from Combined Offshore Exploration and Production Sources

Oil spillage from all offshore exploration and production activities has decreased significantly since 1969-1970.

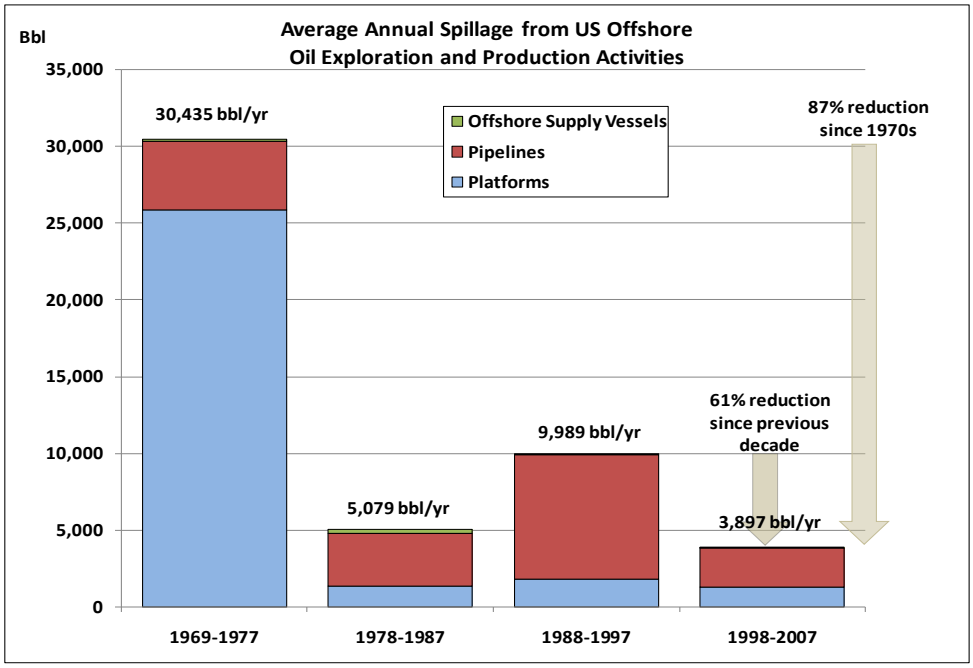

Figure 13: Average Annual Spillage from Offshore Oil Exploration and Production Sources

Average annual spillage from offshore oil exploration and production has decreased by 87% since the 1970s and by 61% since the last decade.

Table 13: Annual Oil Spillage from U.S. Offshore Oil Exploration and Production 1998 - 2007

Year	Platforms	Pipelines	Offshore Vessels	Total
1998	108	17,100	34	**17,241**
1999	163	5,259	70	**5,492**
2000	252	246	0	**498**
2001	203	22	0	**224**
2002	1,377	51	0	**1,429**
2003	761	15	0	**776**
2004	603	1,373	0	**1,976**
2005	7,963	1,788	0	**9,751**
2006	1,193	94	0	**1,286**
2007	109	193	0	**302**
Total	**12,731**	**26,140**	**104**	**38,975**
Average Annual	**1,273**	**2,614**	**10**	**3,898**

Table 14: Spillage (bbl) from U.S. Offshore Exploration and Production by Oil Type 1998 - 2007					
Year	**Crude**	**Diesel**	**Condensate**	**Other Oil**	**Total All Sources**
1998	15,782	100	1,223	28	**17,241**
1999	5,253	34	0	42	**5,492**
2000	241	0	5	0	**498**
2001	14	0	8	0	**224**
2002	12	0	40	0	**1,429**
2003	15	0	0	0	**776**
2004	1,348	0	25	0	**1,976**
2005	1,751	0	37	0	**9,751**
2006	87	0	7	0	**1,286**
2007	193	0	0	0	**302**
Total	**24,696**	**134**	**1,345**	**70**	**38,975**
Average Annual	**2,470**	**13**	**135**	**7**	**3,898**

Table 15: Oil Spillage (bbl) from U.S. Offshore Oil Platforms by Region 1998 - 2007				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
1998	105	0	4	**109**
1999	163	0	0	**163**
2000	252	0	0	**252**
2001	203	0	0	**203**
2002	1,377	0	0	**1,377**
2003	761	0	0	**761**
2004	603	0	0	**603**
2005	7,963	0	0	**7,963**
2006	1,193	0	0	**1,193**
2007	109	0	0	**109**
Total	**12,729**	**0**	**4**	**12,733**
Average Annual	**1,273**	**0**	**0**	**1,273**

Table 16: Spillage (bbl) from U.S. Offshore Exploration and Production by Region 1998 - 2007				
Year	**Gulf of Mexico**	**Pacific**	**Alaska**	**Total**
1998	17,238	0	4	**17,242**
1999	5,491	1	0	**5,492**
2000	498	0	0	**498**
2001	225	9	0	**234**
2002	1,419	0	0	**1,419**
2003	776	0	0	**776**
2004	1,976	0	0	**1,976**
2005	9,751	0	0	**9,751**
2006	1,287	0	0	**1,287**
2007	302	0	0	**302**
Total	**38,963**	**10**	**4**	**38,977**
Average Annual	**3,896**	**1**	**0**	**3,898**

Oil Exploration and Production Spills by Volume

Most offshore oil spills are relatively small. Table 17 and Figures 14 – 18 show the probability distributions of spill volumes by source type and time period.

Table 17: U.S. Offshore Oil Exploration and Production Spills: Probabilities of Spill Volumes

Source Type	Time Period	Spill Volume (bbl)[30]			
		50th percentile	90th percentile	95th percentile	Worst Case
All Offshore E&P Activities	**1969-2007**	4	59	323	65,000
Platforms	**1969-2007**	3	35	117	65,000
Pipelines	**1969-2007**	5	400	1,548	19,833
Platforms	**1998-2007**	6	141	264	1,572
Pipelines	**1998-2007**	5	123	224	8,212

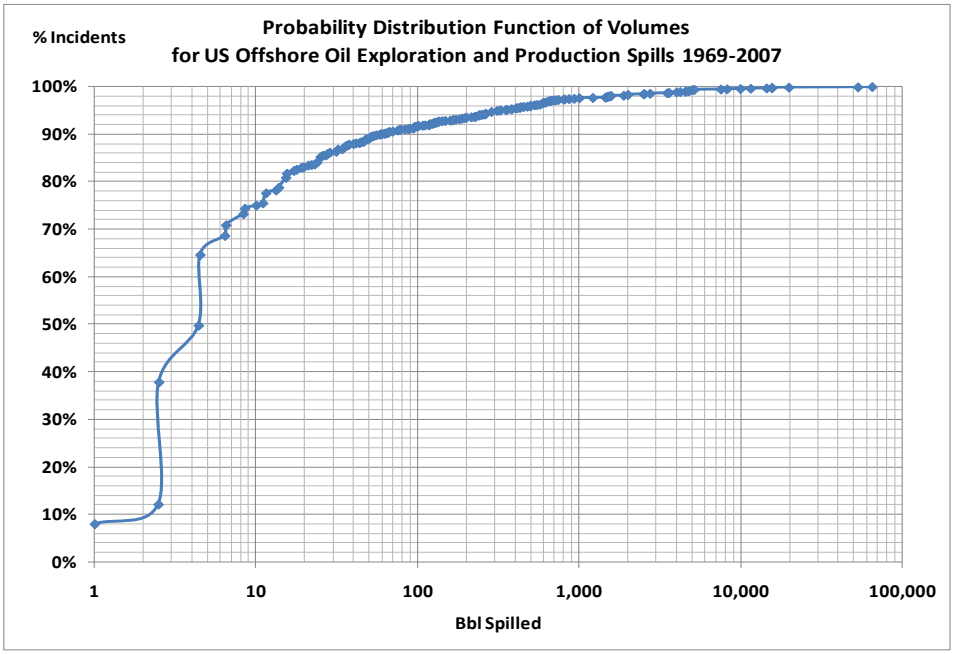

Figure 14: Probability Distribution for Offshore Exploration and Production Spills 1969 – 2007.

The percentages of offshore exploration and production spills (all sources) that are that volume or smaller. (Note the logarithmic scale.)

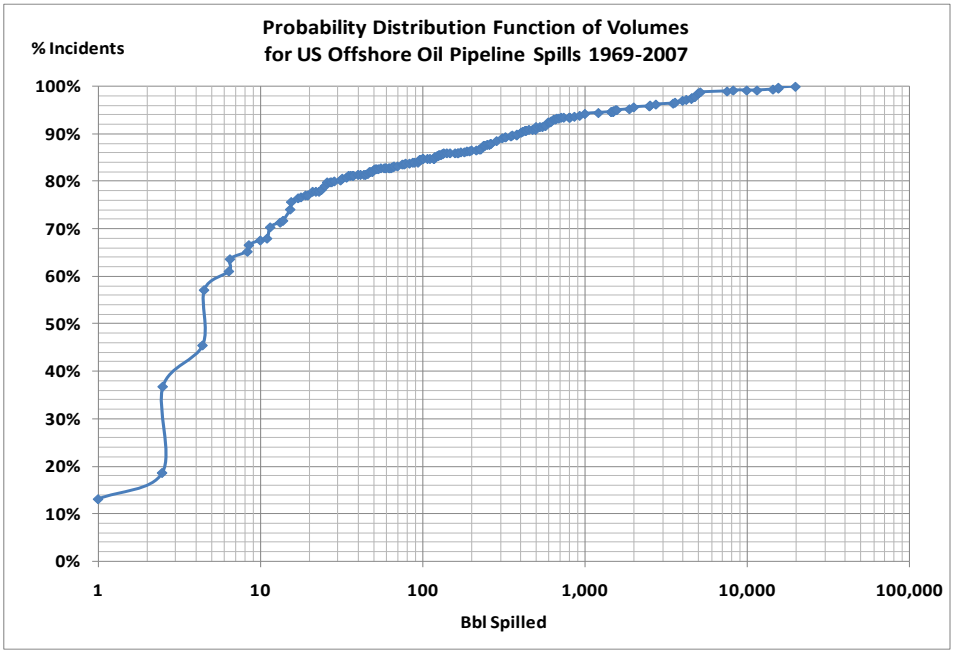

Figure 15: Probability Distribution Function for Offshore Pipeline Spills 1969 – 2007.

The percentages of offshore pipeline spills that are that volume or smaller. (Note the logarithmic scale.)

[30] A percentile spill volume is the percentage of spills that are that volume or less. e.g., a 90th percentile spill of 35 bbl means that 90% of spills are 35 bbl or less. Only 10% of spills are larger.

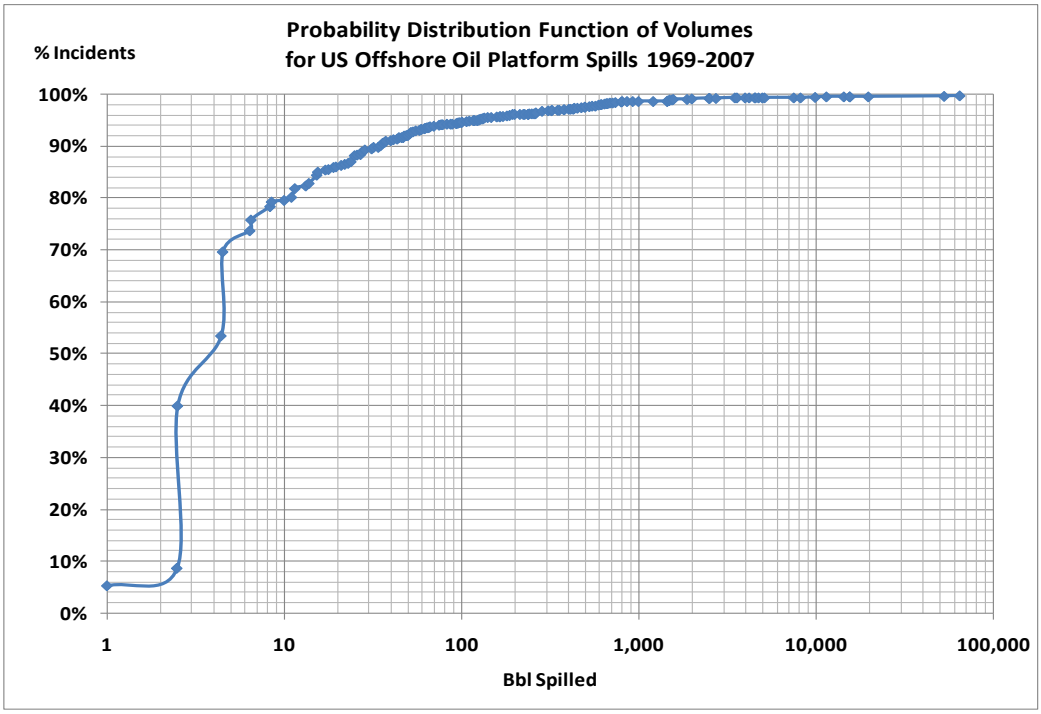

Figure 16: Probability Distribution Function for Offshore Platform Spills 1969 – 2007.

The percentages of offshore exploration and production platform spills that are that volume or smaller. (Note the logarithmic scale.)

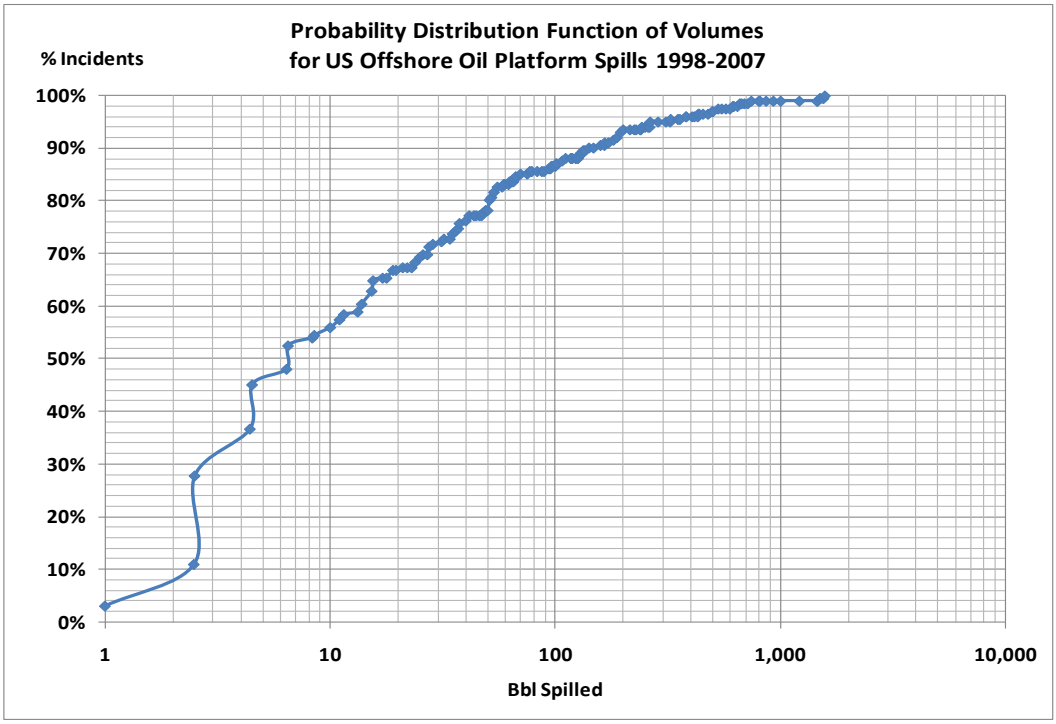

Figure 17: Probability Distribution Function for Offshore Platform Spills 1998 – 2007.

The percentages of offshore exploration and production platform spills that are that volume or smaller. (Note the logarithmic scale.)

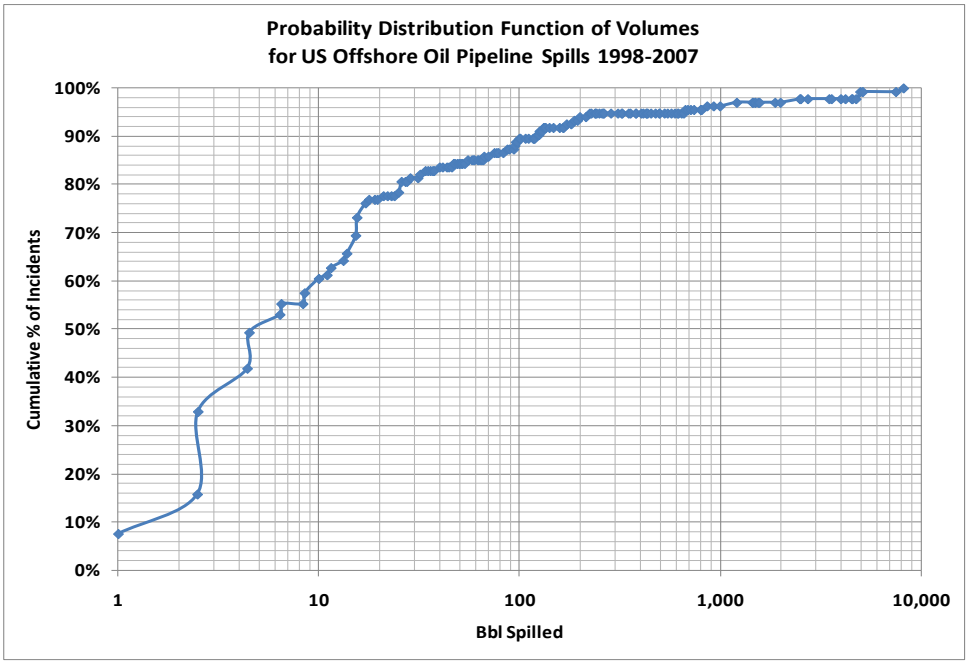

Figure 18: Probability Distribution Function for Offshore Pipeline Spills 1998 – 2007.

The percentages of offshore exploration and production platform spills that are that volume or smaller. (Note the logarithmic scale.)

Offshore Production Spill Causes

Analyses of the causes[31] of offshore platform and pipeline spill incidents are shown in Tables 18 and 19, respectively. In the last decade, the most common cause of platform and pipeline spills was hurricanes.

Table 18: Causes of Oil Spills from U.S. Offshore Oil Platforms

Cause	1969-2007					1998-2007				
	Incidents		Volume		Avg. Vol.	Incidents		Volume		Avg. Vol.
	#	%	Bbl	% Bbl		#	%	Bbl	% Bbl	
Blowout	15	1.45%	234,832	84.77%	15,655	1	0.50%	200	1.57%	200
Structure	198	19.13%	17,153	6.19%	87	53	26.24%	510	4.00%	10
Hurricane	95	9.18%	10,849	3.92%	114	95	47.03%	10,849	85.21%	114
Operator	69	6.67%	4,264	1.54%	62	37	18.32%	1,025	8.05%	28
Damage	9	0.87%	4,234	1.53%	470	2	0.99%	10	0.08%	5
Unknown	627	60.58%	3,582	1.29%	6	5	2.48%	61	0.48%	12
Weather	13	1.26%	2,042	0.74%	157	0	0.00%	0	0.00%	0
Vessel	9	0.87%	77	0.03%	9	9	4.46%	77	0.60%	9
Total	**1,035**	**100.00%**	**277,033**	**100.00%**	**268**	**202**	**100.00%**	**12,731**	**100.00%**	**63**

Table 19: Causes of Oil Spills from U.S. Offshore Oil Pipelines

Cause	1969-2007					1998-2007				
	Incidents		Volume		Avg.	Incidents		Volume		Avg.
	#	%	Bbl	% Bbl	Vol.	Number	%	Bbl	% Bbl	Vol.
Vessel	61	12.06%	110,225	60.44%	1,807	6	4.48%	4,035	15.44%	673
Structure	221	43.68%	41,237	22.61%	187	39	29.10%	10,708	40.97%	275
Damage	24	4.74%	11,826	6.49%	493	3	2.24%	51	0.19%	17
Hurricane	84	16.60%	11,483	6.30%	137	78	58.21%	11,310	43.27%	145
Unknown	16	3.16%	6,333	3.47%	396	2	1.49%	4	0.02%	2
Operator	98	19.37%	1,252	0.69%	13	5	3.73%	29	0.11%	6
Vandalism	1	0.20%	3	0.00%	3	1	0.75%	3	0.01%	3
Explosion	1	0.20%	1	0.00%	1	0	0.00%	0	0.00%	0
Total	**506**	**100.00%**	**182,359**	**100.00%**	**360**	**134**	**100.00%**	**26,140**	**100.00%**	**195**

[31] Structure = structural failure (e.g., corrosion); vessel = damage by vessel (strike, anchor drag)

Well Blowouts

There have been 17 marine well blowouts[32] in the U.S. since 1964 for a total of 248,963 barrels spilled (Tables 20 – 21). Two blowouts have occurred in state waters and account for five percent of the total spillage. The largest of these incidents occurred in January 1969 from Alpha Well 21 off Santa Barbara, California, which spilled 100,000 barrels. The volume of U.S. well blowouts tends to be small. In fact, 50 percent of the well blowouts involved 400 barrels of oil or less (Figure 19). The Santa Barbara incident ties for sixth largest in the world (Table 22).

Table 20: U.S. Oil Well Blowouts (Ordered by Date)

Date	Well	Location	Bbl Spilled	Oil Type
10/1/1964	Ship Shoal 149/199	Gulf of Mexico	11,847	crude
7/1/1965	Ship Shoal 29	Gulf of Mexico	1,690	crude
1/28/1969	Alpha Well 21 Platform A	Pacific (Santa Barbara, CA)	100,000	crude
3/1/1970	Main Pass Block 41 Platform C	Gulf of Mexico	65,000	crude
12/1/1970	South Timbalier B-26	Gulf of Mexico	53,095	crude
10/16/1971	Lafayette Block EI 0215	Gulf of Mexico	45	crude
9/7/1974	Houma Block PL0020	Gulf of Mexico	75	crude
12/2/1974	Houma Block PL0019	Gulf of Mexico	2	crude
2/19/1979	Hebert Bravo 1A	Gulf of Mexico	3,500	condensate
2/23/1985	WD-0090	Gulf of Mexico	5	crude
3/20/1987	VR-0226	Gulf of Mexico	6	crude
9/9/1990	EI-0296	Gulf of Mexico	8	condensate
9/29/1992	Greenhill Timbalier Bay 251*	Gulf of Mexico	11,500	crude
12/26/1992	Block 60 SP0060	Gulf of Mexico	595	condensate
7/8/1994	Fred Stovall Well 9*	Gulf of Mexico	595	condensate
1/13/1995	BLDSU 6	Gulf of Mexico	800	crude
2/28/2000	MC 538	Gulf of Mexico	200	crude
Total			**248,963**	

*In state waters.

Table 21: U.S. Oil Well Blowouts (Ordered by Volume)

Date	Well	Location	Bbl Spilled	Oil Type
1/28/1969	Alpha Well 21 Platform A	Pacific (Santa Barbara, CA)	100,000	crude
3/1/1970	Main Pass Block 41 Platform C	Gulf of Mexico	65,000	crude
12/1/1970	South Timbalier B-26	Gulf of Mexico	53,095	crude
10/1/1964	Ship Shoal 149/199	Gulf of Mexico	11,847	crude
9/29/1992	Greenhill Timbalier Bay 251*	Gulf of Mexico	11,500	crude
2/19/1979	Hebert Bravo 1A	Gulf of Mexico	3,500	condensate
7/1/1965	Ship Shoal 29	Gulf of Mexico	1,690	crude
1/13/1995	BLDSU 6	Gulf of Mexico	800	crude
12/26/1992	Block 60 SP0060	Gulf of Mexico	595	condensate
7/8/1994	Fred Stovall Well 9*	Gulf of Mexico	595	condensate
2/28/2000	MC 538	Gulf of Mexico	200	crude
9/7/1974	Houma Block PL0020	Gulf of Mexico	75	crude
10/16/1971	Lafayette Block EI 0215	Gulf of Mexico	45	crude
9/9/1990	EI-0296	Gulf of Mexico	8	condensate
3/20/1987	VR-0226	Gulf of Mexico	6	crude
2/23/1985	WD-0090	Gulf of Mexico	5	crude
12/2/1974	Houma Block PL0019	Gulf of Mexico	2	crude
Total			**248,963**	

*In state waters.

[32] NOAA defines a well blowout as "an uncontrolled flow of gas, oil, or other fluids from a well into the atmosphere or into an underground formation". MMS defines a "loss of well control" as "uncontrolled flow of formation or other fluids, including flow to an exposed formation (an underground blowout) or at the surface (a surface blowout), flow through a diverter, or uncontrolled flow resulting from a failure of surface equipment or procedures".

Table 22: Largest International Oil Well Blowouts (Ordered by Volume)			
Date	**Well**	**Location**	**Bbl Spilled**
June 1979 – April 1980	Ixtoc I	Bahia del Campeche, Mexico	3,300,000
October 1986	Abkatun 91	Bahia del Campeche, Mexico	247,000
April 1977	Ekofisk Bravo	North Sea, Norway	202,381
January 1980	Funiwa 5	Forcados, Nigeria	200,000
October 1980	Hasbah 6	Gulf, Saudi Arabia	105,000
December 1971	Iran Marine International	Gulf, Iran	100,000
January 1969	**Alpha Well 21 Platform A**	**Pacific, CA, USA**	**100,000**
March 1970	Main Pass Block 41 Platform C	Gulf of Mexico	65,000
October 1987	Yum II/Zapoteca	Bahia del Campeche, Mexico	58,643
December 1970	**South Timbalier B-26**	**Gulf of Mexico, USA**	**53,095**

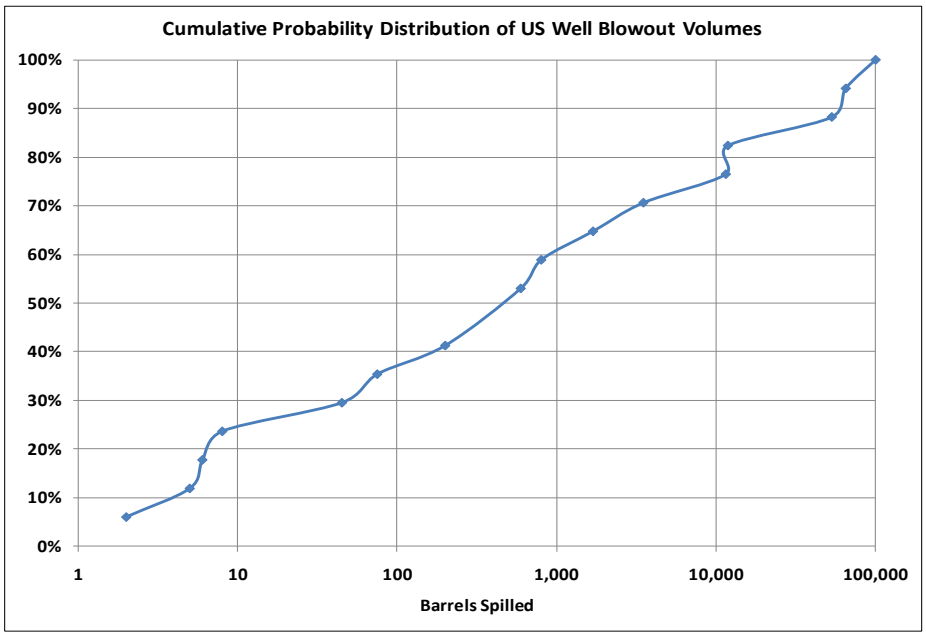

Figure 19: Probability Distribution of Spill Volumes from U.S. Well Blowouts

Each point on the curve represents the percentages of offshore well blowouts that involve that volume (in barrels) or less. For example, 60% of blowouts involve 1,000 barrels or less. (Note the logarithmic scale.)

Offshore Spillage per Production Rates

Offshore oil production has varied over time (Figure 20), changing the likelihood of spillage.

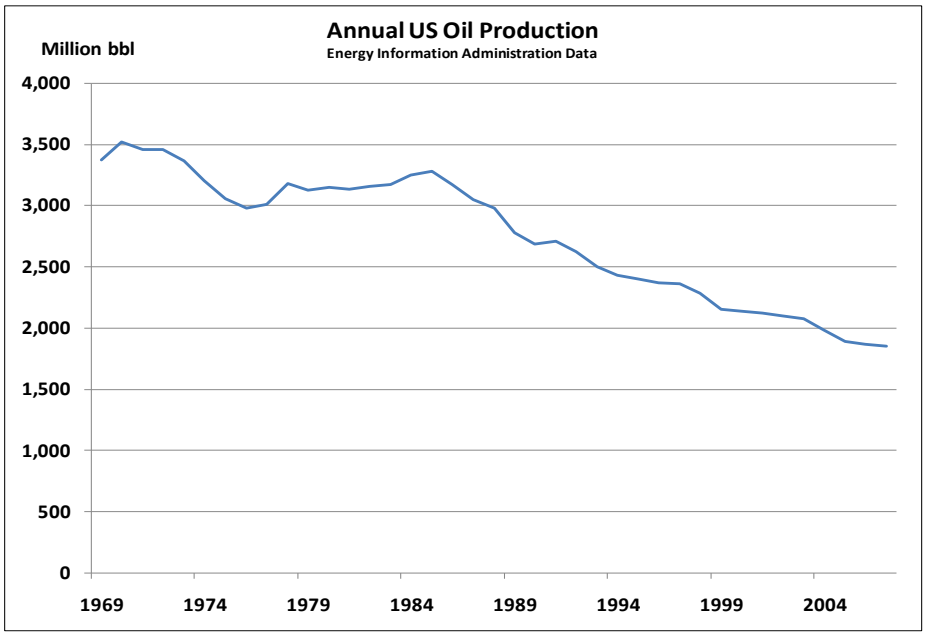

Figure 20: Annual U.S. Offshore Oil Production

Annual U.S. offshore oil production has reduced over time.

Oil spillage per production (i.e., barrels spilled per barrels produced) has decreased over time, as shown in Table 23. In other words, despite increases in production, spillage rates have decreased. Figure 21 shows spillage per production rates by decade.

Table 23: U.S. Offshore Oil Exploration and Production Spillage per Production (bbl)	
Year	**Barrels Spilled per Barrel Produced**
1969	0.0000326
1970	0.0000336
1971	0.0000003
1972	0.0000002
1973	0.0000047
1974	0.0000063
1975	0.0000001
1976	0.0000023
1977	0.0000003
1978	0.0000011
1979	0.0000020
1980	0.0000020
1981	0.0000050
1982	0.0000010
1983	0.0000012
1984	0.0000004
1985	0.0000018
1986	0.0000001
1987	0.0000002
1988	0.0000106
1989	0.0000003
1990	0.0000078
1991	0.0000009
1992	0.0000074
1993	0.0000004
1994	0.0000004
1995	0.0000007
1996	0.0000041
1997	0.0000077
1998	0.0000024
1999	0.0000002
2000	0.0000001
2001	0.0000001
2002	0.0000007
2003	0.0000010
2004	0.0000010
2005	0.0000052
2006	0.0000007
2007	0.0000002
Total	**0.0000042**
Average 1969-1977	**0.0000089**
Average 1978-1987	**0.0000015**
Average 1988-1997	**0.0000040**
Average 1998-2007	**0.0000012**
Average 1969-2007	**0.0000038**

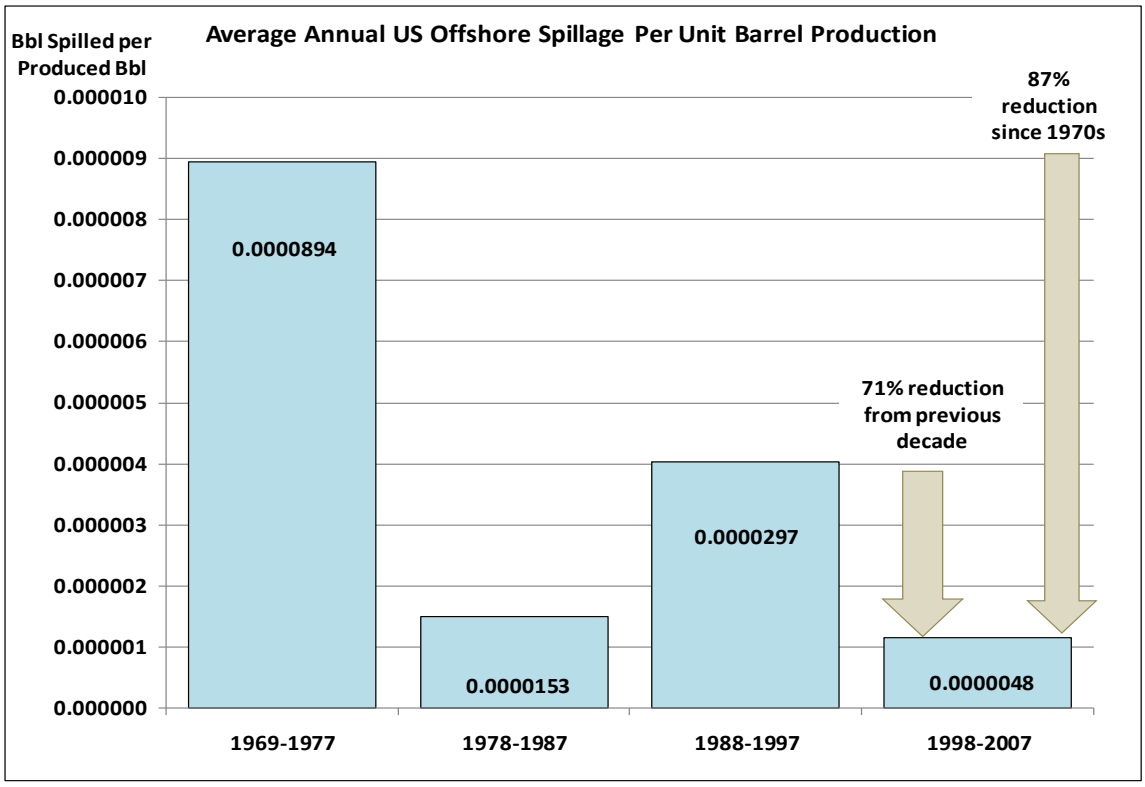

Figure 21: Annual Spillage per Barrel Production by Decade

For every barrel of oil produced in the U.S. less than 0.000005 barrels have spilled from offshore exploration and production activities in the last decade. This is a 71% reduction from the previous decade and an 87% reduction since the 1969-1977 decade.

The rate of spillage per production rate was higher during the 1970s than in the subsequent decades. Had spillage continued at that rate, there would have been an additional 516,000 barrels of oil spilled from offshore exploration and production during 1978 to 2007 (Figure 22 and Table 24).

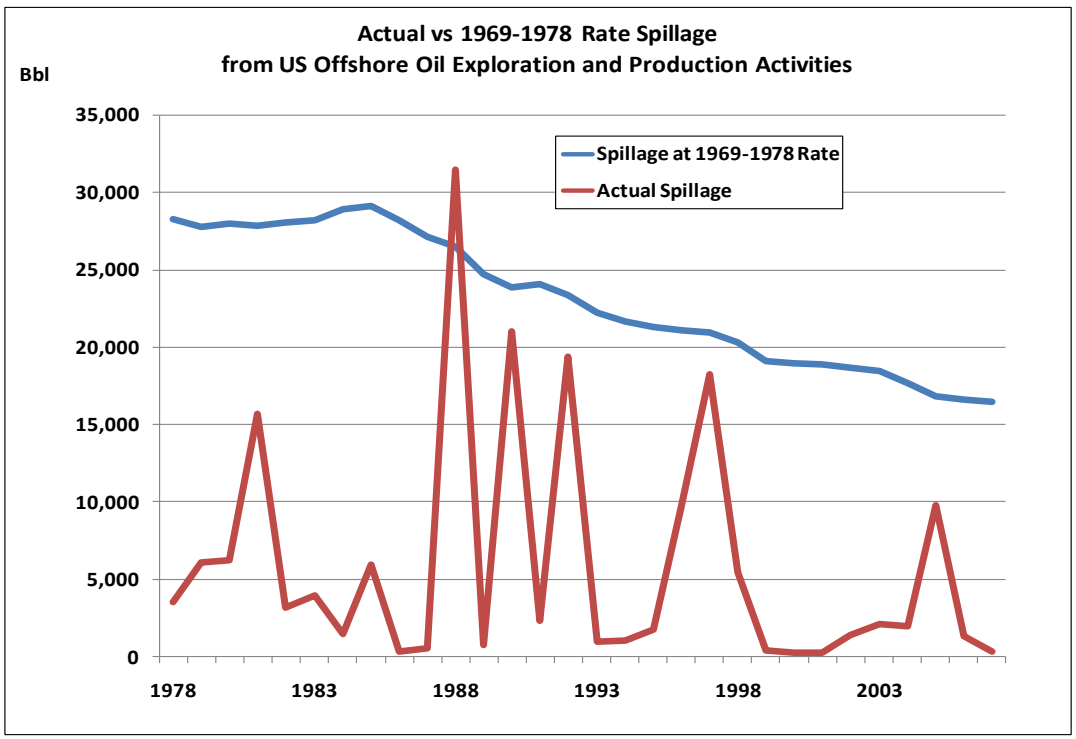

Figure 22: Actual Offshore Spillage vs 1969-1978 Rate Projection

Had spillage continued at the rate of 1969-1978 and additional 516,000 bbl of oil would have spilled from U.S. offshore activities.

Table 24: Actual vs Hypothetical Spillage Offshore Gulf of Mexico and Pacific Facilities			
Year	**Spillage at 1969-1977 Rate[33]**	**Actual Spillage**	**Averted Spillage[34]**
1978	28,286	3,560	24,726
1979	27,780	6,115	21,665
1980	28,003	6,207	21,795
1981	27,845	15,696	12,149
1982	28,095	3,177	24,918
1983	28,222	3,962	24,260
1984	28,922	1,437	27,485
1985	29,144	5,961	23,182
1986	28,197	359	27,839
1987	27,122	555	26,567
1988	26,514	31,481	-4,967
1989	24,731	769	23,962
1990	23,894	21,007	2,887
1991	24,093	2,331	21,761
1992	23,359	19,421	3,938
1993	22,241	977	21,264
1994	21,640	1,005	20,635
1995	21,309	1,713	19,596
1996	21,058	9,770	11,287
1997	20,958	18,247	2,711
1998	20,309	5,433	14,876
1999	19,106	410	18,696
2000	18,963	274	18,689
2001	18,846	254	18,592
2002	18,664	1,392	17,272
2003	18,454	2,134	16,320
2004	17,651	1,976	15,676
2005	16,822	9,751	7,071
2006	16,574	1,287	15,287
2007	16,451	302	16,149
Total	**693,253**	**176,961**	**516,291**

Spills from Inland Production Wells

While the majority of oil production spills have been recorded in offshore waters, there are some reported spills of inland-based oil production wells to inland waterways defined by EPA as "navigable" (Table 25).

Table 25: Estimated Oil Spillage from Inland Oil Production Facilities (Wells)	
Year	**Bbl Spilled**
1980	4
1981	150
1982	2,454
1983	7,181
1984	3,892
1985	7,691
1986	817
1987	7,013

[33] Estimated spillage based on annual production multiplied by average per-unit production rate for the 1969 – 1977 time period (0.0000894).

[34] Averted spillage is the difference between hypothetical expected spillage at the 1969 – 1977 rate and the actual spillage. Where the averted spillage is a negative number, the actual spillage for that year was higher than the expected rate, mainly due to the occurrence of particularly large spills in those years.

Table 25: Estimated Oil Spillage from Inland Oil Production Facilities (Wells)	
Year	**Bbl Spilled**
1988	788
1989	21,128
1990	3,839
1991	3,031
1992	2,340
1993	5,280
1994	8,365
1995	1,432
1996	3,859
1997	1,874
1998	2,041
1999	6,164
2000	3,294
2001	9,574
2002	12,585
2003	7,823
2004	809
2005	-
2006	-
2007	-
TOTAL	**123,426**
Average 1980 - 1987	**3,650**
Average 1988 - 1997	**5,194**
Average 1998 - 2004	**6,041**
Average 1980 - 2004	**4,937**

Spillage from Oil Transport

Spills from Oil Tankers (Tank Ships)

Tank ships carrying oil as cargo spilled an average of 3,600 barrels of oil annually over the last decade. This represents a 90% reduction from the spillage in the previous decade. A breakdown of annual spillage from oil tankers is shown in Table 26. Spillage by decade is shown in Figure 23. Table 27 gives a list of the largest tanker incidents.

Table 26: Estimated Oil Spillage from Oil Tankers in U.S. Waters

Year	Number Spills (1 bbl or more)	Bbl Spilled
1962	-	70,000
1963	-	35,000
1964	-	3,857
1965	-	10,500
1966	-	149,467
1967	-	32,000
1968	-	576,488
1969	-	239,633
1970	-	133,810
1971	-	364,764
1972	-	75,043
1973	369	74,250
1974	397	27,924
1975	274	207,517
1976	237	221,738
1977	227	4,748
1978	276	7,693
1979	292	309,584
1980	246	37,976
1981	186	25,525
1982	127	29,011
1983	106	3,431
1984	90	110,399
1985	62	17,327
1986	89	25,935
1987	58	35,623
1988	86	20,229
1989	87	268,332
1990	105	118,488
1991	73	2,153
1992	54	2,799
1993	48	1,625
1994	39	1,576
1995	24	2,982
1996	20	3,264
1997	17	527
1998	17	1,005
1999	11	195
2000	40	14,480
2001	34	2,958
2002	20	113
2003	14	106
2004	13	15,163
2005	11	1,473
2006	16	150
2007	9	339

Table 26: Estimated Oil Spillage from Oil Tankers in U.S. Waters		
Year	**Number Spills (1 bbl or more)**	**Bbl Spilled**
TOTAL	**3,774**	**1,596,638**
Average 1962 - 1967	**-**	**50,137**
Average 1968 - 1977	**301**	**192,592**
Average 1978 - 1987	**153**	**60,250**
Average 1988 - 1997	**55**	**42,197**
Average 1998 - 2007	**19**	**3,598**
Average 1980 - 2007	**61**	**26,542**

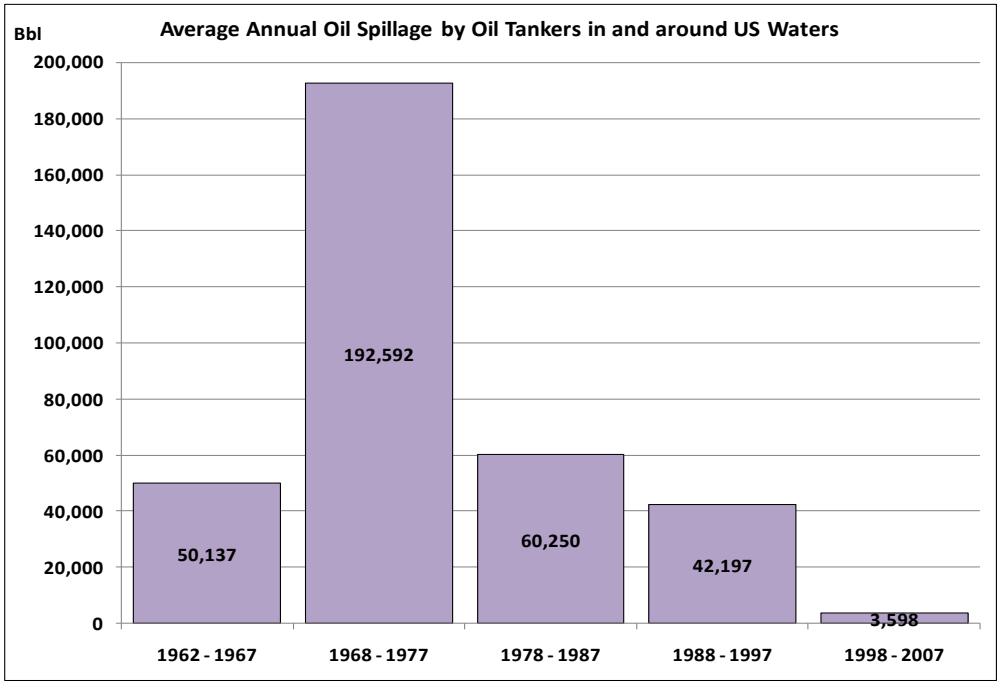

Figure 23: Average Annual Oil Spillage from Tankers in and around U.S. Waters by Decade

Average annual oil spillage from tankers decreased by 91% since the previous decade.

Table 27: Largest Tanker Spills in and near U.S. Waters[35]			
Date	**Tanker Name**	**Location**	**Bbl**
2/29/1968	Mandoil II	Pacific Ocean, off Columbia River, Warrenton, OR	300,000
3/24/1989	Exxon Valdez	Prince William Sound, Valdez, AK	261,905
11/1/1979	Burmah Agate	Gulf of Mexico, off Galveston Bay, TX	254,762
2/8/1968	Pegasus (Pegasos)	Northwest Atlantic Ocean off U.S. east coast	228,500
3/26/1971	Texaco Oklahoma	Northwest Atlantic Ocean off U.S. east coast	225,000
11/5/1969	Keo	Northwest Atlantic Ocean, SE of Nantucket Island, MA	209,524
12/15/1976	Argo Merchant	Nantucket Shoals, off Nantucket Island, MA	183,333
4/4/1975	Spartan Lady	Northwest Atlantic Ocean off U.S. east coast	142,857
10/24/1966	Gulfstag	Gulf of Mexico	133,000
6/9/1990	Mega Borg	Gulf of Mexico, off Texas	119,048
1/31/1970	Gezina Brovig	Caribbean Sea, N of San Juan, PR	112,000
10/4/1976	LSCO Petrochem	Gulf of Mexico, off Louisiana	109,952
10/31/1984	Puerto Rican	Pacific Ocean, Bodega Bay off San Francisco, CA	100,000
7/29/1987	Blue Ridge	Gulf of Mexico, off Florida	80,000
6/1/1971	Santa Augusta	Caribbean Sea, St. Croix, U.S. Virgin Islands	78,643
7/17/1962	Argea Prima	Caribbean Sea, PR	70,000
7/30/1984	Alvenus	Calcasieu River bar channel, off Cameron, Cameron Parish, LA	66,452
1/1/1972	General M.C. Meiggs	Strait of Juan de Fuca, off Port Angeles,WA	54,762
4/7/1974	Sea Spirit	Los Angeles harbor, CA	50,024
3/3/1968	Ocean Eagle	Caribbean Sea, San Juan, PR	47,619

[35] Includes oil tanker spills that occurred in the U.S. Exclusive Economic Zone (EEZ) or affected those waters.

Spills from Tank Barges

Tank barges carrying oil as cargo spilled an average of 5,400 barrels of oil annually over the last decade. This represents a nearly 67% reduction from the spillage in the previous decade. A breakdown of annual spillage from oil tank barges is shown in Table 28. The spillage by decade is shown in Figure 24.

Table 28: Estimated Oil Spillage from Oil Tank Barges in U.S. Waters		
Year	**Number Spills (1 bbl or more)**	**Bbl Spilled**
1968	-	7,333
1969	-	18,333
1970	-	14,667
1971	-	5,857
1972	-	48,190
1973	284	29,696
1974	352	55,447
1975	368	61,165
1976	396	40,435
1977	439	37,178
1978	441	77,050
1979	382	27,490
1980	393	41,262
1981	340	100,017
1982	260	51,027
1983	256	42,993
1984	229	59,024
1985	183	87,634
1986	240	30,346
1987	175	13,044
1988	214	75,108
1989	226	17,705
1990	201	23,513
1991	166	17,715
1992	112	3,532
1993	80	15,824
1994	102	22,720
1995	44	21,216
1996	48	27,683
1997	32	3,805
1998	30	4,566
1999	32	3,772
2000	82	31,751
2001	89	5,055
2002	45	720
2003	56	2,449
2004	51	5,139
2005	52	251
2006	52	378
2007	46	210
TOTAL	**6,498**	**1,036,920**
Average 1968 - 1977	**368**	**31,830**
Average 1978 - 1987	**290**	**52,989**
Average 1988 - 1997	**123**	**22,882**
Average 1998 - 2007	**54**	**5,429**
Average 1968 - 2007	**186**	**28,283**

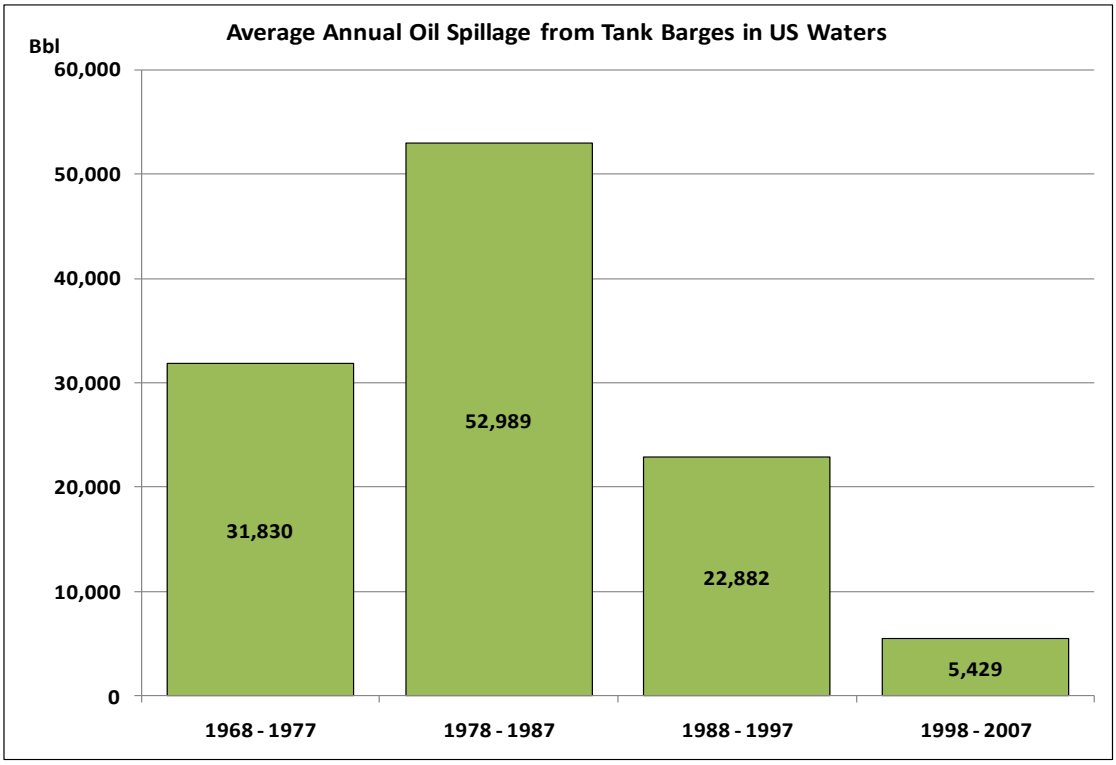

Figure 24: Average Annual Oil Spillage from Tank Barges in U.S. Waters by Decade

Annual average tank barge spillage reduced by 76% from the previous decade.

Table 29: Largest Tank Barge Spills in and near U.S. Waters[36]			
Date	**Barge Name**	**Location**	**Bbl**
1/16/1989	UMTB American 283	Pacific Ocean, south of Semidi Islands, Alaska	48,619
10/25/1972	Ocean 80	Arthur Kill Waterway, Carteret, New Jersey	47,643
8/1/1974	Barge #15	Lower Mississippi River, Bertrandville, Louisiana	46,452
3/5/1975	B-421/Barge 13/B-117	Lower Mississippi River, Vicksburg, Mississippi	37,993
10/9/1974	Bouchard 65	Atlantic Ocean, near Massachusetts	36,643
9/23/1988	n/a	Sandy Hook Channel, New York, New York	35,000
6/17/1991	n/a	Long Island Sound, Port Jefferson, New York	30,000
3/12/1964	n/a	Pacific Ocean, Moclips, Washington	29,762
3/25/1973	Barge 9	Lower Mississippi River, Louisiana	29,310
1/24/1984	n/a	Lower Mississippi River, Wilson, Arkansas	26,119
6/22/1974	ON 524331	Lower Mississippi River, New Orleans, Louisiana	24,000
6/16/1995	Apex 3603 & 3506	Vicksburg, Mississippi, Lower Mississippi River	20,205
3/3/1975	IOT-105	Lower Mississippi River, Vicksburg, Mississippi	20,000
11/22/1985	E-24	Block Island Sound, off Fishers Island, New York	20,000
1/19/1996	North Cape	Block Island Sound, near Galilee, Rhode Island	19,714
1/7/1994	Morris J. Berman	San Juan Harbor, Puerto Rico	19,000
6/24/1974	ABC 2311	Lower Mississippi River, New Orleans, Louisiana	18,238
6/1/1984	n/a	Lower Mississippi River, Louisiana	17,500
3/7/1986	Texas	Upper Mississippi River, Thebes, Illinois	17,048
7/28/1990	Barges 3417, 3503, 3510	Houston Shipping Channel, Galveston, Texas	16,476

[36] Includes oil tank barge spills that occurred in the U.S. Exclusive Economic Zone (EEZ) or affected those waters.

Oil Spillage from Tank Vessels in Relation to Oil Transported

Oil transport by tank vessels (tankers and barges) has changed over the last decades, as shown in Figure 25. Oil spillage from tank vessels in relation to oil transported by this mode has reduced by 71% in the last decade, as shown in Table 30 and Figure 26.

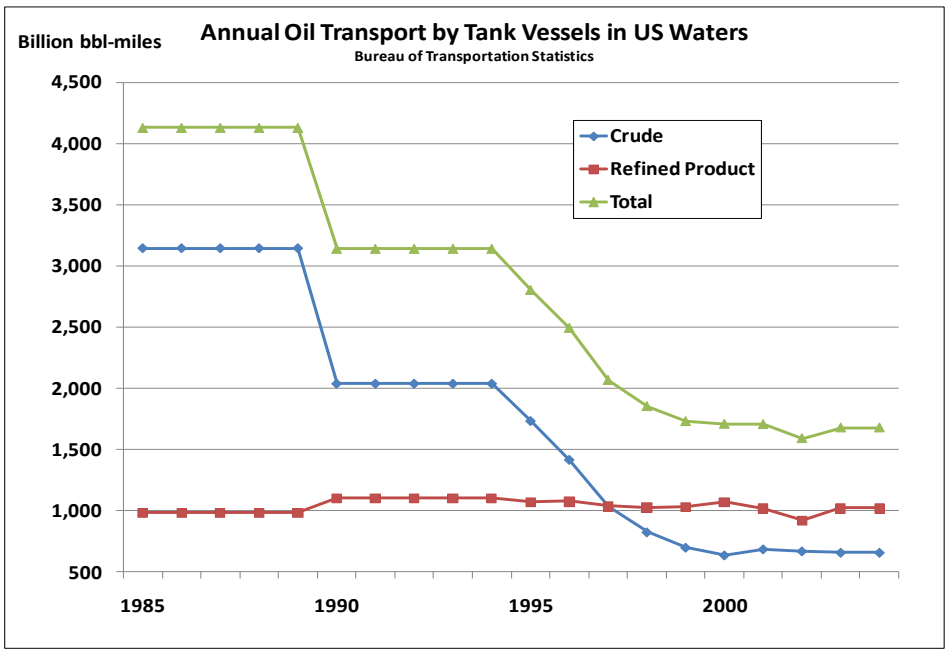

Figure 25: Annual oil transport by tank vessels in U.S. waters

Crude oil transport by tank vessels has decreased since 1990. Since the late 1990s more refined products are transported by tank vessels than crude oil.

Table 30: Oil Spillage by Tank Vessels in Relation to Oil Transported

Time Period	Average Annual Spillage (bbl)			Average Annual Spillage per Billion Barrel-Miles[37] Oil Transport
	Tankers	Tank Barges	Combined	
1978 – 1987	60,250	52,989	113,239	27.40
1988 – 1997	42,198	22,882	65,080	18.22
1998 – 2007	3,598	5,429	9,027	5.28

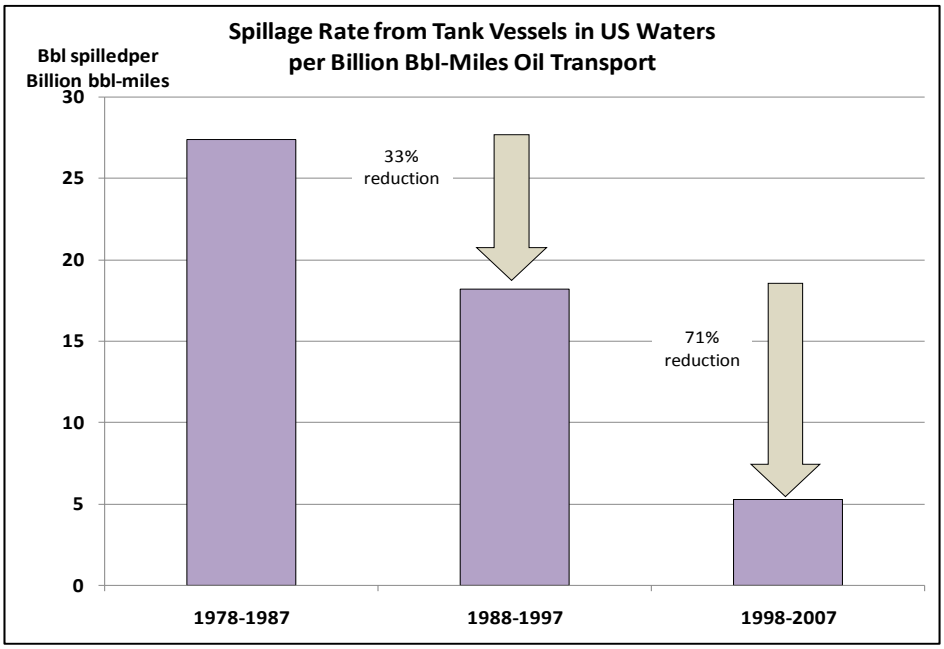

Figure 26: Oil spillage rate from tank vessels per billion barrel miles of oil transport

The spillage rate from tank vessels (oil spilled per oil transported) has reduced by 71% since the previous decade.

[37] Barrel-miles combine volume and distance of transport.

Oil Spillage from Coastal and Inland Pipelines

Spills from pipeline[38] in coastal and inland areas are shown in Table 31. During the last decade coastal and inland pipelines spilled an average of 77,000 barrels of oil annually. This represents a 35% reduction in spillage from the previous decade. Annual spillage is in Figure 27. Average spillage by decade is in Figure 28.

Table 31: Oil Spillage from Coastal and Inland U.S. Pipelines (1968 – 2007)

Year	Number of Spills (1 bbl or more)	Volume Spilled (bbl)
1968	455	316,899
1969	359	243,007
1970	320	478,108
1971	250	170,042
1972	286	321,807
1973	245	320,848
1974	223	224,300
1975	219	183,168
1976	189	183,157
1977	211	152,065
1978	219	165,380
1979	204	208,722
1980	192	214,653
1981	147	96,845
1982	160	193,490
1983	123	135,547
1984	160	238,041
1985	150	110,497
1986	171	243,404
1987	195	205,382
1988	144	154,252
1989	123	156,011
1990	137	100,108
1991	150	179,803
1992	157	106,855
1993	164	87,001
1994	150	116,143
1995	125	85,206
1996	123	94,046
1997	125	139,501
1998	105	113,311
1999	123	130,850
2000	104	82,777
2001	86	32,182
2002	323	43,330
2003	282	56,598
2004	247	41,230
2005	239	124,987
2006	226	98,616
2007	217	43,662
Total	**7,828**	**6,391,829**
Average 1968 - 1977	**276**	**259,340**
Average 1978 - 1987	**172**	**181,196**
Average 1988 - 1997	**140**	**118,297**
Average 1998 - 2007	**195**	**76,754**
Average 1968 - 2007	**196**	**159,796**

[38] In these analyses, coastal and inland pipelines are considered to encompass all parts of the pipeline system, including gathering pipes, transmission pipes, breakout tanks, pump stations, and tank farms directly associated with and operated by pipeline companies. Offshore pipelines are considered separately under offshore exploration and production.

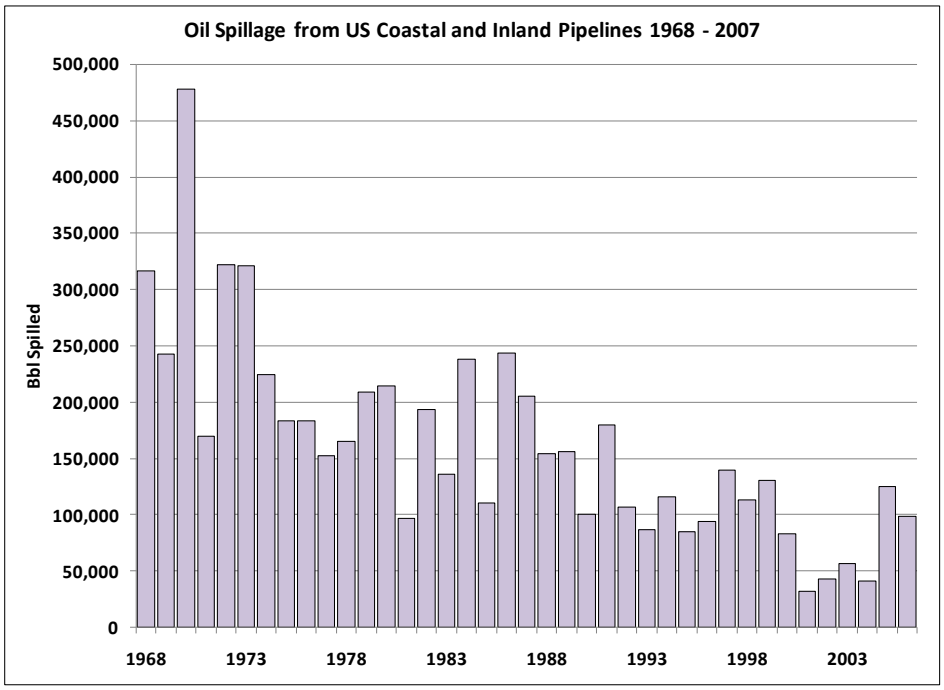

Figure 27: Oil Spillage from U.S. Coastal and Inland Pipelines 1968 – 2007

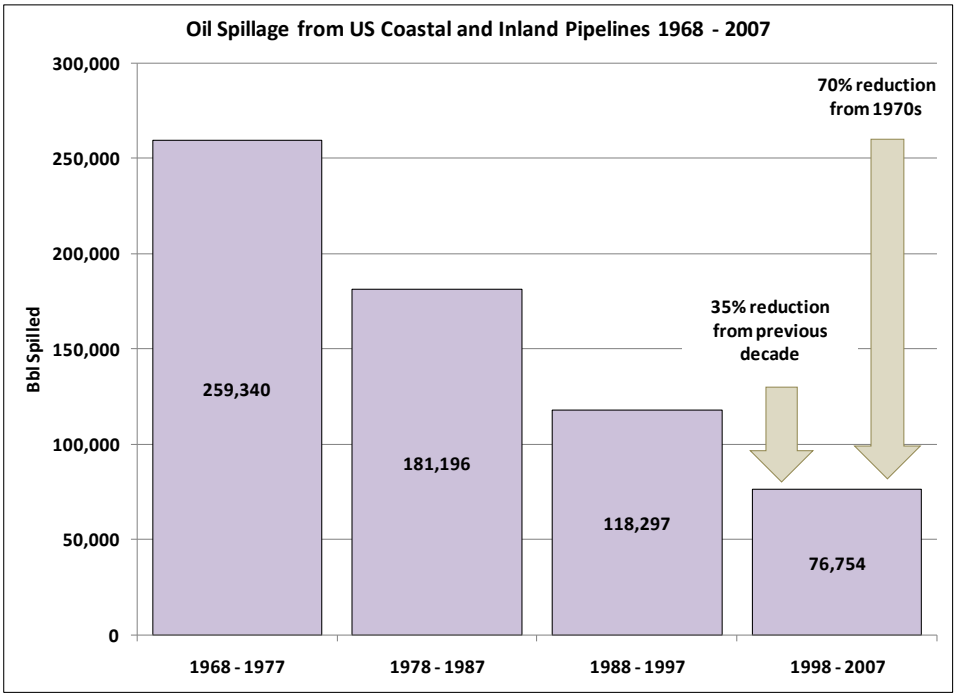

Figure 28: Oil Spillage from U.S. Coastal and Inland Pipelines by Decade

It should be noted that a significant portion of oil (about 85%) that spills from inland pipelines goes to containment areas around breakout tanks or to solid ground rather than directly into surface waters. Reductions in spillage into pipeline rights-of-way have been even greater than 35% in the last decade.

There have been a number of regulatory changes for pipelines – Oil Pollution Act of 1990, the Pipeline Safety Act (PSA) of 2002, and the Pipeline Integrity, Protection, Enforcement, and Safety (PIPES) Act of 2006 that have improved pipeline safety and reduced spillage, as evidenced by the reduced spillage volumes in Figures 27 and 28. Pipeline spillage amounts by oil type and per unit of oil transport are shown in Tables 32 and 33, and Figures 29 – 31.

Table 32: Oil Pipeline Spillage by Oil Type and Transport (1980 – 2007)						
Year	Spillage (bbl)			Bbl Spilled per Billion Barrel-Miles Transport		
	Crude	Refined	Total	Crude	Refined	Total
1980	147,383	67,270	214,653	62.96	41.80	54.34
1981	58,272	38,573	96,845	24.89	23.97	24.52
1982	128,016	65,474	193,490	54.69	40.68	48.98
1983	88,231	47,316	135,547	37.69	29.40	34.31
1984	179,242	58,799	238,041	76.57	36.54	60.26
1985	75,548	34,949	110,497	32.27	21.72	27.97
1986	114,301	129,103	243,404	48.83	80.22	61.62
1987	126,489	78,893	205,382	54.04	49.02	51.99
1988	106,128	48,124	154,252	45.34	29.90	39.05
1989	117,070	38,941	156,011	50.01	24.20	39.50
1990	66,588	33,520	100,108	28.41	19.21	24.48
1991	142,095	37,708	179,803	60.63	21.61	43.98
1992	58,235	48,620	106,855	24.85	27.86	26.13
1993	42,573	44,428	87,001	18.17	25.46	21.28
1994	44,126	72,017	116,143	18.83	41.27	28.41
1995	60,302	24,904	85,206	25.65	13.42	20.25
1996	45,533	48,513	94,046	19.23	24.67	21.70
1997	77,182	62,319	139,501	32.68	31.90	32.33
1998	93,436	19,875	113,311	39.95	9.94	26.12
1999	99,944	30,906	130,850	44.47	14.89	30.26
2000	48,216	34,561	82,777	24.30	16.80	20.48
2001	18,672	13,510	32,182	9.63	6.45	7.98
2002	24,485	18,844	43,330	12.20	8.99	10.56
2003	28,461	28,137	56,598	14.29	13.15	13.70
2004	21,031	20,198	41,230	10.70	10.42	10.56
2005	101,277	23,710	124,987	57.38	14.36	36.59
2006	85,742	12,873	98,616	46.57	8.22	28.95
2007	18,879	24,782	43,662	11.56	15.69	13.59
Total	**2,217,458**	**1,206,868**	**3,424,326**	**35.81**	**24.24**	**30.65**
Average 1980-1987	**79,195**	**43,102**	**122,297**	**35.24**	**25.06**	**30.71**
Average 1988-1997	**114,685**	**65,047**	**179,732**	**48.99**	**40.42**	**45.50**
Average 1998-2007	**75,983**	**45,909**	**121,893**	**32.38**	**25.95**	**29.71**
Average 1980-2007	**54,014**	**22,740**	**76,754**	**27.11**	**11.89**	**19.88**

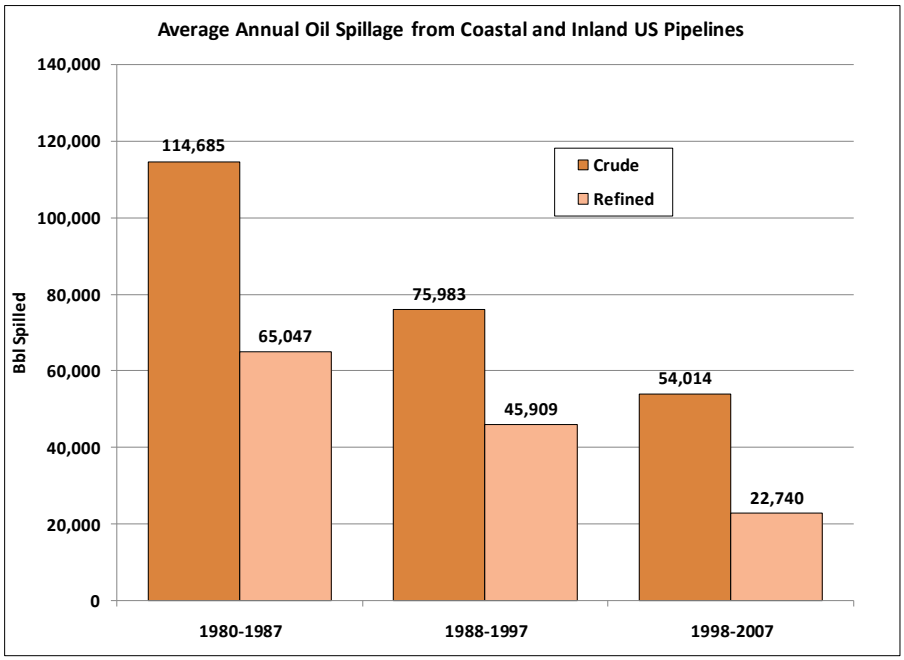

Figure 29: Average Annual Oil Spillage from U.S. Coastal and Inland Pipelines by Oil Type

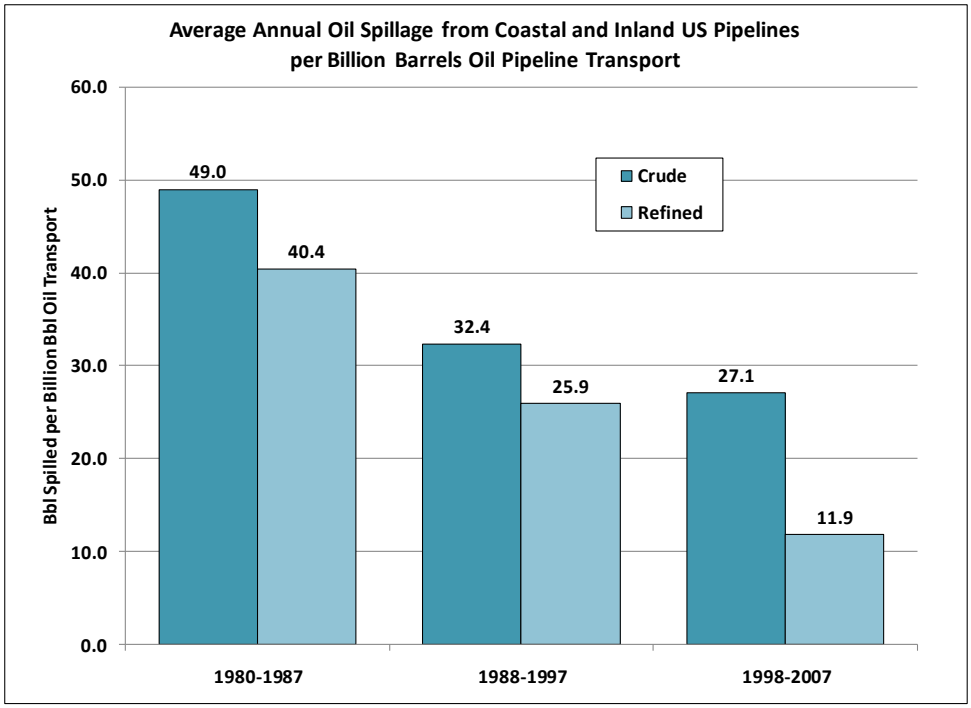

Figure 30: Average Annual Oil Spillage from U.S. Coastal and Inland Pipelines per Oil Transport – by Decade

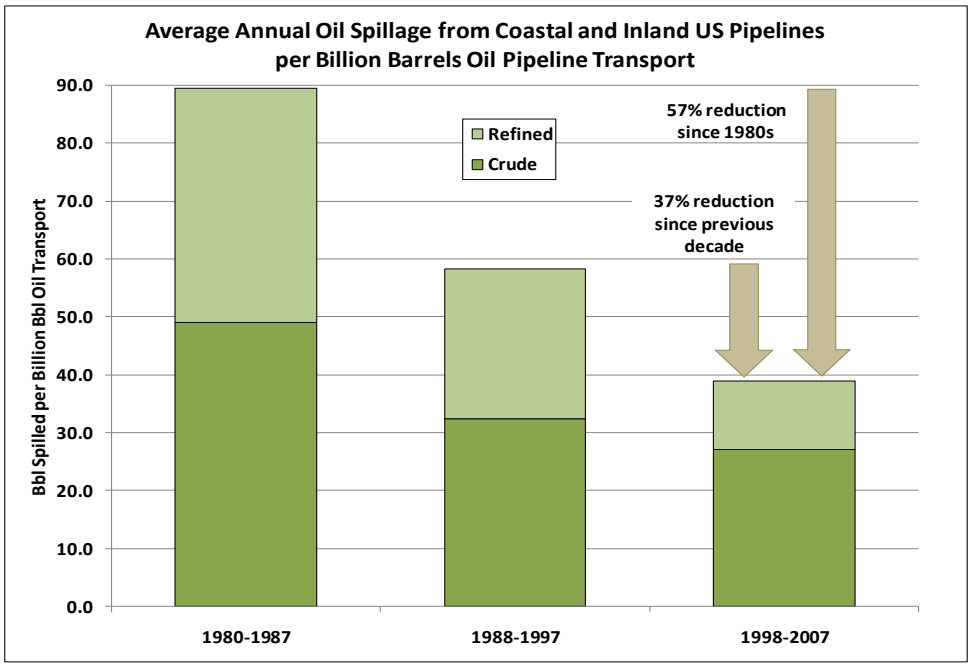

Figure 31: Average Annual Oil Spillage from U.S. Coastal and Inland Pipelines per Oil Transport – by Decade

Table 33: Oil Spillage from Coastal and Inland U.S. Oil Pipelines by Oil Type

Oil Type	Bbl Spilled		% Total Volume Spilled	
	1968-2007	1998-2007	1968-2007	1998-2007
Crude	4,274,404	540,144	66.87%	70.4%
Diesel	653,566	58,724	10.23%	7.7%
Gasoline	1,186,973	121,685	18.57%	15.9%
Jet Fuel	205,130	32,851	3.21%	4.3%
Heavy Fuel	19,026	2,509	0.30%	0.3%
Other Oil	36,031	8,502	0.56%	1.1%
Condensate	14,191	618	0.22%	0.1%
Unknown Oil	2,509	2,509	0.04%	0.3%
Total	**6,391,830**	**767,541**	**100.00%**	**100.0%**

An analysis of the sizes of pipeline spills is shown in Table 34 and Figures 32 and 33.

Table 34: U.S. Coastal and Inland Oil Pipeline Spill Probabilities of Spill Volumes				
Time Period	**Spill Volume (bbl)**			
	50th percentile	**90th percentile**	**95th percentile**	**Worst Case**
1968-2007	180	1,725	3,155	223,183
1998-2007	12	660	1,360	49,000

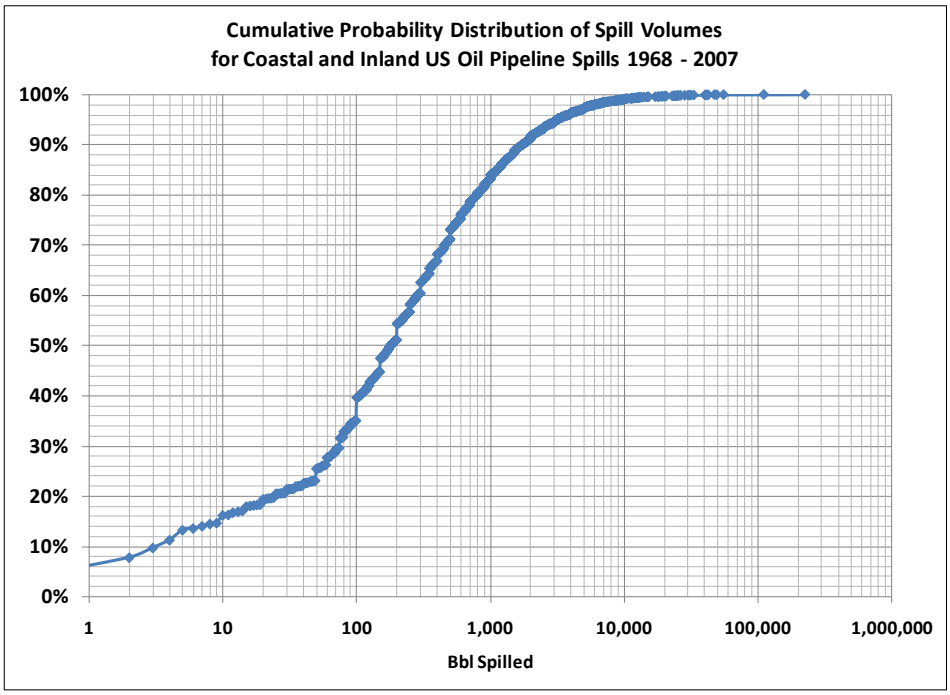

Figure 32: Probability Distribution Function of Spill Volumes for U.S. Coastal and Inland Pipelines 1968 -2007

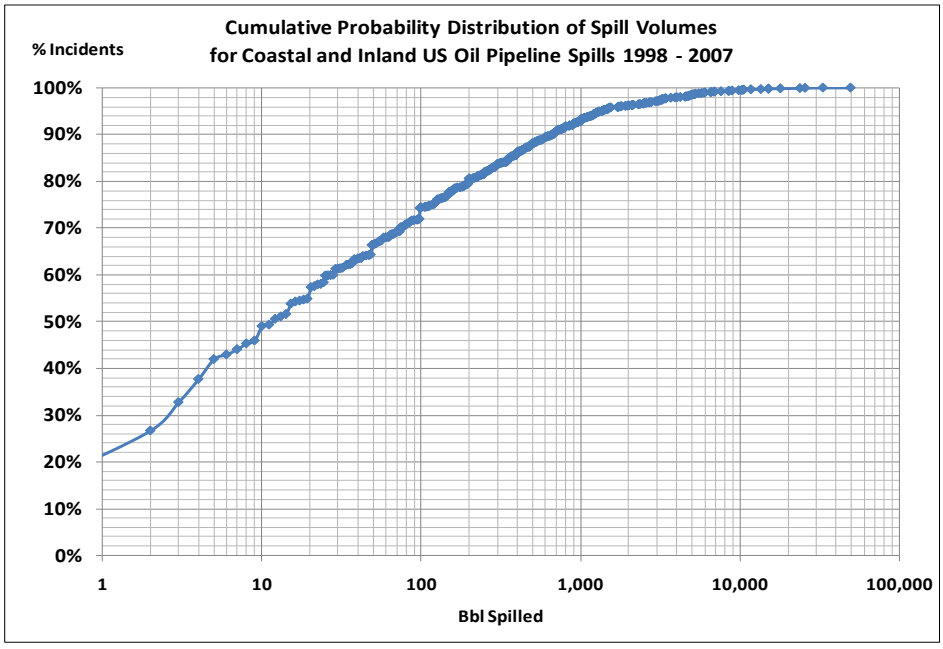

Figure 33: Probability Distribution Function of Spill Volumes for U.S. Coastal and Inland Pipelines 1998 -2007

The volume of spilled oil in pipeline incidents is considerably lower in the last decade than in the overall forty-year time period. Fifty percent of spills in the last 10 years were 12 barrels or below.

Spills from Railroads

Railroads spilled 1,400 barrels of oil annually as cargo in tank cars and as fuel. This is a 34% reduction from the previous decade. An annual breakdown of railroad spillage is shown in Table 35. Spills from railroads often go to ballast and do not always directly impact waterways.

Table 35: Estimated Oil Spillage from Railroads	
Year	**Bbl**
1980	6,921
1981	595
1982	5,511
1983	1,532
1984	336
1985	2,038
1986	216
1987	1,429
1988	592
1989	362
1990	13,274
1991	138
1992	1,648
1993	3,868
1994	208
1995	301
1996	455
1997	799
1998	2,936
1999	6,408
2000	280
2001	364
2002	848
2003	582
2004	111
2005	1,176
2006	163
2007	1,442
TOTAL	**54,533**
Average 1980 - 1987	**2,322**
Average 1988 - 1997	**2,164**
Average 1998 - 2007	**1,431**
Average 1980 - 2007	**1,948**

Spills from Tanker Trucks

Tanker trucks carrying oil (usually fuels) as cargo spilled an average of 9,200 barrels of oil annually in the last decade. This is a 76% increase since the previous decade. (Some of this increase may be attributed to better reporting of these incidents to local authorities. Most of these spill incidents are handled by local emergency response personnel, such as fire departments.) Spills from tanker trucks often go to pavements and do not directly impact waterways. Annual spillage is shown in Table 36.

Table 36: Estimated Oil Spillage from Tanker Trucks

Year	Tanker Trucks (bbl)
1980	2,536
1981	980
1982	4,487
1983	14,955
1984	4,577
1985	4,648
1986	4,568
1987	2,349
1988	3,986
1989	4,941
1990	3,453
1991	3,783
1992	9,938
1993	6,677
1994	4,180
1995	4,299
1996	5,656
1997	5,222
1998	5,183
1999	6,499
2000	17,676
2001	16,190
2002	15,651
2003	8,742
2004	1,845
2005	4,970
2006	6,758
2007	8,291
TOTAL	**183,040**
Average 1980 - 1987	**4,888**
Average 1988 - 1997	**5,213**
Average 1998 - 2007	**9,181**
Average 1980 - 2007	**6,537**

Spillage from Oil Refining

Each year, on average, over 60 billion barrels of imported and domestically-produced crude oil is refined into hundreds of petroleum-based products and fuels at the 162 refineries[39] in the U.S.

Refinery Spills

Spillage from oil refineries averaged 12,136 barrels annually over the last decade, about a 19% reduction from the previous decade, and a 27% reduction in spillage per barrel of oil throughput at refineries. The annual breakdown is shown in Table 37. Average annual refinery spillage by decade is shown in Figure 34. The average annual spillage per barrel of oil processed at refineries is shown in Figure 35.

Table 37: Estimated Oil Spillage from Refineries

Year	Bbl Spilled	Annual Refining Capacity (bbl)[40]	Refinery Utilization	Annual Throughput (bbl)	Spillage (bbl) per bbl Refinery Throughput
1980	2,973	63.57×10^9	77.6%	5.04×10^9	0.00000059
1981	12,356	63.57×10^9	77.6%	4.66×10^9	0.00000265
1982	633	63.57×10^9	77.6%	4.45×10^9	0.00000014
1983	2,252	63.57×10^9	77.6%	4.36×10^9	0.00000052
1984	1,857	63.57×10^9	77.6%	4.46×10^9	0.00000042
1985	376	63.57×10^9	77.6%	4.44×10^9	0.00000008
1986	7,192	64.35×10^9	82.9%	4.68×10^9	0.00000154
1987	461	65.33×10^9	83.1%	4.75×10^9	0.00000010
1988	11,809	65.59×10^9	84.4%	4.91×10^9	0.00000240
1989	26,860	65.80×10^9	86.3%	4.95×10^9	0.00000543
1990	37,096	65.59×10^9	87.1%	4.97×10^9	0.00000746
1991	26,329	66.30×10^9	86.0%	4.93×10^9	0.00000534
1992	10,267	65.04×10^9	87.9%	4.97×10^9	0.00000207
1993	11,273	65.53×10^9	91.5%	5.06×10^9	0.00000223
1994	18,043	65.24×10^9	92.6%	5.13×10^9	0.00000352
1995	1,291	66.22×10^9	92.0%	5.16×10^9	0.00000025
1996	1,461	65.99×10^9	94.1%	5.24×10^9	0.00000028
1997	5,725	67.33×10^9	95.2%	5.42×10^9	0.00000106
1998	3,352	68.31×10^9	95.6%	5.52×10^9	0.00000061
1999	20,142	70.54×10^9	92.6%	5.51×10^9	0.00000366
2000	32,675	71.18×10^9	92.6%	5.59×10^9	0.00000585
2001	823	71.48×10^9	90.3%	5.61×10^9	0.00000015
2002	8,640	72.08×10^9	90.7%	5.54×10^9	0.00000156
2003	8,801	73.00×10^9	92.6%	5.66×10^9	0.00000155
2004	373	73.98×10^9	93.0%	5.76×10^9	0.00000006
2005	42	73.43×10^9	90.6%	5.69×10^9	0.00000001
2006	46,511	74.22×10^9	89.7%	5.70×10^9	0.00000816
2007	0	74.90×10^9	88.5%	5.64×10^9	0.00000000
TOTAL	**299,613**	**$1,892.85 \times 10^9$**	**-**	**143.80×10^9**	**0.00000208**
Average 1980 - 1987	**3,513**	**63.89×10^9**	**78.95%**	**4.61×10^9**	**0.00000076**
Average 1988 - 1997	**15,015**	**65.86×10^9**	**89.71%**	**5.07×10^9**	**0.00000296**
Average 1998 - 2007	**12,136**	**72.31×10^9**	**91.62%**	**5.62×10^9**	**0.00000216**
Average 1980 - 2007	**10,700**	**67.60×10^9**	**87.32%**	**5.14×10^9**	**0.00000208**

[39] Energy Information Administration data.
[40] 10^9 equals one billion.

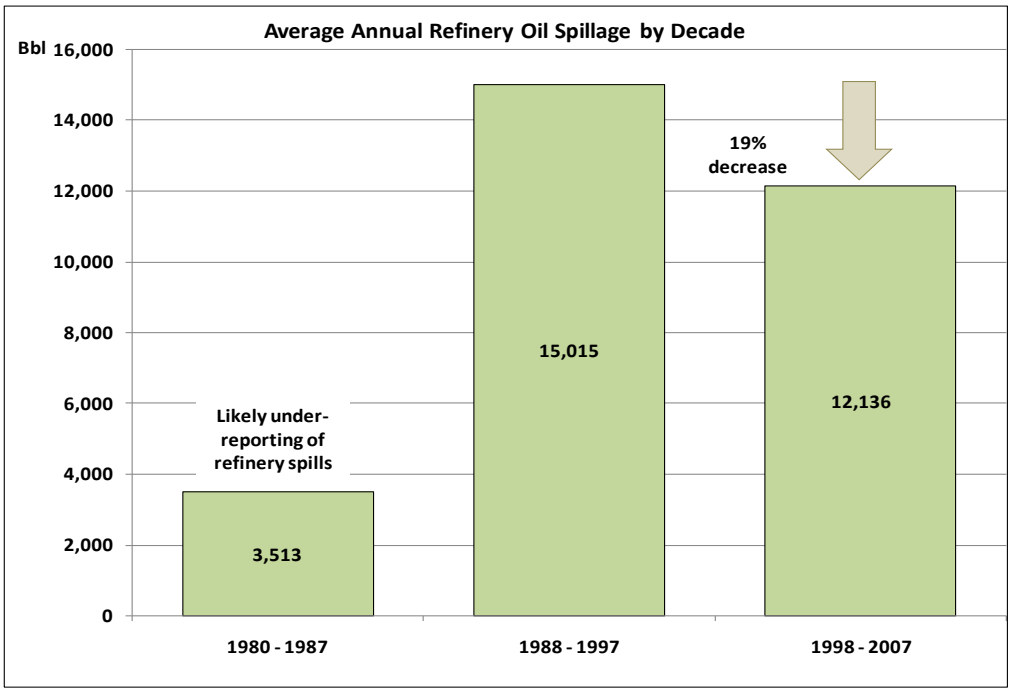

Figure 34: Average Annual Spillage from U.S. Refineries

Refinery spillage decreased 19% since the previous decade. The lower spillage for 1980-1987 is likely a data artifact since spill sources in reports were not always accurately identified. (e.g., a refinery may merely have been identified as a "facility"). There were also changes in reporting requirements in 1986 with the Emergency Planning and Community Right-to-Know Act (EPCRA), which authorized the Toxics Release Inventory (TRI) to track facility releases of a variety of chemicals and toxic substances. While crude oil and refined petroleum products themselves are not encompassed by the TRI-reporting requirements, some of their additives and chemical components are listed. Overall, implementation of the EPCRA created a greater awareness of the need to report discharges from refineries.

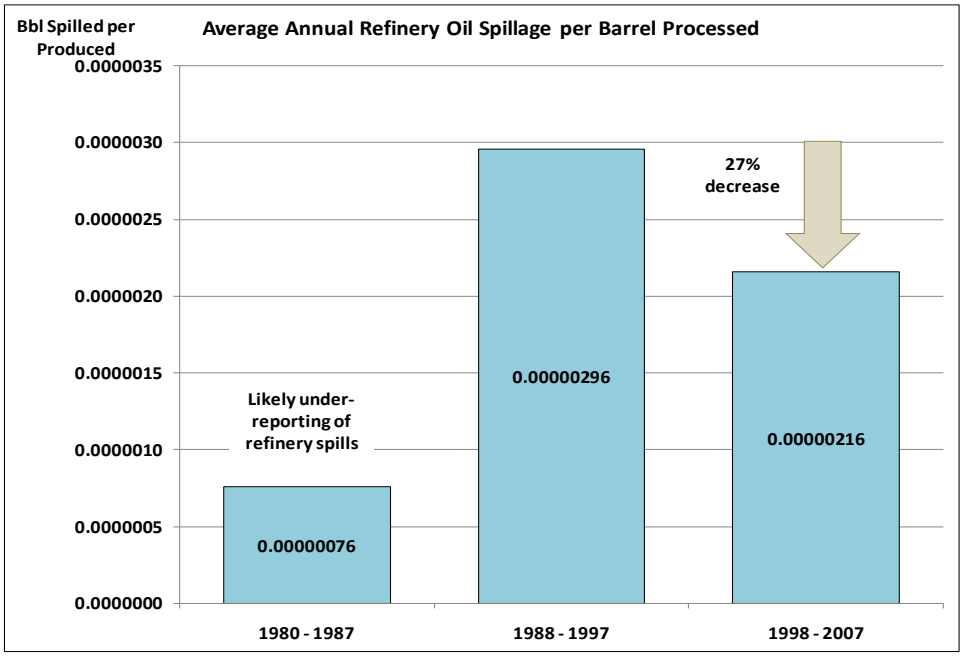

Figure 35: Spillage per barrel of oil processed

The remarkably lower spillage rate for 1980-1987 is likely a data artifact since spill sources in reports were not always accurately identified. (e.g., a refinery may merely have been identified as a "facility"). There were also changes in reporting requirements in 1986 with the Emergency Planning and Community Right-to-Know Act (EPCRA), which authorized the Toxics Release Inventory (TRI) to track facility releases of a variety of chemicals and toxic substances. While crude oil and refined petroleum products themselves are not encompassed by the TRI-reporting requirements, some of their additives and chemical components are listed. Overall, implementation of the EPCRA created a greater awareness of the need to report discharges from refineries.

The data indicate a remarkably lower spillage rate and total spillage for the time period 1980 through 1987. This is most likely a data artifact in that the spills reported for this time period were not always accurately identified as to source owner. The spills may simply have been attributed to a "facility" rather than specifically to a "refinery". That said, there were also some significant changes in reporting requirements in 1986, when the U.S. Congress enacted the Emergency Planning and Community Right-to-Know Act (EPCRA). EPCRA authorized the Toxics Release Inventory (TRI) to track releases of a variety of chemicals and toxic substances from facilities. While crude oil and refined petroleum products (fuels) themselves are not encompassed by the TRI-reporting requirements, some of their additives and chemical components are listed.[41] Overall, implementation of the EPCRA created a greater awareness of the need to report discharges from refineries. In 1990, Congress passed the Pollution Prevention Act (PPA), which required that additional data on waste management and source reduction activities be reported under TRI.

[41] Although diesel, gasoline, and fuel oils are not listed as TRI toxic chemicals, these products contain listed toxic chemicals that may be reportable under EPCRA Section 313, if applicable activity thresholds are met. An EPCRA Section 313 listed a toxic chemical that is a constituent of a fuel that is combusted on-site as being "otherwise used" (62FR §23834, 23851; May 1, 1997). In addition, the combustion of fuels can cause listed toxic chemicals to be generated, or "manufactured". Toxic chemicals in fuel that are prepared for distribution in commerce are "processed". For example, toxic chemicals in fuel contained in automobiles that are sold by a facility are considered toward the processing threshold.

Spillage Related to Oil Consumption and Usage

Refined petroleum products are used in a wide variety of applications, including fuels for transportation, heating, manufacturing, and electricity production. Spillage of oil from sources that "consume" or use oil is generally outside of the realm of the petroleum industry itself, but is presented here for perspective on total oil inputs.

Spills from "Non-Tank Vessels" (Cargo Ships)

"Non-tank vessels" (e.g., cargo ships and freighters) carrying oil as bunker fuel and for operations spill an average of 1,600 barrels of oil annually, a 43% reduction from the previous decade. A breakdown of annual spillage from these vessels is shown in Table 38 and Figure 36.

Table 38: Estimated Oil Spillage from Non-Tank Vessels (Cargo Ships) in U.S. Waters

Year	Number Spills (1 bbl or more)	Bbl Spilled
1973	84	507
1974	96	1,870
1975	90	966
1976	98	542
1977	130	1,333
1978	129	3,653
1979	110	1,708
1980	125	1,101
1981	102	4,231
1982	79	3,089
1983	71	2,439
1984	59	34,996
1985	48	4,209
1986	60	526
1987	66	11,909
1988	58	1,882
1989	58	7,707
1990	84	3,754
1991	79	1,333
1992	95	3,842
1993	93	1,999
1994	99	1,559
1995	103	3,047
1996	86	1,670
1997	75	1,379
1998	63	690
1999	68	2,736
2000	51	662
2001	50	524
2002	29	377
2003	31	452
2004	27	8,233
2005	20	973
2006	20	36
2007	11	1,334
TOTAL	**2,547**	**117,268**
Average 1973 - 1977	**100**	**1,044**
Average 1978 - 1987	**85**	**6,786**
Average 1988 - 1997	**83**	**2,817**
Average 1998 - 2007	**37**	**1,602**
Average 1973 - 2007	**73**	**3,351**

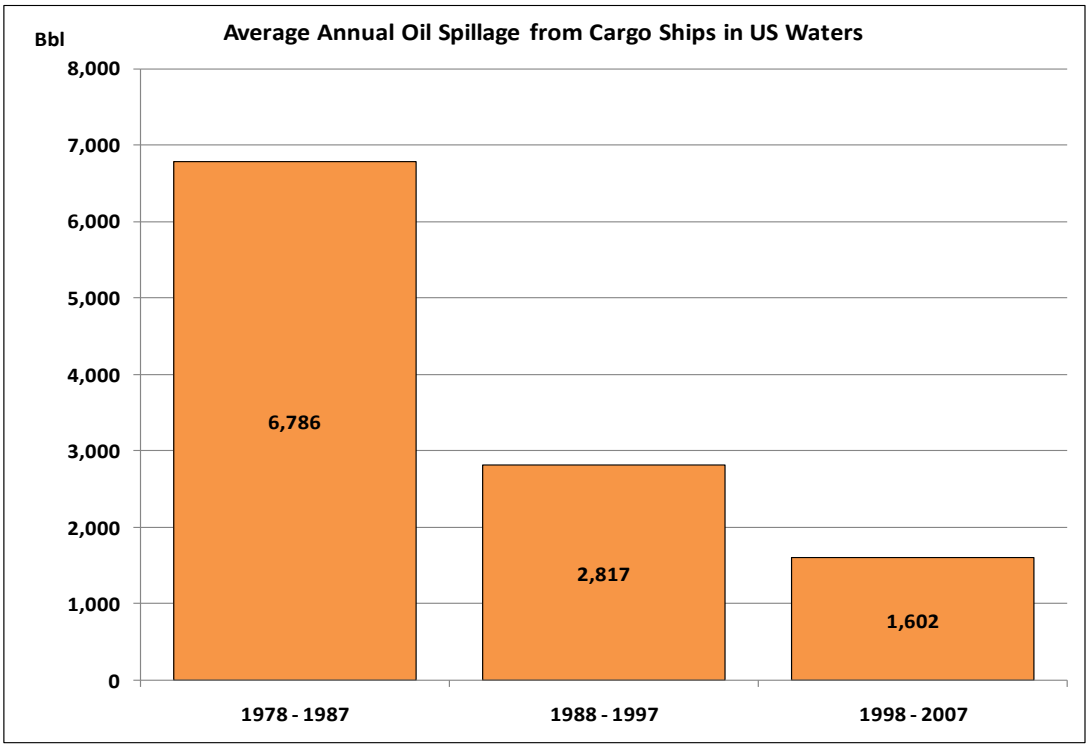

Figure 36: Average Annual Spillage by Decade from Non-Tank Vessels in U.S. Waters

Oil spillage from non-tank (cargo) vessels has decreased by 43% since the previous decade and by 76% since the 1978-1987 time period.

At the same time, the shipment of dry cargo[42] by vessels has increased by 43 percent over the last 30 years (Figure 37). The rate of spillage from these cargo ships in relation to the tonnage of cargo moved in U.S. waters during that time period is shown in Table 39 and Figure 38. Spillage per cargo shipment has reduced by 50% in the last decade.

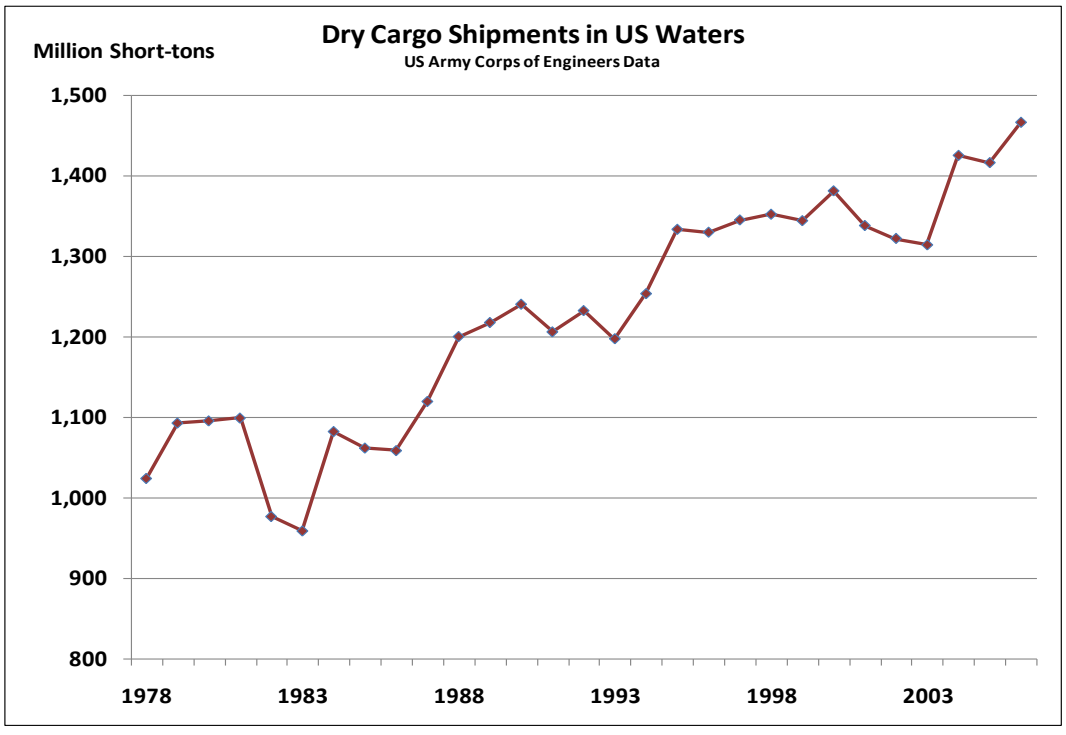

Figure 37: Dry cargo shipping in U.S. waters

Shipments of non-petroleum cargoes by non-tank vessels has increased over the last 30 years.

[42] Includes all non-petroleum cargo shipments.

Table 39: Cargo Vessel Oil Spillage per Dry Cargo Shipments			
Year	**Dry Cargo Shipment (million short tons)**	**Bbl Spilled**	**Bbl Spilled Per Million Short Ton Shipped**
1978	1,024	3,653	3.57
1979	1,093	1,708	1.56
1980	1,096	1,101	1.00
1981	1,099	4,231	3.85
1982	977	3,089	3.16
1983	959	2,439	2.54
1984	1,083	34,996	32.33
1985	1,062	4,209	3.96
1986	1,059	526	0.50
1987	1,120	11,909	10.63
1988	1,200	1,882	1.57
1989	1,218	7,707	6.33
1990	1,240	3,754	3.03
1991	1,206	1,333	1.11
1992	1,233	3,842	3.12
1993	1,198	1,999	1.67
1994	1,254	1,559	1.24
1995	1,333	3,047	2.29
1996	1,330	1,670	1.26
1997	1,345	1,379	1.03
1998	1,352	690	0.51
1999	1,344	2,736	2.04
2000	1,381	662	0.48
2001	1,338	524	0.39
2002	1,322	377	0.29
2003	1,314	452	0.34
2004	1,425	8,233	5.78
2005	1,416	973	0.69
2006	1,466	36	0.02
2007	1,466	1,334	0.91
Total	**36,952**	**112,050**	**3.03**
Average 1978 - 1987	**1,057**	**6,786**	**6.31**
Average 1988 - 1997	**1,256**	**2,817**	**2.26**
Average 1998 - 2007	**1,382**	**1,602**	**1.14**
Average 1978 - 2007	**1,232**	**3,735**	**3.24**

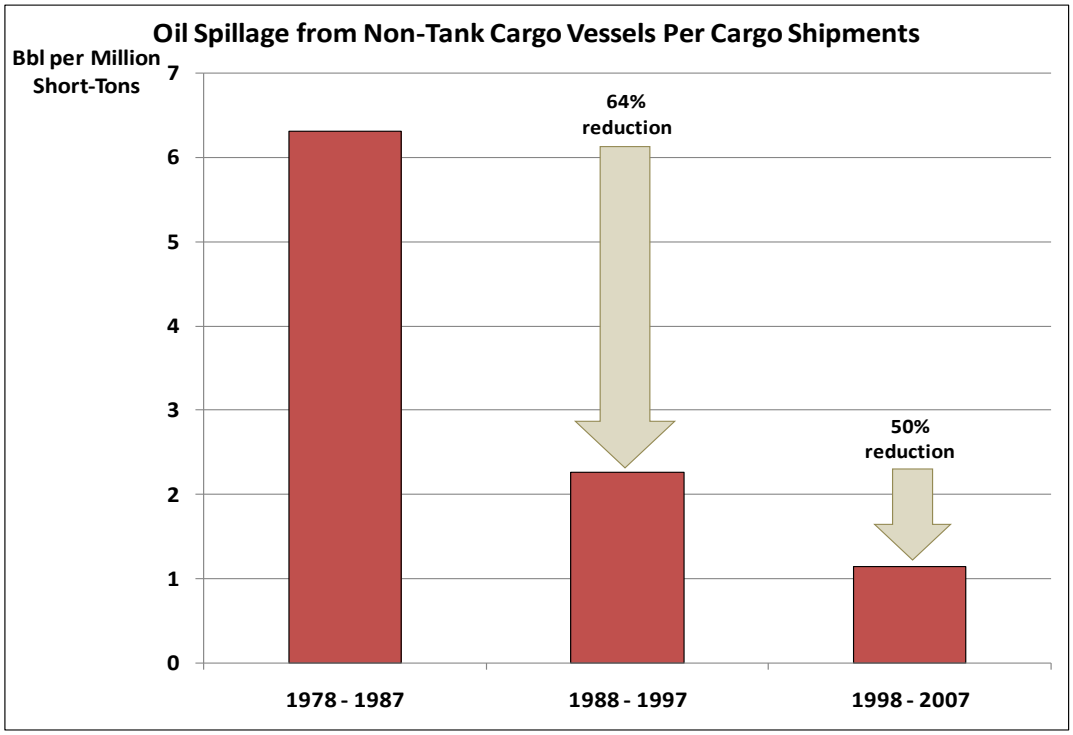

Figure 38: Oil spillage from non-tank cargo vessel per cargo shipments

There has been a 50% reduction in spillage per cargo shipped since the previous decade.

Spills from Smaller Vessels[43]

Spillage from other vessels averaged under 4,200 barrels annually over the last decade, which is a nearly 34% reduction from the previous decade. An annual breakdown of spillage from these vessels is shown in Table 40.

Table 40: Estimated Oil Spillage from Smaller Vessels in U.S. Waters

Year	Bbl Spilled
1973	24,487
1974	5,700
1975	32,736
1976	6,149
1977	5,220
1978	7,636
1979	7,677
1980	5,827
1981	3,903
1982	6,732
1983	6,574
1984	9,371
1985	6,433
1986	3,305
1987	8,287
1988	6,928
1989	8,357
1990	6,196
1991	7,305
1992	5,637
1993	7,762
1994	5,782
1995	6,399

[43] Includes passenger vessels, fishing vessels, recreational vessels, unclassified vessels, and other smaller vessels.

Table 40: Estimated Oil Spillage from Smaller Vessels in U.S. Waters	
Year	**Bbl Spilled**
1996	5,436
1997	3,212
1998	6,845
1999	5,780
2000	6,289
2001	5,008
2002	4,681
2003	2,011
2004	2,574
2005	1,700
2006	2,626
2007	4,153
TOTAL	**244,718**
Average 1973 - 1977	**14,858**
Average 1978 - 1987	**6,574**
Average 1988 - 1997	**6,301**
Average 1998 - 2007	**4,167**
Average 1973 - 2007	**6,992**

Spills from Coastal Marine Facilities

Facilities that are on the coast rather than inland spill an estimated 4,230 barrels of oil annually. This is a 72% reduction from the previous decade. An annual breakdown of these spills is shown in Table 41. It is important to note that spillage volumes from coastal facilities often include oil that spills into secondary containment.[44]

Table 41: Estimated Oil Spillage from Coastal Marine Facilities in U.S. Waters	
Year	**Bbl Spilled**
1973	4,028
1974	91,293
1975	111,029
1976	48,716
1977	56,032
1978	104,562
1979	43,446
1980	69,686
1981	26,833
1982	39,537
1983	32,994
1984	28,423
1985	53,275
1986	21,498
1987	7,558
1988	32,593
1989	10,686
1990	25,221
1991	10,619
1992	12,014
1993	8,337
1994	15,881
1995	20,688
1996	9,676

[44] A secondary containment system provides an essential line of defense in preventing oil from spreading and reaching waterways in the event of the failure of an oil container (e.g., a storage tank) or the primary containment. The system provides temporary containment of the spilled oil until a response can be mounted.

Table 41: Estimated Oil Spillage from Coastal Marine Facilities in U.S. Waters	
Year	**Bbl Spilled**
1997	4,879
1998	3,959
1999	8,751
2000	7,419
2001	4,786
2002	4,731
2003	1,862
2004	1,016
2005	8,350
2006	1,292
2007	135
TOTAL	**931,805**
Average 1973 - 1977	**62,220**
Average 1978 - 1987	**42,781**
Average 1988 - 1997	**15,059**
Average 1998 - 2007	**4,230**
Average 1973 - 2007	**26,623**

Spills from Gas Stations and Truck Stops

In the last decade, gas stations and truck stops spilled an average of 814 barrels of oil annually, a nearly 48% decrease from the previous decade. An annual breakdown of these spills is shown in Table 42. Spills at gas stations and truck stops often go to pavements and other substrates, reducing the direct impacts to waterways.

Table 42: Estimated Oil Spillage Gas Stations and Truck Stops	
Year	**Spillage from Gas Stations and Truck Stops[45] (bbl)**
1980	420
1981	464
1982	925
1983	1,520
1984	972
1985	1,486
1986	2,683
1987	1,088
1988	1,198
1989	1,786
1990	1,600
1991	575
1992	741
1993	856
1994	3,122
1995	2,084
1996	864
1997	2,813
1998	1,446
1999	1,136
2000	1,527
2001	1,258
2002	1,224
2003	632
2004	267
2005	292

[45] This includes all spillages that occur at gas station facilities and truck stops, including spills that occur during the transfer of fuels from tanker trucks.

Table 42: Estimated Oil Spillage Gas Stations and Truck Stops	
Year	**Spillage from Gas Stations and Truck Stops[45] (bbl)**
2006	293
2007	67
TOTAL	**33,339**
Average 1980 - 1987	**1,195**
Average 1988 - 1997	**1,564**
Average 1998 - 2007	**814**
Average 1980 - 2007	**1,191**

Spills from Inland EPA-Regulated Facilities (Excluding Refineries)[46]

Inland SPCC[47] facilities (other than refineries) spill an average of 59,676 barrels of oil annually, a 76% reduction from the previous decade. An annual breakdown of these spills is shown in Table 43. Spills at inland facilities often go to pavements and other substrates, including secondary containments, reducing the direct impacts to waterways.

Table 43: Estimated Oil Spillage from Inland EPA-Regulated Facilities[48]	
Year	**Spillage from Inland SPCC Facilities (bbl)**
1980	18,150
1981	8,127
1982	16,475
1983	68,454
1984	48,184
1985	12,650
1986	19,054
1987	86,823
1988	45,183
1989	249,467
1990	268,797
1991	165,438
1992	156,920
1993	255,440
1994	272,414
1995	290,886
1996	537,570
1997	208,052
1998	217,930
1999	120,481
2000	45,402
2001	155,052
2002	14,936
2003	12,322
2004	5,052
2005	9,447
2006	13,737
2007	2,401
TOTAL	**3,324,844**
Average 1980 - 1987	**34,740**
Average 1988 - 1997	**245,017**
Average 1998 - 2007	**59,676**
Average 1980 - 2007	**118,744**

[46] Facilities regulated under EPA's Spill Prevention, Control, and Countermeasures (SPCC) program.
[47] This does not include slow leakages from underground storage tanks.
[48] Excluding refineries and production wells, which are SPCC-regulated, but are covered elsewhere in these analyses.

Spills from Residential Home Heating Oil Tanks

Oil spillage from home-heating oil tanks (not regulated by EPA unless in sizes larger than 10,000 gallons) amounts to 498 barrels of oil annually,[49] a slight decrease from the previous decade. Annual spillage rates are shown in Table 44.

Table 44: Estimated Oil Spillage from Residential Heating Oil Tanks

Year	Bbl
1980	125
1981	68
1982	186
1983	174
1984	224
1985	138
1986	201
1987	316
1988	328
1989	389
1990	545
1991	292
1992	479
1993	554
1994	709
1995	571
1996	654
1997	658
1998	688
1999	543
2000	881
2001	1,149
2002	761
2003	597
2004	155
2005	70
2006	108
2007	32
TOTAL	**11,595**
Average 1980 - 1987	**179**
Average 1988 - 1997	**518**
Average 1998 - 2007	**498**
Average 1980 - 2007	**414**

[49] This does not include slow leakages from underground storage tanks.

Spills from Other Motor Vehicles

Motor vehicles that carry oil as fuel rather than cargo spill about 2,000 barrels of oil annually. This spillage is about double that of the previous decade, as shown in Table 45. The increase in spillage can be associated with greater motor vehicle traffic, as well as better reporting by local authorities that are usually the emergency spill responders in these cases. Spills from motor vehicles often go to pavements and do not directly impact waterways.

Table 45: Estimated Oil Spillage from Motor Vehicles (Excluding Tanker Trucks)

Year	Spills from Other Vehicles (bbl)[50]
1980	20
1981	22
1982	236
1983	260
1984	198
1985	317
1986	587
1987	517
1988	553
1989	1,233
1990	910
1991	788
1992	883
1993	2,560
1994	890
1995	1,207
1996	1,475
1997	1,393
1998	1,499
1999	1,452
2000	2,665
2001	2,776
2002	3,124
2003	2,287
2004	658
2005	-
2006	-
2007	-
TOTAL	**28,510**
Average 1980 - 1987	**270**
Average 1988 - 1997	**1,189**
Average 1998 - 2007	**2,066**
Average 1980 - 2007	**1,140**

[50] Since the spill data only include spills of one barrel or more, most passenger vehicles are excluded in this analysis.

Spills from Other Inland Sources

Aircraft spill an estimated 344 barrels of jet fuel annually to inland areas. Aircraft spill an additional 3,700 barrels of fuel annually to U.S. marine waters annually. Total aircraft input is about 4,000 barrels of oil annually. An annual breakdown of other inland sources is shown in Table 46.

Table 46: Estimated Oil Spillage (bbl) from Other Inland Sources

Year	Inland Aircraft	Inland Unknown
1980	0	734
1981	0	485
1982	4	498
1983	2	231
1984	39	1,645
1985	24	2,723
1986	30	44
1987	15	1,377
1988	20	913
1989	144	2,212
1990	52	692
1991	81	1,205
1992	205	959
1993	42	12,553
1994	112	768
1995	114	1,013
1996	192	749
1997	657	916
1998	178	804
1999	332	420
2000	355	173
2001	997	515
2002	653	1,698
2003	419	-
2004	12	-
2005	88	-
2006	293	-
2007	109	-
TOTAL	**5,169**	**33,327**
Average 1980 - 1987	**14**	**967**
Average 1988 - 1997	**162**	**2,198**
Average 1998 - 2007	**344**	**516**
Average 1980 - 2007	**185**	**1,333**

Summary of Oil Spillage

Oil spillage from all sources is summarized, by decade in Table 47. Oil spillage from petroleum industry sources is summarized in Table 48 and Figure 39.

Table 47: Estimated Total Average Annual U.S. Oil Spillage (bbl)				
Source	**1969-1977**	**1978-1987**	**1988-1997**	**1998-2007**
PRODUCTION	**31,435**	**8,701**	**15,183**	**9,938**
Offshore Platform Spills	25,858	1,344	1,814	1,273
Offshore Pipelines	4,482	3,462	8,127	2,614
Offshore Supply Vessels	95	245	48	10
Inland Production Wells	1,000	3,650	5,194	6,041
REFINING	**3,000**	**3,512**	**15,015**	**12,136**
Refinery Spills	3,000	3,512	15,015	12,136
TRANSPORT	**488,662**	**301,645**	**190,753**	**96,393**
Coastal/Inland Pipelines	259,340	181,196	118,297	76,754
Tanker Trucks	3,000	4,888	5,213	9,181
Railroads	2,000	2,322	2,164	1,431
Tank Ships	192,492	60,250	42,197	3,598
Tank Barges	31,830	52,989	22,882	5,429
STORAGE AND CONSUMPTION	**118,523**	**97,206**	**278,525**	**77,613**
Non-Tank Vessels (Cargo Ships)	5,000	6,786	2,817	1,602
Other Vessels	14,858	6,574	6,301	4,167
Gas Stations and Truck Stops	1,195	1,195	1,564	814
Residential	150	179	518	498
Aircraft[51]	3,700	3,714	3,862	4,044
Inland EPA-Regulated Facilities[52]	30,000	34,740	245,017	59,676
Coastal Facilities (Non-Refining)	62,220	42,781	15,059	4,230
Inland Unknown	900	967	2,198	516
Motor Vehicles	500	270	1,189	2,066
TOTAL	**641,620**	**411,064**	**499,476**	**196,080**

Table 48: Estimated Average Annual U.S. Oil Spillage from Petroleum Industry Sources (bbl)				
Source	**1969-1977**	**1978-1987**	**1988-1997**	**1998-2007**
PRODUCTION	**31,435**	**8,701**	**15,183**	**9,938**
Offshore Platform Spills	25,858	1,344	1,814	1,273
Offshore Pipelines	4,482	3,462	8,127	2,614
Offshore Supply Vessels	95	245	48	10
Inland Production Wells	1,000	3,650	5,194	6,041
REFINING	**3,000**	**3,512**	**15,015**	**12,136**
Refinery Spills	3,000	3,512	15,015	12,136
TRANSPORT	**488,662**	**301,645**	**190,753**	**96,393**
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Railroads	2,000	2,322	2,164	1,431
Tank Ships	192,492	60,250	42,197	3,598
Tank Barges	31,830	52,989	22,882	5,429
STORAGE AND CONSUMPTION	**1,195**	**1,195**	**1,564**	**814**
Gas Stations and Truck Stops	1,195	1,195	1,564	814
TOTAL Petroleum Industry Spillage	**524,292**	**315,053**	**222,515**	**119,281**

[51] Includes aircraft in inland areas plus estimates of marine inputs (based on NRC 2003).
[52] Excluding refineries, gas stations, and production wells.

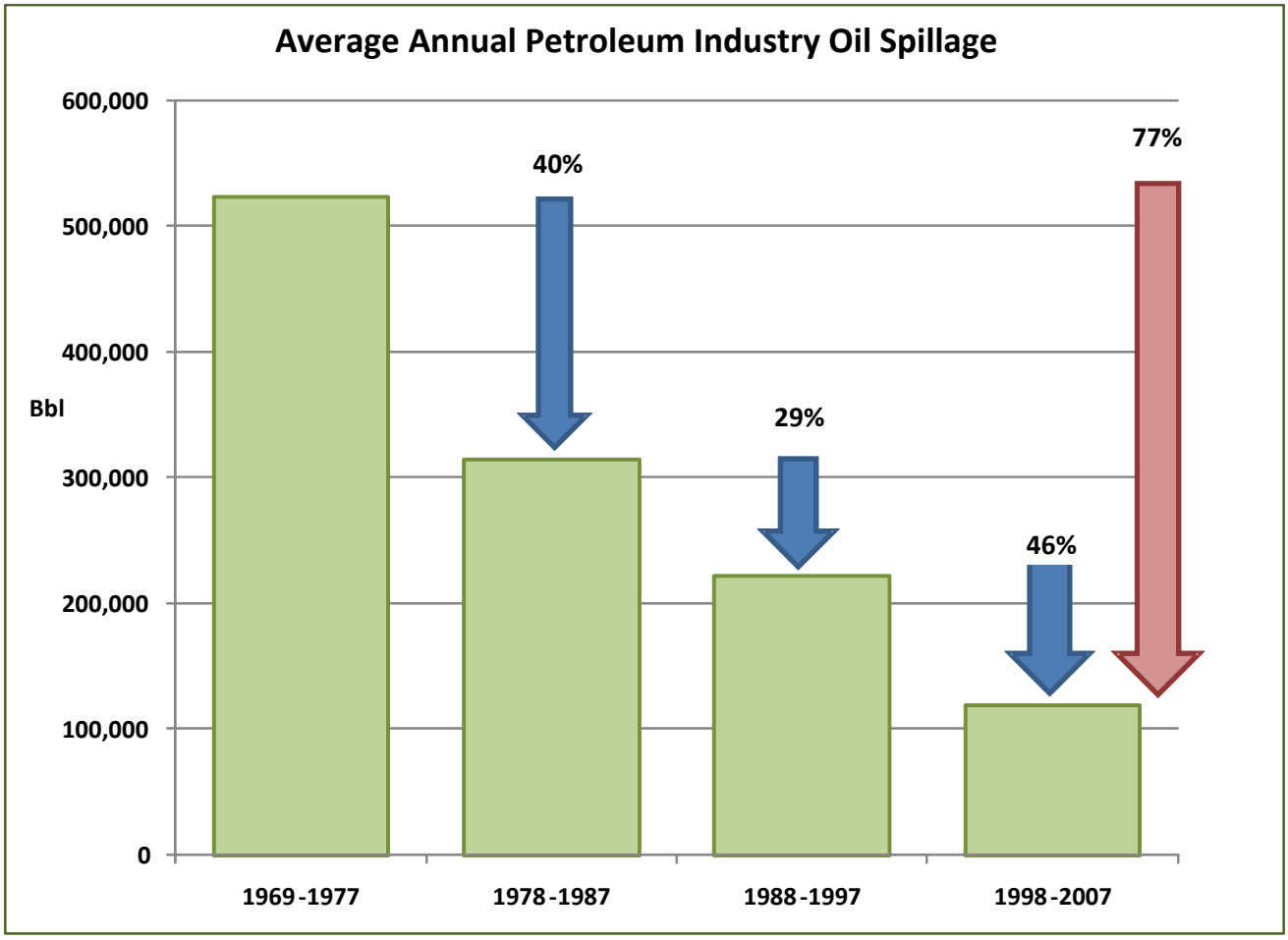

Figure 39: Average Annual Oil Spillage from Petroleum Industry Sources by Decade

Average annual oil spillage from petroleum industry sources, including: spillage related to oil exploration and production platforms and offshore pipelines; spillage from coastal and inland pipelines, spillage from oil transport by tank vessels, railroads, and tanker trucks; spillage from oil refineries; and spillage at gas stations.

In the last decade, on average, 2.017 billion barrels of crude oil were produced domestically, and 4.082 billion barrels of crude oil and petroleum products were imported annually. *For each barrel of crude oil either domestically produced or imported from foreign sources, 0.00003barrels spilled from all sources – of which 60.8%, or 0.00002 barrels, spilled from petroleum industry sources.*

In the last decade, an average of 7.3 billion barrels[53] of oil were "consumed" each year in the U.S. Oil consumption can be viewed as a measure of the amount of oil that is transported, stored, and handled each year. *In the last decade, for every barrel of oil "consumed" in the U.S., 0.000027 barrels spilled from all sources and 0.000016 barrels spilled from petroleum industry sources.*

The oil spillage reported here does not reflect the amounts of oil that were contained or recovered. It also does not reflect the differences between oil that is spilled directly into marine or freshwater systems and oil that is spilled onto other surfaces, including containment areas around storage tanks in tank farms.

The properties of the oil spilled (crude vs. refined, heavy vs. light) and the locations in which the oil spills (marine waters, inland waters, dry surfaces, wetlands, industrial zones) will largely determine the impacts of these spills and should be considered in addition to the actual volumes of oil spilled.

[53] Based on Energy Information Administration data.

Legally-Permitted Oil Discharges

Legal Oil Discharges in Produced Water

During the oil extraction process at offshore oil platforms, water in the oil reservoir is also pumped to the surface. Industry practice is to treat this "produced water" to separate free crude oil, and then to inject the water back into the reservoir, or to discharge the water overboard from the platform. Increasingly the reinjection process is becoming the preferred technique. Note that U.S. regulations now prohibit most produced water discharges to state waters of Texas and Louisiana.[54] Shore-based facilities in the Upper Cook Inlet of Alaska are legally permitted to discharge produced waters.

The *highly diluted oil content* in produced water (maximum of 29 ppm oil content) [55] from offshore oil exploration and production processes is generally dispersed very quickly in the open waters where offshore oil platforms are located. The impacts from these inputs in offshore waters have been studied extensively and, as concluded by the NRC (2003) study, "there is little evidence of significant effects from petroleum around offshore platforms in deep water." The *oil inputs* from produced water are calculated as shown in Table 49 – on average, 17,500 barrels per year. It is important to note that these inputs are *permitted operational discharges* that are distinct from accidental spillage previously reviewed.

Table 49: Oil Inputs from Produced Water from Offshore Oil Exploration and Production[56]

U.S. Region	Produced Water (bbl/yr)	Oil/Grease Content (ppm)			Oil/Grease Discharge (bbl/yr)		
		Low	High	"Best"[57]	Low	High	"Best"
Gulf of Mexico OCS	473,000,000	15	29	20	9,100	17,500	11,900
Louisiana State	186,000,000	15	29	20	3,150	6,020	4,200
Texas State	4,300,000	-	-	6.6	0	0	32
California Offshore	36,100,000	15	29	18	595	1,190	595
Alaska State	45,700,000	15	29	15	770	1,470	770
Total U.S.	**745,100,000**	**-**	**-**	**20**	**14,000**	**25,200**	**17,500**

Legally-Permitted Refinery Effluent Discharges

During refining processes, wastewater containing minute concentrations of oil is *legally* discharged in effluents, as permitted under the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act.[58] The *NPDES-permitted refinery effluents* contain no more than five parts of oil per million parts of wastewater. The effluents are generally discharged in rivers and coastal areas where the already dilute oil concentrations are quickly diluted even further. Environmental impacts from the oil in the effluents are extremely low and localized.[59] The total amount of aqueous effluent discharged from oil refineries has decreased by 20% over the last forty years due to increases in the use of air cooling and recirculation of cooling water. In addition, the toxicity of effluent discharges has decreased significantly due to the implementation of various wastewater treatment systems.[60] The estimated maximum discharge of oil in

[54] Notable exceptions are the highly dispersive distributaries of the Mississippi and Atchafalaya Rivers (NRC 2003).
[55] One part oil for one million parts water. This is the equivalent of milligrams per liter.
[56] Based on NRC 2003 methods.
[57] Best estimate as determined by panel of experts in NRC 2003.
[58] Clean Water Act Section 402. The NPDES permit program is enforced by the U.S. Environmental Protection Agency (EPA) or state agencies under authority delegated by the EPA.
[59] The environmental impacts of refinery effluents have been studied fairly extensively. Refineries are, however, generally located in industrial areas that have other permitted discharges, making it difficult to separate the effects of oil in effluents from those of background concentrations of other contaminants from other point- and non-point sources. A comprehensive review of the ecological impacts of refinery effluents (Wake 2005) concluded that any minor impacts are limited to the areas close to the outfalls, but that it is difficult to distinguish these impacts from other pollution sources.
[60] Wake 2005; CONCAWE 2004.

refinery effluents over the last decade is 54,000 barrels per year. This estimate, which is the equivalent of less than 0.00001 barrels of oil for each barrel of oil processed,[61] is based on the following assumptions:

- Refinery throughput is as shown in Figure 40;
- Wastewater production as a function of refinery capacity averages as shown in Figure 41,[62] with the average for the last decade being 2.37 barrels of wastewater (refinery effluent) produced for each barrel of refining capacity; and
- Effluents contain 5 ppm[63] of oil (based on NPDES guidelines).

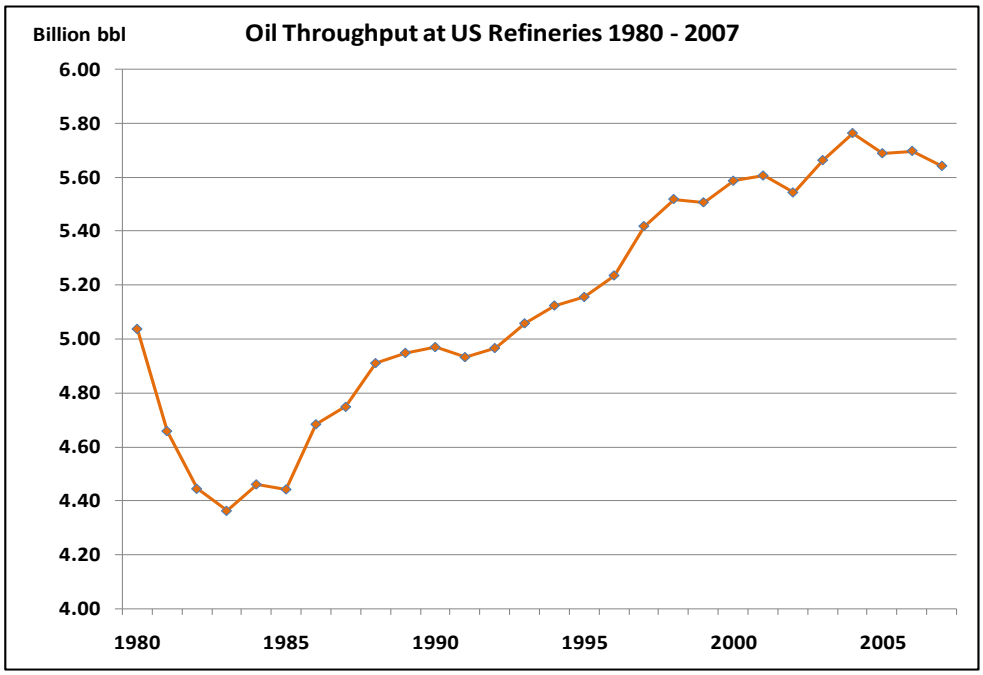

Figure 40: Oil Throughput by U.S. Refineries 1980 – 2007

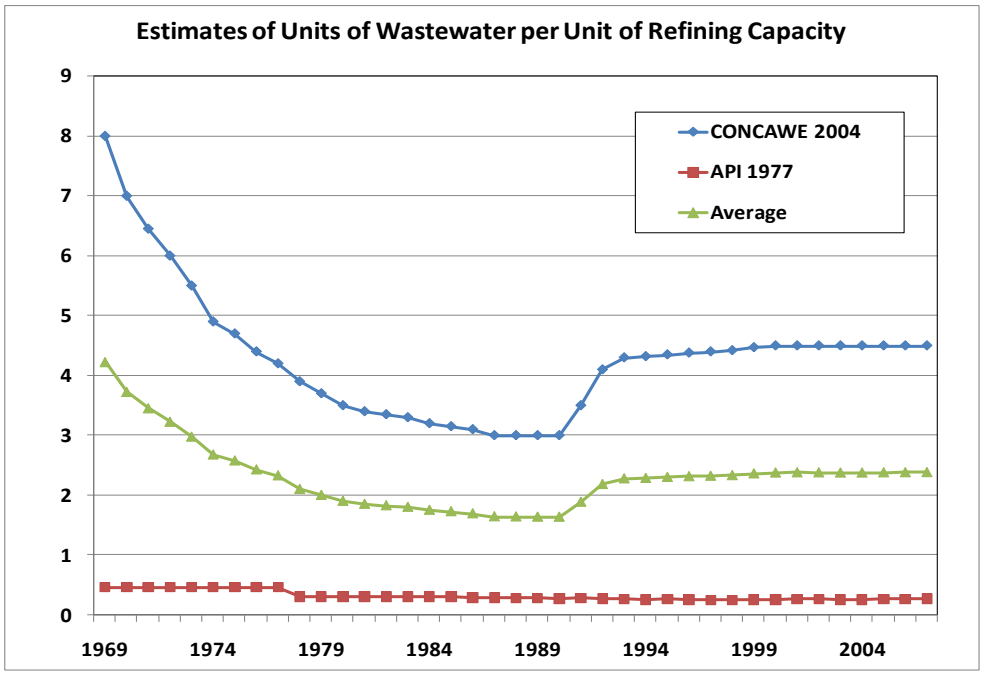

Figure 41: Estimates of Units of Wastewater per Unit of Refining Capacity

Units of waste water for each unit of refining capacity (e.g., barrels of wastewater per barrels of refining capacity)

[61] This is the equivalent of 1 barrel of oil in effluent for every 100,000 barrels processed.
[62] There are a number of estimates of the amount of wastewater produced per unit of refining capacity. The average of the two best-documented sources (CONCAWE 2004 and API 1977) was taken.
[63] Parts per million.

An annual breakdown of refinery effluent discharges is shown in Table 50. *The average annual oil in legally-permitted refinery effluent discharges is based on an assumption of maximum effluent oil concentration of 5 ppm. This value is the maximum allowed. Actual oil concentrations in effluents are likely to be lower.*

Table 50: Estimated Annual Oil Discharged in U.S. Oil Refinery Effluents

Year	Throughput (billion bbl)	Wastewater bbl per bbl Throughput	Waste Water (billion bbl)	Oil in Effluent (bbl)
1980	5.04	1.90	9.58	47,880
1981	4.66	1.85	8.62	43,105
1982	4.45	1.83	8.14	40,718
1983	4.36	1.80	7.85	39,240
1984	4.46	1.75	7.81	39,025
1985	4.44	1.73	7.68	38,406
1986	4.68	1.69	7.91	39,546
1987	4.75	1.64	7.79	38,950
1988	4.91	1.64	8.05	40,262
1989	4.95	1.64	8.12	40,590
1990	4.97	1.64	8.15	40,754
1991	4.93	1.89	9.32	46,589
1992	4.97	2.19	10.88	54,422
1993	5.06	2.28	11.54	57,684
1994	5.13	2.29	11.75	58,739
1995	5.16	2.31	11.92	59,598
1996	5.24	2.32	12.16	60,784
1997	5.42	2.33	12.63	63,143
1998	5.52	2.34	12.92	64,584
1999	5.51	2.36	13.00	65,018
2000	5.59	2.38	13.30	66,521
2001	5.61	2.38	13.35	66,759
2002	5.54	2.38	13.19	65,926
2003	5.66	2.38	13.47	67,354
2004	5.76	2.38	13.71	68,544
2005	5.69	2.38	13.54	67,711
2006	5.70	2.38	13.57	67,830
2007	5.64	2.39	13.48	67,398
Total	**143.81**	**-**	**303.42**	**1,517,078**
Average 1985-2007	**4.61**	**2.15**	**8.17**	**40,859**
Average 1985-1987	**5.07**	**1.69**	**10.45**	**52,256**
Average 1988-1997	**5.62**	**2.05**	**13.35**	**66,765**
Average 1998-2007	**5.14**	**2.38**	**10.84**	**54,181**

Other Oil Inputs

Operational Inputs from Recreational Vessels

Operational inputs of oil and gasoline from two-stroke engines were estimated by the NRC 2003 Oil in the Sea study to average 49,000 barrels of oil annually. A breakdown of these inputs by region is shown in Table 51.

Table 51: Estimates of Oil Inputs to Marine Waters from Two-Stroke Recreational Vessels[64]	
Region	**Estimated Average Annual Barrels Input**
Atlantic	21,700
Gulf of Mexico	10,780
Pacific	15,652
Alaska	490
Total	**48,622**

It should be noted that this estimate has been questioned by a number of researchers with regard to the assumption that all of the gasoline enters the water rather than combusts or evaporates. The use of two-stroke engines of the type that were referred to in this study *has significantly decreased in the last few years*. This estimate should thus be viewed with this perspective.

Oil Inputs from Urban Runoff

About 350,000 barrels of oil[65] enters U.S. marine waters each year through urban runoff. This oil is the accumulation of drops of oil that leak from automobiles, trucks, and other vehicles, as well as small chronic spillages that occur from other land-based sources. The oil washes off into storm sewers, culverts, and other waterways into streams and rivers that enter marine waters. Because the exact source of this spillage cannot be pin-pointed, it is termed "non-point source" pollution. The inputs are broken down by region in Table 52.

Table 52: Estimates of Oil Inputs from Urban Runoff[66]	
Region	**Estimated Average Annual Barrels Input**
Atlantic	220,500
Gulf of Mexico	88,200
Pacific	40,803
Alaska	560
Total	**350,063**

Oil Inputs from Potentially-Polluting Sunken Shipwrecks

There are an estimated 7,000[67] sunken vessel wrecks in U.S. coastal waters (Figure 42). Many of these wrecks contain fuel oil and petroleum cargo that could leak or spill impacting U.S. coastal resources. While many of these wrecks are smaller vessels that would cause localized impacts in the event of a spill, there are an estimated 400 oil-carrying tank ships and barges, as well as 1,300 non-tank vessels[68] carrying oil as fuel in and near U.S. waters. These sunken wrecks, many of which have been submerged for decades,[69] may contain as much as 4.3 million barrels of oil.[70]

As the structural integrity of these vessels weakens the oil may be released in chronic or periodic discharges, or in a sudden massive spill. Some of the vessels have begun to leak, or have been leaking for some time,

[64] Based on NRC 2003.
[65] Estimates based on analyses in NRC 2003.
[66] Based on NRC 2003
[67] Based on analyses of the NOAA Resources and Undersea Threats (RUST) database
[68] At least 400 gross tons
[69] A large percentage of the wrecks in U.S. and other waters stem from World War II
[70] Based on ERC's Worldwide Shipwreck Database as presented in Michel, et al. 2005.

causing environmental impacts and necessitating responses to chronic "mystery spills".[71] *There are no current estimates for annual leakage rates from these vessels, though there are reports of leakages from a number of vessels.*

Figure 42: Sunken Vessels in U.S. Waters

This illustration depicts the mass number of sunken vessels that exist around the coastal waters of the U.S. (from NOAA RUST database). These vessels may release 4.3 million barrels or more of oil and other contaminants.

[71] An example of this is the S.S. Jacob Luckenbach, which sank off of San Francisco, California, in 1953, and has impacted wildlife, particularly 51,000 seabirds, and the California coastline since 1992.

Summary of Findings

Estimates of average annual U.S. oil spillage by decade from all source categories are shown in Table 53. Over the last decade, offshore platform spills have represented one percent of total oil spillage in the U.S. (Table 54). The largest source category of spillage is inland EPA-regulated facilities.

The oil spillage reported here does not reflect the amounts of oil that were contained or recovered. It also does not reflect the differences between oil that is spilled directly into marine or freshwater systems and oil that is spilled onto other surfaces, including containment areas around storage tanks in tank farms.

The properties of the oil spilled (crude vs. refined, heavy vs. light) and the locations in which the oil spills (marine waters, inland waters, dry surfaces, wetlands, industrial zones) will largely determine the impacts of these spills and should be considered in addition to the actual volumes of oil spilled.

Table 53: Estimated Total Average Annual U.S. Oil Spillage (bbl)

Source	1969-1977	1978-1987	1988-1997	1998-2007
PRODUCTION	**31,435**	**8,701**	**15,183**	**9,938**
Offshore Platform Spills	25,858	1,344	1,814	1,273
Offshore Pipelines	4,482	3,462	8,127	2,614
Offshore Supply Vessels	95	245	48	10
Inland Production Wells	1,000	3,650	5,194	6,041
REFINING	**3,000**	**3,512**	**15,015**	**12,136**
Refinery Spills	3,000	3,512	15,015	12,136
TRANSPORT	**488,662**	**301,645**	**190,753**	**96,393**
Inland Pipelines	259,340	181,196	118,297	76,754
Tanker Trucks	3,000	4,888	5,213	9,181
Railroads	2,000	2,322	2,164	1,431
Tank Ships	192,492	60,250	42,197	3,598
Tank Barges	31,830	52,989	22,882	5,429
STORAGE AND CONSUMPTION	**118,523**	**97,206**	**278,525**	**77,613**
Non-Tank Vessels (Cargo Ships)	5,000	6,786	2,817	1,602
Other Vessels	14,858	6,574	6,301	4,167
Gas Stations and Truck Stops	1,195	1,195	1,564	814
Residential	150	179	518	498
Aircraft[72]	3,700	3,714	3,862	4,044
Inland EPA-Regulated Facilities[73]	30,000	34,740	245,017	59,676
Coastal Facilities (Non-Refining)	62,220	42,781	15,059	4,230
Inland Unknown	900	967	2,198	516
Motor Vehicles	500	270	1,189	2,066
TOTAL	**641,620**	**411,064**	**499,476**	**196,080**

[72] Includes aircraft in inland areas plus estimates of marine inputs (based on NRC 2003).
[73] Excluding refineries, gas stations, and production wells.

Table 54: Estimated Total Average Annual U.S. Oil Spillage (bbl) 1998 – 2007		
Source	**1998-2007 bbl spilled**	**% Total Spillage**
PRODUCTION	**9,938**	**5.07%**
Offshore Platform Spills	1,273	0.65%
Offshore Pipelines	2,614	1.33%
Offshore Supply Vessels	10	0.01%
Inland Production Wells	6,041	3.08%
REFINING	**12,136**	**6.19%**
Refinery Spills	12,136	6.19%
TRANSPORT	**96,393**	**49.16%**
Inland Pipelines	76,754	39.14%
Tanker Trucks	9,181	4.68%
Railroads	1,431	0.73%
Tank Ships	3,598	1.83%
Tank Barges	5,429	2.77%
STORAGE AND CONSUMPTION	**77,613**	**39.58%**
Non-Tank Vessels (Cargo Ships)	1,602	0.82%
Other Vessels	4,167	2.13%
Gas Stations and Truck Stops	814	0.42%
Residential	498	0.25%
Aircraft[74]	4,044	2.06%
Inland EPA-Regulated Facilities[75]	59,676	30.43%
Coastal Facilities (Non-Refining)	4,230	2.16%
Inland Unknown	516	0.26%
Motor Vehicles	2,066	1.05%
TOTAL	**196,080**	100.00%

Table 55compares natural seeps and oil spillage by sector. For the last decade, production-related spillage was less than 0.9% of the amount released from natural seeps. Total spillage from all sources was less than 18% of the amount released in natural seeps, that is, nearly six times as much oil was released from natural seeps as was spilled from all sources.

Table 55: Average U.S. Oil Spills by Source Group (Compared to Natural Seeps)								
Source	**1969-1977**		**1978-1987**		**1988-1997**		**1998-2007**	
	Annual Bbl	**% Seeps**[76]	**Annual Bbl**	**% Seeps**	**Annual Bbl**	**% Seeps**	**Annual Bbl**	**% Seeps**
Natural Seeps	1,123,000	100.00%	1,123,000	100.00%	1,123,000	100.00%	1,123,000	100.00%
Production	31,435	2.80%	8,701	0.77%	15,183	1.35%	9,938	0.88%
Refining	3,000	0.27%	3,512	0.31%	15,015	1.34%	12,136	1.08%
Transport	488,662	43.51%	301,645	26.86%	190,753	16.99%	96,393	8.58%
Storage/Consumption	118,523	10.55%	97,206	8.66%	278,525	24.80%	77,613	6.91%
Total Spillage	**641,620**	**57.13%**	**411,064**	**36.60%**	**499,476**	**44.48%**	**196,080**	**17.46%**

Table 56 shows spillage from petroleum industry sectors only. Overall, petroleum industry-related spillage represented 60.8% of total spillage from all sources during the last decade. A comparison of petroleum industry spillage and natural seeps is shown in Table 57. Over the last decade, total petroleum industry spillage was 10.6% of the amount released in natural seeps. Natural seeps released over nine times as much oil as the total of petroleum industry spillage (Figure 43).

[74] Includes aircraft in inland areas plus estimates of marine inputs (based on NRC 2003).
[75] Excluding refineries, gas stations, and production wells.
[76] Percent of the amount attributed to natural seeps.

Table 56: Estimated Average Annual U.S. Oil Spillage from Petroleum Industry Sources (bbl)				
Source	**1969-1977**	**1978-1987**	**1988-1997**	**1998-2007**
PRODUCTION	**31,435**	**8,701**	**15,183**	**9,938**
Offshore Platform Spills	25,858	1,344	1,814	1,273
Offshore Pipelines	4,482	3,462	8,127	2,614
Offshore Supply Vessels	95	245	48	10
Inland Production Wells	1,000	3,650	5,194	6,041
REFINING	**3,000**	**3,512**	**15,015**	**12,136**
Refinery Spills	3,000	3,512	15,015	12,136
TRANSPORT	**488,662**	**301,645**	**190,753**	**96,393**
Inland Pipelines	259,340	181,196	118,297	76,754
Tanker Trucks	3,000	4,888	5,213	9,181
Railroads	2,000	2,322	2,164	1,431
Tank Ships	192,492	60,250	42,197	3,598
Tank Barges	31,830	52,989	22,882	5,429
STORAGE AND CONSUMPTION	**1,195**	**1,195**	**1,564**	**814**
Gas Stations and Truck Stops	1,195	1,195	1,564	814
TOTAL Petroleum Industry Spillage	**524,292**	**315,053**	**222,515**	**119,281**

Table 57: Average U.S. Petroleum Industry Spills (Compared to Natural Seeps)								
Source	**1969-1977**		**1978-1987**		**1988-1997**		**1998-2007**	
	Annual Bbl	**% Seeps[77]**	**Annual Bbl**	**% Seeps**	**Annual Bbl**	**% Seeps**	**Annual Bbl**	**% Seeps**
Natural Seeps	1,123,000	100.00%	1,123,000	100.00%	1,123,000	100.00%	1,123,000	100.00%
Production	31,435	2.80%	8,701	0.77%	15,183	1.35%	9,938	0.88%
Refining	3,000	0.27%	3,512	0.31%	15,015	1.34%	12,136	1.08%
Transport	488,662	43.51%	301,645	26.86%	190,753	16.99%	96,393	8.58%
Storage/Consumption[78]	1,195	0.11%	1,195	0.11%	1,564	0.14%	814	0.07%
Total Spillage	**524,292**	**46.69%**	**315,053**	**28.05%**	**222,515**	**19.81%**	**119,281**	**10.62%**

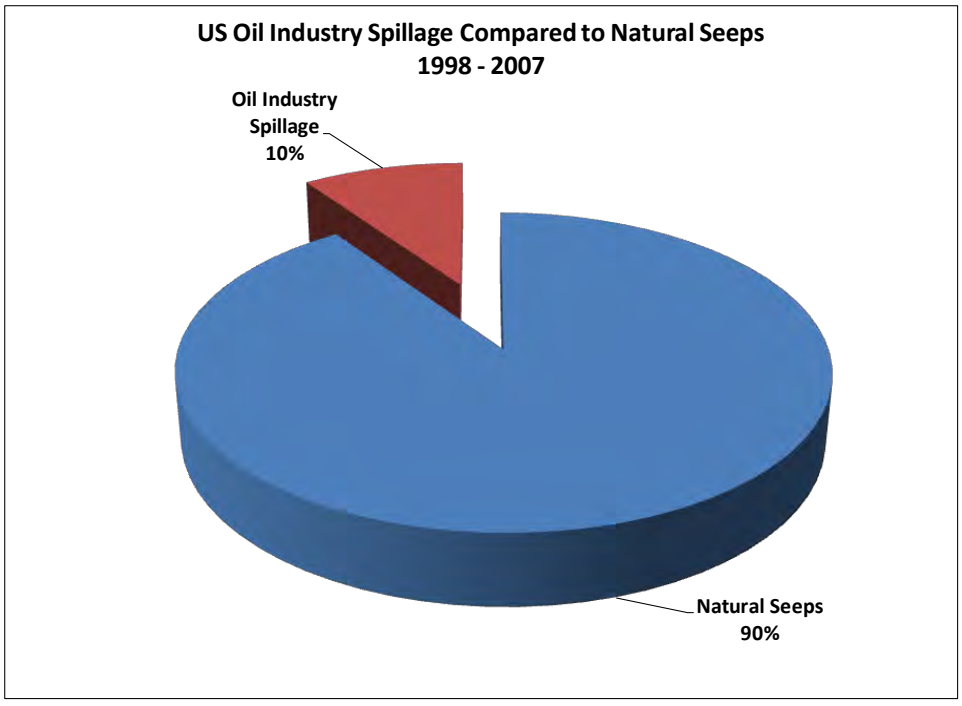

Figure 43: U.S. Oil Industry Spillage Compared to Natural Seeps 1998 – 2007.

[77] Percent of the amount attributed to natural seeps.
[78] Gas stations and fuel depots.

Conclusions

As shown in Figure 44, total petroleum industry spillage[79] has decreased consistently over the last 40 years. Seventy-seven percent less oil is spilling since the 1970s and 46% less since the decade previous to the last decade.

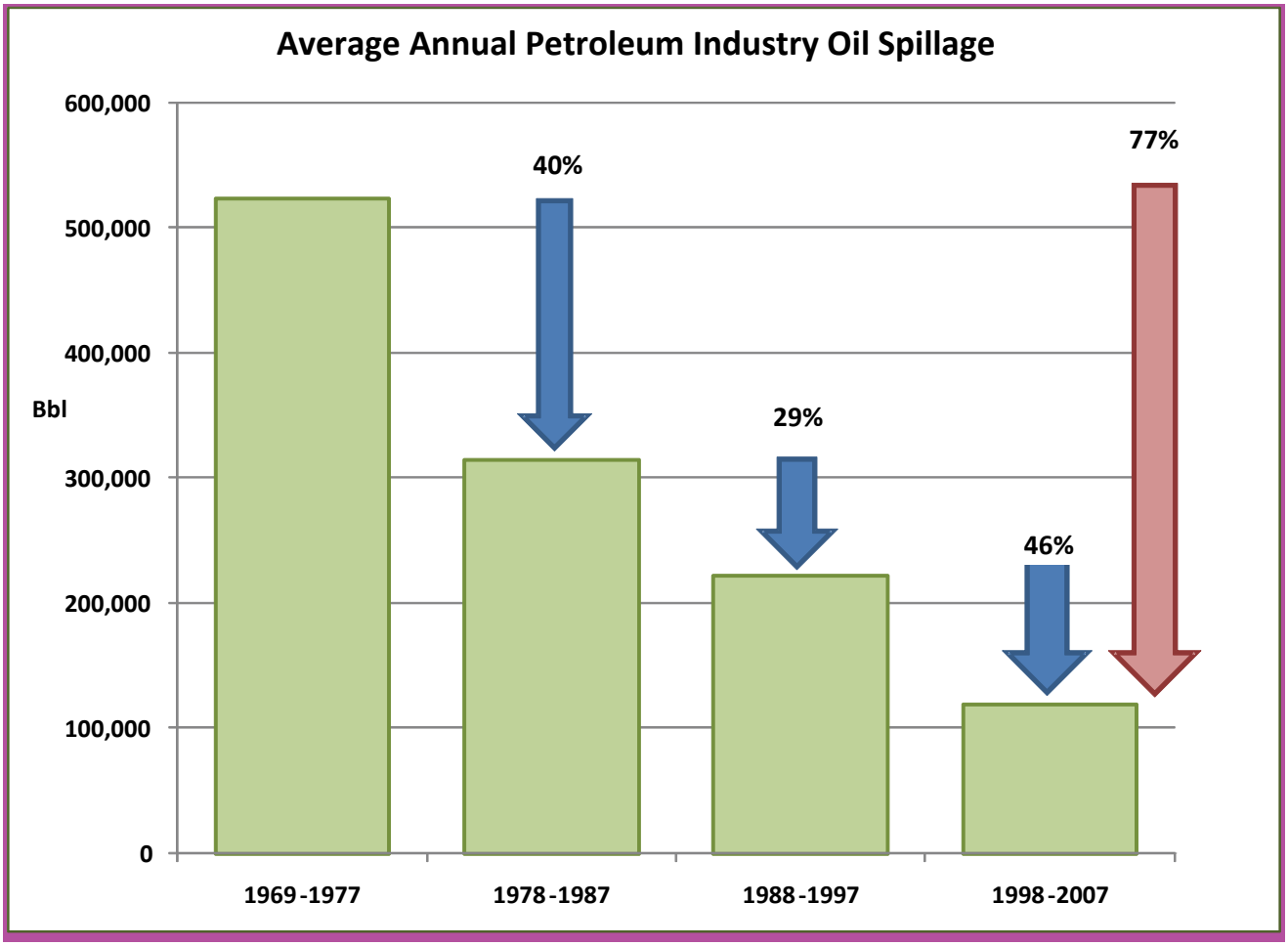

Figure 44: Average Annual Oil Spillage from Petroleum Industry Sources by Decade

Average annual oil spillage from petroleum industry sources, including: spillage related to oil exploration and production platforms and offshore pipelines; spillage from coastal and inland pipelines, spillage from oil transport by tank vessels, railroads, and tanker trucks; spillage from oil refineries; and spillage at gas stations.

In the last decade, on average, 2.017 billion barrels of crude oil were produced domestically, and 4.082 billion barrels of crude oil and petroleum products were imported annually. *For each barrel of crude oil either domestically produced or imported from foreign sources, 0.00003barrels spilled from all sources – of which 60.8%, or 0.00002 barrels, spilled from petroleum industry sources.*

In the last decade, an average of 7.3 billion barrels[80] of oil were "consumed" each year in the U.S. Oil consumption can be viewed as a measure of the amount of oil that is transported, stored, and handled each year. *In the last decade, for every barrel of oil "consumed" in the U.S., 0.000027 barrels spilled from all sources and 0.000016 barrels spilled from petroleum industry sources.*

[79] Spillage from inland pipeline transport is not included.
[80] Based on Energy Information Administration data.

In the Upstream sector, oil spillage from offshore platforms has decreased by 30% from the previous decade and by 95% since the 1970s. Overall average annual oil spillage from offshore exploration and production activities has decreased by 61% from the previous decade and 87% from the 1970s. On the basis of unit production, oil spillage has decreased by 71% since the previous decade and 87% from the 1970s. Had the rate of spillage from 1969-1970 continued, an additional 516,000 barrels of oil would have spilled.

In the Marine sector, oil spillage from tankers has decreased by 91%, and from tank barges by 76% since the previous decade. Spillage from tank vessels (tankers and tank barges combined) per unit oil transported decreased by 71% from the last decade.

In the Pipeline sector, oil spillage has decreased 35% since the previous decade, with even greater reductions in pipeline rights-of-way.

In the Refining sector, oil spillage from refineries has decreased by 19% from the last decade, and 27% when taken on the basis of per-unit oil processing or throughput.

In the Downstream sector, oil spillage from petroleum industry gas stations and truck stops has been reduced by nearly 48% from the previous decade.

The oil spillage reported here does not reflect the amounts of oil that were contained or recovered. It also does not reflect the differences between oil that is spilled directly into marine or freshwater systems and oil that is spilled onto other surfaces, including containment areas around storage tanks in tank farms.

The properties of the oil spilled (crude vs. refined, heavy vs. light) and the locations in which the oil spills (marine waters, inland waters, dry surfaces, wetlands, industrial zones) will largely determine the impacts of these spills and should be considered in addition to the actual volumes of oil spilled.

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Appendix: Key Terms of Reference

Coastal and inland pipelines: all parts of pipeline systems that are inland or along the coast but not offshore, including gathering pipes, transmission pipes, breakout tanks, pump stations, and tank farms directly associated with and operated by pipeline companies. (Note: Offshore pipelines are considered separately under offshore exploration and production.)

Consumption (of oil): the use of oil as a fuel or as a source of petro-chemicals by industry, governments, and private citizens.

Discharge: a legal permitted release of oil (usually in a highly-diluted state in water) as part of normal operations.

Downstream API Sector: refineries, tanker trucks, rail tank cars, and gas stations.

Effluent: *see* ***Refinery effluent.***

Loss of well control: "uncontrolled flow of formation or other fluids, including flow to an exposed formation (an underground blowout) or at the surface (a surface blowout), flow through a diverter, or uncontrolled flow resulting from a failure of surface equipment or procedures" (MMS). *See also* ***Well blowout.***

Marine API Sector: the part of the Midstream API Sector that focuses on marine transport by tank vessels.

Natural seeps: natural springs from which liquid and gaseous hydrocarbons (hydrogen-carbon compounds) leak out of the ground.

Oil: *in this report*, the term "oil" encompasses a broadly-defined class of liquid hydrocarbon mixtures, including crude oil and liquid refined petroleum products (e.g., diesel, bunker fuels, gasoline, hydraulic oils, lubricating oils, jet fuel, alkylates), and waste oils, but does not include BTEX compounds (butane, toluene, ethylene, and xylene), petrochemicals, or highly-volatile liquids (HVL), specifically liquefied petroleum gas (LPG), liquefied natural gas (LNG), carbon dioxide (CO_2), and anhydrous ammonia.[81] *The term is used interchangeably with "petroleum" in this report.*

Other oils: petroleum products other than diesel or heavy oil, including jet fuel, mineral oil, lubricating oil (lube), hydraulic oil, gasoline, waste oil, oil-based drilling muds, and other miscellaneous or unknown oils.

Petroleum: see ***Oil.***

Petrochemicals: organic and inorganic compounds and mixtures that include but are not limited to organic chemicals, cyclic intermediates, plastics and resins, synthetic fibers, elastomers, organic dyes, organic pigments, detergents, surface active agents, carbon black, and ammonia.

Primary containment: an oil container (e.g., a storage tank).

Produced water: water pumped to the surface during the oil extraction process at offshore oil platforms.

Refinery: an installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates, through a series of distillation processes.

[81] LNG, LPG, carbon dioxide (CO_2) and anhydrous ammonia while petroleum products, are not included in oil spillage data analysis because they rapidly volatilize upon release and do not cause the environmental impacts of liquid petroleum.

Refinery capacity: the volume capability of refineries to process inputs to atmospheric distillation units.

Refinery effluent: legally discharged wastewater containing minute concentrations of oil that is discharged from refineries during their processes.

Refinery throughput: the actual volume of petroleum products "processed" or produced at a refinery, or essentially, the refinery capacity multiplied by the refinery utilization.

Refinery capacity utilization: ratio (or percentage) of the total amount of crude oil, unfinished oils, and natural gas plant liquids run through crude oil distillation units at a refinery to the operable capacity of these units.

Refined petroleum products: include, but are not limited to, gasolines, kerosene, distillates (including No. 2 fuel oil), liquefied petroleum gas,[82] asphalt, lubricating oils, diesel fuels, alkylates, and residual fuels.

Refinery utilization: *see* ***Refinery capacity utilization.***

Right-of-way (ROW): a strip of land usually about 25 to 150 feet wide containing the pipeline; the ROW enables workers to gain access for inspection, maintenance, testing or emergencies, maintains an unobstructed view for frequent aerial surveillance, and identifies an area that restricts certain activities to protect the landowner and the community through which the pipeline passes and the pipeline itself. The ROW is established by written agreements, or easements, between landowners and pipeline companies that allow pipeline companies to construct and maintain pipeline rights-of-way across privately owned property. Most pipelines are buried below ground in an ROW.

Secondary containment (secondary containment system): an essential line of defense in preventing oil from spreading and reaching waterways in the event of the failure of an oil container (e.g., a storage tank) or the primary containment. A secondary containment system provides temporary containment of the spilled oil until a response can be mounted.

Spill: a discrete event in which oil is accidentally or, occasionally, intentionally released to the environment.

Spillage: the aggregated amount of oil that is spilled, rather than legally discharged, from a particular source.

Tank ship: a large self-propelled vessel that carries oil as cargo, also called an oil "tanker".

Tank vessel: a tank ship (tanker) or a tank barge that carries oil as cargo (the category "tank vessel" does not distinguish whether the vessel is self-propelled or not).

Upstream API Sector: oil exploration and production.

Waterway: for the purposes of simplicity and clarity in this report, "waterways" shall include all of the waterways in the *broadest* sense of the definition (as applied by EPA and U.S. Army Corps of Engineers in 33 CFR§328.3) of the term for all spills.

Well blowout: "an uncontrolled flow of gas, oil, or other fluids from a well into the atmosphere or into an underground formation" (NOAA).

[82] While liquefied petroleum gas (LPG) is a refined petroleum product, it is not included in the data analyses in this report due to its highly volatile nature and propensity to volatilize on release so that it does not cause any of the environmental impacts normally associated with the spillage of liquid petroleum products.

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