

MANAGEMENT OF RESIDUAL MATERIALS: 1995

PETROLEUM REFINING PERFORMANCE

HEALTH AND ENVIRONMENTAL AFFAIRS DEPARTMENT
PUBLICATION NUMBER 339
JUNE 1997



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Management of Residual Materials: 1995

Petroleum Refining Performance

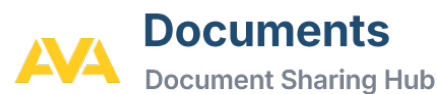
Health and Environmental Affairs Department

API PUBLICATION NUMBER 339

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JUNE 1997



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ACKNOWLEDGMENTS

THE FOLLOWING PEOPLE ARE RECOGNIZED FOR THEIR CONTRIBUTIONS OF TIME AND EXPERTISE DURING THIS STUDY AND IN THE PREPARATION OF THIS REPORT:

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J. A. Stirling, Phillips Pipeline Company

THE REFINERS

At each refinery participating in the survey, one or more individuals assumed the responsibility to complete the survey questionnaire. Their efforts deserve special recognition and thanks from the industry.

Carol Gosnell (API) is recognized for her contribution to the cover art for this publication.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Executive Summary	ES-1
1. Methodology	1-1
Listing of Refineries	1-1
Rationale for Survey Clarifications	1-1
Residual Streams	1-2
Management Practices and Techniques	1-2
Data Analysis	1-3
2. Results	2-1
Response Rate	2-1
Reprocessing of Used Oil	2-3
Wastewater Treatment Facility	2-3
Pollution Prevention	2-7
3. Residual Stream Profiles	3-1
API Separator Sludge	3-2
Biomass	3-6
Contaminated Soils & Solids	3-9
DAF Float	3-13
FCC Catalyst	3-16
Hydro. Catalyst	3-20
Other Spent Catalysts	3-24
Pond Sediments	3-27
Primary Sludges	3-30
Slop Oil Emulsion Solids	3-34
Spent Cresylic Caustic	3-37
Spent Naphthenic Caustic	3-40
Spent Sulfidic Caustic	3-43
Tank Bottoms	3-47



Documents

Document Sharing Hub

4. Combined Streams	4-1
Oily Wastewater Residuals	4-1
Spent Caustics	4-3
Appendix A	
ELECTRONIC SURVEY FORM	A-1
Appendix B	
DESCRIPTION OF STATISTICAL PROCEDURES	B-1
Appendix C	
DATA TABLES	C-1

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1 Sample Screen from the Survey Form	1-2
2 Response Rate by Refinery Capacity	2-1
3 U.S. Department of Energy's PAD Regions	2-1
4 Response Rate by PAD Region	2-1
5 Response Distribution by Complexity of Facility	2-2
6 Response Distribution by Age of Facility	2-2
7 Response Distribution by Avg. Wt. % of Sulfur	2-2
8 Wastewater Treatment System Summary	2-4
9 Stormwater and Wastewater Holding Structures	2-5
10 Stormwater and Wastewater Impoundment Acreage	2-5
11 Sources of Discharge Water	2-6
12 Nationwide Estimates of Residual Quantity per Year	3-1
13 Nationwide Estimates of Residuals Distribution	3-1
14 Nationwide Estimates of API Separator Sludge per Year: 1987-1995	3-2
15 Nationwide Estimates of API Separator Sludge by Management Practice: 1994-1995	3-2
16 Distribution of API Separator Sludge by Management Technique: 1994-1995	3-3
17 API Separator Sludge Summary: 1995	3-4
18 Onsite Management Cost for API Separator Sludge: 1995	3-5

19	Offsite Management Cost for API Separator Sludge: 1995	3-5
20	Total Management Cost for API Separator Sludge: 1995	3-5
21	Nationwide Estimates of Biomass per Year: 1987-1995	3-6
22	Nationwide Estimates of Biomass by Management Practice: 1994-1995	3-6
23	Distribution of Biomass by Management Technique: 1994-1995	3-7
24	Biomass Summary: 1995	3-8
25	Nationwide Estimates of Contaminated Soils & Solids per Year: 1987-1995	3-9
26	Nationwide Estimates of Contaminated Soils & Solids by Management Practice: 1994-1995	3-9
27	Distribution of Contaminated Soils & Solids by Management Technique: 1994-1995	3-10
28	Contaminated Soils & Solids Summary: 1995	3-11
29	Onsite Management Cost for Contaminated Soils & Solids: 1995	3-12
30	Offsite Management Cost for Contaminated Soils & Solids: 1995	3-12
31	Total Management Cost for Contaminated Soils & Solids: 1995	3-12
32	Nationwide Estimates of DAF Float per Year: 1987-1995	3-13
33	Nationwide Estimates of DAF Float by Management Practice: 1994-1995	3-13
34	Distribution of DAF Float by Management Technique: 1994-1995	3-14
35	DAF Float Summary: 1995	3-15
36	Nationwide Estimates of FCC Catalyst per Year: 1987-1995	3-16
37	Nationwide Estimates of FCC Catalyst by Management Practice: 1994-1995	3-16
38	Distribution of FCC Catalyst by Management Technique: 1994-1995	3-17
39	FCC Catalyst Summary: 1995	3-18
40	Onsite Management Cost for FCC Catalyst: 1995	3-19
41	Offsite Management Cost for FCC Catalyst: 1995	3-19
42	Total Management Cost for FCC Catalyst: 1995	3-19
43	Nationwide Estimates of Hydro. Catalyst per Year: 1987-1995	3-20
44	Nationwide Estimates of Hydro. Catalyst by Management Practice: 1994-1995	3-20
45	Distribution of Hydro. Catalyst by Management Technique: 1994-1995	3-21
46	Hydro. Catalyst Summary: 1995	3-22
47	Onsite Management Cost for Hydro. Catalyst: 1995	3-23
48	Offsite Management Cost for Hydro. Catalyst: 1995	3-23
49	Total Management Cost for Hydro. Catalyst: 1995	3-23

50	Nationwide Estimates of Other Spent Catalysts per Year: 1987-1995	3-24
51	Nationwide Estimates of Other Spent Catalysts by Management Practice: 1994-1995	3-24
52	Distribution of Other Spent Catalysts by Management Technique: 1994-1995	3-25
53	Other Spent Catalysts Summary: 1995	3-26
54	Nationwide Estimates of Pond Sediments per Year: 1987-1995	3-27
55	Nationwide Estimates of Pond Sediments by Management Practice: 1994-1995	3-27
56	Distribution of Pond Sediments by Management Technique: 1994-1995	3-28
57	Pond Sediments Summary: 1995	3-29
58	Nationwide Estimates of Primary Sludges per Year: 1987-1995	3-30
59	Nationwide Estimates of Primary Sludges by Management Practice: 1994-1995	3-30
60	Distribution of Primary Sludges by Management Technique: 1994-1995	3-31
61	Primary Sludges Summary: 1995	3-32
62	Onsite Management Cost for Primary Sludges: 1995	3-33
63	Offsite Management Cost for Primary Sludges: 1995	3-33
64	Total Management Cost for Primary Sludges: 1995	3-33
65	Nationwide Estimates of Slop Oil Emulsion Solids per Year: 1987-1995	3-34
66	Nationwide Estimates of Slop Oil Emulsion Solids by Management Practice: 1994-1995	3-34
67	Distribution of Slop Oil Emulsion Solids by Management Technique: 1994-1995	3-35
68	Slop Oil Emulsion Solids Summary: 1995	3-36
69	Nationwide Estimates of Spent Cresylic Caustic by Management Practice: 1994-1995	3-37
70	Distribution of Spent Cresylic Caustic by Management Technique: 1994-1995	3-38
71	Spent Cresylic Caustic Summary: 1995	3-39
72	Nationwide Estimates of Spent Naphthenic Caustic by Management Practice: 1994-1995	3-40
73	Distribution of Spent Naphthenic Caustic by Management Technique: 1994-1995	3-41
74	Spent Naphthenic Caustic Summary: 1995	3-42
75	Nationwide Estimates of Spent Sulfidic Caustic by Management Practice: 1994-1995	3-43
76	Distribution of Spent Sulfidic Caustic by Management Technique: 1994-1995	3-44
77	Spent Sulfidic Caustic Summary: 1995	3-45
78	Onsite Management Cost for Spent Sulfidic Caustic: 1995	3-46
79	Offsite Management Cost for Spent Sulfidic Caustic: 1995	3-46

80	Total Management Cost for Spent Sulfidic Caustic: 1995	3-46
81	Nationwide Estimates of Tank Bottoms per Year: 1987-1995	3-47
82	Nationwide Estimates of Tank Bottoms by Management Practice: 1994-1995	3-47
83	Distribution of Tank Bottoms by Management Technique: 1994-1995	3-48
84	Tank Bottoms Summary: 1995	3-49
85	Nationwide Estimates of Oily Wastewater Residuals per Year: 1987-1995	4-1
86	Nationwide Estimates of Oily Wastewater Residuals by Management Practice: 1994-1995	4-1
87	Distribution of Oily Wastewater Residuals by Management Technique: 1994-1995	4-2
88	Nationwide Estimates of Spent Caustics per Year: 1987-1995	4-3
89	Nationwide Estimates of Spent Caustics by Management Practice: 1994-1995	4-3
90	Distribution of Spent Caustics by Management Technique: 1994-1995	4-4

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 Sources of Discharge Water as a Percent of Total	2-6
2 Water Quality Discharge Parameters (pounds per year)	2-6
3 Water Quality Discharge Parameters (pounds per million gallons of wastewater discharge)	2-7
4 Pollution Prevention Activities	2-8

EXECUTIVE SUMMARY

The 1995 API Refining Residual Survey collected data on the manner in which U.S. petroleum refineries manage their residual materials. This report summarizes the characteristics of the facilities that responded, and presents nationwide trends in residual management practices. The nationwide estimates were determined from a regression analysis of the respondent data in terms of residual quantity in wet tons by refinery capacity in barrels per stream day (bsd).

1995 Refining Residual Survey-Response Level

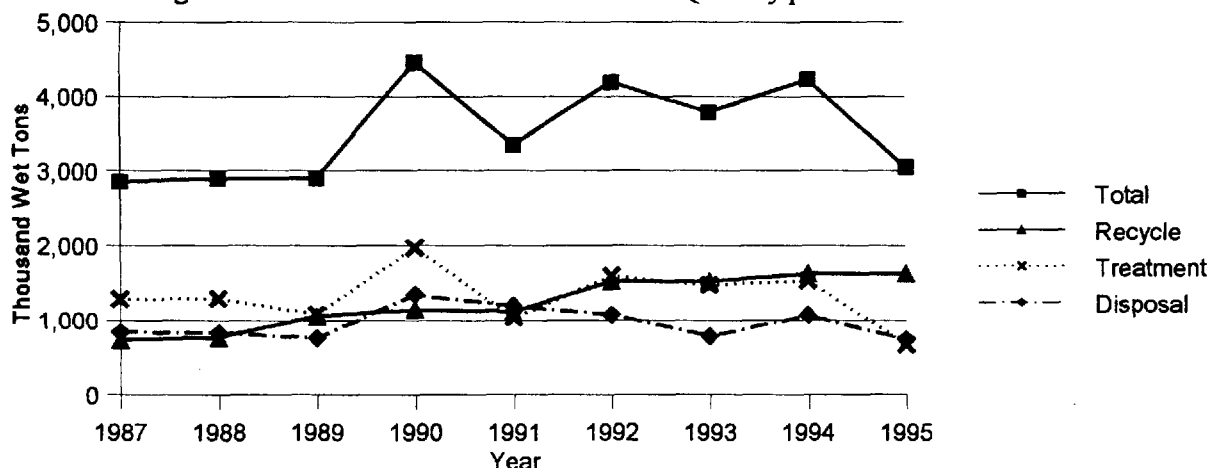
	<u>Estimated U.S. Total</u>	<u>Survey Respondents</u>	<u>Percent</u>
No. of Facilities	149	74	50 %
Refining Capacity	15,006,371 bsd	8,257,071 bsd	55 %
Residual Quantity	3,049,000 wet tons	1,708,452 wet tons	56 %

The 1995 survey collected data on the management of 14 residual streams, believed to represent nearly 80% of the total quantity of residuals managed at U.S. refineries, and requested cost data on six of those streams. As with previous surveys, data were collected on the age, size, location, and type of refinery, and on the configuration of the wastewater treatment systems.

DIFFERENCE FROM PRIOR YEAR RESULTS

Efforts in this year's survey to collect more consistent data resulted in significant departures from prior years' data trends. Some facilities had previously reported the quantity of residual generated prior to dewatering, while others had reported the quantity managed after dewatering. This year's survey specified that only the quantity of residual remaining after dewatering was to be reported, without the recovered water or oil, thus providing for a consistent basis of response and more accurately reflecting quantities of residuals managed. In the following chart, the data for 1987 through 1994 have been adjusted by deleting the quantities considered to be recovered oil or water rather than true residuals.

Trends in Management Practices-Nationwide Estimates of Quantity per Year



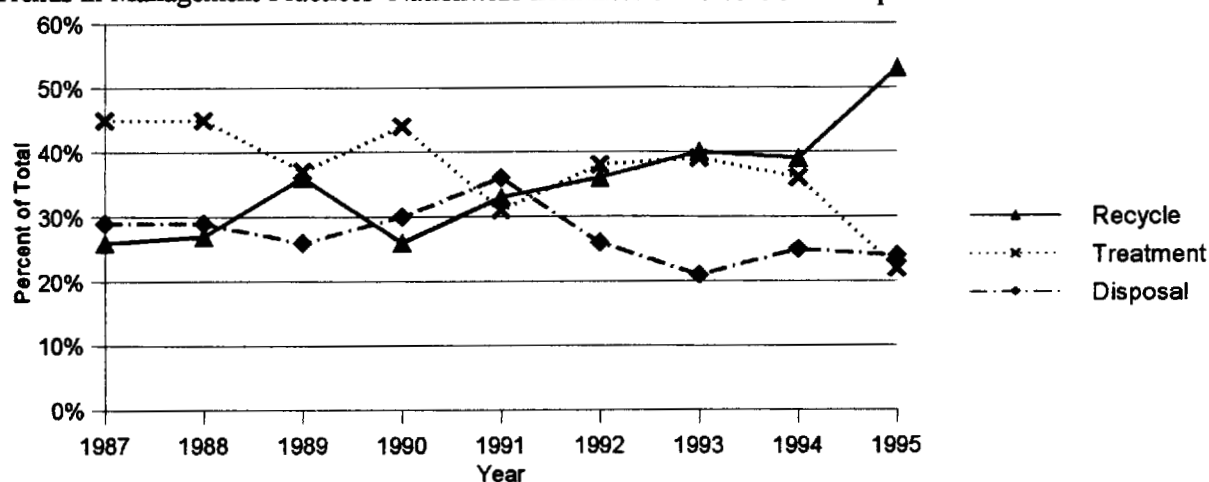
The specific adjustments made to prior years' data were to delete the amounts shown as managed by wastewater treatment from the streams that are reduced by dewatering, which are the *tank bottoms*, *API separator sludge*, *DAF float*, *primary sludges*, *slop oil emulsion solids*, *biomass*, and *pond sediments* streams. Amounts listed as recycled to a crude unit were deleted from these same streams, with the exception of *DAF float* and *slop oil emulsion solids*. The latter two streams had entries in the *crude units*

category for 1995, and therefore this category was retained for these two streams in the adjustments of prior years' data.

The estimated total quantity of residuals managed at U.S. refineries dropped from 4,232,000 wet tons in 1994 to 3,049,000 wet tons in 1995, a reduction of 1,183,000 wet tons. The reporting units of wet tons indicate that the stream volumes are taken in their as-managed condition, rather than on a dry-solids basis. While residuals that have been dewatered will have a higher percent-solids content than if they had not been dewatered, they may nevertheless include a significant amount of water.

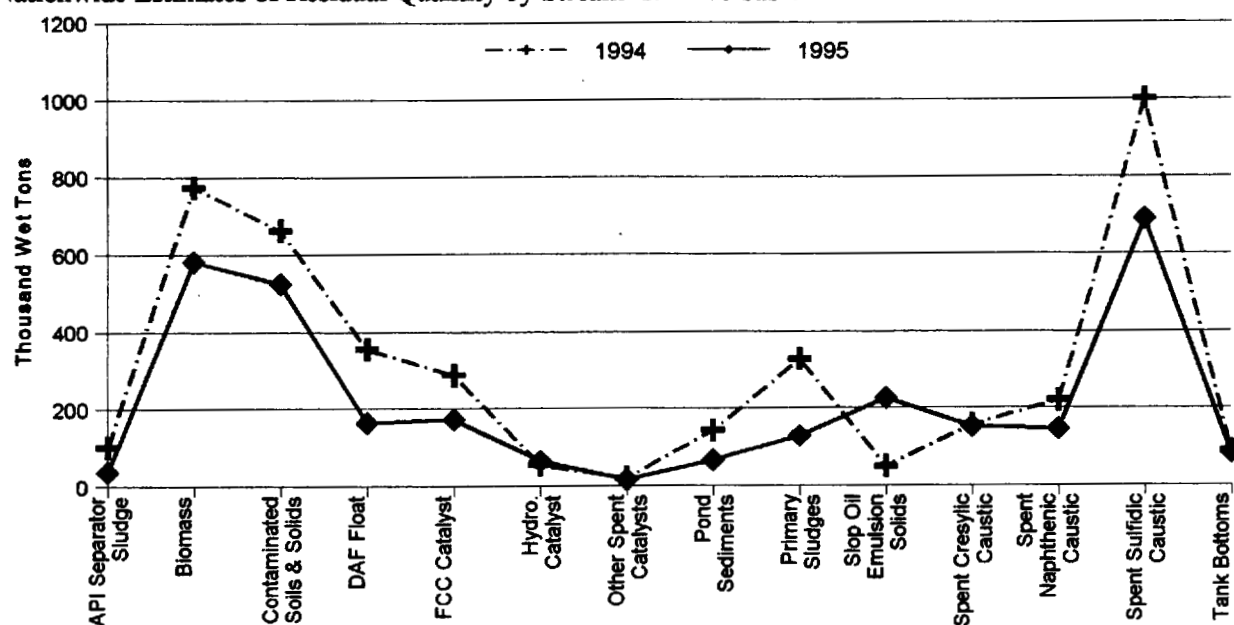
The quantity of residual material reported as having been *recycled* continues the slight upward trend of the previous three years, but as a percent of total it has jumped markedly due to the drop in the other categories. Over half of the total quantity managed is now shown as *recycled*.

Trends in Management Practices—Nationwide Estimates of Percent of Total per Year



The next chart compares residual quantities by stream for 1994 and 1995. The 1994 data have again been adjusted for recovered oil and water to make the data comparable to 1995.

Nationwide Estimates of Residual Quantity by Stream—1994 versus 1995



ES-2



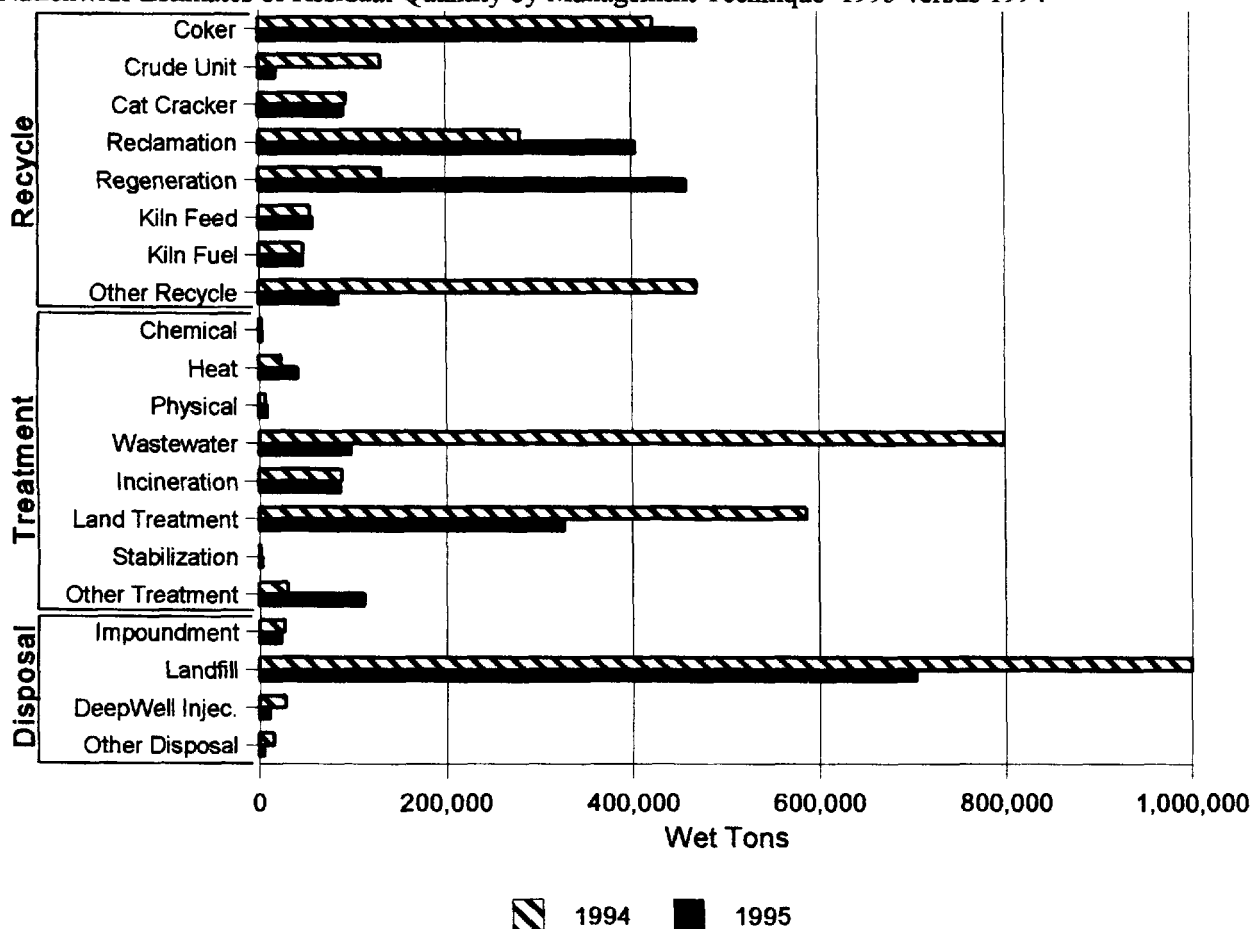
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Several facilities reported a combined amount of certain residuals associated with wastewater treatment facilities (i.e., *API separator sludge*, *DAF float*, *primary sludges*, and *slop oil emulsion solids*), in that they commingle these streams for management. The sum of these oily wastewater residuals decreased from 833,000 wet tons in 1994 to 554,000 wet tons in 1995.

Another step taken in the 1995 survey to improve reporting consistency was to combine all manner of *land farming* and *land spreading* into a single *land treatment* category. In the following chart, the quantity reported under *land spread* as a *disposal* technique in 1994 has been combined with *land treatment*, in order to make the data comparable to 1995. As discussed previously, the 1994 data have also been adjusted for recovered oil and water.

Nationwide Estimates of Residual Quantity by Management Technique—1995 versus 1994



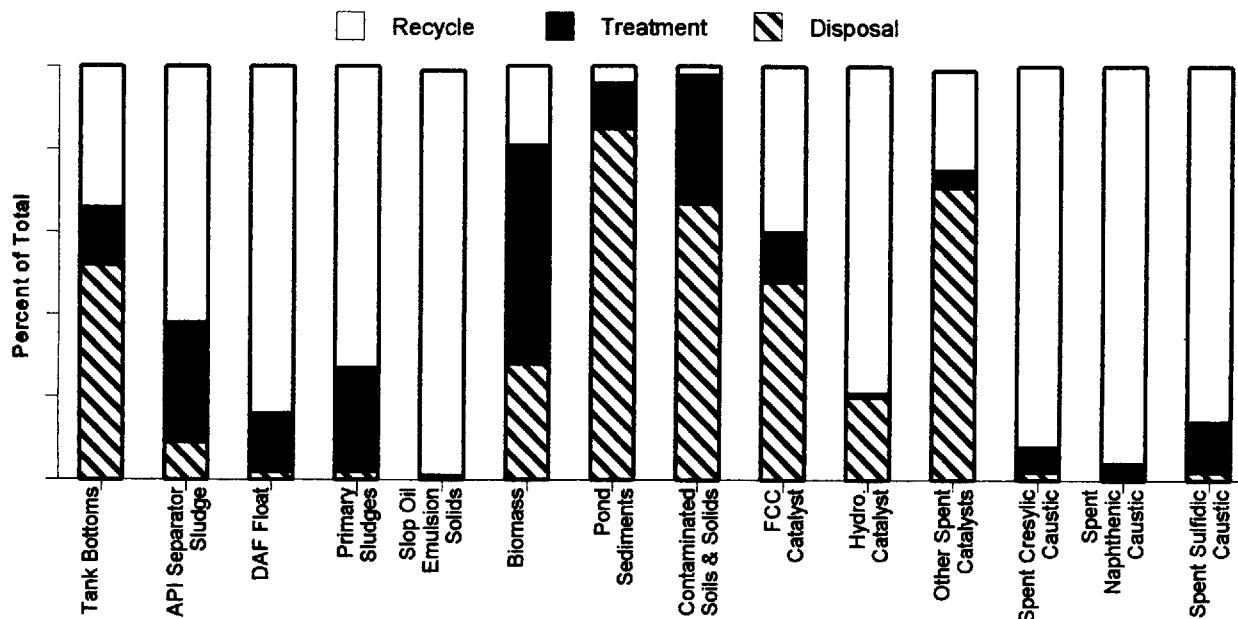
The most obvious difference from 1994 to 1995 is the 88% decrease in the amount managed by *wastewater treatment*. Much of this decrease occurred in the quantities reported for *spent sulfidic caustic*, which were offset in part by an increase in the amount of this stream that was *regenerated*.

There was also a marked drop off in the estimated quantity of residuals managed by *land treatment*, which was almost entirely attributable to reduced amounts of *biomass* being *land treated*. There was, however, a new entry for *biomass* being managed by *other treatment*. This arose from one facility reporting management of *biomass* by *sludge digestion*.

The reduction in the estimated quantity of residuals being *landfilled* included a near-elimination of the *landfilling of primary sludges*.

The next chart displays the nationwide distribution by management practice for each stream, as estimated from the 1995 survey. The streams that are sometimes dewatered, which include *tank bottoms*, the *oily wastewater residuals*, *biomass*, and *pond sediments*, are on the left side of the chart.

Nationwide Estimates of Distribution by Management Practice—1995



Much of the difference in the survey results for 1995 versus previous years is due to improved consistency in the reporting methods. It is evident nonetheless that the reported quantity of residual material managed by U.S. refineries has decreased by more than a million wet tons, and *recycling* has become the dominant management practice.

Section 1 METHODOLOGY

LISTING OF REFINERIES

The term 'petroleum refinery' is used differently in various contexts. For purposes of the 1995 API Refining Residual Survey, a refinery is defined as a facility that currently processes crude oil. Facilities that do not have crude units are not included in the survey.

The 1995 survey was distributed in electronic format (i.e., computer software on diskettes). While electronic formats had been attempted previously, this survey was the first in which respondents were required to enter their data on a computer and return the data to API on a diskette. A copy of selected screens from the electronic survey form is presented in Appendix A.

The survey was sent initially to a mailing list maintained by API. Additional facilities were identified from the API Publication *Entry & Exit in U.S. Petroleum Refining, 1948-1995* and from the list of *Worldwide Refineries-Capacities as of January 1, 1995* published by the Oil & Gas Journal. A total of 145 refineries received the survey, of which 74 responded. The list of refineries was updated further prior to analyzing the data, resulting in 149 facilities being included in the data analysis. The 74 respondent refineries represent 55% of the nationwide refining capacity.

RATIONALE FOR SURVEY CLARIFICATIONS

It became apparent during the preparation of the 1995 survey that several aspects of prior years' surveys had been interpreted inconsistently by respondents. For example, while many facilities had properly reported the quantity of residuals that remained after dewatering as that which was subsequently managed, other facilities had additionally listed the quantities and disposition of the recovered oil and water. This resulted in such curious responses as showing *primary sludge*, which is a residual removed from the wastewater plant, as being managed by *wastewater treatment*, which would imply that it was managed by returning it to the wastewater plant. In actuality, it was not the *primary sludge* residual that was managed by *wastewater treatment*, but rather it was water recovered from a dewatering process. This same water may then be bound in more *primary sludge* and again removed by dewatering and recycled back to the wastewater plant. The quantities of the dewatered streams, then, were being distorted by recovered oil and water which were cycled within the facility, in addition to the actual residual quantities that were managed. This year's survey specified that only the quantity of residual remaining after dewatering was to be reported, without the recovered water or oil, thus providing for a consistent basis of response and more accurately reflecting quantities of residuals managed.

The quantity reported for each stream, then, was that remaining after any dewatering of the sludge. For those streams that are not defined as RCRA-listed hazardous wastes, the quantity may include both hazardous and nonhazardous materials. Where it was determined that a facility had reported both the quantity of material that was treated and the quantity that was disposed of after treatment, only the quantity treated was included in the analysis.

The reporting units of wet tons indicate that the stream volumes are taken in their as-managed condition, rather than on a dry-solids basis. While residuals that have been dewatered will have a higher percent-solids content than if they had not been dewatered, they may nevertheless include a significant amount of water.

It was determined that respondents previously had different interpretations of the definitions of the

individual residual streams. In order to facilitate consistency of response, definitions were added to the 1995 survey as pop up messages attached to buttons on the survey form, as shown in the following figure.

Figure 1—Sample Screen from the Survey Form

Clicking the <?> button next to a stream name results in a box popping up with the definition.

Begin by clicking a stream from the list, continue until complete.

Refinery I.D.: 10005

Type of Residual Stream: API Sep. Sludge

Did your facility manage any of this in 1995? YES NO

Treatment: YES NO

Disposal: YES NO

when done, click to close

when finished with all streams: click here for a report on your residual streams

API Separator Sludge Contaminated Solids & Solids ?

DAF Float Spent Sulfidic Caustic ?

Primary Sludges Description The sludge that settles out by gravity in the API Separator. (aka K051)

Biomass

Pond Sediments Catalyst

Slap Oil Emulsion Solids Hydro. Catalyst ?

Tank Bottoms Other Spent Catalyst ?

OK

RESIDUAL STREAMS

Earlier annual surveys had collected data on 30 separate residual streams, but the 1994 survey reduced the number of streams to 15 for simplification. These 15 streams were believed to represent approximately 80% of the total quantity of refinery residuals. The 1994 survey had included two separate categories for *primary sludges* (i.e., the F037 and F038 RCRA categories). Combining these two streams into a single *primary sludges* category resulted in 14 streams in the 1995 survey. The 1995 survey also collected information on the cost of managing six of the 14 streams in the survey, compared to three streams having had cost data questions in the 1994 survey. The 14 residual streams in the 1995 survey and the definitions assigned to each are listed in Appendix A.

It should be understood that the residual stream labels used in this survey are NOT used in a regulatory sense. Whereas the Environmental Protection Agency (EPA) regulations implementing RCRA have given these terms special meaning, the usage here is in a broader, more generic sense. API's intent is to have survey participants report the management of all residual type materials (e.g., materials that are byproducts or residuals of petroleum refining operations). This includes residuals that are beneficially recycled or reclaimed, as well as materials that are discarded.

MANAGEMENT PRACTICES AND TECHNIQUES

The 1995 survey continued to group management techniques into three categories of management practice—recycling, treatment, and disposal. As with the residual streams, however, it was found that there was substantial variation in the understood definitions of the individual management techniques. Again,

definitions were added to the survey form as pop up messages. The management techniques from the 1994 and 1995 surveys, with the definitions assigned to them for the 1995 survey, are listed in Appendix A. *Each of these management techniques is allowed under certain regulatory scenarios.*

DATA ANALYSIS

Completed survey forms were received from respondent facilities in the form of data files on diskettes. Data cleaning included a check of the data for self-consistency. For example, if a facility indicated that its classification is 'topping', then it should not have reported any spent FCC catalyst; or if it did not report having an API separator, then there should not be any API separator sludge. The data were also reviewed visually and statistically for outliers. Follow up phone calls resolved apparent discrepancies, such as whether the quantity had been reported in the correct units and, if so, why the amount differed from expected levels.

As with previous surveys, the data from the respondents were extrapolated to nationwide estimates by applying a regression analysis in which throughput capacity is taken as the explanatory variable. For consistency with previous years, the following form of equation was retained.

$$\sqrt{R} = b_0 + b_1 C$$

Where:

- R = total residuals managed by a facility (wet tons),
- b_0 = the y-intercept of the regression line,
- b_1 = the slope of the regression line, and
- C = the throughput capacity of the facility (bsd).

The equation developed from the 1995 survey is

$$\sqrt{R} = 31.913 + 7.888 \times 10^{-4} C$$

with an R^2 measure of correlation equal to 0.70, which is an improvement over the correlation measure determined for previous surveys. While the correlation improved and the variance decreased, the percent error increased somewhat (from 5.44% to 7.43%) due to the lower estimated total quantity (3.05 million wet tons rather than 4.80 million wet tons). The statistical analysis is described in more detail in Appendix B.

Section 2 RESULTS

RESPONSE RATE

The 1995 survey response rate is illustrated by several parameters in the following charts.

Figure 2—Response Rate by Refinery Capacity.

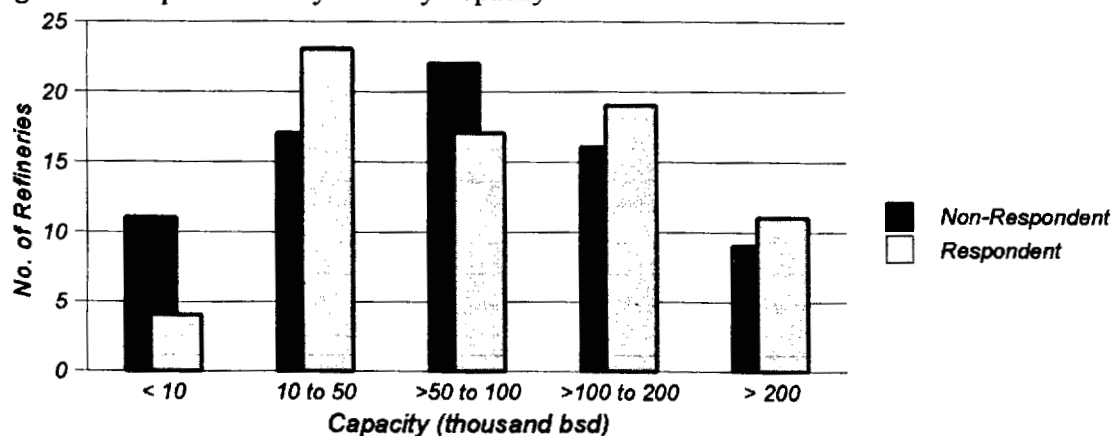


Figure 3—U.S. Department of Energy's Petroleum Administration for Defense (PAD) regions.

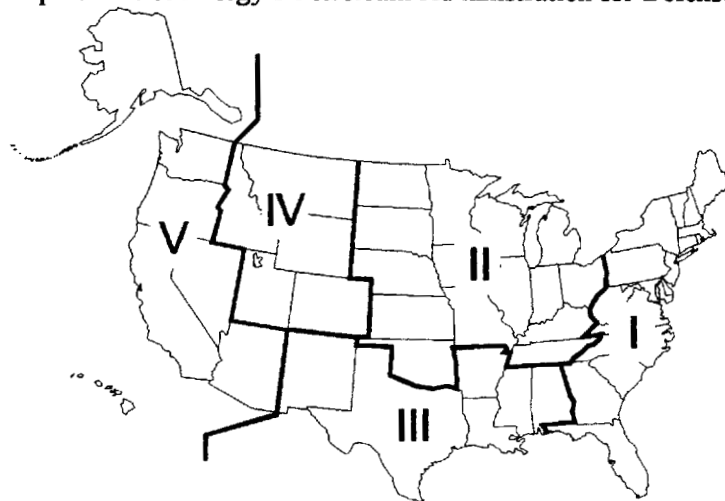


Figure 4—Response Rate by PAD Region.

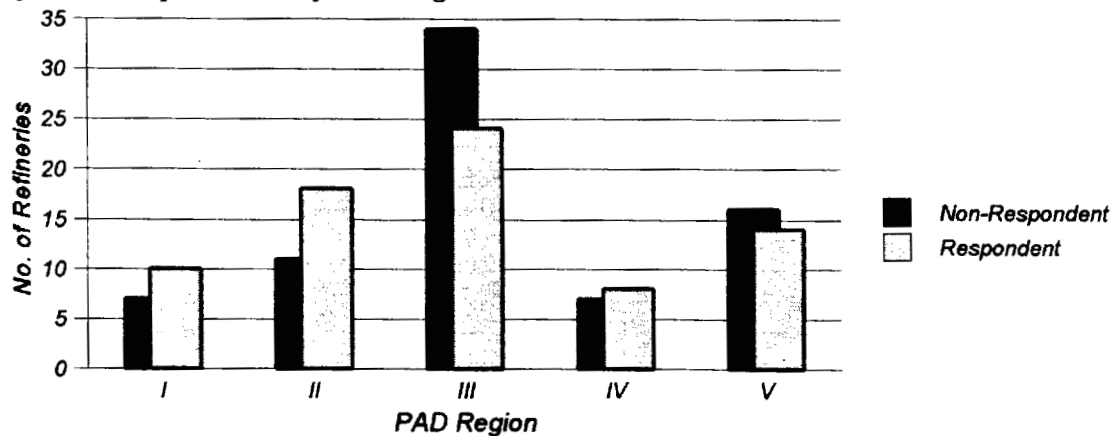


Figure 5—Response Distribution by Complexity of Facility.

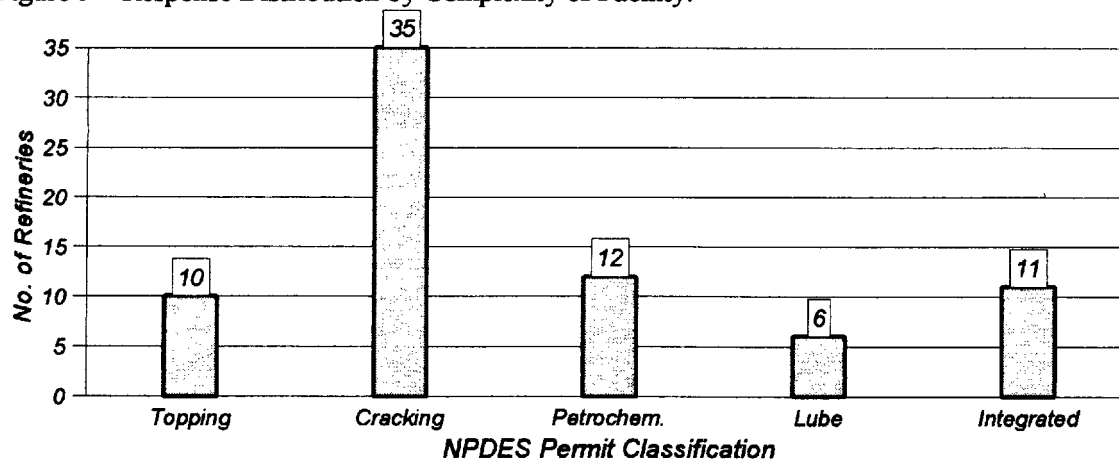


Figure 6—Response Distribution by Age of Facility.

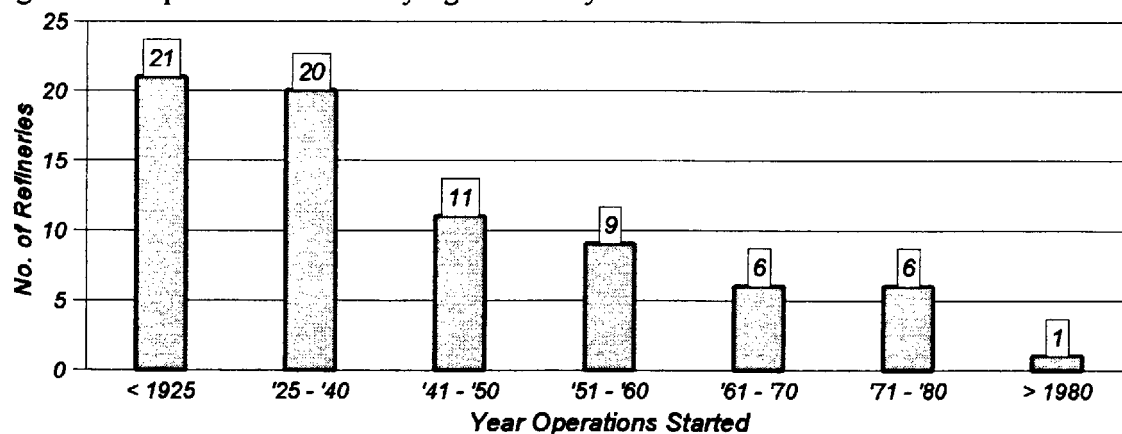
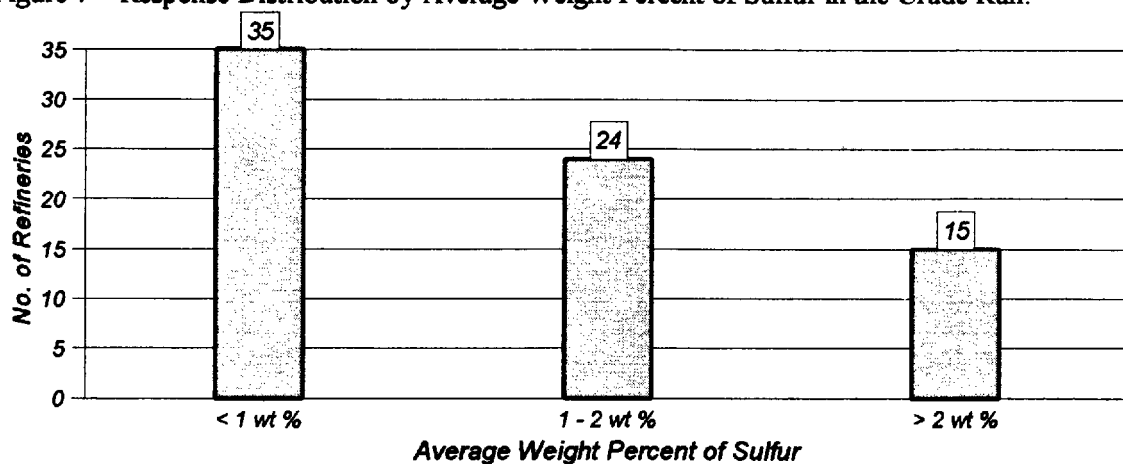


Figure 7—Response Distribution by Average Weight Percent of Sulfur in the Crude Run.



REPROCESSING OF USED OIL

The 1995 survey added a question concerning the reprocessing of used oil. The question asked whether the refinery had received direct delivery of used oil for reprocessing that was generated by vehicles or equipment at other company-owned or non-company-owned facilities. Only eight of the 74 respondents answered yes, and two of those did not report the amount. One additional facility that responded no, however, did list a quantity. These nine facilities ranged in size from 5,500 to 157,900 bsd, and represented every PAD region except III. The amounts of used oil reprocessed by the seven facilities that reported a quantity varied from 1 wet ton to 14,655 wet tons. The total reported amount was 19,486 wet tons, and the median amount was 42 wet tons.

WASTEWATER TREATMENT FACILITY

Every responding facility indicated that its wastewater is treated prior to discharge. All of the 74 responding facilities reported having primary oil-water separation equipment, with 58 indicating that they use an API Separator. The remaining 16 facilities listed various types of equipment for primary separation, with the most frequent mention being a corrugated plate interceptor. There was no apparent correlation to facility size among those using equipment other than an API Separator, in that their capacities ranged from 5,500 to 290,000 bsd. The distribution of equipment in the wastewater treatment facilities is illustrated by the schematic in Figure 8 on the following page.

Three facilities reported having primary separation only. The remaining respondents (96%) reported some wastewater treatment in addition to primary separation. The equipment for slightly more than half of the wastewater facilities includes primary separation, gas flotation, and activated sludge. The following list summarizes the responses.

Primary separation	100% (typically an API Separator)
Secondary separation	84% (typically some type of gas flotation)
Secondary biological treatment	84% (typically includes activated sludge)
Polishing and/or tertiary treatment	51% (no dominant equipment type)

None of the respondents reported having biological denitrification, and only one facility reported having metals removal in their wastewater plant.

Figure 9 illustrates the type of structures used to hold stormwater and wastewater. The predominant type of structure reported for holding wastewater-only was tanks and for stormwater-only was impoundments. More than half of the respondents (42 out of 74) reported using segregated sewers. Four of the facilities that reported segregated wastewater did not indicate how their stormwater was managed. The other facilities reporting segregated wastewater also listed segregated stormwater, combined sewers, or both—in addition to their segregated wastewater sewer. The reporting of multiple sewers by these facilities resulted in the total number of responses in Figure 9 exceeding 74.

Figure 8--Wastewater Treatment System Summary. (total number of responses = 74)

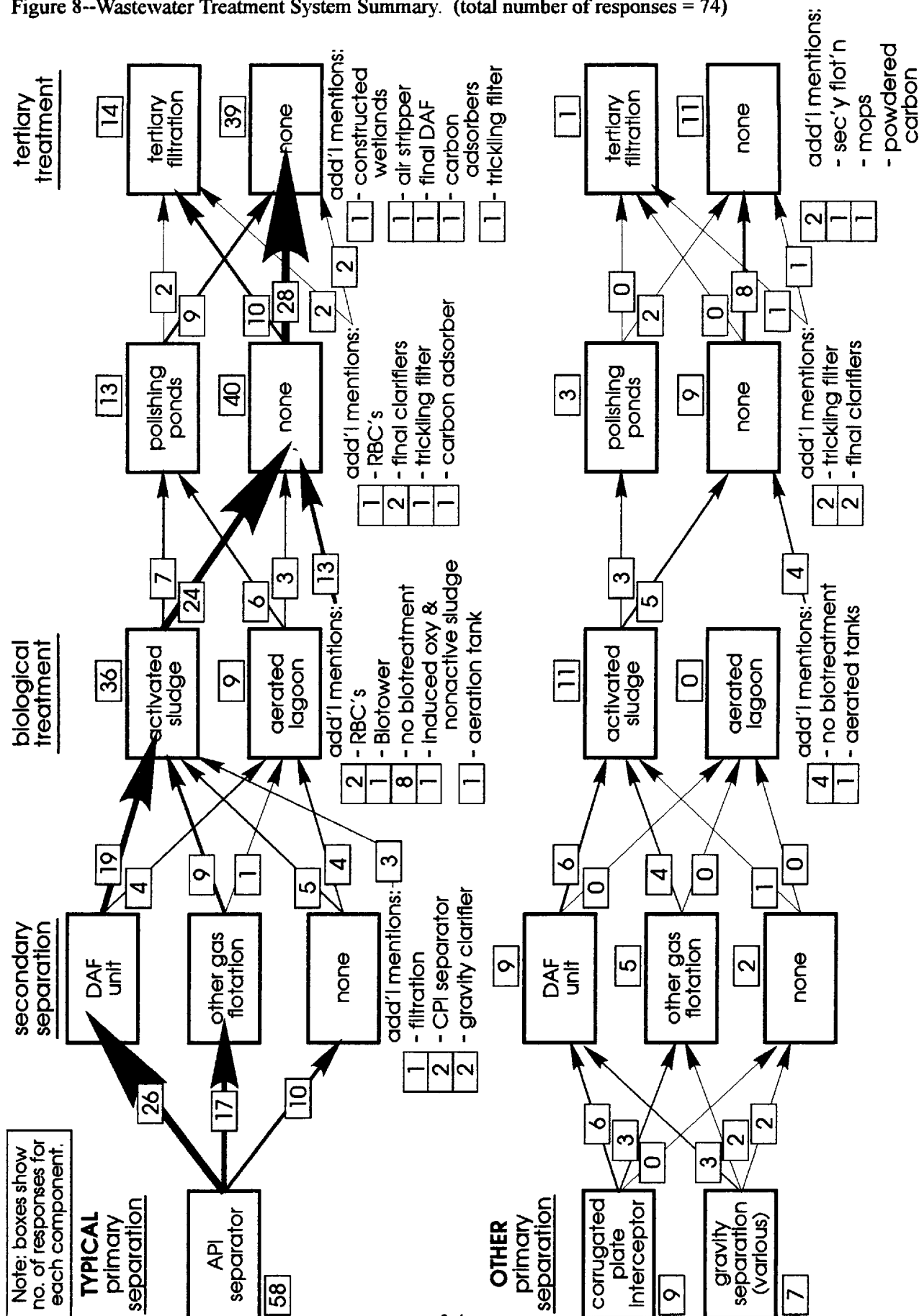
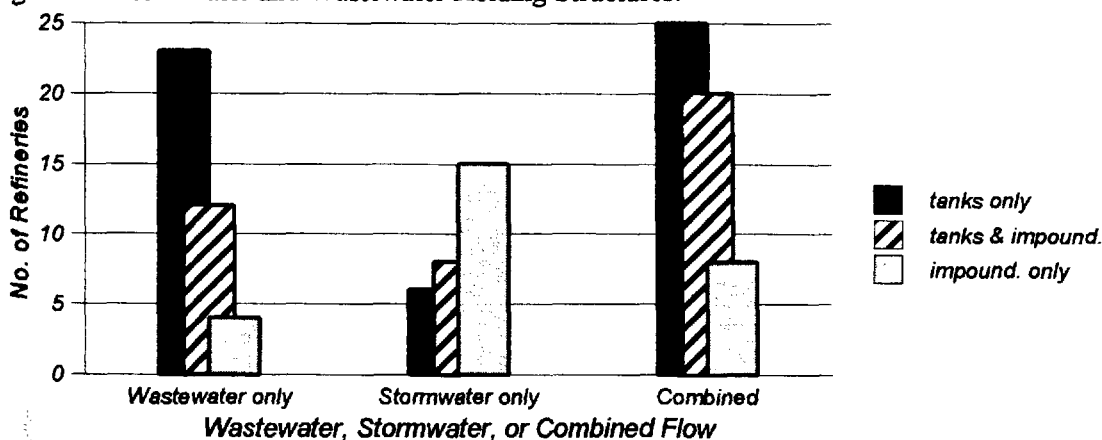
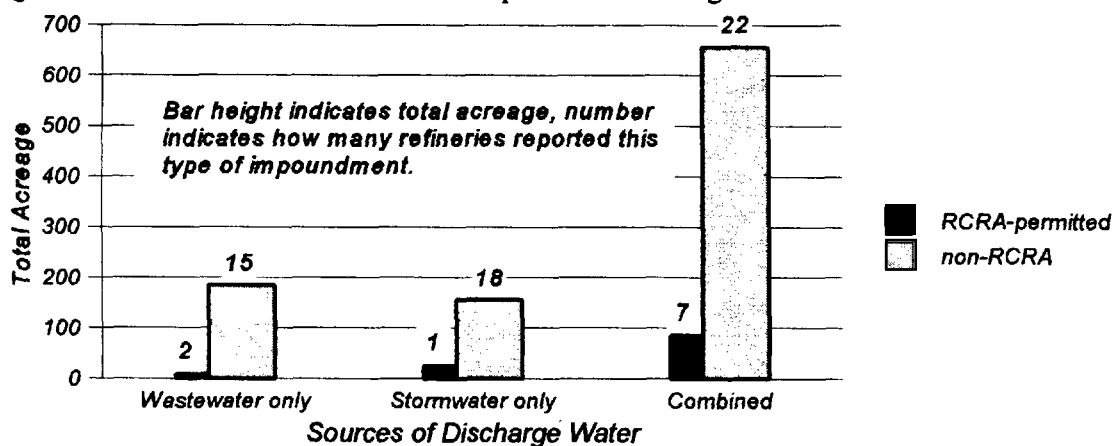


Figure 9—Stormwater and Wastewater Holding Structures.



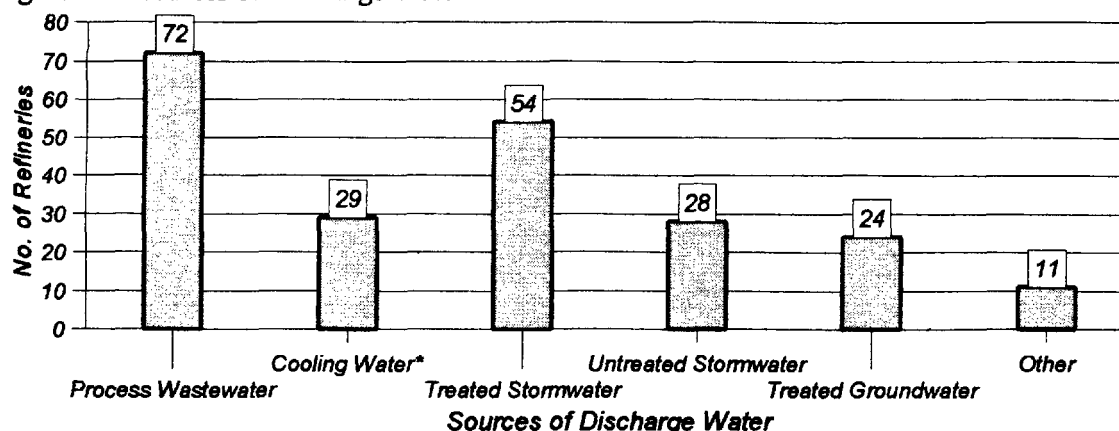
Most of the facilities that reported using impoundments also reported the estimated acreage, which varied from 0.03 to 350 acres per facility. Figure 10 shows the total acreage having RCRA permits or interim status versus the acreage of impoundments that are not RCRA regulated. The chart also indicates the number of respondents for each category.

Figure 10—Stormwater and Wastewater Impoundment Acreage.



Every responding facility listed the quantity of wastewater discharged daily. The average of the reported daily discharge rates was 2.7 million gallons per day (MGD), and the median rate was 1.6 MGD. One facility indicated that it practices 100% evaporation, and thus is a zero discharge facility. All but one of the remaining respondents gave a breakdown of the sources of their discharge water, with each reporting some contribution from process wastewater. The number of facilities reporting each source of discharge water is shown in Figure 11. Note that most facilities report more than one source of discharge water. Of those listing 'other' sources, most reported the other source to be blowdown water.

Figure 11—Sources of Discharge Water.



*Only includes non-contact once through cooling water that is treated prior to discharge.

Additional detail on the sources of discharge water is provided in Table 1. In this table, the contribution of each source is shown as a percent of total discharge water, for those facilities reporting that source.

Table 1—Sources of Discharge Water as a Percent of Total.

	No. of Respondents reporting this source	Range	Median	Median Flow (MGD)
Process Wastewater	72	5 – 100 %	76%	1.0
Noncontact Cooling Water*	29	2 – 94 %	22%	0.13
Treated Stormwater	54	1 – 56 %	9%	0.17
Untreated Stormwater	28	1 – 42 %	8%	0.13
Treated Groundwater	24	1 – 80 %	1.7%	0.05
Other	11	1 – 63 %	23%	0.03

* only includes non-contact once through cooling water that is treated prior to discharge.

Levels of eight discharge parameters were requested in the question on effluent quality. The levels are presented as an amount (pounds per year) in Table 2, and as a concentration (pounds per million gallons) in Table 3.

Table 2—Water Quality Discharge Parameters (pounds per year).

	No. of Respondents reporting this parameter	Median
Total Suspended Solids (TSS)	72	66,000 lbs
Biochemical Oxygen Demand (BOD)	68	40,000 lbs
Chemical Oxygen Demand (COD)	60	310,000 lbs
Ammonia	66	9,400 lbs
Oil & Grease	72	17,000 lbs
Chromium	45	29 lbs
Nickel	12	120 lbs
Selenium	19	42 lbs

Table 3—Water Quality Discharge Parameters (pounds per million gallons of wastewater discharge).

	<u>Median-1995</u>	<u>Median-1994</u>
Total Suspended Solids (TSS)	130 lbs/MG	113 lbs/MG
Biochemical Oxygen Demand (BOD)	77 lbs/MG	54 lbs/MG
Chemical Oxygen Demand (COD)	680 lbs/MG	583 lbs/MG
Ammonia	31 lbs/MG	31 lbs/MG
Oil & Grease	26 lbs/MG	22 lbs/MG
Chromium*	0.08 lbs/MG	*
Nickel*	0.20 lbs/MG	*
Selenium*	0.15 lbs/MG	*

*no data available for 1994.

POLLUTION PREVENTION

The pollution prevention question was simplified in the 1995 survey. Rather than soliciting pollution prevention practices for each residual stream, a single listing was requested for the entire facility. The question asked for a description of those pollution prevention activities undertaken in 1995. Most respondents listed only those projects brought on line in 1995, but it is evident from other portions of the survey that virtually every facility practices certain pollution prevention techniques, such as recycling.

Many of the pollution prevention techniques relate to recognizing that waste streams are often comprised largely of water and dirt which have been contaminated by being combined with process materials.

Accordingly, the pollution prevention techniques include:

- ▶ reducing the amount of dirt that enters the oily wastewater stream,
- ▶ reducing the amount of water that enters the oily wastewater stream,
- ▶ dewatering to reduce the volume of oily sludges, and
- ▶ minimizing the contamination of dirt by reducing spills and leaks.

In addition to reducing the volume of water and dirt in the wastewater residuals, the industry has continued to implement strategies to better manage the process residuals, including:

- ▶ source reduction,
- ▶ waste segregation, and
- ▶ recycling.

Each of these practices is enhanced by education and training. The specific responses from the 1995 survey are listed in Table 4.

Table 4—Pollution Prevention Activities.

General PracticeSurvey Response

Reduction of dirt to the oily water sewer.

Improved housekeeping.
 Modified drains and sewers.
 Cleaned stormwater drains upstream of the oily sewer.
 Paved areas that drain into the sewer.
 Resloped and/or lined earthen dikes and dike areas.
 Erected construction-type filter screens at sewer inlets.

Reduction of water to the oily water sewer.

Segregated cooling tower blowdown from process wastewater.
 Segregated steam condensate from process wastewater.
 Constructed curbs and gutters to direct stormwater away from the oily wastewater sewer.

Dewatering of oily sludges.

Installed new dewatering equipment.
 Replaced existing dewatering equipment.
 Expanded the use of dewatering equipment.

Reduction of spills and leaks.

Improved housekeeping.
 Improved or expanded leak inspection programs.
 Installed gauges to monitor or control leaks.
 Replaced leaking lines or gaskets.
 Improved containment of runoff.
 Installed spill prevention/collection system at the main dock loading facility.
 Installed double bottoms in storage tanks.
 Changed from drums to bulk handling of additives.

Source reduction/process modification.

Process modifications to reduce benzene concentration in the wastewater.
 Process modifications to reduce FCC catalyst carryover.
 Improved sulfur processing.
 Improved oil/water separations in the process units.
 Reduced use of chlorinated cleaning compounds.
 Closed surface impoundments.
 Modified amine treating to reduce the generation of spent sulfidic caustic.
 Replaced sandblasting media with blast media having a lead stabilizer.
 Improved hydrocyclone separation of 'blackwater' solids to reduce the amount of coke fines entering the sewer.
 Reduced methyl ethyl ketone (MEK) feed rates to the aeration basins.
 Improved pH control.

Table 4—Pollution Prevention Activities (continued).

<u>General Practice</u>	<u>Survey Response</u>
Waste segregation.	Kept nonlisted residuals from combining with listed wastes. Segregated boiler feedwater, steam condensate, and/or blowdown from the oily wastewater sewer to keep solids such as feedwater treatment solids or hardness precipitation from entering the wastewater facility.
Recycling.	Found markets for materials formerly treated or disposed of. Routed oily sludges to the coker. Designed & constructed a patented spent caustic stripper. Installed fuel blending technology. Installed vapor recovery for storage tanks. Filtered and reused cleaning agents. Recycled office paper.
Education and training.	Raised awareness of the facility's pollution prevention practices.
Improved treatment.	Brought on-line a tertiary treatment facility.

Section 3 RESIDUAL STREAM PROFILES

The U.S. refinery industry managed an estimated 3.05 million wet tons of material from the fourteen residual streams included in the 1995 API Refining Residual Survey. A summary of the total quantity of residuals managed per year is presented in Figure 12. The data for 1987 through 1994 have been adjusted in Figures 12 and 13 by deleting the quantities considered to be recovered oil or water rather than true residuals.

Figure 12—Nationwide Estimate of Residual Quantity per Year: 1987-1995.

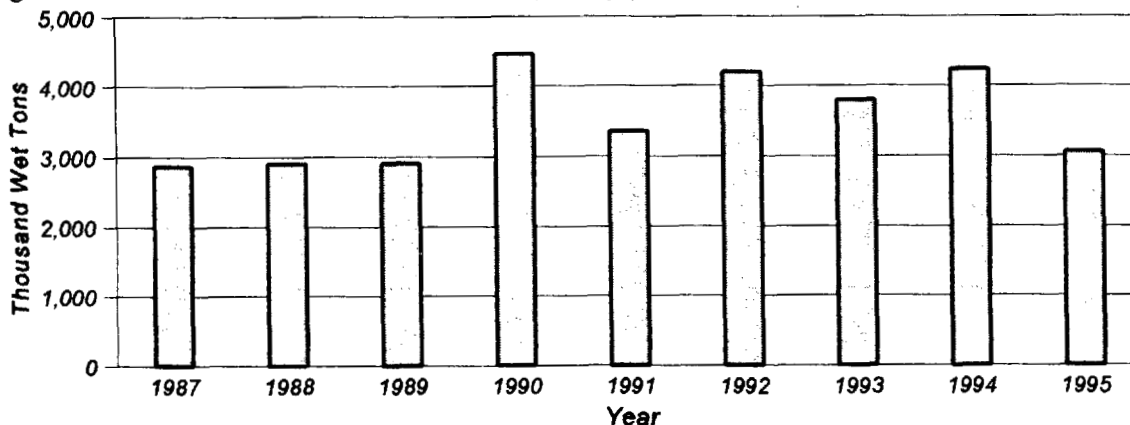
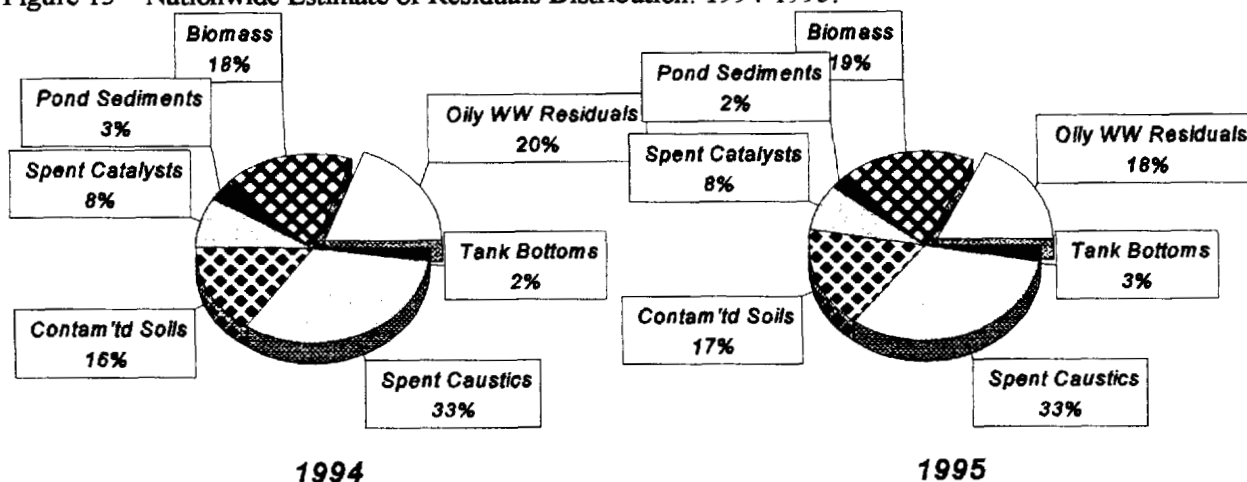


Figure 13 shows the relative contribution of the residual streams, with certain streams grouped together. The FCC catalyst, hydro. catalyst, and other spent catalyst streams are combined into a *spent catalysts* category; and a *spent caustics* category includes spent cresylic caustic, spent naphthenic caustic, and spent sulfidic caustic. The *oily wastewater residuals* (i.e., API separator sludge, DAF float, primary sludges, and slop oil emulsion solids) make up a third grouping. The contribution of each category in 1995 is estimated to be within two percentage points of its contribution to the adjusted 1994 data.

Figure 13—Nationwide Estimate of Residuals Distribution: 1994-1995.

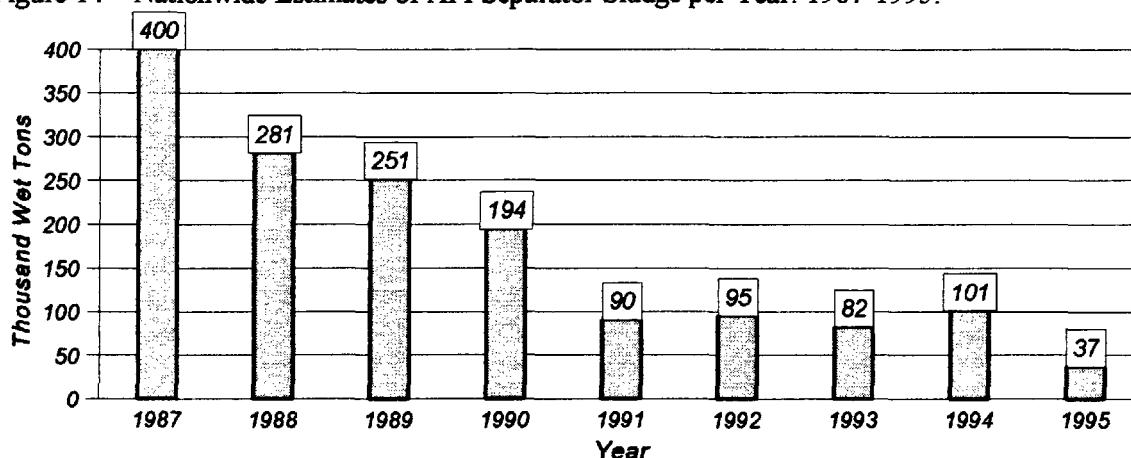


The remainder of this section presents detailed information for the individual streams, with the streams arranged in alphabetical order. The data for this section are summarized in the tables of Appendix C.

API SEPARATOR SLUDGE¹

The U.S. petroleum refining industry managed an estimated 37 thousand wet tons of API Separator Sludge in 1995, which was a 63% reduction from 1994. A summary of the quantity of API Separator Sludge managed per year is presented in Figure 14. The data for 1987 through 1994 have been adjusted by deleting the quantities considered to be recovered oil or water rather than true residuals.

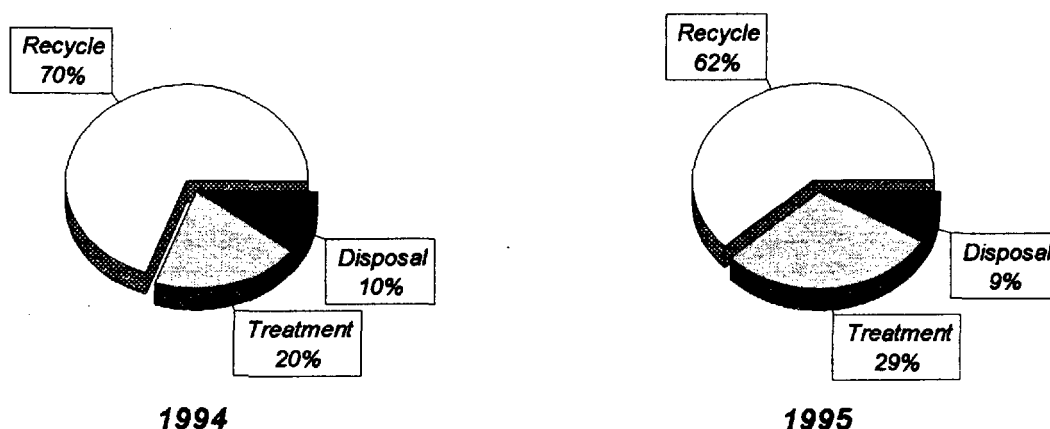
Figure 14—Nationwide Estimates of API Separator Sludge per Year: 1987-1995.



Several facilities combine some or all of the residuals associated with their wastewater treatment facility (i.e., API Separator Sludge, DAF Float, Primary Sludges, and Slop Oil Emulsion Solids). The combined quantities of these oily wastewater streams are summarized in Figure 85, which shows a decrease from 833 thousand wet tons in 1994 to 554 thousand wet tons in 1995, a reduction of 33%.

The portion of the API Separator Sludge stream that is managed by each management practice is shown in Figure 15 for 1994 and 1995. Recognizing only the actual residual stream, and not recovered oil or water, has shown recycling to be the most common management practice.

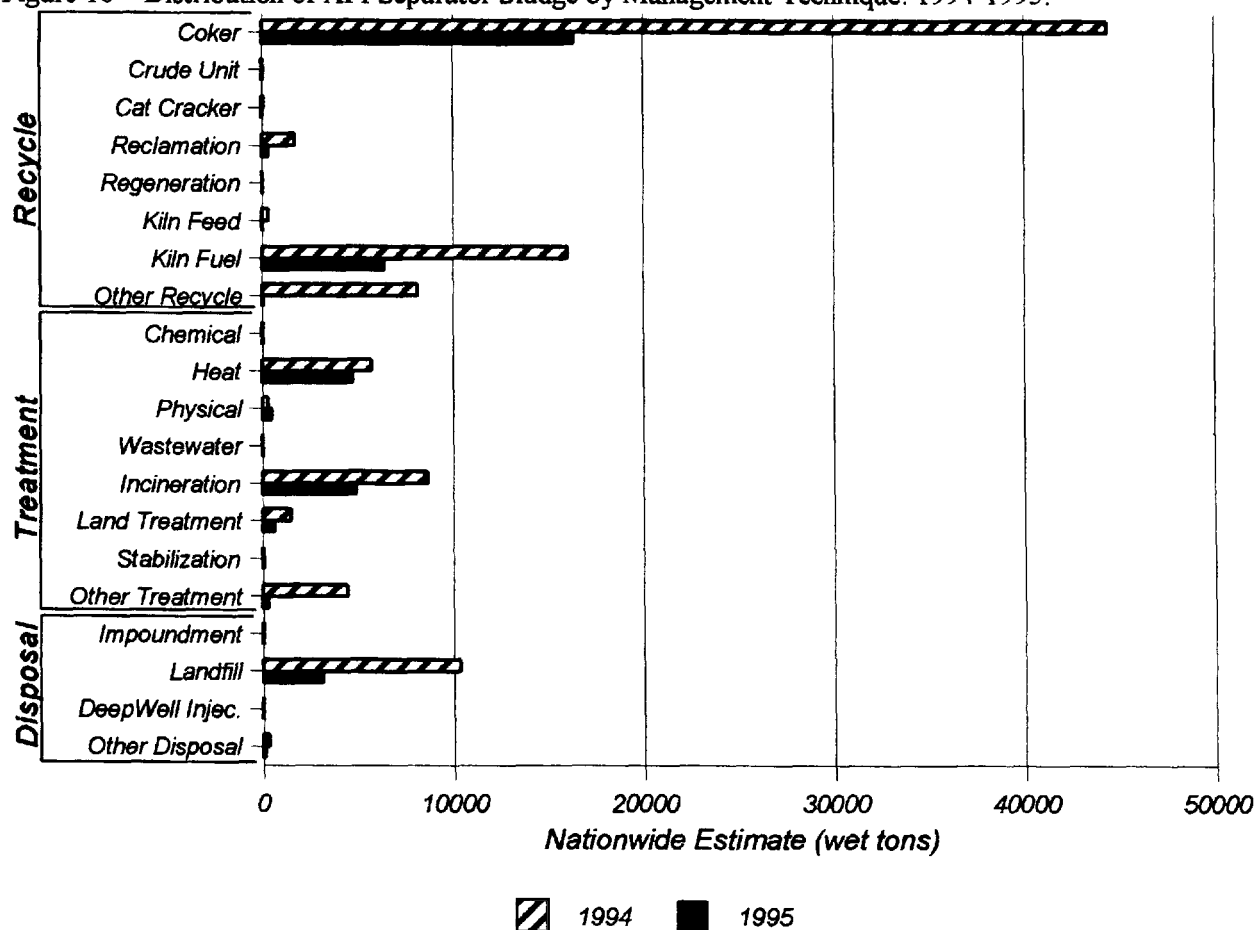
Figure 15—Nationwide Estimates of API Separator Sludge by Management Practice: 1994-1995.



¹Recall that this report uses labels such as API Separator Sludge in the broader context of a *residual stream* which includes materials that are not subject to RCRA regulation.

Figure 16 shows the API Separator Sludge distribution by management technique for 1994 and 1995. The quantities shown for recycling to the *crude unit* and for *wastewater* treatment have gone to zero, in that recovered oil and water from dewatering operations are not truly residuals and are no longer included. The *kiln feedstock* quantity shown in 1994 has been eliminated in 1995. The 1994 listing may have been in error, in that API Separator Sludge is typically used as fuel when sent to a cement kiln.

Figure 16—Distribution of API Separator Sludge by Management Technique: 1994-1995.



Responses in the *other* categories are listed below.

Other Recycle: none.

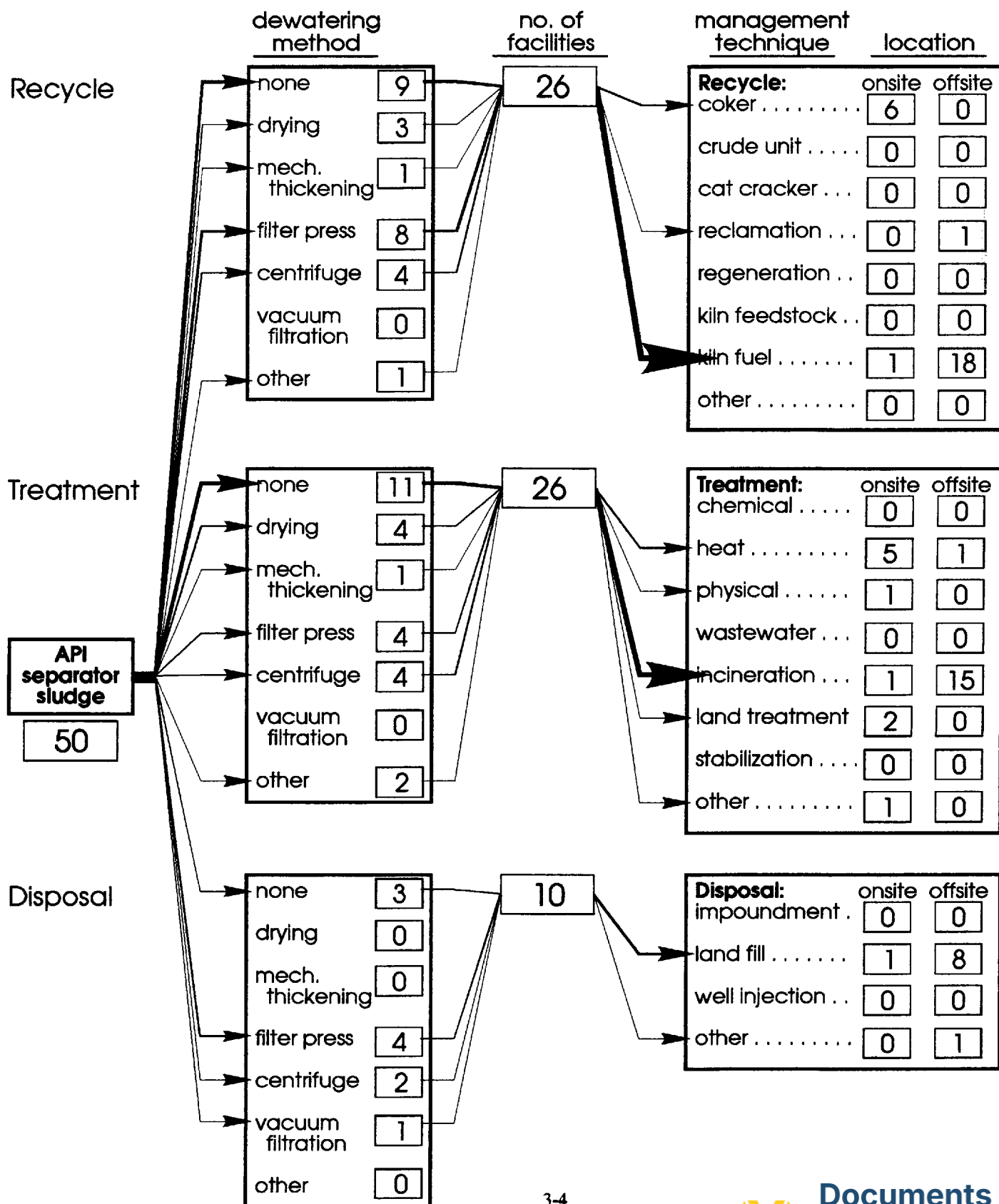
Other Treatment: one facility uses a proprietary biological process to treat oily sludges.

Other Disposal: one facility sends oily sludges to a treatment, storage, and disposal facility (T.S.D.F.) for disposal.

The schematic on the next page illustrates the distribution of dewatering techniques and onsite versus offsite management for this stream by number of respondents.

Figure 17 - API Separator Sludge Summary: 1995

Note: Boxes show no. of facilities reporting each option.
Some facilities report multiple options



The following three graphs summarize the cost data reported for API Separator Sludge.

Figure 18—Onsite Management Cost for API Separator Sludge: 1995

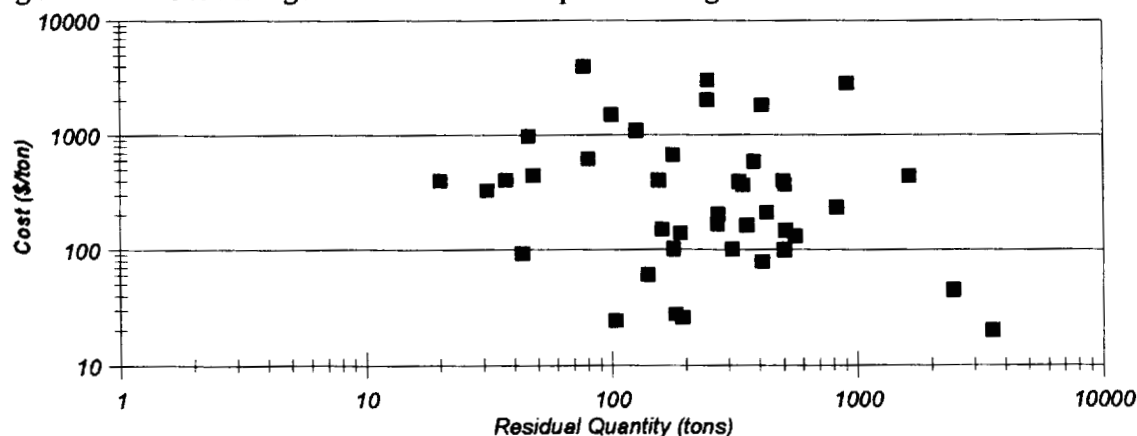


Figure 19—Offsite Management Cost for API Separator Sludge: 1995

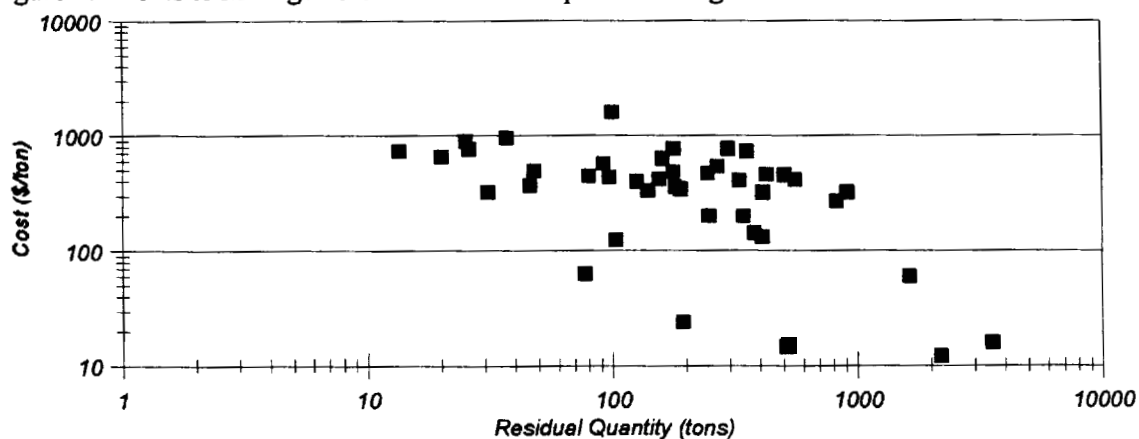


Figure 20—Total Management Cost for API Separator Sludge: 1995

