
ENVIRONMENTAL
RESEARCH
CONSULTING

Purpose of Study

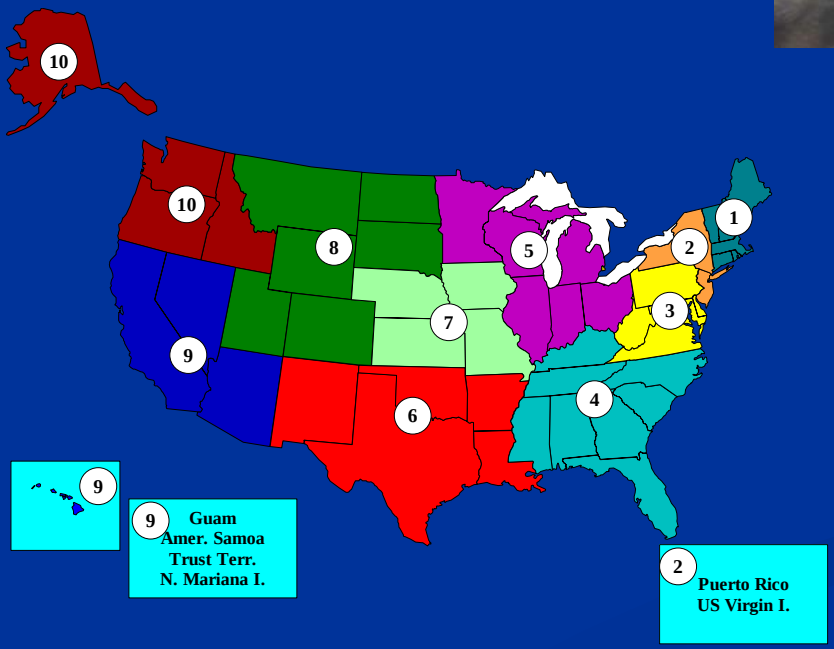
Conduct risk assessment of nearly 52,000 oil spills that have occurred in US inland navigable waterways since 1980

Risk Assessment

Risk = Probability* x Consequences (Impacts)

Risk Categories

- Source Type
- Oil Type
- EPA Region

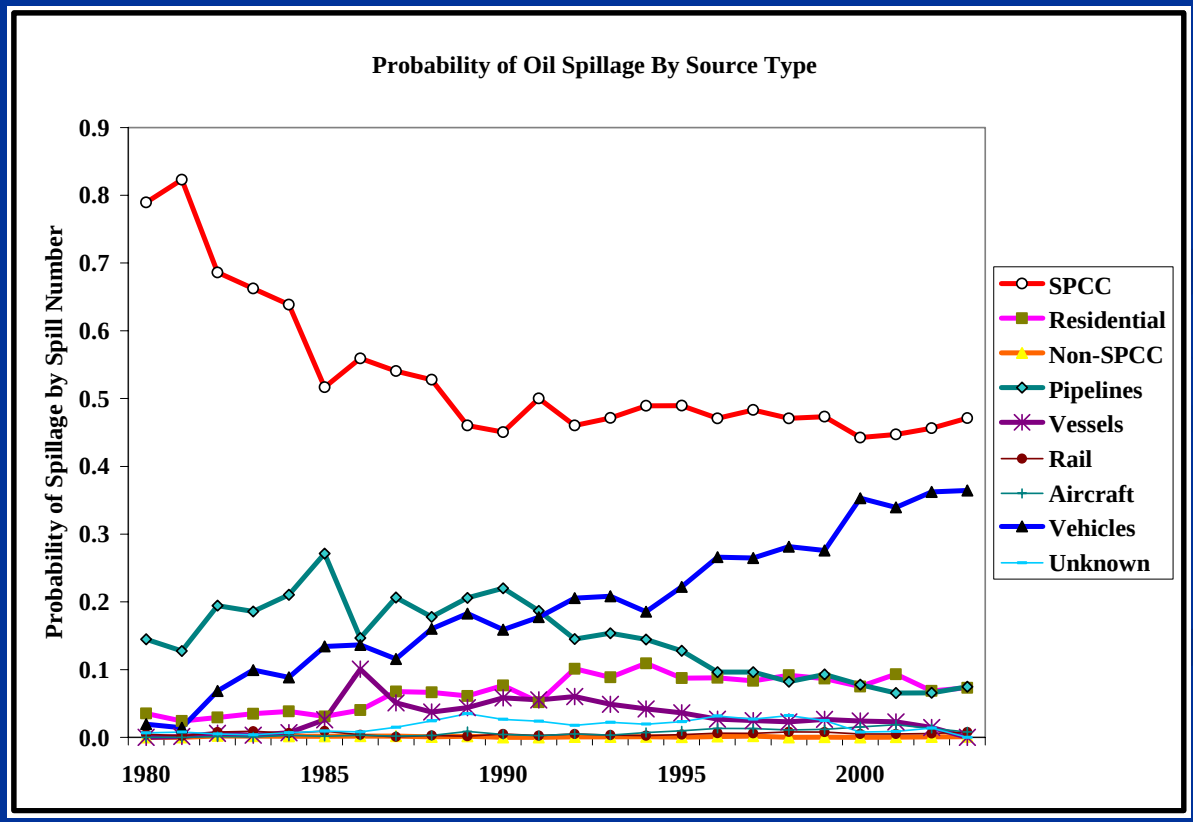


$$\text{Spill risk}_{ijk} =$$

Where

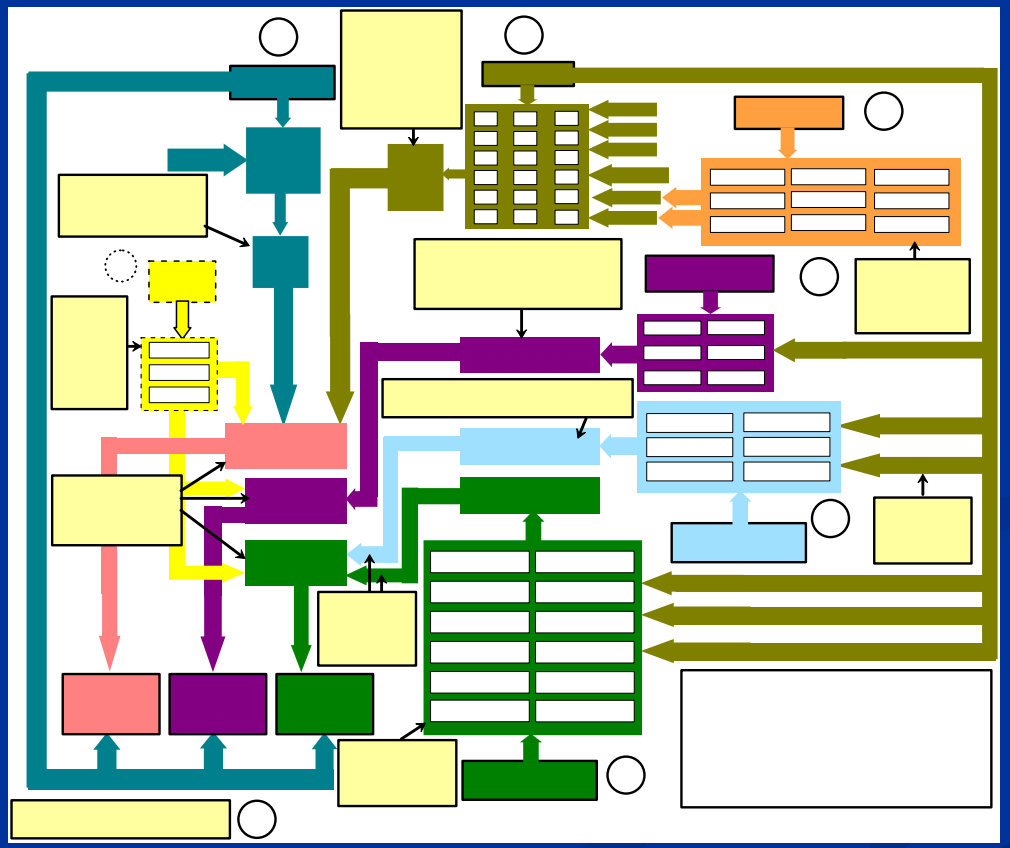
Methodology

- Determine probability of different types of spills by spill source, oil type, and EPA region for each year (based on ERC Oil Spill Databases)



- Determine

Model)



Results: Spills By Source Type

- Largest sources are SPCC facilities and pipelines – 55% of volume is from SPCC facilities and 39% from pipelines.
- The largest number of oil spills to inland waterways is from SPCC facilities (51%) with average volume per spill of 5,900 gallons.

Spills by Source Type *(continued)*

- Pipelines make up 13% of the spill number with average volume of 16,000 gallons.

- Vehicles make up 22% of the spill number with average volume of 680 gallons.

Spillage by Source Type

Source Type	Number	Volume (gal)	Avg Volume (gal)
SPCC	26,375	155,922,130	5,912
Pipelines	6,967	110,397,511	15,846
Vehicles	11,593	7,838,499	676
Vessels	1,573	4,713,234	2,996
Rail	265	2,168,906	8,185
Residential	3,707	483,010	130
Aircraft	420	191,414	456
Non-SPCC	41	30,310	739

Spill Probability by Source Type

Source Type	Average Probability	Standard Deviation
SPCC Facilities	0.533	0.108
Vehicles	0.195	0.103
Pipelines	0.146	0.057
Residential	0.067	0.025
Vessels	0.031	0.024
Unknown	0.017	0.010
Aircraft	0.007	0.005
Rail	0.005	0.002

Spills by Oil Type

- The most frequent type of oil spilled is light fuel oils, followed by crude oil.
- The average volume of crude spills is three times that of light fuel.
- Volatile distillates (including gasoline) spilled at third highest rate.

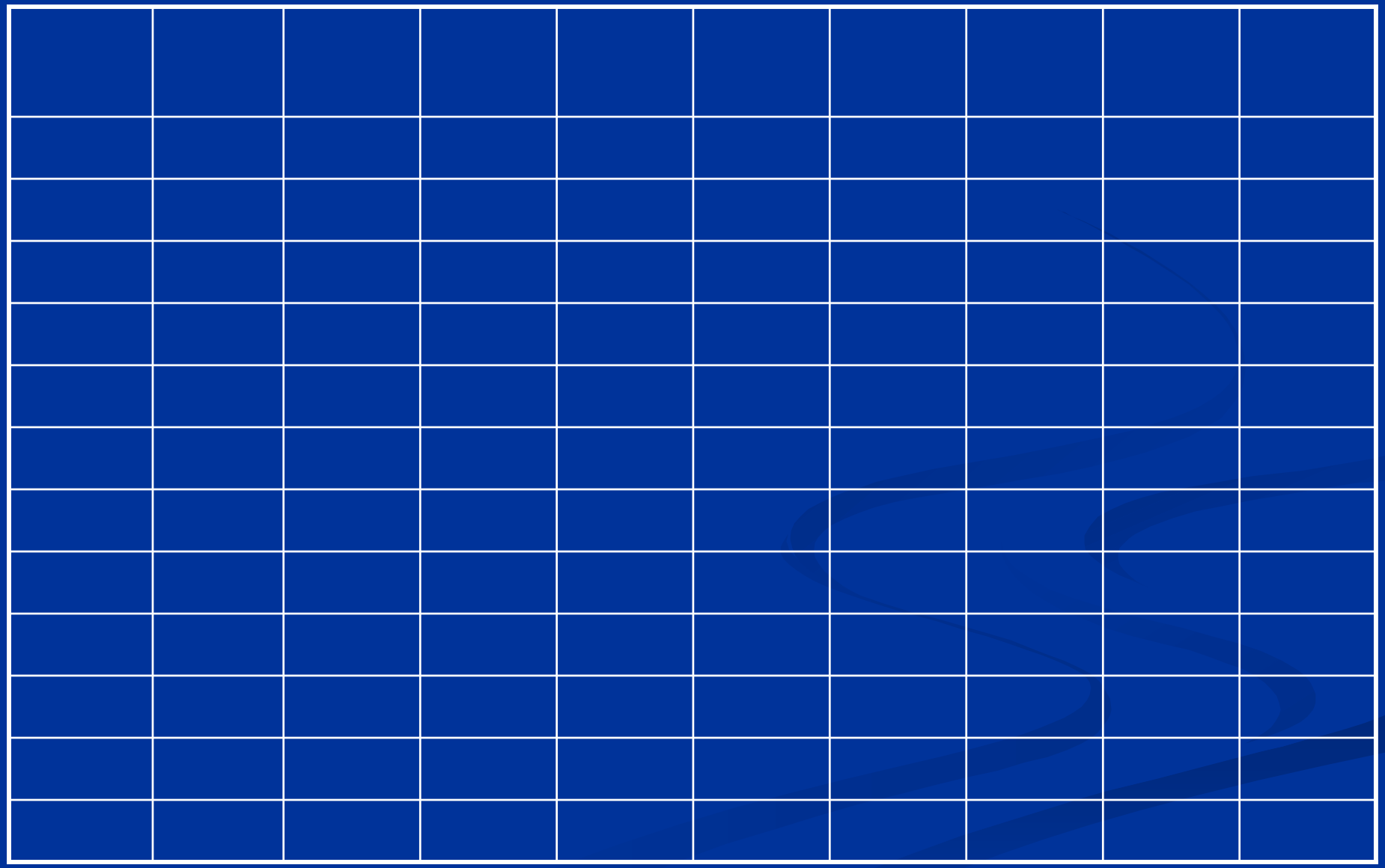
Spills by Oil Type

Oil Type	Number	Volume (gal)	Avg Volume
Crude	11,809	135,158,696	11,445
Volatile Dist	7,417	56,822,936	7,661
Light Fuel	21,220	45,663,963	2,152
Heavy Fuel	1,260	12,367,934	9,816
Asphalt/Tar	793	8,815,116	11,116
Light Oils	3,379	7,392,086	2,188
Unknown Oil	1,751	5,403,287	3,086
Lube Oil	1,645	3,737,988	2,272
Waste Oil	1,358	3,461,648	2,549
IFO	320	1,831,042	5,722
AFVO	366	1,420,444	3,881

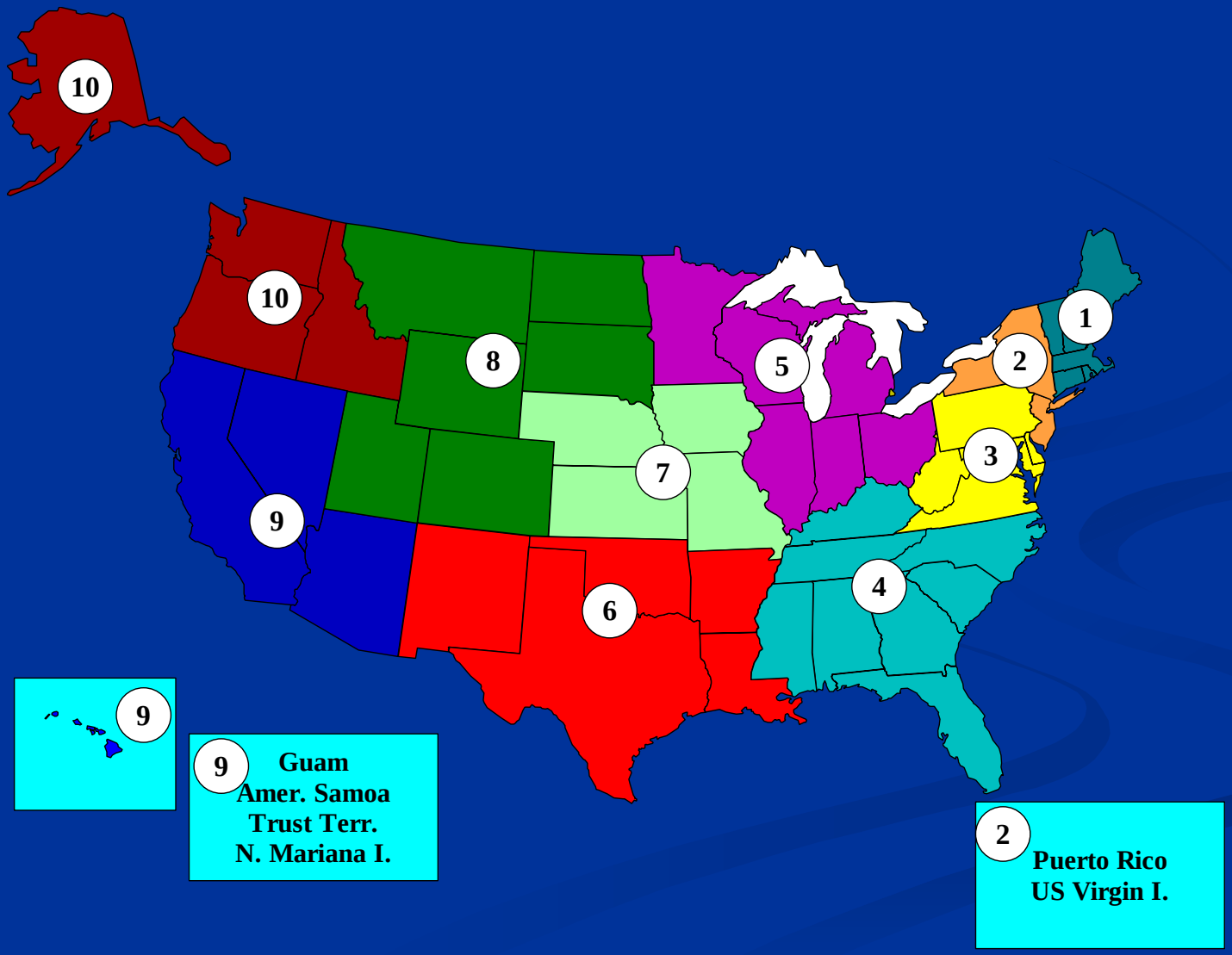
Spill Probability by Oil Type

Oil Type	Average	Standard Deviation
Light Fuels	0.3754	0.140
Crude	0.2581	0.128
Volatile Distillate	0.1526	0.042
Light Oils	0.0590	0.024
Lubricating Oil	0.0318	0.007
Unknown Oil	0.0314	0.016
Heavy Fuel	0.0266	0.010
Waste Oil	0.0247	0.012
Asphalt/Tar	0.0154	0.006
Other Oil	0.0107	0.009
AFVO	0.0076	0.004

Combined Probability of Oil Type and Source Type

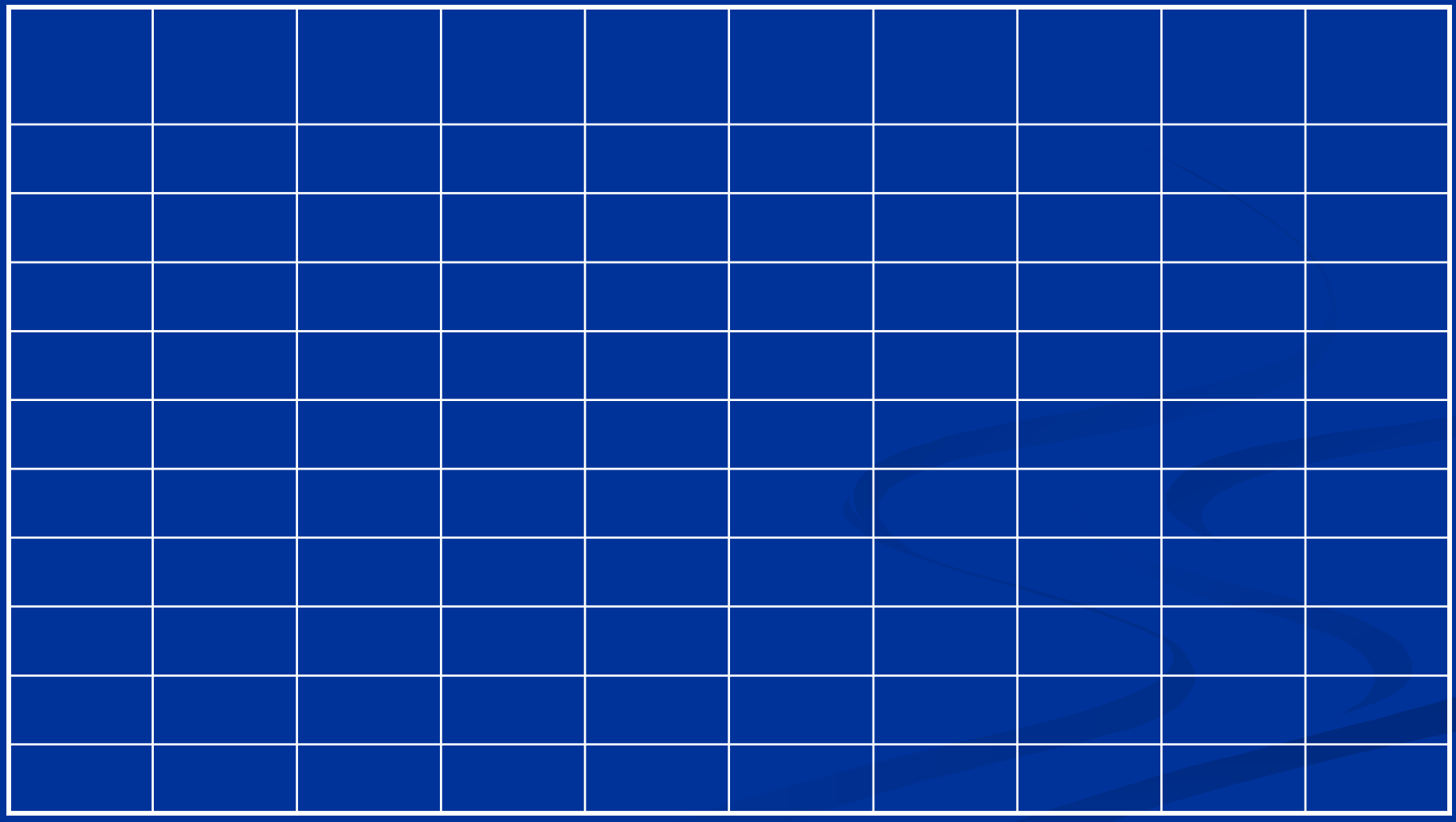


Spillage by EPA Region



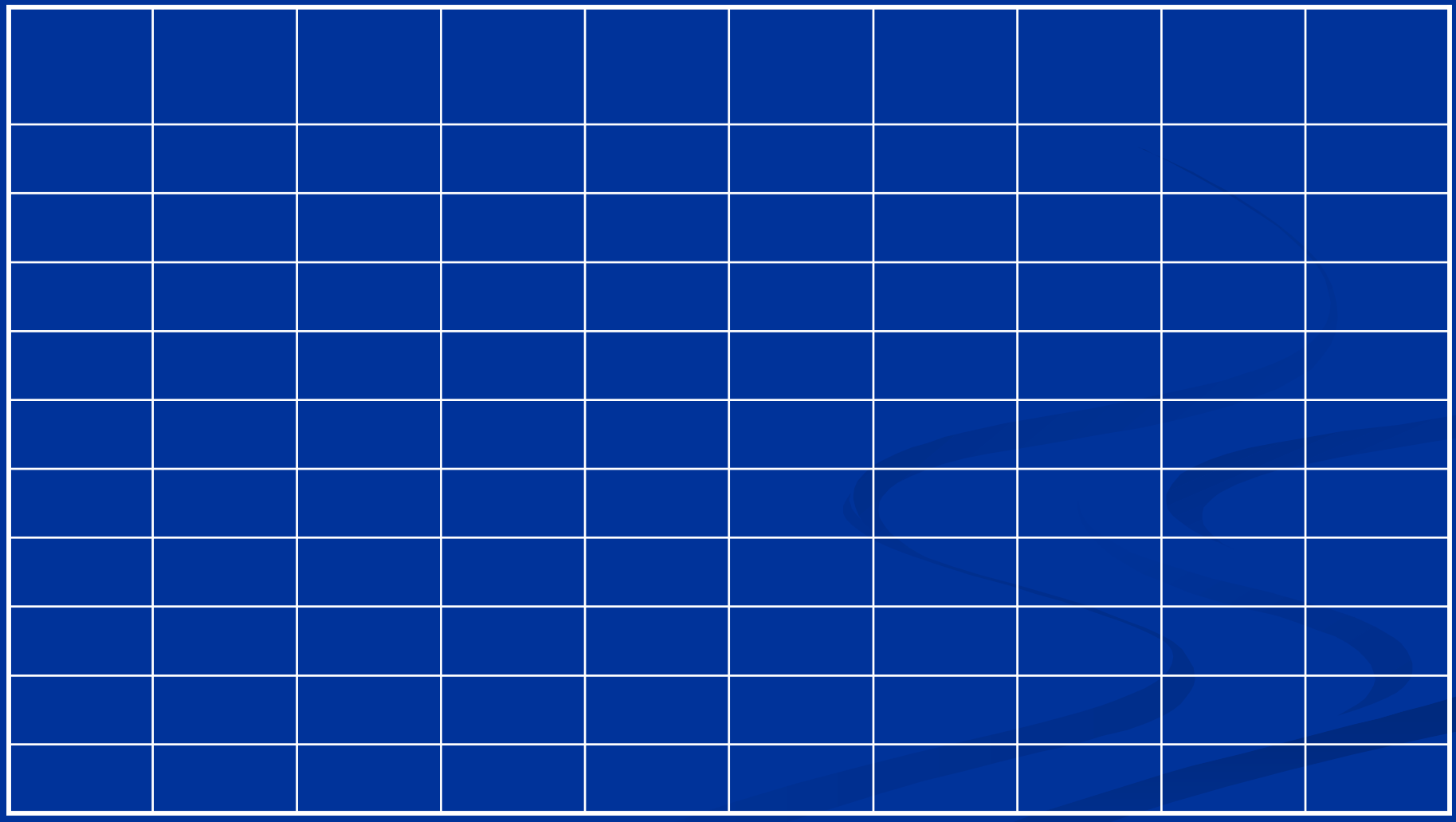
Within each source type, if there is a spill, which EPA region is it most likely to occur within?

Spillage by EPA Region Within Source Type



Within each EPA region, what is the probability that a spill will be from a particular source type?

Spillage by Source Type Within EPA Region

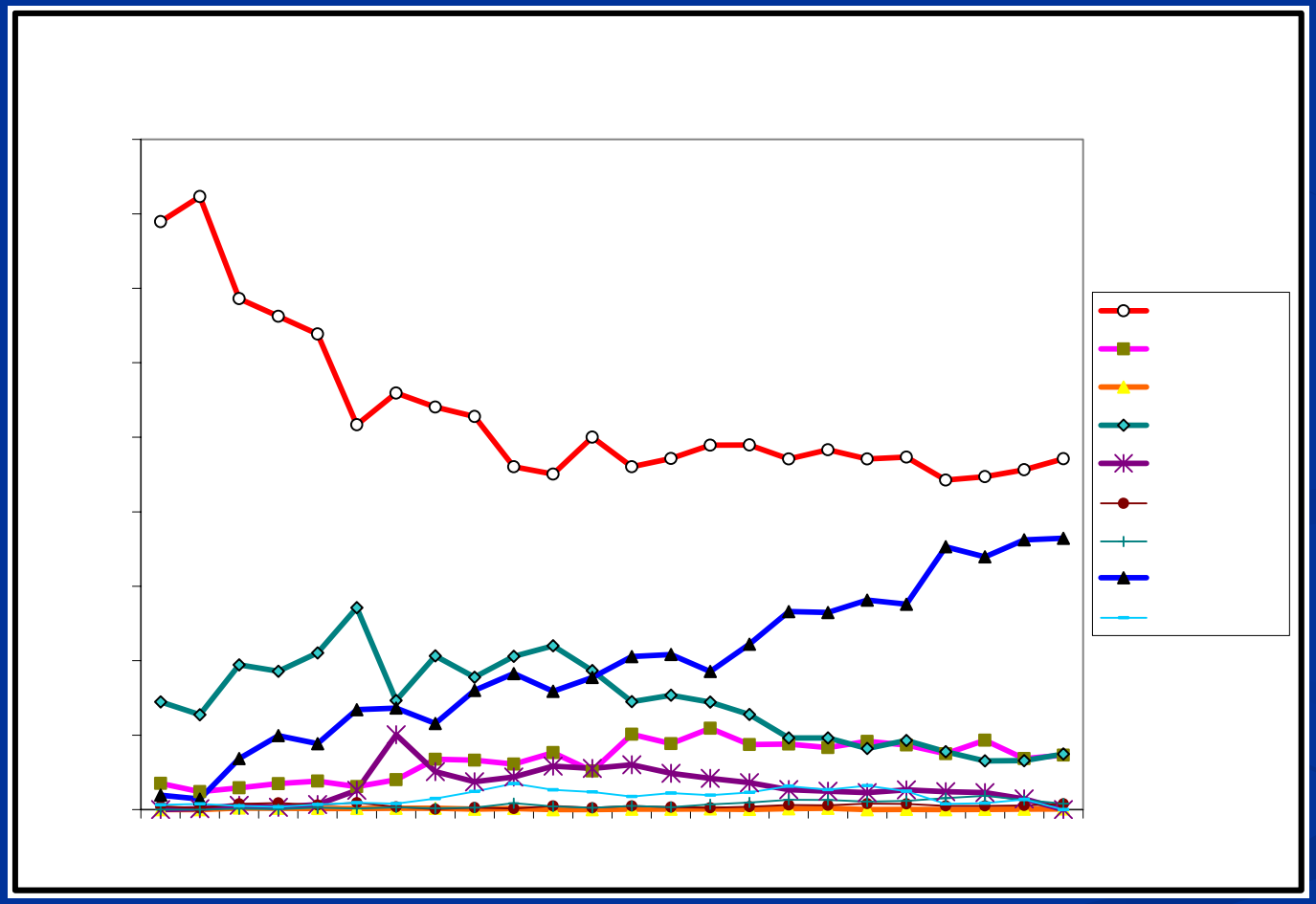


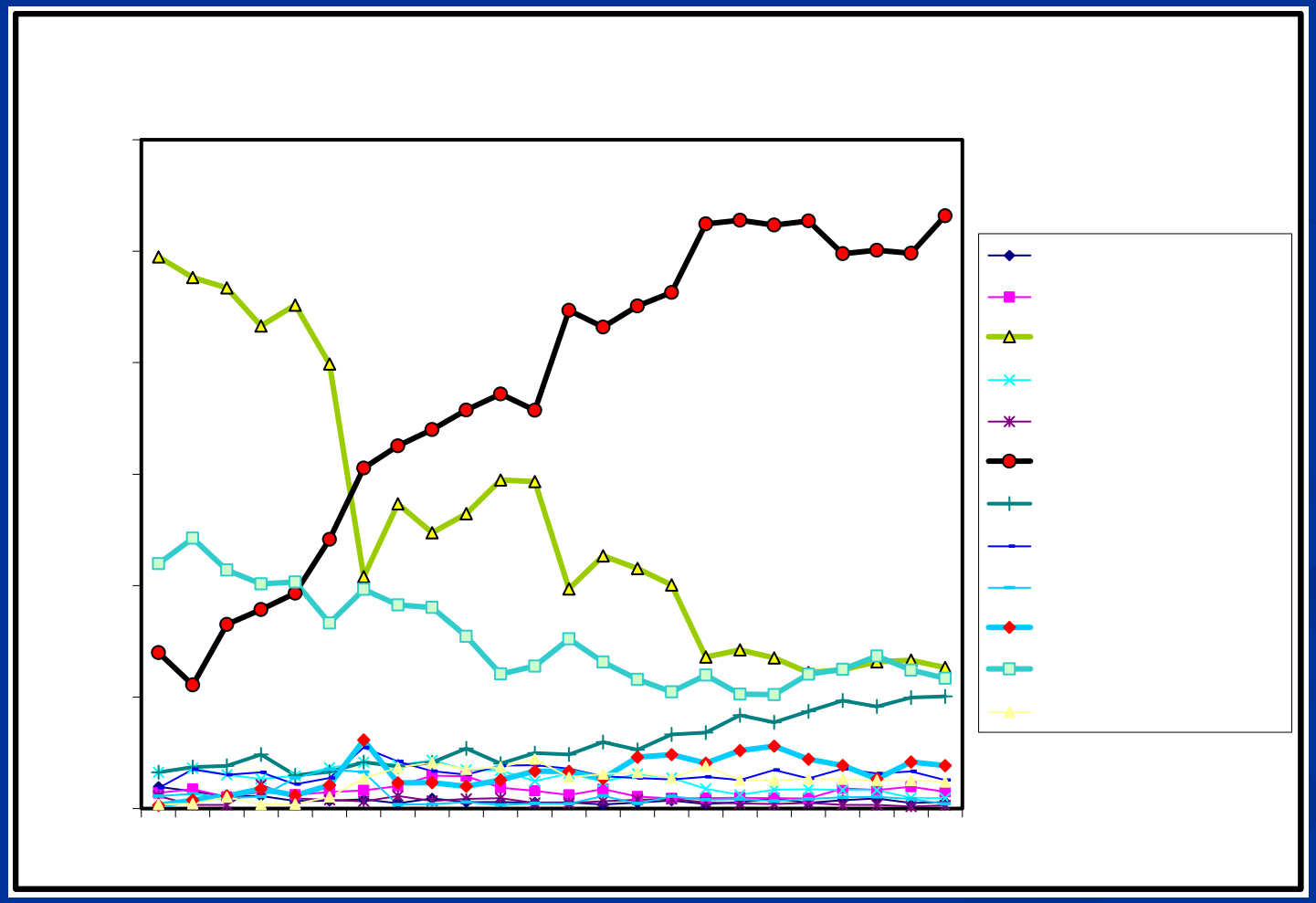
Most Likely Spills

Rank	Source Type	Oil Type	EPA Region
1	pipeline	crude	6
2	vehicle	light fuel	5
3	SPCC	crude	6
4	residential	light fuel	1
5	vehicle	light fuel	1
6	SPCC	light fuel	5
7	SPCC	light fuel	1
8	SPCC	volatile distillate	6
9	SPCC	light fuel	10

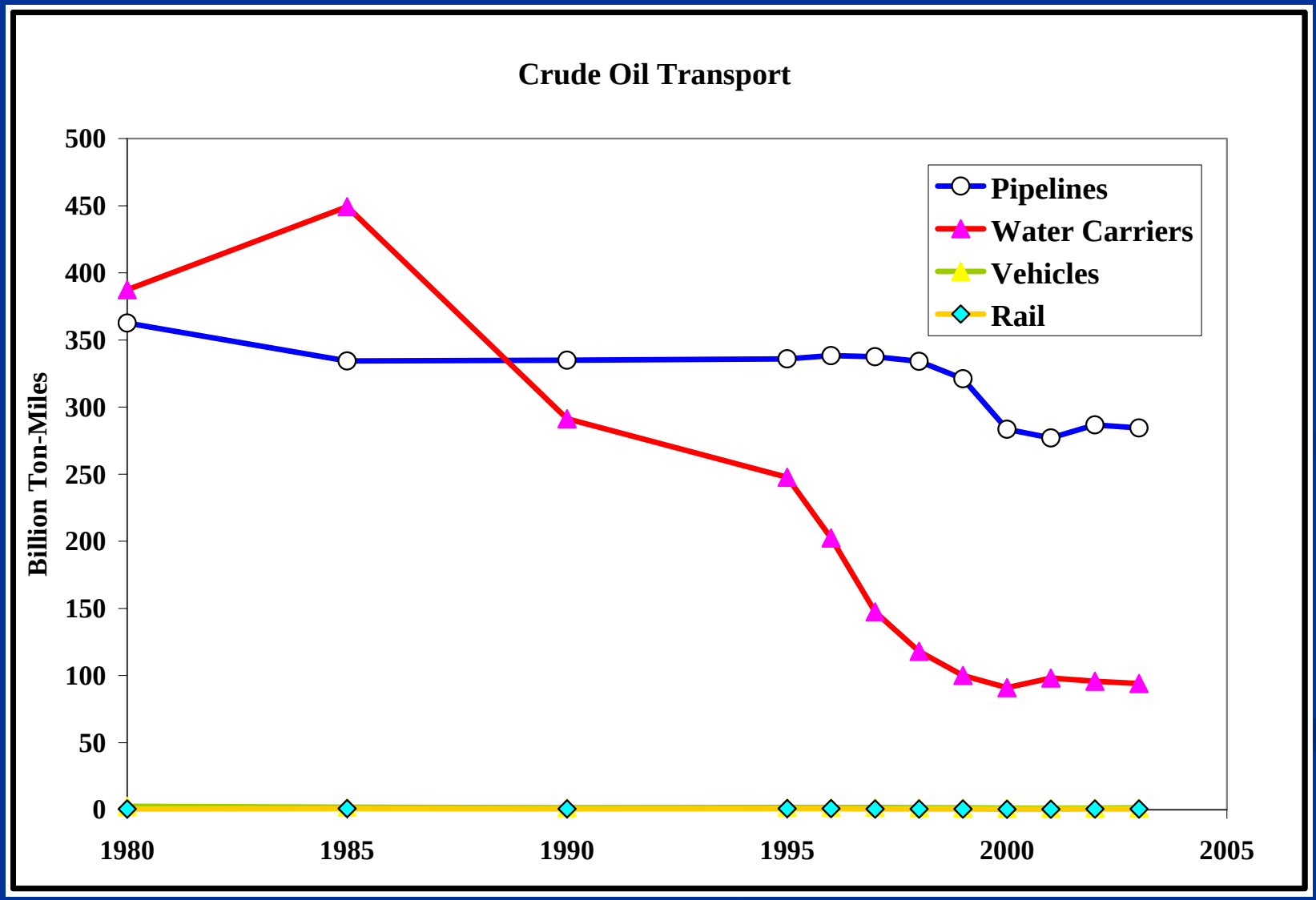
Based on spill number

Changes in Spill Trends – Source Type

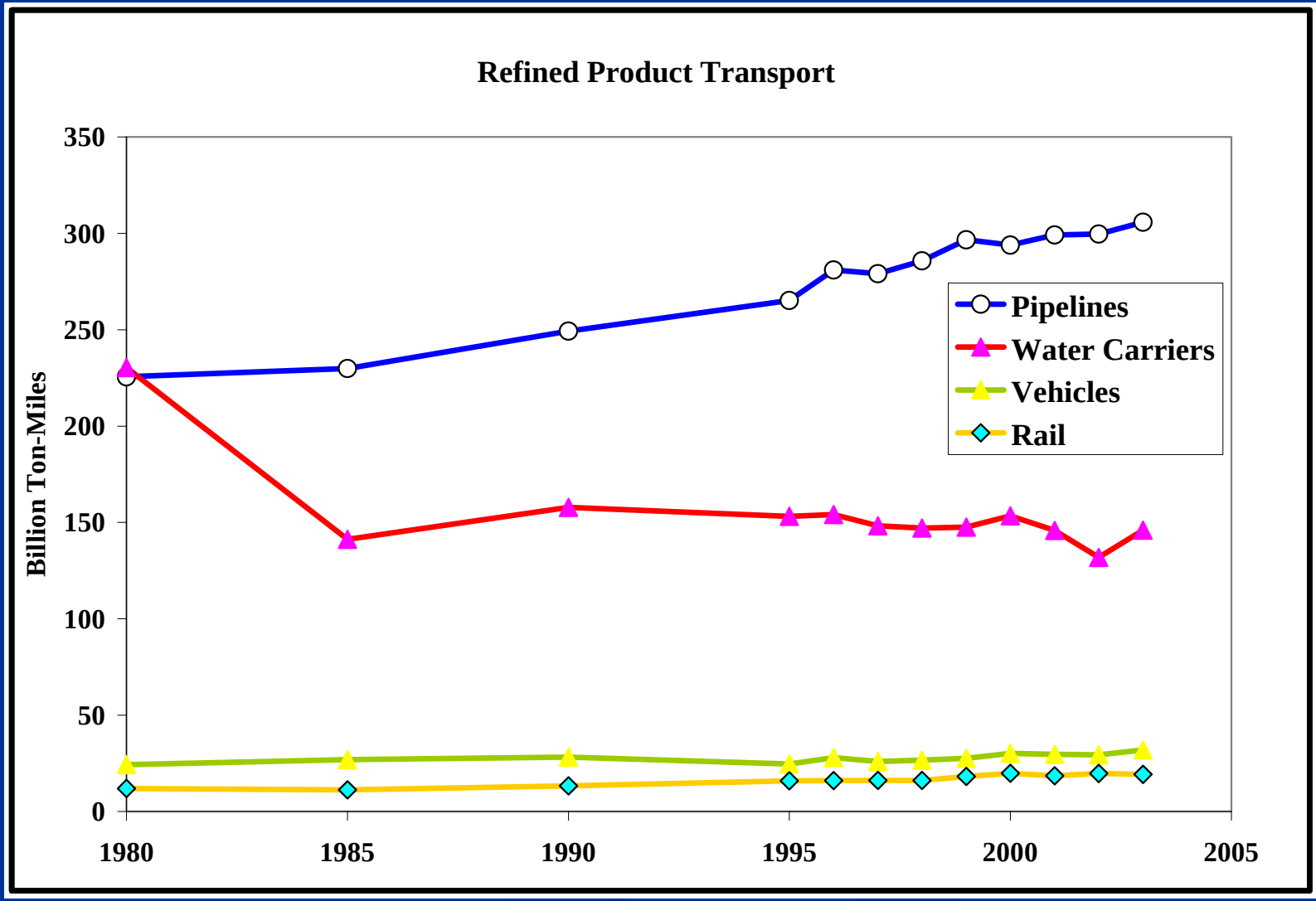




Trends in Crude Transport



Trends in Refined Oil Transport



Spillage by Transport Mode (1980-2003)
Gallons Spilled per Billion Gallon-Miles Transported

Oil Type	Pipelines	Vehicles	Rail
Crude Average	38.3	15.5	80.1
Refined Average	8.8	595.4	399.3

Spillage By Transport Mode

- 99% crude and 70% refined products are transported by pipeline
- For crude oil, rail transport leads to twice the spillage of pipelines, and five times the spillage of vehicular transport
- For refined products, pipeline transport is the least risky mode – rail transport results in 45 times more spillage and vehicular transport in 67 times the spillage of pipelines

Risk Analysis

Based on:

- Probability of a spill being in a certain category (oil type and source type)
- Consequences of those spills (response costs, environmental damages, and socioeconomic impacts)

Relative Risk Oil Type and Source Type (All EPA Regions)

Type	SPCC	Pipe	Veh	Vess	Rail	Resid	Non-SPCC	Air	Unkn
LFO	$343	$40	$16	$2	$11	$10	$0	$0	$8
Crude	$435	$691	$2	$0	$2	$2	$0	$0	$2
Volat	$305	$65	$26	$0	$6	$1	$0	$1	$1
Light	$65	$5	$0	$0	$0	$0	$0	$0	$0
Lube	$71	$9	$2	$0	$1	$3	$0	$0	$1
Unkn	$45	$5	$6	$0	$0	$0	$0	$0	$1
Waste	$71	$1	$2	$0	$1	$0	$0	$0	$2
HVO	$197	$3	$5	$0	$32	$1	$0	$0	$2
Asph	$146	$2	$21	$0	$2	$2	$0	$0	$0
Other	$10	$0	$0	$0	$0	$0	$0	$0	$0
AFVO	$11	$0	$2	$0	$0	$1	$0	$0	$0
IFO	$14	$0	$0	$0	$1	$0	$0	$0	$0

Risk Analysis Results

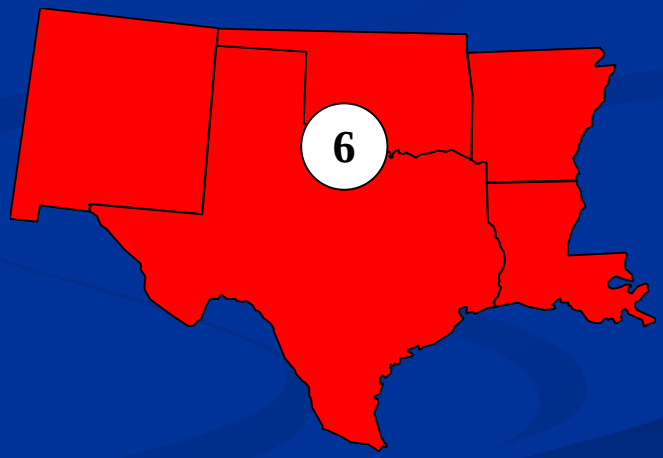
- Overall, SPCC facilities present greatest risk across oil types and EPA regions (more than twice that of pipelines)
- Crude spills present the greatest risk by oil type – 2.6 times that of light fuel spills and 2.8 times that of volatile distillates (gasoline, jet fuel)
- Crude pipeline spills present the greatest risk, then crude SPCC spills and light fuel SPCC spills.
- Within SPCC facilities, crude oil spills present 1.3 times the risk of light fuel spills

Risk Analysis Results - *continued*

- With apparent shifts in oil types spilling (concurrent with increase in refined products transported and decrease in crude transport), there may be an increasing risk from light fuel spills and somewhat less from crude spills in the future.

Risk Analysis by EPA Region

- The greatest risk to inland waterways lies with crude pipeline spills in EPA Region 6.
- The next highest risk comes from SPCC facility spills from EPA Region 6.



Detailed risk analyses by EPA Region, source type, and oil type are in appendices of paper

What Does This Mean?

- Overall spill risk can be reduced by decreasing the probability of spillage through spill prevention measures and by increasing the consequences for spillers.
- Spill risk can be greatly lessened by reducing the frequency of high-impact spills – those in the most sensitive areas, with the largest volumes, and with the most toxic and/or persistent oil types

- Focus prevention measures on the highest risk types of spills
- Focus prevention and preparedness on the most environmentally- and socioeconomically-sensitive locations
- Reduce volume of spillage through rapid spill detection, response, and source control
- Shift usage of more persistent and toxic oils to lesser-impact oil types
- Reduce impacts by better spill response that more effectively removes oil – increasing response capability and decreasing response time