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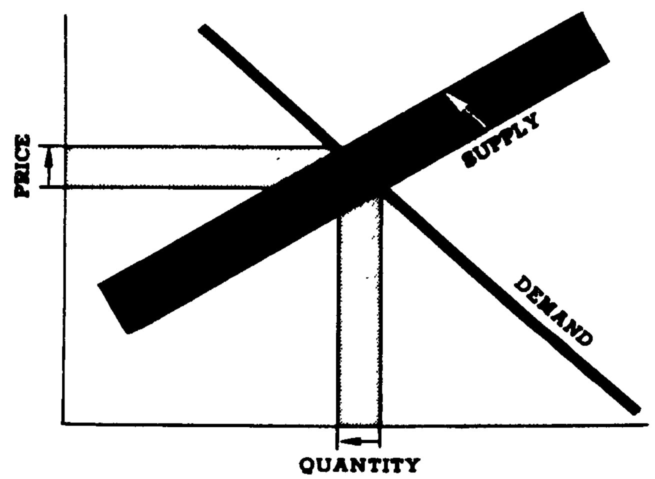
AUGUST 1973

ECONOMIC ANALYSIS
OF
PROPOSED EFFLUENT GUIDELINES

CEMENT INDUSTRY



U.S. ENVIRONMENTAL PROTECTION AGENCY
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Washington, D.C. 20460

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ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES: CEMENT INDUSTRY

U. S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PLANNING AND EVALUATION
WASHINGTON, D. C. 20460

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This report has been reviewed by the Office of Planning and Evaluation, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

PREFACE

The attached document is a contractors' study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports promulgation of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with the various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of EPA-230/1-73-004 and 68-01-1571 by Southern Research Institute. Work was completed as of August, 1973.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study has not been reviewed by EPA and is not an official EPA publication. The study will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

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ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES: CEMENT INDUSTRY

I. INTRODUCTION AND SUMMARY

The economic impact of water pollution control requirements on the cement industry, based on the data available, may strain the internal financial resources of some companies, and will probably result in negligible increases in cement prices, depending on the type of controls required in each plant and on the proximity of polluting plants to nonpolluting plants. Plant closings and unemployment due to the imposition of pollution control requirements are not anticipated, however, so long as the demand for cement continues at projected levels.

The methodology used to determine the economic impact of pollution controls on cement producing companies included a comparison of the estimated costs of controls, both capital and annual, at the 123 cement plants reviewed in the study with estimated profitability and cash flow of cement companies per average cement plant in 1972. Price effects were measured by adding estimated average plant production costs per ton in 1973 to the incremental annual operating costs for pollution controls. Pollution control categories were determined by segmenting plants according to the quantity and type of pollutants discharged and by the availability of control technologies. These categories were based on data reported in the technical study of the cement industry prepared for the Environmental Protection Agency[1]. In the technical study, cement plants were classified as either nonleaching plants or as leaching plants, according to whether leaching systems were used for kiln-dust recovery. In this report, subcategories of these two major types of plants were included to differentiate between 1) nonleaching plants that were or were not discharging unacceptable levels of pollutants and 2) leaching plants for which control technologies were or were not available.

The total cost of achieving essentially pollutant-free discharges in the cement industry is estimated at $14,885,000

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1. Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry, report prepared by Southern Research Institute, Birmingham, June 21, 1973.

for capital investment by 1977 and an additional $2,860,000 by 1983. Total annual operating costs for pollution controls are estimated at $5,510,400 in 1977 and $7,233,100 in 1983. Costs of meeting pollution control requirements range from a zero investment for the 56 nonleaching plants already meeting proposed standards, to almost a half million dollars each for the eight leaching plants with the most serious pollutant problems. These latter plants are not likely to shut down, however, as they tend to be the most productive (and profitable) in the industry.

The analysis of the ability of polluting companies to meet the increased costs of pollution control was based on average per-plant company profits and cash flow in 1972, and on the assumption that financial data for 1972 will be reasonably representative of other years in this decade. Annual reports were obtained from 28 of the 35 companies known to be producing cement, and Standard & Poor Company stock sheets were consulted for the others. The financial analysis was based on the proportion of cement sales to total sales for only 19 plants, however, as neither cement's contribution to total profits nor to total sales could be determined from the other financial data available. This analysis indicated that all but three companies could meet the costs of instituting pollution controls in all of their plants without difficulty, often from internal funds generated just in 1972. These three companies are presently engaged in extensive modernization programs that may include installation of pollution controls, although no specific details were provided in the sources consulted.

The impact of pollution controls, which might justify price increase of from 1 percent to 3 percent per ton in polluting plants are apt to be mitigated by competitive pressures from nonpolluting plants located in close proximity to them and selling in approximately the same market areas. Plant closings, and resulting unemployment in affected areas are more likely to result from a decrease in cement consumption than from pollution control requirements. The number of cement plants has been declining for many years, but the only plant known to have been abandoned during the past two years was a nonpolluting plant. Communities, therefore, will benefit from clean water, rather than experience employment losses due to production curtailments.

The value of cement imports and exports of portland cement amounted to less than $1 million in 1972, representing an increase in imports and a decrease in exports over previous years but still insignificant in terms of our balance of payments situation. Domestic shortages of cement, generally in localized areas, are more likely to contribute to shifts in international trade in cement than pollution controls.

There are some significant limitations to this study. Perhaps the most important is the lack of data on the polluting practices of 44 nonleaching plants. These plants account for approximately 20 percent of total cement production and capacity. Moreover, many of these plants are owned by one or two plant companies for which financial data are also lacking. The presumption is that plants that did not apply for RAPP applications may not be polluting plants, but further investigation appears to be warranted.

II. INDUSTRY SEGMENTS

A. Types of Plants as Affected by Pollution Control Requirements

The economic impact of water pollution control requirements on the cement industry can be determined most practically by segmenting the industry on the extent to which pollution controls will be required in plants by 1977 and 1983. As indicated in the report, Development Document for Effluent Limitations Guidelines and Standards of Performance,[1] submitted to the Environmental Protection Agency (EPA) in June, 1973, pollution control standards are based on achieving essentially pollutant-free effluent discharges by 1977 or 1983, depending on the availability of technologies to achieve this goal. Cement plants have been categorized as leaching or nonleaching plants because the extent to which plants rely on kiln-dust leaching systems determines the type and quantity of pollutants discharged, as well as the extent to which pollution control standards can be met by 1977 or 1983.

Cement plants can achieve essentially pollutant-free discharges by:

1. Discharging less than 0.01 lb/ton of suspended solids, or 0.01 lb/ton of dissolved solids, with the total not to exceed 0.01 lb/ton of clinker or cement.

2. Limiting thermal pollution to less than a 5°F increase in stream temperature.

3. Containing coal- and dust-pile runoffs.

4. Limiting the pH of discharged water to less than 9.0.

The technology for achieving these standards by 1977 is currently available for all nonleaching plants, or plants that do not recover kiln dust by leaching systems. According to RAPP applications and Southern Research Institute questionnaire responses, 56 nonleaching plants have already met these requirements. No technology has as yet been specifically designed to reduce the discharges of dissolved solids from the leaching systems of cement plants that practice kiln-dust recovery. Leaching plants, therefore,

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1. *Op. cit.*

have until 1983 to limit discharges of dissolved solids and until 1977 to limit discharges of suspended solids to 0.30 lb/ton and to meet the same requirements as nonleaching plants for reducing thermal, dust, and pH pollution to acceptable levels. Of the 13 reported plants with leaching systems, five have met the 1977 standards for reduction of suspended solids, but three of these will require some additional pollution controls to meet all the 1977 requirements.

A major factor in determining the economic impact of pollution controls on the cement industry is the cost, both capital and annual, of implementing these standards. All cement plants will be affected by pollution control requirements to some extent, but the type of plant most severely affected will be the type that leaches. The costs of implementing pollution controls are directly related to the type and quantity of pollutants discharged, and leachate systems not only generate the greatest quantity of solid pollutants, but the pollutants discharged tend to be least amenable to control at the present time.

An analysis of the variety of pollutants discharged by each of the 123 plants for which data were available is presented in Table 1. The alternative technologies to control these pollutants are described in Table 2. The data indicate that 56 of the 110 reported nonleaching plants currently meeting 1977 control standards will require no further investment for pollution control systems. The 54 polluting nonleaching plants will each have an estimated capital expenditure of $205,000 for the installation of either the so-called A or B pollution control systems described in Table 2. Estimated annual operating costs for Alternative A are $79,900, as compared with $61,900 for Alternative B. Thermal pollution, however, can only be treated through Alternative A and only the 21 nonleaching plants without thermal pollution problems can select either alternative. Because the control system selected by any one plant will depend on its existing equipment and local conditions, for which data are not available, it has been assumed in this study that all nonleaching polluting plants will choose Alternative A. The costs for installing the B pollution control technology have consequently been disregarded in the remainder of this report. The total initial cost of installing pollution controls in the 54 nonleaching plants with pollutant discharges is, therefore, estimated at $11,070,000.

Cement plants with leachate systems may be considered as consisting of two separate operations, one involved in the production of cement and the other in the recycling of collected kiln dusts. The cement manufacturing facilities of these plants are similar to those of nonleaching plants, but the leaching operation generates far greater quantities of pollutants than does the direct production process. Pollution control standards for leaching plants in 1977 are less stringent than for nonleaching plants, as

Table 1

Number of Cement Plants by Information Source, Manufacturing Process, Alternative Pollution Control Systems, and Type of Pollution[a]

		Information source		Manufacturing process		Alternative pollution control systems
	Total	RAPP applications	SRI survey	Wet	Dry	
Number of plants, total	123	88	35	81	42	
<u>Nonleaching plants, total</u>	110	76	34	70	40	
Currently meeting 1977 pollution control standards for nonleaching plants	56	23	33	33	23	X
By types of pollution:						
Total solids of 0.01 lb/ton or over (solids)	14	14	0	11	3	A or B
Thermal rise of 5° or over (thermal)	13	12	1	7	6	A
Dust pile runoff (dust)	0	0	0	0	0	H
pH of 9.0 or over (pH)	0	0	0	0	0	H
Solids and thermal	13	13	0	11	2	A
Solids, thermal, and dust	1	1	0	0	1	A
Solids, thermal, and pH	3	3	0	2	1	A
Solids, thermal, dust, and pH	2	2	0	1	1	A
Solids and dust	1	1	0	1	0	A or B
Solids and pH	4	4	0	1	3	A or B
Solids, dust, and pH	2	2	0	2	0	A or B
Thermal, dust, and pH	1	1	0	1	0	A
Total	54	53	1	37	17	
<u>Leaching plants, total</u>	13	12	1	11	2	C,C(A),C(H), D,E
By types of pollution:[b]						
Currently meeting 1977 standards for leaching plants but requiring control of dissolved solids by 1983	2	2	0	2	0	D or E
Dissolved and suspended solids of 0.30 lb/ton or over (total solids)	1	0	1	0	1	C and D or E
Total solids and thermal	2	2	0	2	0	C and D or E
Total solids, thermal, and pH	3	3	0	3	0	C and D or E
Total solids and pH	2	2	0	2	0	C and D or E
Dissolved solids and thermal	1	1	0	1	0	C(A) and D or E
Dissolved solids, thermal, and pH	1	1	0	0	1	C(A) and D or E
Dissolved solids and pH	1	1	0	1	0	C(H) and D or E
Total	13	12	1	11	2	

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. Leaching plants have until 1983 to achieve the essentially pollutant-free status required of nonleaching plants by 1977. Pollution control standards for 1977 allow leaching plants to discharge 0.30 lb/ton of suspended solids and set no limitations dissolved solid pollutants because the technology is not currently available for their control. Thermal, dust, and pH pollution must be controlled by all cement plants by 1977, however, as the technology is currently available and in use.

Table 2

Alternative Pollution Control Systems for Achieving Essentially No Discharge of Pollutants by Cement Plants in 1977 or 1983[a]

Pollution control systems		Year	Number of plants
	Nonleaching plants	1973	110[b]
X	Currently meeting 1977 and 1983 pollution control standards	1973	56
A	Requiring installation of cooling tower or spray pond for control of total solids, thermal and pH pollution, and containment of dust-pile runoff	1977	54
B	Requiring isolation of cooling streams and limited reuse of cooling and miscellaneous wastewater for control of total solids, pH, and containment of dust-pile runoff	1977	21
	Leaching plants	1973	13[b]
D	Currently meeting 1977 standards for leaching plants, but requiring electrodialysis or other technique to reduce dissolved solids and recycle leachate stream by 1983	1983	2
C	Requiring installation of cooling tower or spray pond, plus neutralization and reuse of cooling and miscellaneous water, neutralization and settling of leachate for control of suspended solids, and thermal and pH pollution, and containment of dust-pile runoff	1977	8
C(A)	Requiring installation of cooling tower or spray pond for control of thermal and pH pollution	1977	2
C(H)	Requiring treatment of pH in effluent discharges	1977	1
E	Electing to abandon leaching systems	1977 or 1983	13

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. The sum of individual plants exceeds the total number of plants in each category because some plants are classified under more than one pollution control system.

the maximum limit for suspended solids is set at 0.30 lb/ton of cement. Reduction of suspended and dissolved solids to 0.10 lb/ton, with the total not to exceed 0.10 lb/ton, will not be required of leaching plants until 1983.

Two of these leaching-system plants will require no further expenditures for pollution control until 1983. Two leaching plants currently causing thermal and pH pollution will each be required to install the equivalent of Alternative A pollution controls by 1977 at a capital cost of $205,000 and annual costs of $79,900 each. One leaching plant will be required to treat its effluent discharges with acid to reduce excessive pH. This treatment, listed as pollution control Alternative H, is estimated to cost a maximum of $5,000. The eight other polluting leaching plants will be required to install so-called Alternative C technology by 1977 to meet control requirements.

The Alternative C control system is basically the A technology involving the installation of a cooling tower or spray pond for recycling and reuse of cooling and miscellaneous water, plus a neutralization and settling process for the leachate discharges. The initial investment for installing the complete Alternative C system is estimated at $425,000 and annual operating expenses are expected to total $129,500.

The total initial investment for installing pollution controls at the 11 leaching plants not meeting 1977 standards is estimated at $3,815,000 by 1977. All 13 leaching plants, however, will also be required to achieve an essentially pollutant-free status by 1983, which will entail the application of so-called Alternative D technology for the reduction of dissolved solids and recycling of the leachate. The electrodialysis technology was estimated[1] to require an investment of $220,000 over and above the costs for implementing Alternative C, with annual costs increasing to $224,500 for the complete control system. By 1983, therefore, the 13 leaching plants will be required to make an additional investment of $2,860,000, bringing the total capital investment for the control of effluent discharges at the 13 leaching plants to $6,675,000 by 1983.

The comparatively higher cost of controlling effluent discharges from leachate systems may induce some leaching plants to abandon the leaching process and maintain only their cement manufacturing operations. Those plants that choose this alternative, listed as Alternative E in Table 2, will be required to meet the

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1. Op. cit.

1977 pollution control standards for nonleaching plants, but will require no additional investment in 1983, or until such time as they may again decide to recover kiln dust by leaching.

The total investment for achieving essentially pollutant-free effluent discharges in the cement industry by 1983 is estimated at $17,745,000. As indicated above, these costs are directly related to the type and quantity of pollutants discharged by the two major categories of cement plants, those that leach and those that do not.

1. Types of firms

The cement industry consists of 50 companies and 167 plants dispersed throughout 41 states and Puerto Rico (see Figure 1). The Bureau of Mines[1] has estimated that total production reached 84.8 million short tons of cement in 1972, with annual plant capacities estimated at 86.8 million short tons. The industry as a whole may have been operating at 97.7% of total capacity in that year. Imports for consumption totaled 4.4 million short tons in 1972, an increase of 42.5% over the tonnages imported in 1971.

a. Size of firms

If cement plants were operating at full capacity in 1972, or for 365 days, the 123 plants covered in this report, or 74.1% of the total, produced an estimated 68.3 million short tons, or 80.5% of all cement produced, and accounted for 70.1 million short tons, or 80.8% of total capacity. The 44 plants for which no data are available, except plant name, company, and location, therefore, represent approximately one-fifth of the total industry. The Bureau of Mines has estimated that 15 companies accounted for 67% of total cement production in 1972. According to the data presented in Table 3, 14 companies accounted for 67.5% of the total reported production, suggesting that the larger companies have been adequately represented by the 123 plants covered in this report. As also indicated in Table 3, however, the fewer the number of plants operated by a company, the fewer is the number of plants that company is likely to have had included in the 123-plant survey. No plant data are available for three companies with two plants each and 12 one-plant companies. Thus, it should be noted that the 35 companies with plants for which data were reported are more representative of the larger companies than of the smaller firms in the cement industry.

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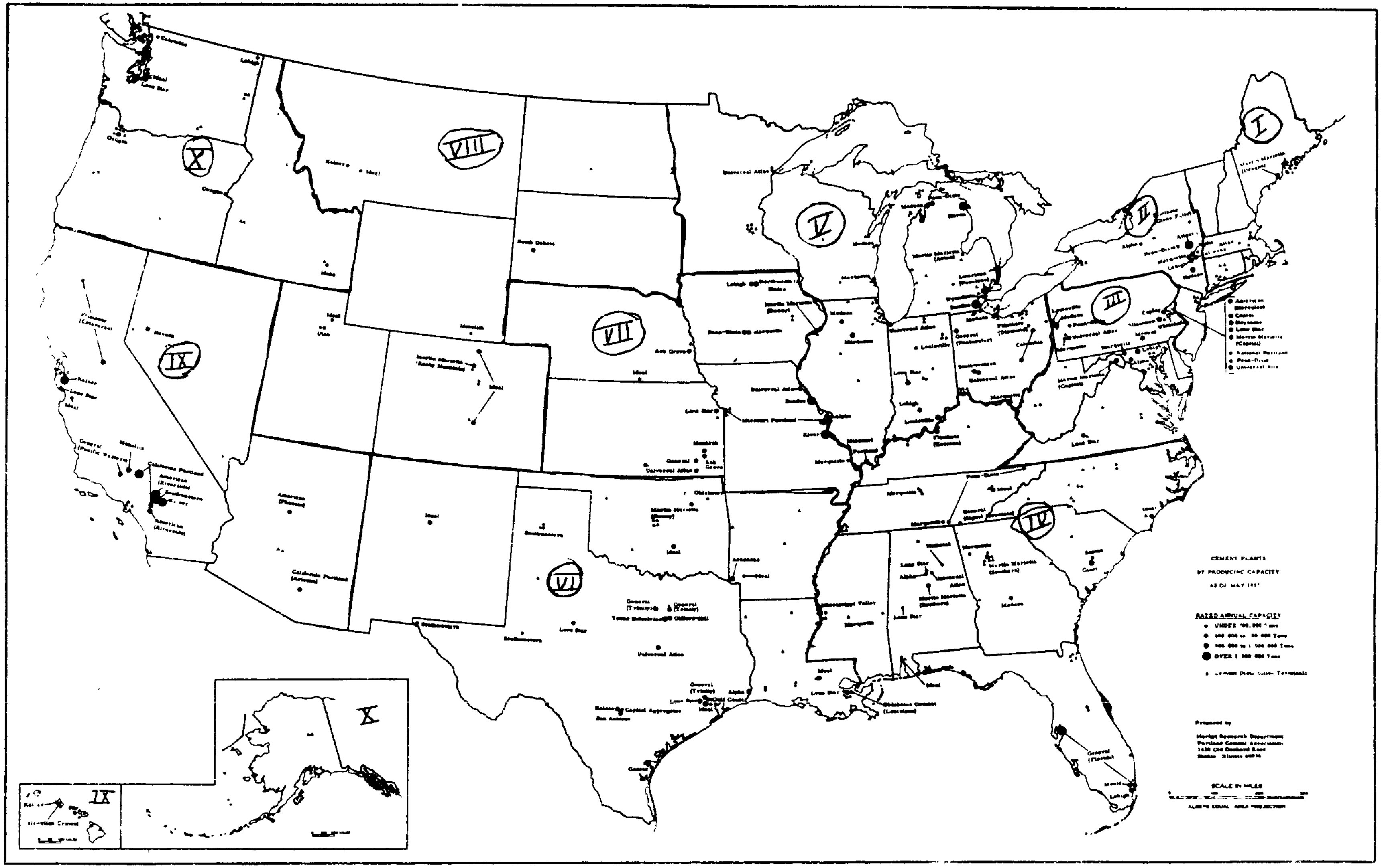
1. Commodity Data Summaries, Bureau of Mines, United States Department of the Interior, Washington, January, 1973.

Figure 1
Location of Cement Mills and Cement Distribution Terminals—May, 1972[a]



a. Prepared by Southern Research Institute from map published by the Portland Cement Association, Skokie, 1972.

Table 3
Cement Companies and Plants Segmented by Type of Plant and Required Pollution Control[a]

Company	Plant identification: Location	Plant identification: Code	Current water treatment techniques	Nonleaching plants — None required (RAPP permits or SRI survey suggest that no further controls are required to meet EPA standards for 1977 or 1983): Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Alternative A (Cooling tower or spray pond and dust containment): Capacity (1000 short tons	Employees (number)	Production (tons/day)
Alpha Portland Industries, Inc.	4	101					340[b]	134[b]	900[b]
	3	102	WTF	430	110	1,220			
	6	103					470	130	1,030
	2	105		510	150	1,600			
	2	106					170[b]	77[b]	564[b]
	7	c							
Amcord, Inc.	3	201	R&R				660	160	1,690
	5	202							
	5	203							
	5	204							
	9	205	R&R	490	136	1,597			
	9	206	R&R	960	300	3,000			
	9	207	R&R	1,220	265	3,500			
Arkansas Cement Corporation	6	c							
Ash Grove Cement Company	7	401	WTF	530[b]	150[b]	1,570[b]			
	7	402		660	250	1,600			
Atlantic Cement Company, Inc.	2	501	WTF/R&R				1,600[b]	300[b]	4,850[b]
California Portland Cement Company	9	1101	WTF				850[b]	321[b]	2,260[b]
	9	c							
	9	c							
Capital Aggregates, Inc.	6	c							
Centex Cement Corporation	6	c							
	9	c							
Century Cement Company	1	c							
Columbia Cement Company	10	1503					360	114	1,030
	5	c							
	5	c							
Coplay Cement Manufacturing Co.	3	c							
	3	c							
Dundee Cement Company	5	2101	WTF/R&R						
	7	c							
The Flintkote Company	9	2201	R&R	850	334	2,600			
	9	2202	R&R	280	92	900			
	5	2203	WTF/R&R	600	180	1,200			
	2	2204		340	150	960			
	4	2205		560	401	1,200			
General Portland, Inc.	4	2302	WTF				1,320	321	3,010
	5	2303					470[b]	175[b]	1,350[b]
	4	2304					380[b]	70[b]	1,880[b]
	6	2305	WTF				660[b]	153[b]	1,220[b]
	6	2306					750	160	2,140
	4	c							
	6	c							
	7	c							
	9	c							
Giant Portland Cement Company	4	2401		750	250	2,270			
Gifford-Hill & Company	6	c							
Gulf Cost Portland Cement Company	6	2601		750	65	1,200			
Hawaiian Cement Corporation	9	c							
Hudson Cement Company	2	c							

Table 3 (Cont'd)
Cement Companies and Plants Segmented by Type of Plant; and Required Pollution Control[a]

Plant identification		Leaching plants								
		Alternative C ("A" plus recycling and reuse of cooling water; neutralization and settling of leachate)			Alternative C(A) or (H) (Cooling tower or spray pond and dust containment or treatment for excessive pH)			Alternative D (Reduction of total dissolved solids and recycling of leachate by 1983)		
Location	Code	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)
4	101									
3	102									
6	103									
2	105									
2	106									
7	c									
3	201									
5	202	260	55	690						
5	203	770	70	2,060						
5	204	190	75	1,260						
9	205									
9	206									
9	207									
6	c									
7	401									
7	402									
2	501									
9	1101									
9	c									
9	c									
6	c									
6	c									
9	c									
1	c									
10	1503									
5	c									
5	c									
3	c									
3	c									
5	2101							1,130	220	3,000
7	c									
9	2201									
9	2202									
5	2203									
2	2204									
4	2205									
4	2302									
5	2303									
4	2304									
6	2305									
6	2306									
4	c									
6	c									
7	c									
9	c									
4	2401									
6	c									
6	2601									
9	c									
2	c									

Table 3 (Cont'd)
Cement Companies and Plants Segmented by Type of Plant; and Required Pollution Control[a]

Company	Plant identification: Location	Plant identification: Code	Current water treatment techniques	Nonleaching plants — None required (RAPP permits or SRI survey suggest that no further controls are required to meet EPA standards for 1977 or 1983): Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Nonleaching plants — Alternative A (Cooling tower or spray pond and dust containment): Capacity (1000 short tons)	Employees (number)	Production (tons/day)
Ideal Basic Industries, Inc.	4	3201							
	6	3202	WTF				360[b]	133[b]	762[b]
	8	3205	R&R				410	150	1,178
	6	3206							
	6	3207							
	8	3208					280[b]	126[b]	[illegible][b]
	7	3209		380	135	563			
	6	3210	R&R	660	101	846			
	4	3211					660[b]	168[b]	1,384[b]
	6	3213		660	143	1,129			
	8	3214					360	131	805
	4	3215					530	164	1,005
	8	c							
	9	c							
	10	c							
Kaiser Cement and Gypsum Corporation	9	3301	WTF				1,600	520	4,700
	8	3304	WTF/R&R				260	81	980
	6	3305					510	138	1,200
	9	c							
	9	c							
Keystone Portland Cement Company	3	c							
Lehigh Portland Cement Company	3	4101		920	173	2,620			
	2	4102	WTF				510	125	1,090
	4	4103		510	120	1,360			
	5	4104	WTF				470	125	1,420
	7	4105					620	170	1,820
	10	c							
Lone Star Industries, Inc.	4	4202	R&R				280[b]	110[b]	700[b]
	5	4203	WTF	750	148	2,375			
	7	4204	R&R				450	155	1,145
	6	4205	R&R	550	128	1,545			
	3	4206	R&R	680	223	1,700			
	3	4207	R&R	640	197	1,700			
	4	4208	R&R				360[b]	141[b]	705[b]
	6	4209		410	225	1,540			
	10	4210		240	116	1,175			
	9	4211	WTF/R&R	560	256	1,200			
	6	4213	WTF/R&R				620[b]	160[b]	1,300[b]
Louisville Cement Company	3	4303	WTF				880	300	1,970
	5	c							
	5	c							
Marquette Cement Manufacturing Company	4	5101		240	82	850			
	5	5102		750	c	2,080			
	2	5103	R&R				620	125	1,700
	4	5104	R&R	190	c	440			
	7	5105					410	165	1,166
	5	5106							
	7	5107[d]		300	c	744			
	4	5108	WTF/R&R						
	3	5109		410	c	1,290			
	3	5110		380	c	1,150			
	4	5111					240	c	670
	5	5112					240	85	750
Martin Marietta Corporation	5	5201		190	c	1,850			
	3	5202	R&R	900	295	2,700			
	7	5203	R&R				640	200	1,650
	6	5204	R&R	640	c	1,900			
	1	5205					470[b]	210[b]	1,250[b]
	8	5206	R&R	430	115	1,300			
	4	5207	WTF/R&R				550	c	1,640
	4	5208	R&R	560	80	1,875			
	3	5209		450	c	1,150			
Maule Industries	4	c							
Medusa Corporation	3	5801					770	112	2,000
	5	5803	WTF/R&R				660	c	1,650
	3	5804					490	190	1,820
	5	5805	WTF/R&R				750	90	2,100
	4	c							
	5	c							

Table 3 (Cont'd)
Cement Companies and Plants Segmented by Type of Plant; and Required Pollution Control[d]

Plant identification		Leaching plants								
		Alternative C ("A" plus recycling and reuse of cooling water; neutralization and settling of leachate)			Alternative C(A) or (H) (Cooling tower or spray pond and dust containment or treatment for excessive pH)			Alternative D (Reduction of total dissolved solids and recycling of leachate by 1983)		
Location	Code	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)
4	3201	530	158	1,308						
6	3202									
8	3205									
6	3206				710[a]	155[a]	1,909[a]			
6	3207	560	162	970						
8	3208									
7	3209									
6	3210									
4	3211									
6	3213									
8	3214									
4	3215									
8	c									
9	c									
10	c									
9	3301									
8	3304									
6	3305									
9	c									
9	c									
3	c									
3	4101									
2	4102									
4	4103									
5	4104									
7	4105									
10	c									
4	4202									
5	4203									
7	4204									
6	4205									
3	4206									
3	4207									
4	4208									
6	4209									
10	4210									
9	4211									
6	4213									
3	4303									
5	c									
5	c									
4	5101									
5	5102									
2	5103									
4	5104									
7	5105									
5	5106	240	c	696						
7	5107[d]									
4	5108	230	75	627						
3	5109									
3	5110									
4	5111									
5	5112									
5	5201									
3	5202									
7	5203									
6	5204									
1	5205									
8	5206									
4	5207									
4	5208									
3	5209									
4	c									
3	5801									
5	5803									
3	5804									
5	5805									
4	c									
5	c									

Table 3 (Cont'd)
Cement Companies and Plants Segmented by Type of Plant; and Required Pollution Control[a]

	Plant identification			Nonleaching plants					
				None required (RAPP permits or SRI survey suggest that no further controls are required to meet EPA standards for 1977 or 1983)			Alternative A (Cooling tower or spray pond and dust containment)		
Company	Location	Code	Current water treatment techniques	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)
Mississippi Valley Cement Industries, Inc.	4	5401	R&R				[illegible]30	53	600
Missouri Portland Cement Company	7	5501							
	7	5502							
	5	5503	WTF/R&R	560	79	1,700			
Monarch Cement Company	7	5601	WTF	450	165	1,130			
Monolith Portland Cement Company	8	c							
	9	c							
National Cement Company	4	6101	WTF	380	160	1,128			
National Gypsum Company	5	6201					2,440	970	6,670
	3	6202					940	130	2,760
Nat[illegible] Portland Cement Company	3	6301	WTF						
Northwestern States Portland Cement Company	7	c							
OKC Corporation	6	7102					320[b]	60[b]	1,020[b]
	6	c							
Oregon Portland Cement Company	10	7201					190	55	300
	10	7202					790	c	830
	10	7203		380	90	380			
Penn-Dixie Cement Corporation	4	7303	WTF						
	5	7305	WTF	660	167	1,880			
	2	c							
	3	c							
	3	c							
	4	c							
	7	c							
Portland Cement Company of Utah	8	c							
Puerto Rican Cement Company, Inc.	2	7501	R&R				1,600[b]	400[b]	3,760[b]
	2	7502					560[b]	400[b]	1,880[b]
River Cement Company	7	c							
San Antonio Portland Cement Company	6	c							
San Juan Cement Company	2	8301	WTF/R&R	380	250	1,320			
Santee Portland Cement Company	4	8401	WTF/R&R	380	100	1,130			
South Dakota Cement Plant	8	8501	WTF				450	150	1,500
Southwestern Portland Cement Company	9	8601	R&R	1,410	405	2,440			
	5	8602	R&R	620	272	1,550			
	6	8603	R&R	340	175	800			
	6	8604	R&R	230	66	685			
	6	8605	R&R	230	69	580			
Universal Atlas Cement Division U.S. Steel Corporation	2	9201	R&R				750	280	[illegible],900
	3	9202	WTF/R&R	550	270	1,280			
	3	9203	R&R	510	c	1,200			
	5	9204	WTF/R&P	470	c	1,200			
	5	9205		429	c	1,300			
	5	9206	R&R	320	c	875			
	7	9207	R&R	680	180	1,800			
	7	9208					390[b]	150[b]	1,180[b]
	4	9209	R&R	340	c	880			
	6	9210	R&R				390[b]	170[b]	[illegible],200[b]
Whitehall Cement Manufacturing Company	3	9301		550	200	1,690			

Table 3 (Cont'd)
Cement Companies and Plants Segmented by Type of Plant; and Required Pollution Control[a]

Plant identification		Leaching plants								
		("A" plus recycling and reuse of cooling water; neutralization and settling of leachate)			Alternative C(A) or (B) (Cooling tower or spray pond and dust containment or treatment for excessive pH)			Alternative D (Reduction of total dissolved solids and recycling of leachate by 1983)		
Location	Code	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)	Capacity (1000 short tons)	Employees (number)	Production (tons/day)
4	5401									
7	5501				940B	200B	2,850B			
7	5502				560A	147A	1,800A			
5	5503									
7	5601									
8	c									
9	c									
4	6101									
5	6201									
3	6202									
3	6301	380	180	1,130						
7	c									
6	7102									
6	c									
10	7201									
10	7202									
10	7203									
4	7303							300	123	940
5	7305									
2	c									
3	c									
1	c									
4	c									
7	c									
8	c									
2	7501									
2	7502									
7	c									
6	c									
2	8301									
4	8401									
8	8501									
9	8601									
5	8602									
6	8603									
6	8604									
6	8605									
2	9201									
3	9202									
3	9203									
5	9204									
5	9205									
5	9206									
7	9207									
7	8208									
4	9209									
6	9210									
3	9301									

a. Sources. RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. Nonleaching plants with no discharge of thermal pollutants that can achieve total pollution control through Alternative A or B.

c. No data available.

d. Closed.

WTF Wastewater treatment facility.

R&R Recycling and reuse of water.

When cement companies are grouped by size, or by number of plants reported, as in Table 4, the data suggest that pollution practices may be related to size of company, particularly companies with nonleaching plants. The 110 nonleaching plants for which data are available, as pointed out earlier, are almost equally divided between polluting and nonpolluting plants, with 56 plants currently meeting pollution control standards and with 54 to be required to control pollutant discharges. Companies with either one plant or with four to seven plants also have approximately the same total number of polluting and nonpolluting plants. Companies with either two or three plants or nine or more, however, deviate from this pattern, as companies with two or three plants have a marked preponderance of polluting plants. The largest companies, or those with nine or more plants operate most of the polluting, leaching plants. Although the data suggest that the largest cement companies may have been more active than smaller companies in limiting pollutant discharges in their nonleaching plants, the evidence is inconclusive because smaller companies are, as noted above, inadequately represented in the 123-plant survey.

As indicated in Table 4, the 16 companies with data available for one plant each account for 46% of the companies and 13% of the plants. Seven companies with two or three plants reported account for 20% of the companies and 14% of the plants, and the seven companies with four to seven plants reported also account for 20% of the companies, but for 33% of the plants. The five largest companies, with nine or more plants reported for each, account for 14% of the companies and 40% of the plants, or almost a complete reversal of the role of the smallest companies. Companies with two or three plants, however, appear to have a greater share and companies with nine or more plants a lesser share of total capacity, employment, and production than is consistent with their share of total plants. The similarities between these groups of companies, whether measured by polluting practices or size of plants, suggests that further investigation might be warranted to determine if a relationship does in fact exist between the size of a company and the need for water pollution controls.

b. Level of integration

Cement companies generally quarry their own limestone and other raw materials and, thus, are integrated as far backward as possible. Forward integration has also advanced rapidly to the production of concrete by most smaller firms, and to construction and to retail outlets for cement and concrete by the larger companies. It is difficult to separate integration from diversification for cement companies, as the smaller companies are as likely to be absorbed by concrete producers as they are likely to produce concrete. Only one of the companies with five or more plants produces cement exclusively and, as indicated in Table 5, the primary product produced by cement companies with from one to three plants was as likely to be concrete as cement.

Table 4
Companies by Number of Plants Reported, Capacity, Employment, and Production Segmented by Required Pollution Controls[a]

Companies by number of plants reported	Companies		Pollution controls required											
			Total		Nonleaching plants				Leaching plants					
					X		A		C		C (A) or (H)		D	
	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total
1	16	45.7	16	13.0	7	5.7	7	5.7	1	0.8			1	0.8
2 or 3	7	20.0	17	13.8	3	2.4	11	8.9			2	1.6	1	0.8
4 to 7	7	20.0	41	33.3	19	15.4	18	14.6	4	3.3				
9 to 12	5	14.3	49	39.8	27	22.0	18	14.6	3	2.4	1	0.8	—	—
Total	35	100.0	123	100.0	56	45.5	54	43.9	8	6.5	3	2.4	2	1.6

	Capacity (thousand short tons)											
	Total		Nonleaching plants				Leaching plants					
			X		A		C		C (A) or (H)		D	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
1	9,840	14.0	3,640	5.2	4,690	6.7	380	0.5			1,130	1.6
2 or 3	13,480	19.2	1,600	2.3	10,080	14.4			1,500	2.1	300	0.4
4 to 7	22,710	32.4	11,290	16.1	9,970	14.2	1,450	2.1				
9 to 12	24,049	34.3	13,479	19.2	8,530	12.2	1,330	1.9	710	1.0	—	—
Total	70,079	100.0	30,009	42.8	33,270	47.5	3,160	4.5	2,210	3.2	1,430	2.0

	Employment[b] (number)											
	Total		Nonleaching plants				Leaching plants					
			X		A		C		C (A) or (H)		D	
	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total	Number	Percent of total
1	2,888	15.5	1,190	6.4	1,298	7.0	180	1.0			220	1.2
2 or 3	3,900	20.9[b]	336	1.8	3,094	16.6			347	1.9	123	0.7
4 to 7	5,940	31.9[b]	3,388	18.2	2,277	12.2	275	1.5				
9 to 12	5,907	31.7[b]	2,694	14.5	2,738	14.7	320	1.7	155	0.8	—	—
Total	18,635	100.0	7,608	40.8	9,407	50.5	775	4.2	502	2.7	343	1.9

	Production (tons/day)											
	Total		Nonleaching plants				Leaching plants					
			X		A		C		C (A) or (H)		D	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
1	27,228	14.5	9,868	5.3	13,230	7.1	1.130	0.6			3,000	1.6
2 or 3	35,800	19.1	3,960	2.1	26,250	14.0			4,650	2.5	940	0.5
4 to 7	61,993	33.1	30,252	16.1	27,104	14.5	4,637	2.5				
9 to 12	62,488	33.3	37,197	19.8	20,408	10.9	2,974	1.6	1,909	1.0	—	—
Total	187,509	100.0	81,277	43.3	86,992	46.4	8,741	4.7	6,559	3.5	3,940	2.1

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. Excludes 18 plants for which no employment data were reported.

Table 5
Cement Companies by Sales and Other Activities[a]

Company	Number of plants	Estimated sales of cement, 1972 (in millions of dollars)	Companies listing cement as their primary industry	Companies not listing cement as a major product	Companies that are divisions or subsidiaries	Other company activities
Ideal	15	175	x		Div	Concrete, aggregates, potash
Marquette	12	104	x			
Lone Star	11	148		x	Div	Concrete, furniture, carpets, construction, retail building, rugs, ore processes, commercial development
Universal-Atlas	10	n.a.		x	Div	Steel production
General	9	116	x			Retail furniture, real estate development
Martin Marietta	9	115		x	Div	Aerospace, construction materials
Amcord	7	106	x			Holding company
Penn-Dixie	7	55	x			Chemicals, holding company
Alpha	6	36		x		Construction, holding company, recreation products
Lehigh	6	108[c]	x			Concrete, furniture, carpeting
Medusa	6	81	x			Heavy engineering
Flintkote	5	40			Group	Concrete, paperboard, gypsum, and asbestos
Kaiser	5	83	x		Sub	Manufacturing and wholesale gypsum insulating products
Southwestern	5	56	x		Sub	Beverages, sugar, oil, and gas
California	3	72[b]	x			Concrete, oil and gas exploration
Columbia	3	n.a.			Div	
Louisville	3	44	x			
Missouri	3	31	x			Concrete, machine gears
Oregon	3	13	x			Lime, agricultural products
Ash Grove	2	n.a.	x			Lime
Centex	2	259[b]		x		Building contractors holding company
Coplay	2	17	x			
Dundee	2	n.a.				
Monolith	2	12	x		Sub	
National Gypsum	2	78		x		Gypsum, wall covering, mobile homes, building supplies
OKC	2	16	x			Crude oil refining, real estate, oil and gas exploration
Puerto Rican	2	36	x			Lime, bags, sugar processing
Arkansas	1	19		x	Sub	Retail building products
Atlantic	1	40	x			Concrete
Capitol	1	12	x		Sub	Concrete, petroleum storage - warehousing, trucking
Century	1	n.a.				
Giant	1	18	x			
Gifford-Hill	1	5	x		Sub	Concrete aggregates, transportation, pipe
Gulf Coast	1	n.a.			Div	
Hawaiian	1	65[b]	x			
Hudson	1	n.a.				
Keystone	1	14	x			Concrete, furniture, carpets, and rugs
Maule	1	32[b]		x	Sub	Concrete, lumber, and building materials
Mississippi Valley	1	3	x			
Monarch	1	6	x			
National Cement	1	n.a.			Div	
National PC	1	n.a.				
Northwestern	1	n.a.				
Portland	1	5	x			
River	1	36[b]	x		Sub	Concrete, oil and gas drilling
San Antonio	1	5	x			
San Juan	1	n.a.				
Santee	1	10	x			
South Dakota	1	6	x			
Texas	1	88[b]		x	Sub	Concrete, sand and gravel, stone and stone products
Whitehall	1	12	x			

a. Dun and Bradstreets Million Dollar Directory, Dun and Bradstreet, Inc., New York, 1973, and annual reports of cement companies.

b. Sales of cement have been included in total company sales.

c. Cement sales include sales include sales of other construction materials.

c. Number of plants

Cement companies, as noted earlier, each currently operate from one to 15 plants. The 35 companies and 123 plants for which data were reported include: five companies with nine to 12 plants, accounting for 44% of the total; seven companies with four to seven plants, or 29% of the total; seven companies with two or three plants, or 14% of the total; and 16 companies with one plant each that account for 13.0% of the total number of plants. Data on individual companies by number of plants and types of pollution control systems, required by 1977 or 1983 were presented in Table 3, above.

d. Number of products

Cement plants generally produce only one product—cement, and the specialization ratio for the cement industry is generally about 99%. Approximately 95% of total production consists of portland cement. Portland cement may be classified as normal portland, white, sulfate resisting, high-early strength, slag, or masonry cement, but the three basic types classified by the Bureau of Mines and the Department of Commerce are normal, masonry, and slag cement.

e. Level of diversification

Companies in the cement industry are highly diversified, particularly the eleven companies with five or more plants. Only one of these eleven companies produces only cement. The other ten are divisions or subsidiaries of firms whose activities range, as indicated in Table 5, from the manufacture of concrete, furniture, and tufted rugs to retail and wholesale outlets and to engineering, construction, land development, and holding companies. Companies with one to three cement plants are rarely diversified except in concrete manufacturing, and most of the companies that do integrate forward are divisions or subsidiaries of other companies or conglomerates.

2. Types of plants

Cement plants produce one basic product by either a wet or dry process. Despite numerous variations in the application of these processes to cement manufacture, the only significant difference between plants is whether collected kiln dust is reused or wasted and, if reused, whether it is returned to the kiln directly or leached. Dust recovery is not essential to cement manufacture, except to the degree that recovery and reuse affect costs and profitability. Typical cement plant processes were described in the aforementioned report on effluent limitation guidelines.[1]

The 23 plants covered in this report have been segmented by pollution control categories, as well as by location, size (capacity and production), age, employment, and productivity levels as measured in tons of cement produced per man/day. There appears to be little or no relationship between these factors. The 13 leaching plants appear to have higher average levels of productivity than non-leaching plants, but leaching plants as a whole are neither the newest nor the largest plants in the industry and their productivity ratios are not related to the extent to which they discharge pollutants.

a. Size of plants

Data on the size of plants, by location and pollution control categories, are presented in Tables 6 and 7. Table 6 describes cement plants in terms of capacity and Table 7 in terms of production of cement in tons/day. Regardless of the measure used, the data indicate that nonleaching plants requiring Alternative A pollution controls tend to be larger than nonleaching plants requiring no additional controls (Category X). For nonleaching plants, therefore, the data suggest a possible relationship between size and polluting practices. Data for plants with leaching systems, however, appear to suggest the opposite, as plants with the most serious polluting problems, or leaching plants in Category C, are well below average size in both capacity and production. Size of plant, therefore, does not appear to bear a significant relationship to polluting practices.

b. Age of plants

The age of cement plants also appears to be unrelated to size, efficiency, location, or pollution status. Almost all of the older plants, and some are a hundred years old, have been extensively re-engineered so that age alone is no measure of productivity, or of the technology employed. Fifty-year old plants are as likely to have computerized controls as newer plants.

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1. Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry, report prepared by Southern Research Institute, Birmingham, June 21, 1973.

Table 6

Cement Plants by Location, Capacity, and Pollution Control Categories[a]
(in number of plants and thousands of tons)

				Pollution control categories									
				Nonleaching plants				Leaching plants					
			Average capacity	X		A		C		C(A) or (H)		D	
EPA District	Total plants	Total capacity	by district	No. of plants	Annual capacity	No. of plants	Annual capacity	No. of plants	Annual capacity	No. of plants	Annual capacity	No. of plants	Annual capacity
I	1	470	470			1	470						
II	10	7,040	704	3	1,230	7	5,810						
III	17	10,540	620	11	6,420	5	3,740	1	380				
IV	22	9,860	448	9	3,910	10	4,890	2	760			1	300
V	21	12,969	618	10	5,349	6	5,030	4	1,460			1	1,130
VI	19	9,820	517	9	4,470	8	4,080	1	560	1	710		
VII	13	7,010	539	4	1,810	7	3,700			2	1,500		
VIII	6	2,190	365	1	430	5	1,760						
IX	9	8,220	913	7	5,770	2	2,450						
X	5	1,960	392	2	620	3	1,340						
Total	123	70,079		56	30,009	54	33,270	8	3,160	3	2,210	2	1,430
Average capacity per plant		570			536		616		395		737		715

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

Table 7

Cement Plants by Location, Production in Tons/Day, and Pollution Control Categories[a]

				Pollution control categories									
				Nonleaching plants				Leaching plants					
				X		A		C		C(A) or (H)		D	
EPA district	Total plants, (number)	Estimated total production	Average daily production per plant	No. of plants	Production	No. of plants	Production	No. of plants	Production	No. of plants	Production	No. of plants	Production
I	1	1,250	1,250			1	1,250						
II	10	18,624	1,862	3	3,880	7	14,744						
III	17	29,070	1,710	11	17,700	5	10,240	1	1,130				
IV	22	26,502	1,205	9	11,133	10	12,494	2	1,935			1	940
V	21	37,656	1,793	10	16,010	6	13,940	4	4,706			1	3,000
VI	19	22,976	1,209	9	10,225	8	9,872	1	970	1	1,909		
VII	13	19,018	1,463	4	4,237	7	10,131			2	4,650		
VIII	6	6,501	1,084	1	1,300	5	5,201						
IX	9	22,197	2,466	7	15,237	2	6,960						
X	5	3,715	743	2	1,555	3	2,160						
Total	123	187,509		56	81,277	54	86,992	8	8,741	3	6,559	2	3,940
Average daily production per plant			1,524		1,451		1,611		1,093		2,186		1,970

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

Cement plants vary in age from new to 96 years. Of the 123 plants reviewed, 23 are no more than 10 years old; 28 are 11 to 25 years old; 29 are 26 to 50 years old, and 42 are at least 50 years old. The 56 nonpolluting plants include 11 plants no more than 10 years old, 16 plants from 11 to 25 years old, 11 plants 26 to 50 years old, and 18 plants 50 years old or more. Thus, nonpolluting plants account for slightly less than half of each group, just as they account for slightly less than half of all cement plants. The five newest plants in the industry, all operating for less than five years, are located in five different districts, have annual capacities ranging from 0.4 to 0.8 million short tons of cement and produce from 5.3 to 29.3 tons per worker daily. Two of these plants are nonleaching plants requiring no additional controls, two are nonleaching plants requiring A controls, and one is a leaching plant requiring C controls. Age of plant, therefore, does not appear to be significant in polluting practices.

c. <u>Location</u>

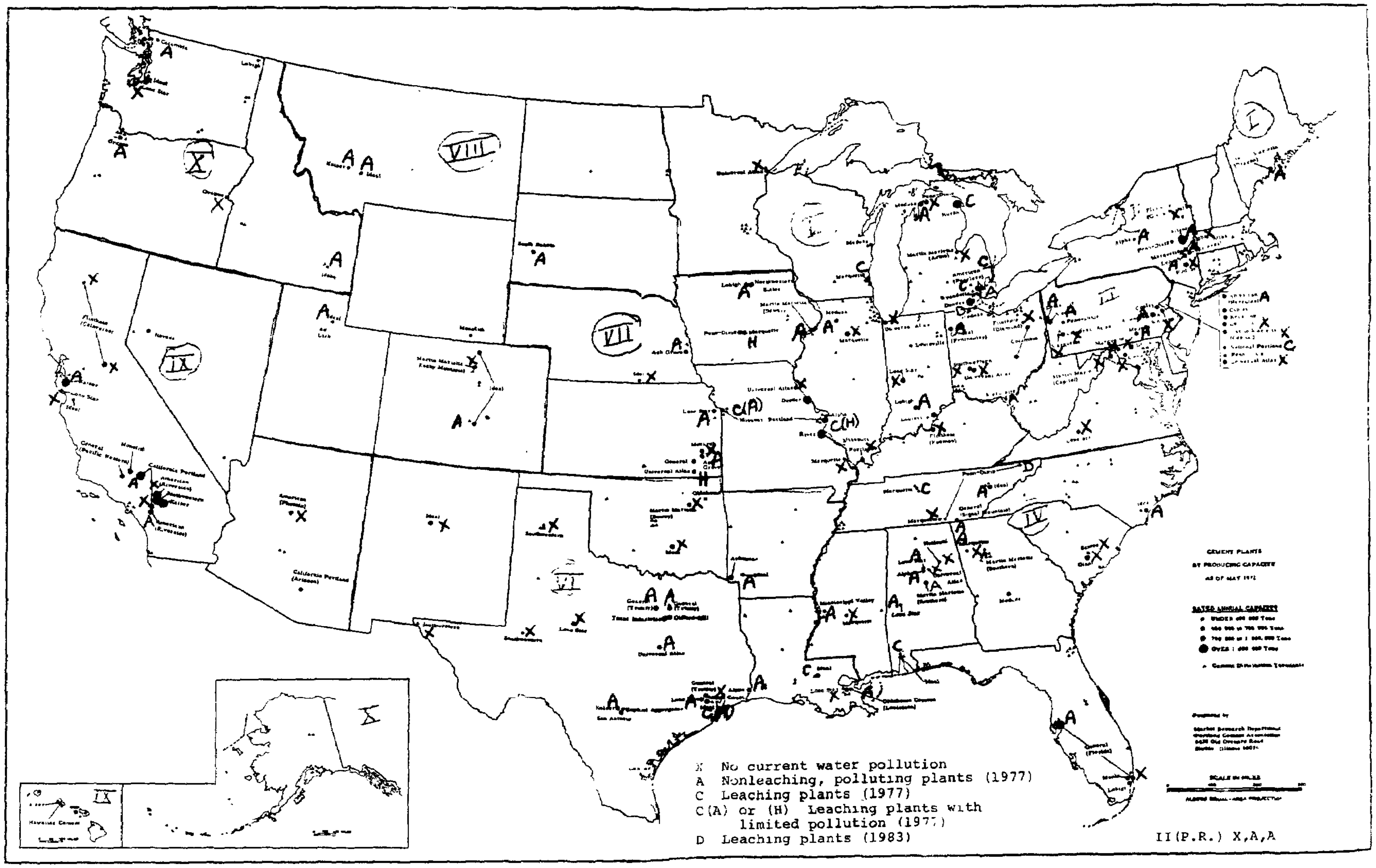
Approximately half of all cement produced in this country came from six states in 1972, each representing a different EPA region: California (IX), Pennsylvania (III), Texas (VI), Michigan (V), New York (I), and Missouri (VIII). Approximately 11% of total production was produced in California alone.

Of the 123 plants for which data are available, those 56 whose current discharges apparently already meet pollution control standards may generally be characterized as being widely dispersed throughout the United States, as indicated by the letter X in Figure 2. For the most part, these plants are within 300 miles of the more important regional (metropolitan) markets in the nation. A moderate concentration of 11 plants may be found in the Maryland-Philadelphia-Hudson River Valley region.

The 54 nonleaching plants that will require installation of a cooling tower or spray pond and containment of dust-pile runoff by 1977 are, as in the case of the nonpolluters, highly dispersed in the nation, too. These are characterized by the letter A. Many of these, with the exception of four or five in the Northwest, are within 300 miles of nonpolluters. The high-volume eastern half of the nation, especially, is marked by considerable mixing of the nonpolluters and the A-type plants.

The 11 (of the 13) leaching plants that have not met water pollution control standards for 1977 are to be found, for the most part, inland in the eastern half of the nation, with a concentration of four of these (including one now closed) in the Detroit region. These 11 plants are characterized by the letter C and generally are located within 200 miles of plants that apparently do not pollute. The two leaching plants that may require electrodialysis or another process to meet 1983 standards are characterized by the letter D. One plant is located in Michigan and the other in Tennessee.

Figure 2
Dispersion of Cement Plants by Water Pollution Status[a]



a. Prepared by Southern Research Institute from map published by the Portland Cement Association, Skokie, 1972.

Thus, most of the 67 plants in pollution categories A, C, and D, with relatively significant pollution problems are within competititive marketing reach of those with either no or relatively limited pollution problems. As a consequence, any tendency toward increased prices following from increases in costs required to curtail pollution may tend to be mitigated; any reductions in output that may ensue among so-called polluters should generally be matched by increases in output and sales of nearby nonpolluters.

d. Level of technology

The state of the art in cement making has been undergoing some change in recent years, with much of the impact visible in terms of efficiency, or increased output per worker, or relatively reduced costs per unit of output. Many improvements have been directed toward two major objectives, labor savings and, more recently, fuel and energy economy. The labor savings have often resulted in, or allowed, greater economies with increased scale of operations. The fuel and energy savings, as we understand the case, have not necessarily benefitted large-scale plants more than small-scale and small-scale plants may well have an edge in this matter at present.

The techniques of quarrying raw materials do not vary too much for most plants and have been improved primarily with the use of high-speed drills and large-capacity cranes and trucks. The mining of oyster shells does constitute a difference in technique. Oyster shells are normally dredged from lakes and bays, rather than excavated.

The transportation of raw materials to plant exhibits some differences among plants, depending upon location of the quarry and access to intervening types of transportation. Some transportation techniques are: hauling by truck, barge, or railroad car; and transport by conveyor belt or cable-drawn gondolas on tracks. The use of trucks, barges, and railroad cars has been affected by increases in container capacity and loading-unloading techniques, with opportunities for reductions in costs per unit of output. The conveyor belts and cable-drawn gondolas have also contributed to economies.

In crushing and grinding operations, techniques have undergone relatively little change, the major changes being in improved construction materials for reduced wear and down time and increased capacities for economies of scale.

Kilns constitute the most significant area of change in cement plants. Kilns have achieved increases in length and, to a lesser extent, diameter over the years, allowing for increases in capacity. They have also experienced modifications for reasons of fuel efficiency, as in the case of suspension preheaters in older, shorter kilns. This allows utilization of waste heat for significantly warming the raw mix before being fed to the kiln. Another change of this type has involved the use of new heat-exchange equipment within the kiln (new chain designs and materials and circular or radial heat exchangers). Kiln design has also been affected by changes in shapes and materials.

Finishing equipment (grinders and cement coolers) have changed relatively little, much of it in the same manner as crushing and grinding equipment used in preparing the raw materials.

Water management has improved through the use of lagoons, cooling towers, and ponds and efficient water management practices have increased over the years as the real cost of water has increased. Overall plant control and operations have tended to be improved with the use of electronic information and control systems.

Detailed information on these changes or improvements has not been tallied by plant or company. However, it is presupposed that the effects of the changes or improvements will be manifest largely in greater output per worker, or in lower relative average total costs per unit of output. In the case of fuel and energy, to the extent these costs have been rising, economies in fuel and energy consumption should tend to result in relatively stabilized average total costs per unit of output.

e. Efficiency

Efficiency of operation in cement plants, measured by production per man/day, has been computed for the 105 plants for which data on production in tons per day and number of production workers are available. These efficiency or productivity ratios, as indicated in Table 8, are the mean or average for each group of plants, segmented by EPA district and pollution control category.

Average cement production in 105 plants is approximately 8.9 tons per day per production worker. This productivity ratio is highest in EPA district V and lowest in District I, where only one plant is located. Nonleaching plants requiring A pollution controls are only slightly more productive on average than nonpolluting, nonleaching plants, although their average size, as indicated in Tables 6 and 7, was considerably larger. Leaching plants in all pollution control categories are well above average in productivity ratios. It may be recalled that capacity for leaching plants in the C category was well below average. The data

Table 8

Cement Plants by Location, Productivity Ratio Averages, and Pollution Control Categories[a]

			Pollution control categories									
			Nonleaching plants				Leaching plants					
			X		A		C		C(A) or (H)		D	
EPA District	Total plants	Average tons produced per man/day	No. of plants	Average tons produced per man/day	No. of plants	Average tons produced per man/day	No. of plants	Average tons produced per man/day	No. of plants	Average tons produced per man/day	No. of plants	Average tons produced per man/day
I	1	6.0			1	6.0						
II	10	8.3	3	7.1	7	8.6						
III	13[b]	9.6	7[b]	8.8	5	11.5	1	6.3				
IV	18[b]	8.4	7[b]	8.2	8[b]	8.8	2	8.3			1	7.6
V	14[b]	10.3	5[b]	10.3	5[b]	8.5	3[b]	20.1			1	13.6
VI	18[b]	8.8	8[b]	8.7	8	8.9	1	6.0	1	12.3		
VII	12[b]	8.8	3[b]	7.3	7	8.2			2	13.4		
VIII	6	8.6	1	11.3	5	8.2						
IX	9	8.4	7	8.5	2	8.3						
X	4[b]	7.7	2	7.6	2[b]	7.9						
Total	105	8.9	43	8.6	50	8.7	7	10.4	3	13.1	2	11.5

a. Source: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. The 18 plants for which employment data were not available include 13 plants in the X category, four in the A category, and one in the C category of pollution controls.

suggest that there is no overall relationship between size of plant and productivity measured by labor productivity in the cement industry. Leaching plants, however, regardless of size, appear to achieve higher productivity per worker than nonleaching plants. The five plants with the highest productivity levels in the industry produce from 21.5 to 29.4 tons/day per production worker. These plants range from two to 46 years in age and have capacities of from 3.8 to 7.7 million short tons annually. Two of these plants are nonpolluting, nonleaching plants in the X category, two are nonleaching, polluting plants in the A category, and one leaching plant is in the C category of pollution controls.

f. Level of integration in production

Cement plants generally have their kilns and their grinding and recycling facilities on their own premises and most quarry their raw materials from nearby sites. As noted earlier, the production process tends to be similar in all plants, depending on whether the basic process is wet or dry, so that cement manufacturers do not vary to any great extent in the levels to which their production processes are integrated. Information on extent of production integration by pollution status was not directly available.

B. Number of Plants and Employees in Each Segment

Data on employment point up the differences between leaching and nonleaching plants, but do not appear to be related to the impact of pollution controls on the cement industry. As indicated in Table 9, there are 18,635 employees in the 105 plants for which employment data are available, or an average of 177 employees per plant. Average employment per plant is highest in nonleaching, polluting plants in the A category, followed by nonleaching plants in the X category, and is lowest in leaching plants.

C. Percent of Total Industry in Each Segment

The cement industry has been segmented into five pollution control categories, as described in Table 2, above. Of the 123 plants for which data were available, 56 plants are in the X category of plants currently meeting 1977 pollution control standards and two plants are in the D category of leaching plants currently meeting 1977 standards that have until 1983 to meet the standard of "essentially no discharges of pollutants".

One leaching plant in the C(H) pollution category can meet 1977 standards with an estimated maximum expenditure of $5,000 as its pollutants are primarily in the form of excessive pH and its dissolved solids are not expected to come under control until 1983.

Table 9
Cement Plants by Location, Number of Employees, and Pollution Control Categories[a]

District	Number of plants, total	Number of employees, total	Average employees per plant	Nonleaching plants: X Number of plants	Nonleaching plants: X Number of employees	Nonleaching plants: A Number of plants	Nonleaching plants: A Number of employees	Leaching plants: C Number of plants	Leaching plants: C Number of employees	Leaching plants: C(A) or (H) Number of plants	Leaching plants: C(A) or (H) Number of employees	Leaching plants: D Number of plants	Leaching plants: D Number of employees
I	1	210	210			1	210						
II	10	2,257	226	3	550	7	1,707						
III	13[b]	2,540	195	7[b]	1,468	5	892	1	180				
IV	18[b]	2,710	150	7[b]	1,193	8[b]	1,161	2	233			1	123
V	14[b]	2,711	194	5[b]	846	5[b]	1,445	3[b]	200			1	220
VI	18[b]	2,383	132	8[b]	962	8	1,104	1	162	1	155		
VII	12[b]	2,067	172	3[b]	480	7	1,240			2	347		
VIII	6	753	126	1	115	5	638						
IX	9	2,629	292	7	1,788	2	841						
X	4[b]	375	94	2	206	2[b]	169	—	—	—	—	—	—
Total	105	18,635		43	7,608	50	9,407	7	775	3	502	2	343
Average per plant			177		177		188		111		167		172

a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. The 18 plants for which employment data were not available include 13 plants in the X category, 4 in the A category, and 1 plant in the C category of pollution controls.

The 56 nonleaching plants in the A pollution category and the two leaching plants with thermal pollutants will require the installation of a cooling tower or spray pond for control of solids and thermal pollution. By 1977, each of these plants will require an investment of up to $205,000, depending on the extent to which current equipment can be utilized, and annual outlays of almost $80,000. The C pollution category covers 8 plants that will require the same A pollution control installation as nonleaching plants for their cement manufacture operations because these plants discharge excessive suspended, as well as dissolved, solids. Should these plants abandon their leachate systems by 1977, or choose the E alternative, the investment will be about the same as for A controls, but annual operating costs may total about $245,000. If leachate systems are retained, then C controls for the neutralization and settling of the leachate will be required, in addition to A controls, by 1977, at an additional capital cost of approximately $220,000 for each plant and additional annual costs of about $50,000.

1. Number of plants as percent of total

A summary of the data presented above on capacity, production, employment, and average productivity ratios for cement plants segmented by pollution control categories reveals a certain consistency that may be of some significance in establishing pollution standards. As indicated in Table 10, nonleaching plants in Category X, or those that are currently meeting 1977 pollution control standards, and leaching plants in Category C, or plants that will require the most extensive pollution controls by 1977, have one thing in common. Both groups of plants account for a higher proportion of total plants than is accounted for by their proportion of total capacity, production, or employment. In contrast, leaching plants in Category D that will require no additional controls in 1977, leaching plants in Category C(H) that will require minimal controls in 1977, and leaching and nonleaching plants in Categories C(A) and A that will require A controls by 1977 account for a higher proportion of total capacity, production, or employment than indicated by their proportions of total plants. Average productivity per worker, however, is lower for both categories of nonleaching plants than for any category of leaching plants.

If, as the data indicate, nonleaching plants tend to have lower productivity per worker than leaching plants, one conclusion might be that leaching plants will be better able to cope with the greater costs of instituting pollution controls in 1977 and in 1983. A smilar inference might be derived from the average productivity ratios for polluting and nonpolluting nonleaching plants, but the difference is too small to be conclusive. It is, of course, also possible that the generally larger size of polluting plants may be attributable to modernization programs that the plants have instituted from funds not available to nonpolluting plants because of their capital and operating expenditures for pollution controls.

Table 10

Cement Industry by Number of Plants, Capacity, Production, Employment, and Productivity Rates, Distributed by Pollution Control Categories[a]

		Pollution control categories				
		Nonleaching plants		Leaching plants		
	Total	X	A	C	C(A) or (H)	D
Number of plants, total	123	56	54	8	3	2
Percent of total plants[b]	100.0	45.5	43.9	6.5	2.4	1.6
Capacity in thousands of tons, total	70,079	30,009	33,270	3,160	2,210	1,430
Percent of total capacity	100.0	42.8	47.5	4.5	3.2	2.0
Production in tons/day, total	187,509	81,277	86,992	8,741	6,559	3,940
Percent of total production[b]	100.0	43.3	46.4	4.7	3.5	2.1
Number of employees, total[c]	18,635	7,608	9,407	775	502	343
Percent of total employment[b]	100.0	40.8	50.5	4.2	2.7	1.9
Annual average production per man/day[c]	8.9	8.6	8.7	10.4	13.1	11.5

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a. Sources: RAPP applications submitted by 88 cement plants to EPA and questionnaire responses, personal contacts, and visits to selected cement plants by staff of Southern Research Institute.

b. Percentages do not add to 100.0% because of rounding.

c. Only 105 plants reported.

2. Production and employment as percents of totals

The percentages of the total industry represented by production and employment in the 123 plants under review are presented in Table 10 and discussed in the previous section. Detailed data on production and employment in plants grouped by location in EPA districts and segmented by pollution control categories are presented in Tables 7 and 9.

D. Significantly Impacted Segments of the Cement Industry

The segments of the cement industry affected most severely by pollution control standards are 1) companies with the greatest number of plants in the A and C pollution categories, but with a relatively strong financial base, and 2) companies with plants in the A and C pollution categories, but with relatively limited financial resources. This statement is based on a number of qualifying assumptions. The first is that the estimated investment and annual costs of reducing pollutant discharges are approximately equal for all nonleaching plants in the A pollution control category. Plants reported to be recycling or reusing water, or with wastewater treatment facilities, may have already installed at least part of the equipment required for pollution control and, as a result, the additional costs required may vary considerably.

Another assumption is that companies with leaching plants in the C and D pollution control categories will choose to retain their leachate systems rather than convert to nonleaching plants by adopting Alternative E. Operating expenses for leaching plants selecting Alternative E are approximately three times ($244,900) the estimated operating costs for nonleaching plants in the A category ($79,900). Leaching plants that choose to retain their leachate systems and invest an additional $220,000 for neutralization and settling of the leachate (C) over and above the $205,000 required to install A controls may anticipate an additional expenditure of approximately $220,000 by 1983 to achieve the ultimate goal of eliminating all pollutant discharges (D). Only two leaching plants are reported to meet all 1977 requirements at the present time.

The decision on whether to abandon leachate systems will depend on the ability of the companies with leaching plants to invest the initial capital required for the C alternative by 1977. Those plants that are able to retain the systems will incur lower operating expenses, as well as the benefits of dust recovery, at a considerably lower total cost than those that choose Alternative E, or abandonment. The differences in operating costs of the two alternatives, in fact, will cover the installation of pollution controls to eliminate dissolved solids (D) by 1983, and the higher operating costs involved in later years, but still be lower for plants that retain the leachate systems than for those that abandon them. As indicated on Table 11, total costs for both alternatives will be approximately equal in 1978 and higher each year thereafter for plants abandoning their leaching systems.

If it is assumed that A and C pollution controls will be implemented by 1977 and D controls by 1983, then those companies having the largest number of polluting plants will require the most sizable investments for pollution control. Companies with fewer polluting plants, however, generally lack the financial resources of the larger firms and may experience just as much difficulty in obtaining the necessary funds, despite the smaller amounts required.

Table 11
Total Estimated Cumulative Capital and Operating Costs for Leaching Plants under Pollution Control Alternatives C and E, 1977-1983[a]

			Retaining leaching system	Abandoning leaching system
1977	Capital	(C)	$ 425,000	$ 205,000
	Operating	(C)	129,500	244,900
			554,500	449,900
1978	Operating	(C)	129,500	244,900
			684,000	694,800
1979-1982	Operating	(C)	518,000	979,600
			1,202,000	1,674,400
1983	Capital	(D)	220,000	----
			1,422,000	1,674,400
	Operating	(D)	224,500	244,900
			$1,646,500	$1,919,300

a. Derived from estimates provided in Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry, report prepared by Southern Research Institute, Birmingham, June 21, 1973.

III. Financial Profiles

Cement companies, given the limitations of the financial data available for 1972 and assuming a relatively strong demand for cement during the coming decade, should generally experience relatively little difficulty in meeting pollution control standards set for 1977 and 1983. Just as previous sections of this report indicated that polluting plants tend to be among the largest and most productive in the industry, data presented in this section suggest that companies with polluting plants also tend to be among the most profitable.

Cement represents the total product of comparatively few companies in the cement industry. The only data generally available on the role of cement in these companies is the proportion of total sales accounted for by cement sales. This proportion of total sales was used to estimate the amount that cement plants contribute to t their parent companies in total profits before taxes, in cash flow, and in current assets. The amounts attributable to cement were then divided by the total number of cement plants operated by each company to estimate the amount that might be allocated to each plant.

Sources consulted for readily available information on financial structure included Dun and Bradstreet directories, Standard & Poor company stock reports, and annual reports published by companies engaged in cement manufacture. The available data covered 19 of the 35 companies for which plant data were available and 114 of their plants, 93 of which are reported by pollution control requirements. There appears to be an adequate sampling of companies by number of plants in all pollution categories, except for one-plant companies, only one of which is included in the financial profiles. The paucity of data for the other 10 one-plant companies is especially unfortunate because this one company with the highest per-plant profits before taxes, current assets, and cash flow of any cement plant is not considered to be characteristic of other one-plant companies. Its outstanding performance was attributable to the gain from the sale of one of its plants in 1972.

A. Plants in Each Segment

The summary of plants for which financial data are available, as indicated in Table 12, indicates that the average nonleaching plant in the A pollution control category was more profitable, generated a greater cash flow, and had greater current assets than average nonleaching, nonpolluting plants in the X category. The average leaching plant in the C category of plants requiring the most extensive pollution controls in 1977 was less profitable, generated a smaller cash flow, and had fewer current assets than the average

Table 12
Estimated Total and Average-Per-Plant Net Profits before Taxes, Cash Flow, and Value of Current Assests, of Selected Cement Companies and Plants by Pollution Control Categories[a]

			Pollution control category				
			Nonleaching plants		Leaching plants		
	Total	Not known	X	A	C	C(A) or (H)	D
Number of plants per category	114	21	38	44	7	3	1
			(in millions of dollars)				
Net profits before taxes, total	143.2	26.2	41.5	62.3	6.8	6.2	0.2
Average per plant	1.3	1.2	1.1	1.4	1.0	2.1	0.2
Estimated cash flow, total	159.5	37.2	44.7	62.9	6.8	5.7	2.3
Average per plant	1.4	1.8	1.2	1.4	1.0	1.9	2.3
Value of current assets, total	490.3	86.8	153.0	203.7	31.0	13.1	2.8
Average per plant	4.3	4.1	4.0	4.6	4.4	4.4	2.8

a. Derived from company annual reports and Standard & Poor's stock reports, 1972.

leaching plant in the C(A) or (H) categories that require only limited controls in 1977. Both groups of average plants in the C category, however, were more profitable and had greater assets but generated a smaller cash flow than the average leaching plant in the D category, which requires no controls until 1983. The data for leaching plants are inconclusive because so few plants are involved.

1. Annual profits before taxes

All cement companies for which financial data were available were profitable in 1972. As indicated in Table 13, however, estimated average net profits per plant were highest for companies with three plants, and the highest per-plant profits were experienced by a company with two plants (if the profits of the one-plant company are disregarded as not being representative of other one-plant companies). It may be recalled that companies with two or three plants also had a higher proportion of polluting plants than companies with either fewer or more plants. There does not appear to be any particular relationship between pollution category and net profits in companies with five or more plants. However, profit data do suggest that many of the cement companies with polluting plants are also among the most profitable and are apparently financially capable of meeting pollution control requirements.

2. Annual cash flow

Cash flow was computed by adding depreciation allowances to profits after taxes and subtracting an estimate of interest paid on long-term debt at a flat rate of eight percent, except when more precise debt and interest information was provided. Although the company generating the largest cash flow in 1972 per plant was also the company with the highest per-plant profits before taxes for its two cement plants, companies with six plants tended to have higher cash flows than any other group of companies with more or less plants.

3. Market value of current assets

All of the cement companies for which data are available appear to have substantial current salvage assets per plant, but no consistent pattern is evident. The value of current assets per plant tends to vary as much by companies with different numbers of plants as it does for pollution control categories.

Table 13

Estimated Per-Plant Net Profits before Taxes, Cash Flow, and Value of Current Assets in 19 Cement Companies, 1972, by Pollution Control Categories[a]

Company	Number of plants per company	Plants by pollution control categories	Estimated net profits before taxes per plant	Estimated cash flow per plant	Estimated value of current assets per plant
			(in millions of dollars)		
Giant Portland Cement Co.	1	1X	7.1	4.7	18.4
OKC Corporation	2	1A	1.4	0.3	3.2
Puerto Rican Cement Co., Inc.	2	2A	0.7	1.1	8.5
National Gypsum Company	2	2A	4.2	3.3	1.7
Missouri Portland Cement Co.	3	1X,1C(A),1C(H)	2.0	1.9	4.8
Oregon Portland Cement Co.	3	1X,2A	2.5	n.a.	2.6
Louisville Cement Company	3	1A	2.9	2.2	5.5
The Flintkote Company	5	5X	0.4	0.6	2.5
Kaiser Cement & Gypsum Corp.	5	3A	1.4	1.4	6.4
Alpha Portland Industries	6	2X,3A	0.4	2.8	2.8
Medusa Corporation	6	4A	1.2	1.6	4.6
Lehigh Portland Cement Co.	6	2X,3A	1.8	2.1	6.4
Penn-Dixie Cement Corporation	7	1X,1D	0.2	2.3	2.8
Amcord, Inc.	7	3X,1A,3C	0.8	0.6	6.2
Martin Marietta Corp.	9	6X,3A	1.1	1.0	4.7
General Portland, Inc.	9	5A	1.4	1.1	4.3
Lone Star Industries, Inc.	11	7X,4A	1.0	1.0	4.7
Marquette Cement Mfg. Company	12	6X,4A,2C	0.2	0.5	2.6
Ideal Basic Industries, Inc.	15	3X,6A,2C,1C(A)	2.1	1.9	3.5

a. Derived from company annual reports and Standard and Poor's stock reports, 1972.

4. Cost structure

Data on fixed and variable assets are not available in published form. Cost data for average cement plants were provided by J. D. Wilson in the aforementioned report on effluent limitation guidelines.[1]

B. Distribution of Plants by Pollution Categories

The distribution of cement plants by pollution categories was presented in Tables 12 and 13. The available financial data suggest that all of the cement companies are capable of meeting the pollution standards set for 1977 and 1983. As indicated, the polluting companies with the lowest average net profits before taxes and cash flow per plant are the companies with the lowest pollution control expenditures required per plant. The nonpolluting companies are not generally in as favorable a position in terms of profits as the polluting companies, but will also not be as directly affected by pollution control requirements. As discussed later in this report, the three companies with plants in both the A and C categories that did not generate sufficient cash flow or profits in 1972 alone to cover the total investment for pollution controls required by 1977 were those undertaking ambitious modernization programs.

C. Constraints in Financing

The constraints in financing pollution control installations in cement companies are not likely to be too stringent. As indicated above, almost all the cement companies surveyed appear to be financially able to meet investment costs just from the profits and cash flows experienced in 1972, let alone from profits and cash flow of the next few years, and no diminution of the demand for cement is anticipated, at least before 1977. As indicated in the following section on prices, estimated annual costs for water pollution abatement are likely to be relatively minor in most instances, when computed on the basis of production per ton of cement.

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1. *op. cit.*

IV. PRICE DETERMINATION

A. How Prices are Determined in the Cement Industry

Because cement is a dense, bulky commodity, the cement industry is highly localized. Cement mills are often located close to quarries, from which raw materials are obtained, and the mills serve markets that are often less than 300 miles in radius. The industry in each marketing region can be characterized as oligopolistic, or dominated by relatively few producers, each of whom sells a largely undifferentiated product. The probability is that plants or firms with a relatively large market share in a given region, and located close to raw material reserves, as well as to the market, play a significant role in establishing price.

Price, at least in an initial sense, is likely to be based on a "cost plus" mechanism. According to this mechanism, for a level of output at or above the breakeven point, average direct cost per ton of cement is estimated and a given percentage of direct cost is added to direct cost to cover both fixed cost per ton and desired profit margin per ton. The price based on this formula may be called the normal price. The actual price per ton that a firm seeks to charge in a given location is the normal price, plus the published freight charge per ton from the mill to the given customer location, minus any discounts and allowances. Hence, the actual price (including freight) that a firm seeks to charge in a given location varies according to the customer location relative to the mill.

The firm that ordinarily sets the price as price leader usually has a cost advantage based on location and scale and is usually large in terms of local market share. Other firms that have less of a cost advantage and produce lower volumes of output will charge an actual price close to that of the actual price charged by the price leader. The normal price determined by the price leader in a given location is the price at which it presumably maximizes its profits (or minimizes its losses).

The process by which price determination is achieved by the price leader is graphically suggested in Figure 3, according to the comments of F. M. Sherer,[1] but this diagram has not been substantiated by detailed supporting data during the course of this study.

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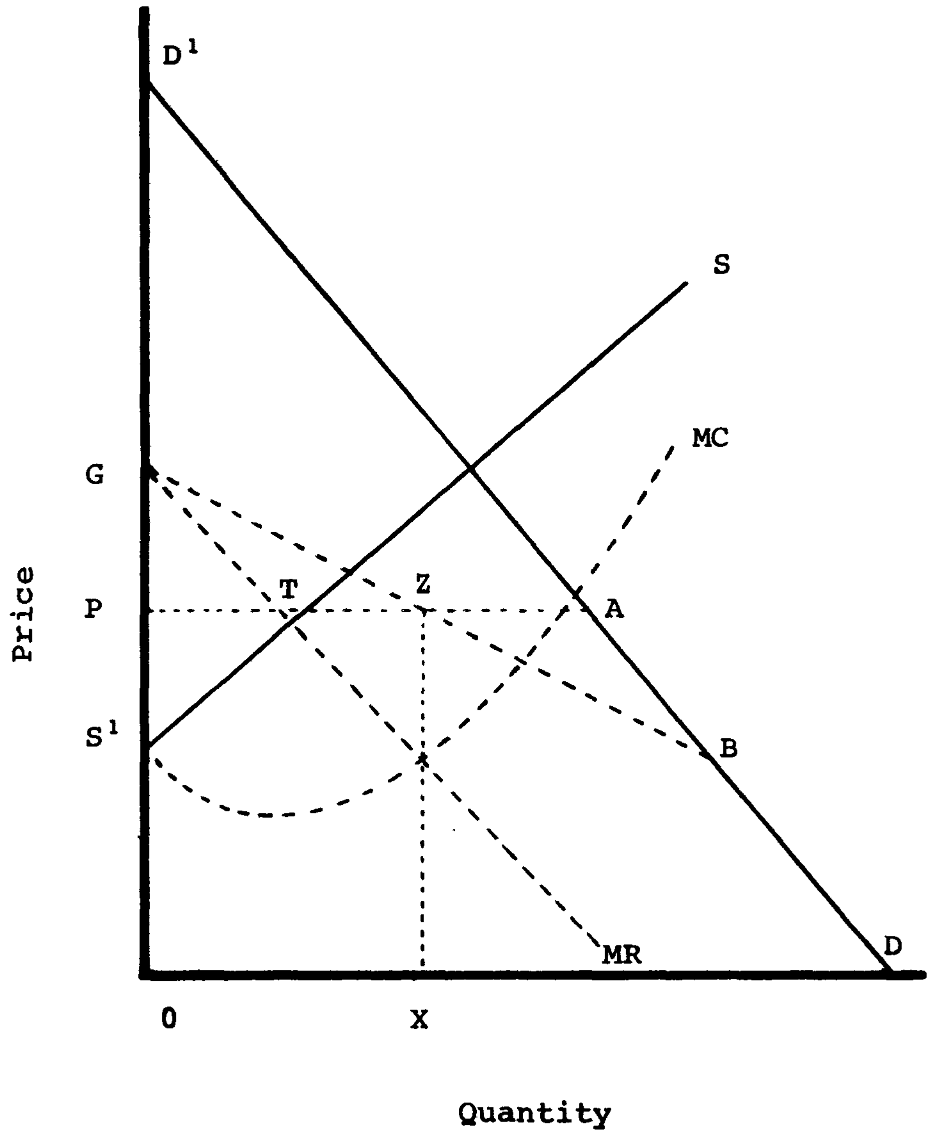
1. "Conditions Facilitating Oligopolistic Coordination", Industrial Market Structure and Economic Performance, F.M. Sherer, Rand McNally & Company, Chicago, 1970.

Figure 3
Equilibrium Under Dominant Firm Price Leadership



Cement is a homogeneous product and there are often both large and small firms producing cement in a given market area. The dominant firm supplies a major portion of the market and the fringe of competitive firms supply the rest. The fringe of competitive firms is hypothesized to take the announced price of the dominant firm and produce a level of output at which marginal revenue (MR) and marginal cost (MC) are equal, whereupon short-run marginal cost rises to equality with price. The overall market demand curve in a given location is D'D. The supply curve for all the members of the competitive fringe, except the price leader, is S'S. At the price OS' that may be set by the dominant firm, the supply of output by the fringe of competitive firms, according to Sherer, is zero. At price OG, the competitive fringe supplies all the output demanded in the market with no output left over for the dominant firm. At price OS' the entire market is held by the dominant firm. Hence, the effective demand curve of the dominant firm (residual demand curve) is a kinked demand curve, GBD. The marginal revenue curve of the dominant firm is GMR. The price announced by the dominant firm is OP, at which the dominant firm maximizes its profits (MR=MC). The output produced and sold by the dominant firm is OX=PZ and the output produced by the fringe of competitive firms is ZA=PT. The total output supplied in the market is PA=(PZ + PT) and the overall local market is in equilibrium (supply=demand).

Although the dominant firm in practice may not exactly follow a path as illustrated in the graph, the dominant firm periodically revises its price and such price revision is generally followed by the fringe of competitive firms.

The leader and its fringe of competitors generally serve a market within a radius of about 200 miles, although large-scale plants often serve markets within about 300 miles. Prices do vary from small area to small area because, apart from varying raw material conditions and processing differences, freight charges are added to the normal price. The dominant firm may serve a market beyond 200 miles, thus encroaching upon markets in other locations. In such case, the dominant firm may absorb part of the profit to achieve penetration; may give discounts or easy credit; may provide retail distribution facilities, or may give any other non-price benefit to the customer. The cement firms in a given location may also ship to other distant locations in which there is short-run excess demand over supply.

B. Likelihood of Price Changes and Possible Secondary Effects

According to the distribution of cement plants by water pollution status, it is clear that in most local geographic markets there are cement plants both with and without water pollution problems. Of all the alternative pollution control methods, Alternative E has the highest estimated additional annual cost of implementing water pollution control. Extra annual costs of implementing alternative pollution control methods are given below:

Alternative Pollution Control Methods	A	C	D	E
Extra annual average cost per short ton	$0.24	$0.40	$0.69	$0.75

These figures are arrived at by dividing the estimated incremental total annual costs per plant for each alternative by average output. The average cost per short ton was estimated as $15.91. Average mill prices[1] per short ton, average city prices, and average area prices in the United States are about $24.28, $26.00, and $27.90, respectively (see Figure 4). The difference between the average mill price and the city or area price is presumed to be reflective of freight, storage, and related charges. The average estimated additional cost for Alternative A (installation of cooling tower or spray pond and containment of runoff from dust piles is $0.24 per short ton; for Alternative C (recycle and reuse) it is $0.40; for Alternative D (same as C, plus electrodialysis of leachate to reduce TDS and recycling of leachate) it is $0.69; and for Alternative E (abandonment of dust leaching) it is $0.75.

Whether or not the demand curve shifts upwards, the primary impact of implementing water pollution control methods is most likely to be an increase in prices, however limited these increases may be and however these increases may vary from one local market to the next. The reasoning relative to the increase in prices is illustrated graphically in Figure 5.

Suppose the price leader has a plant without water pollution control problems and suppose one or all the competitive fringe firms in a given market area have to implement water pollution control methods. Then the supply curve of the competitive fringe will be shifted downwards from S_1S_1 to S_2S_2 and, hence, the demand curve of the price leader and marginal revenue of the price leader will be shifted upwards. The result will be an increase in price charged by the price leader and the other firms. The price increase is most likely to occur, however, when the price leader has to implement water pollution control methods.

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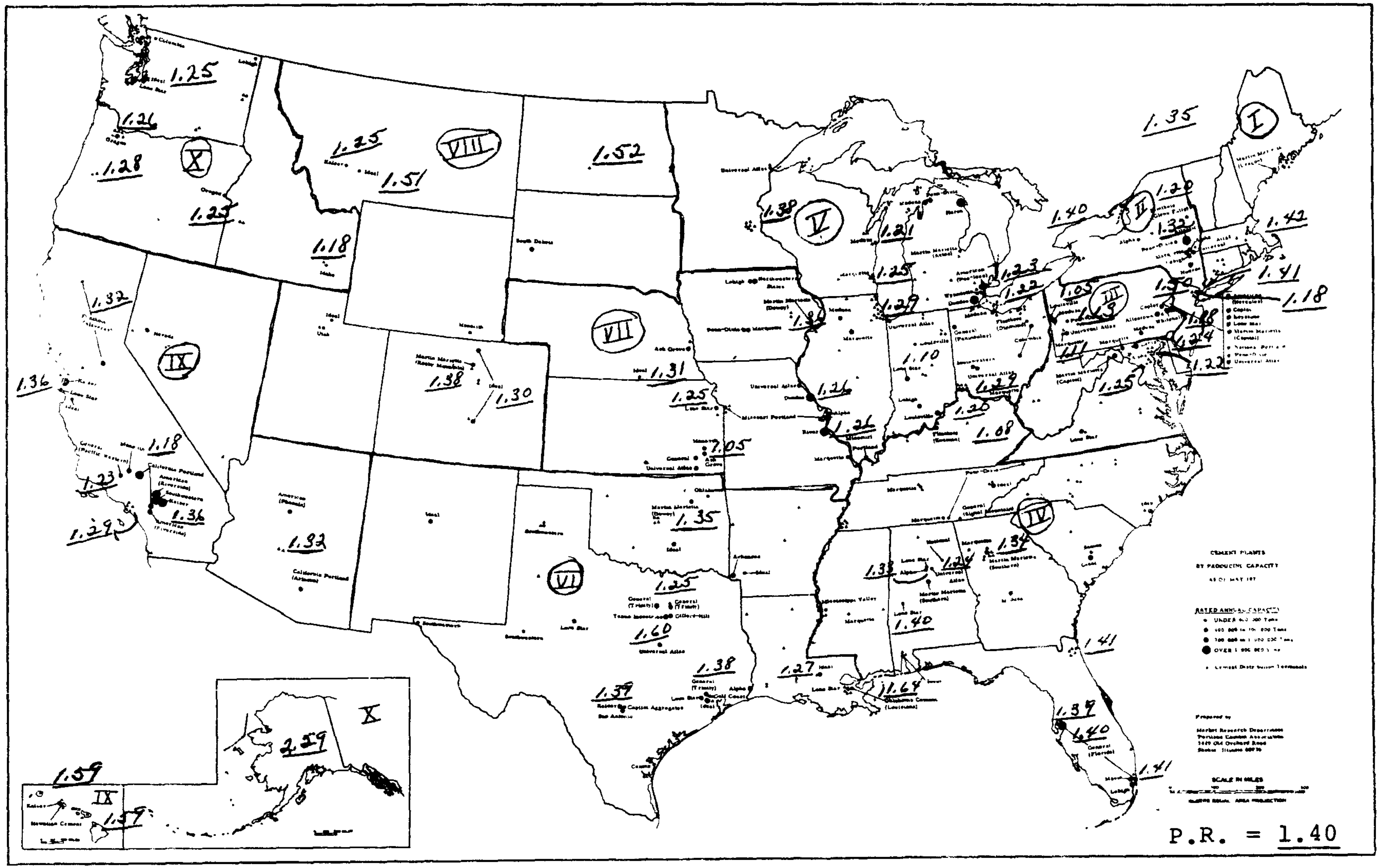
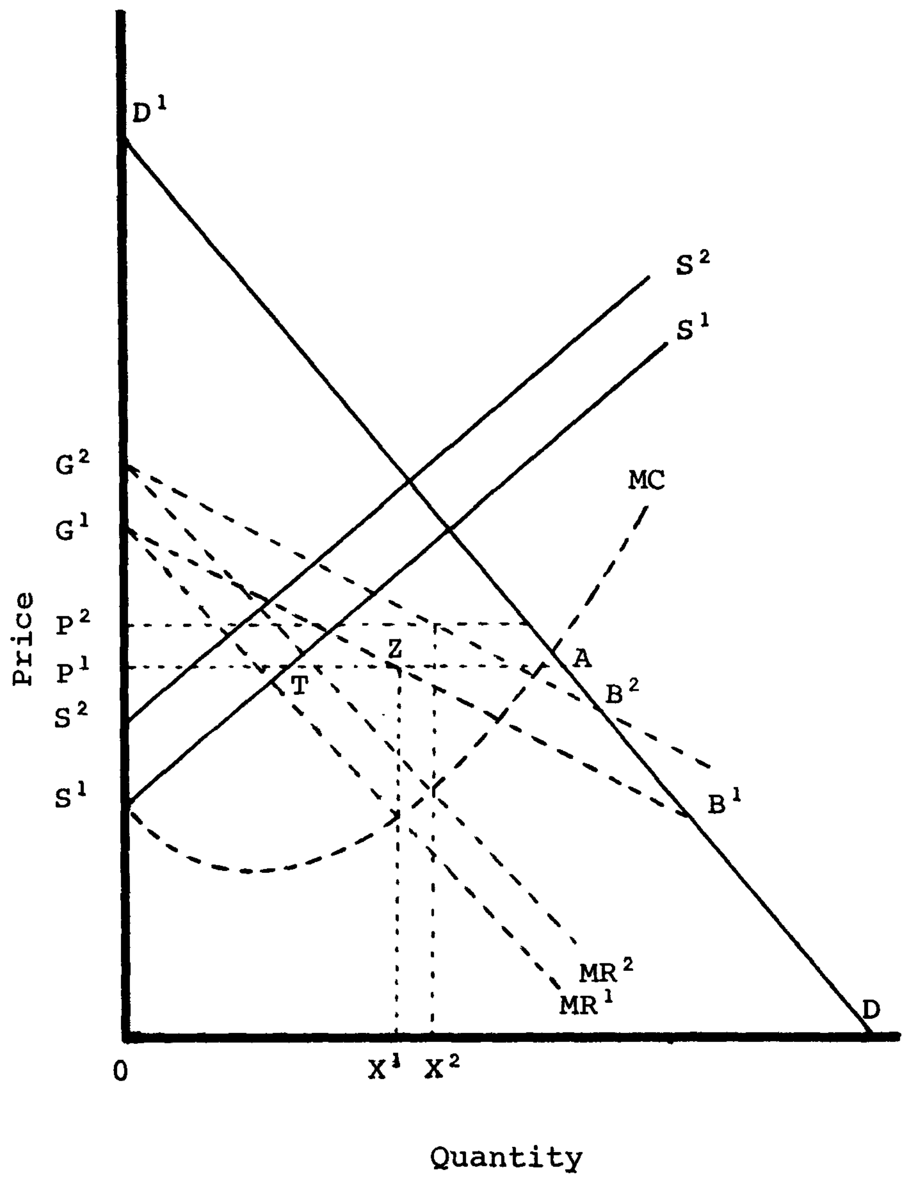
1. Engineering News Record, "Monthly Market Quotation," August 9, 1973.

Figure 4
Selected Prices of Bulk Cement[a]
(in dollars per CWT)



a. Engineering News Record, McGraw-Hill Publishing Co., Highstown, August 9, 1973. Prices are quoted after deduction for discounts and include city, mill, and area averages.

Figure 5
Equilibrium Under Dominant Firm Price Leadership
Before and After Cost Increases of Competitive Fringe Firms



Although the extent of the price increases cannot be predicted accurately, such increases, in terms of average current area prices in the United States for alternate pollution control categories, are estimated as 0.86 percent for the A category; 1.43 percent for C; 2.47 percent for D; and 2.68 percent for E. The number of plants in category A (54) is similar to the number of plants (56) without water pollution problems. The number of plants in categories C, D, and E is small. Hence, the increase in overall price because of the implementation of water pollution problems appears to be insignificant.

As a result, meaningful secondary effects in the industry are likely to be rather limited.

To the extent that some polluting plants experience an increase in variable costs, however minor, their preferred level of output will decline. But that decline in output (and sales), should it occur, is likely to be matched by an increase in output (and sales) of nonpolluters. Thus, some changes in factor employment or utilization may take place. If small plants lose sales to larger, more efficient plants, some small net loss in employment may ensue in a local market.

To the extent that costs of some polluting plants increase and if those plants choose to absorb the increase and not seek to raise prices, a decline in profits may then follow. This should be followed in turn by a reduction, however small, in state and federal corporate income taxes. To the extent that increased depreciation is involved as a result of installing new pollution control facilities, a decline in profits should be partially offset by increased cash flow.

V. ASSESSMENT OF ECONOMIC IMPACT OF POLLUTION CONTROL REQUIREMENTS ON THE CEMENT INDUSTRY

A. Best Practicable Control Technology Currently Available

The technology for implementing pollution control standards in the cement industry by 1977 is not only available and practicable, but is already operating in approximately half the 123 cement plants for which data are available. The 44 plants which have not been reviewed are also plants that have not applied for RAPP applications, suggesting that they may in fact not be discharging pollutants at this time.

B. Best Available Control Technology Economically Achievable

The most economically achievable technology for achieving essentially no discharge of pollutants in cement plants with leaching systems has not yet been determined. An electrodialysis process has been suggested, but its suitability for cement plants has not been tested. All cement plants with leaching systems, however, can at about the same level of additional capital expenditures as nonleaching plants, achieve no discharge of pollutants by abandoning their leaching systems and instituting the same pollution control procedures as nonleaching plants. This, however, will result in increased annual costs. Only two leaching plants have achieved the maximum level of pollution control attainable by technology currently available and these plants may also achieve a nonpolluting status in 1977 by abandoning their leachate systems, at least until such time as economically achievable control technology is developed.

C. New Source Standards

Standards for new sources of effluent discharges into navigable streams apparently need only be set at 1977 levels to insure that all new cement plants achieve essentially no discharge of pollutants by avoiding the use of leaching systems. Should new plants with leachate systems be built, they would have to meet the standards in effect at the time of construction.

D. New Source Pretreatment Standards

Pretreatment standards for new sources discharging process wastes into municipal sewer systems should be basically similar to the standards set for new sources discharging into navigable streams. Inasmuch as these municipal water treatment facilities have their own guidelines or limitations on allowable discharges, and few currently permit any cement plant discharges except sanitary wastes into their systems, the issue may be academic.

VI. IMPACT ANALYSIS

The economic impact of pollution control standards on the cement industry, based on data available for 35 companies and 123 plants, will involve a strain on the internal financial resources of some companies with polluting cement plants and only negligible increases in cement prices in most sections of the country. No general curtailments of production and no general manpower layoffs are anticipated as a direct result of pollution control requirements. Should the demand for cement soften relative to supply, however, a few of the more inefficient and financially weak polluting plants located close to nonpolluting plants may be among the first to be abandoned.

In the light of recent trends in the cement industry, it is unlikely that new cement plants will be built, especially new plants with leaching systems. Should new plants be built, however, they could and should be obliged to meet 1977 or 1983 standards. For that reason, new source pretreatment standards (Levels III and IV), will be unnecessary.

A. Price Effects

It has already been established in the preceding section on prices that the annual average increase in operating costs per ton resulting from pollution control installation is estimated at $0.24 per ton for the 54 nonleaching plants in the A catergory, and $0.40 per ton for the 11 leaching plants in the C category. The annual average operating costs for all plants in the C category and the two leaching plants currently meeting 1977 standards, it was estimated, will increase to $0.69 per ton at the time the 1983 standards for no discharge of pollutants are implemented.

1. Price increase

All other things remaining the same, these increased annual average costs, including interest and depreciation allowances, as was pointed out, may generally be expected to result in average cement price increases of less than 1% (0.86) for plants in the A category, of less than 1.5% (1.43) for plants in the C category, and less than 2.5% (2.47) for leaching plants meeting 1983 standards. Leaching plants choosing to abandon leachate systems may anticipate additional annual average costs of $0.75 per ton, requiring average cement price increases of a little less than 2.75% (2.68).

Estimated increases in operating expenditures as a result of pollution control requirements, however, may not, as suggested, actually result in increased prices to consumers. Part of the cost increases arising from water pollution control efforts may be absorbed in whole or in part in numerous markets across the country by cement plants located in close proximity to nonpolluting plants, if the polluting plants choose to retain their competitive market sales position. On the other hand, the domination of any local market area by polluting companies may be reflected in slightly higher prices by all cement plants, as the nonpolluting companies may also choose to raise their prices to the same level as polluting companies, especially in the face of strong demand, and increase their profits, rather than attempt to encroach on the market held by the dominant companies.

2. Secondary effects

The full range of secondary effects from price increases arising from increased costs due to pollution control efforts may include changes in the following: market share of competitors in close proximity to each other; production and employment in the various competitive plants; scale of operations of either polluters or nearby nonpolluters; profits and internal cash generation; and consumption of cement and its substitutes.

To the extent that plants experiencing such cost increases operate in local markets where nonpolluters are also located, as is the case in many areas across the nation, price increases may be forestalled, as already pointed out, and the polluting firms may be obliged to absorb such increased costs, thus sharing those increased costs between themselves and income tax collecting agencies. A rise in depreciation expenses should tend to mitigate somewhat a decline in cash flow. Should these firms choose to curtail their own production and employment and thus avoid some part of the increase in costs, that part of demand not satisfied would likely be transferred to other firms, which in turn will face the option of increasing their capacity and improving their production, thus experiencing at least a relative decline in their costs and prices.

The polluting companies, however, are often those with modernized plants and relatively high productivity. Faced with the prospect of rising short-run average total costs for pollution control in a period of relatively strong demand, these polluting firms may choose to expand their capacity and improve their productivity even further, thus protecting their shares of the market and their profitability.

If a transfer of output does occur from low-productivity to high-productivity plants in given local markets as a result of increases in average total costs arising from pollution control efforts, there may follow a minor reduction in overall employment.

To the extent that price increases arising from pollution control efforts remain negligible or, at worst, minor, resulting changes in the amount of cement consumed, in the amount of cement substitutes consumed, and in the volume of construction, should likewise be negligible or minor. Imposition of pollution controls on industries producing cement substitutes should serve to minimize further the extent of change in employment, output, and use of cement arising from the imposition of water pollution controls in the cement industry.

B. Financial Effects

The financial data covered in this report are all as of 1972, a year in which demand for cement was relatively strong, plants tended to operate at or near capacity, and profits apparently were generally high. The demand for cement from 1970 to 1980 has been estimated to increase at a 3% annual rate in Rock Products[1], and at a 3.3% annual rate in Predicasts[2]. Engineering News Record[3] has forecast an increase of 6% in profits before taxes for the cement industry as a whole between 1972 and 1973. Thus, 1972 may be considered a representative year for the decade of the 1970's for the cement industry.

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1. Rock Products, McLean-Hunter Publishing Company, Chicago, December, 1972, p 68.

2. Predicasts, Predicasts, Inc., Cleveland, April 27, 1973, p A-17.

3. Engineering News Record, McGraw-Hill Publishing Company, Hightstown, March 15, 1973, p 61.

1. Profitability

Profit data available for 19 of the 35 companies with cement plants suggest that all cement companies experienced substantial profits in 1972. The proportion of total company profits before taxes attributed to cement plants only has been estimated on the basis of the proportion of cement sales to total company sales, rather than to the actual contribution of cement plants to net profits. This proportion is, therefore, only a rough approximation based on limited data about the larger companies, but represents the only data generally available. Percentages based on sales may even be somewhat conservative because, for the two companies for which the proportion of cement net profits to total net profits was also reported, one was higher (by 10%) and one was lower (by 0.3%) than the percentages based on sales.

As indicated in Table 14, all companies for which data are presented and which operate cement plants experienced a profit in 1972, although estimated average net profit before taxes per cement plant varied from $0.16 million per plant for a company with 12 plants to $4.19 million for a company with two plants. The one-plant company with net profits after taxes of $7.1 million is not considered representative of other one-plant companies, as explained earlier in this report.

Net profits before taxes from cement operations totaled an estimated $145.0 million in 1972 for the 19 companies for which data were available. Annual operating costs for pollution controls, including the costs of capital, operation and maintenance, energy and power, and depreciation, were estimated to total $4.7 for these companies in 1977, or 3.3% of cement plant profits in 1972, and $6.0 million, or 4.2% of 1972 profits in 1983. These annual costs constitute a relatively small percentage of annual profits in most companies reported and should not adversely affect profitability to any great extent.

On a per-plant basis, however, one company is estimated to require a greater amount for annual operating expenses for pollution controls in 1977 than its estimated profits before taxes per cement plant in 1972. This same firm recently abandoned one nonleaching plant, but the plant was not discharging pollutants. It may, however, have contributed to the company's relatively poor profits in 1972.

The 19 companies for which financial data are provided account for approximately 86% of the total annual expenditures estimated for the entire industry, as summarized in Table 15, and for approximately 75% of the total estimated capital investment required in 1977 for pollution controls. Although the financial data presented in this study are limited to about half of all the companies in the industry, annual reports received from almost every company with cement plants indicated that cement operations were profitable in 1972.

Table 14

Estimated Profitability and Annual Water Pollution Control Costs for Cement Plants by Company[a]

Company	Reported total net profits before taxes (in millions of dollars)	Cement sales as a percentage of total company sales	Estimated net profits before taxes of cement plants (in millions of dollars)	Total Number of plants	Number of cement plants reported by water pollution control category	Estimated average net profits before taxes per cement plant (in millions of dollars)	Estimated annual operating costs for water pollution controls, 1977 (in millions of dollars)	Estimated annual operating costs for water pollution controls, 1983 (in millions of dollars)
Alpha Portland Industries, Inc.	6.3	33.6	2.1	6	2X,3A	0.35	0.24	0.24
Amcord, Inc.	7.4	71.1	5.3	7	3X,1A,3C	0.75	0.47	0.75
The Flintkote Company	24.0	9.0	2.2	5	5X	0.43	-	-
General Portland, Inc.	19.2	63.7	12.2	9	5A	1.36	0.40	0.40
Giant Portland Cement Co.	7.1	100.0	7.1	1	1X	7.10	-	-
Ideal Basic Industries, Inc.	36.4	86.4	31.4	15	3X,6A,2C,1C(A)	2.10	0.82	1.15
Kaiser Cement & Gypsum Corp.	13.0	55.2	7.2	5	3A	1.44	0.24	0.24
Lehigh Portland Cement Co.	12.6	86.0[b]	10.8[b]	6	2X,3A	1.81[b]	0.24	0.24
Lone Star Industries, Inc.	35.8	32.0	11.5	11	7X,4A	1.04	0.32	0.32
Louisville Cement Company	8.6	100.0	8.6	3	1A	2.87	0.08	0.08
Marquette Cement Mfg. Co.	1.9	100.0	1.9	12	6X,4A,2C	0.16	0.58	0.77
Martin Marietta Corp. (Cement and Lime Division)	86.7	11.0	9.5	9	6X,3A	1.06	0.24	0.24
Medusa Corporation	10.9	66.0	7.2	6	4A	1.20	0.32	0.32
Missouri Portland Cement Co.	7.6	80.0	6.1	3	1X,1C(A),1C(H)	2.03	0.08	0.45
National Gypsum Company	55.9	15.0	8.4	2	2A	4.19	0.16	0.16
OKC Corporation	8.6[c]	33.0	2.8[c]	2	1A	1.42[c]	0.08	0.08
Oregon Portland Cement Co.	7.6	100.0	7.6	3	1X,2A	2.53	0.16	0.16
Penn-Dixie Cement Corp.	7.4	23.0	1.7	7	1X,1D	0.24	0.13	0.22
Puerto Rican Cement Co., Inc.	1.8	79.0	1.4	2	2A	0.71	0.16	0.16

a. Financial data were derived from company annual reports and Standard & Poor's stock reports, 1972. Estimates of annual costs were derived from Development Document for Effluent Limitations Guidelines and Standards of Performance, report prepared by Southern Research Institute, Birmingham, June 21, 1973.

b. Includes sales of all construction materials.

c. Excludes extraordinary items.

Table 15
Costs of Meeting Pollution Control Requirements in the Cement Industry in 1977 and 1983[a]

Number of plants	Pollution control category	Investment: Per plant	Investment: Total 1977	Investment: Total 1983
56	X	-	-	-
54	A	$205,000	$11,070,000	-
8	C	425,000	3,400,000	$1,760,000
2	C(A)	205,000	410,000	440,000
1	C(H)	5,000	5,000	220,000
2	D	220,000	-	440,000
Total 123			$14,885,000	$2,860,000
		Annual operating costs		
56	X	-	-	-
54	A	$ 79,900	$ 4,314,600	$4,314,600
8	C	129,500	1,036,000	1,796,000
2	C(A)	79,900	159,800	449,000
1	C(H)	-	-	224,500
2	D	224,500	-	449,000
Total 123			$ 5,510,400	$7,233,100

a. Development Document for Effluent Limitations Guidelines and Standards of Performance: Cement Manufacturing Industry, report prepared for U.S. Environmental Protection Agency by Southern Research Institute, June 21, 1973.

2. Capital availability

Cash flow represents the internal generation of funds, or, as defined in earlier sections of this report, the sum of net income after taxes and depreciation less interest payments. The ease with which companies may raise funds from outside sources, particularly in periods of high interest rates and limited availability of funds, is an aspect of capital availability that has been omitted from this study.

As indicated on Table 16, the estimated average cash flow generated in 1972 per cement plant for companies for which selected data are available is less than the estimated required capital expenditures for pollution control in 1977 in the three companies with the greatest number of polluting plants. Noting that there are four years remaining to 1977, all of these three companies can readily generate sufficient internal funds to pay for these pollution control investments, but obviously, this may impinge on other necessary investments and distributions. These companies, however, all have substantial resources and, in the expectation of a continued strong demand for cement are engaged in or planning to increase capacity, rather than to shut down operations.

One of these companies has been undergoing a major management reorganization and two of its leading plants are temporarily closed for repairs and modernization. Nevertheless, the company was able to negotiate a bank loan for $20 million in 1972 for consolidation of its debts, suggesting that its operations are basically solvent. Another had been financing capital outlays through internally generated funds until 1972, but anticipates having to borrow to finance estimated capital outlays of $37 million in 1973. Some part of these outlays may well be for pollution controls. The third company has been actively engaged in enlarging capacity in its plants in recent years, using both internally generated and borrowed funds. Only one nonpolluting, nonleaching plant was abandoned in the process (in 1973). The rest of its plants are far more likely to be modernized in its continuing program of increasing capacity than to be closed.

C. Production Effects

As indicated above, expansion, rather than curtailment, of productive facilities has been the goal of cement companies, especially in more recent years, and this process is expected to be continued for the rest of this decade. Although cement production is apparently currently profitable, companies are building few new facilities, but rather are modernizing older plants in their effort to increase capacity and ostensibly improve their cost standing. In a general sense, capital expenditures for required water pollution controls appear to be almost negligible when compared with outlays for larger kilns, for

Table 16
Companies by Number of Plants and Estimated Capital Costs for Pollution Controls, 1977 and 1983[a]

Company[b]	Number of cement plants by pollution control category						Estimated capital costs, 1977, for pollution control (in thousands of dollars)	Estimated capital costs, 1983, for pollution control (in thousands of dollars)	Estimated net profits per plant before taxes, (in millions of dollars)	Estimated annual cash flow per plant (in millions of dollars)
Dundee Cement Company						1D		220		
Penn-Dixie Cement Corporation	1X					1D		220	0.24	2.27
Atlantic Cement Company		1A					205			
California Portland Cement Company		1A					205			
Columbia Cement Company		1A					205			
Louisville Cement Company		1A					205		2.87	2.23
Mississippi Valley Portland Cement Company		1A					205			
OKC Corporation		1A					205		1.09	0.30
South Dakota Cement Plant		1A					205			
Missouri Portland Cement Company	1X			1C(A)	1C(H)		210	440	2.03	1.89
Ash Grove Cement Company		2A					410			
National Gypsum Company		2A					410		4.19	3.33
Puerto Rican Cement Company, Inc.		2A					410		0.71	1.05
Oregon Portland Cement Company	1X	2A					410		2.53	N/A
National Portland Cement Company			1C				425	220		
Alpha Portland Industries, Inc.	2X	3A					615		0.35	2.75
Kaiser Cement and Gypsum Corp.		3A					615		1.44	1.41
Lehigh Portland Cement Company	2X	3A					615		1.31	2.13
Martin Marietta Corporation	6X	3A					615		1.06	0.96
Universal-Atlas Cement Div.	7X	3A					615			
Medusa Corporation		4A					820		1.20	1.56
Lone Star Industries, Inc.	7X	4A					820		1.04	0.97
General Portland, Inc.		5A					1,025		1.36	1.11
Amcord, Inc.	3X	1A	3C				1,670	660	0.75	0.64
Marquette Cement Mfg. Company	6X	4A	2C				1,480	440	0.16	0.51
Ideal Basic Industries, Inc.	3X	6A	2C	1C(A)			2,285	660	2.10	1.93
Total	39X[b]	54A	8C	2C(A)	1C(H)	2D	14,885	2,860		

a. Financial data were derived from company annual reports and Standard & Poor's stock reports, 1972. Estimates of capital costs were derived from Development Document for Effluent Limitations Guidelines and Standards of Performance, report prepared by Southern Research Institute, Birmingham, June 21, 1973.

b. The other 9 companies and 17 plants currently meeting 1977 pollution standards include Flintkote and Southwestern with 5 plants each and Giant, Gulf Coast, Monarch, National Cement, San Juan, Santee, and Whitehall with one plant each.

example. Annual operating costs for water pollution control are similarly minor compared to annual profitability. Pollution control standards, if enforced during a period of strong demand for cement, are not likely to have a serious negative economic impact on the cement industry, so far as can be determined. Should the demand for cement decrease after 1977, as it did during the 1960's, the only plants not pollutant free at that time will be those with leaching systems, which represent a minor percentage of total plants and capacity in the industry.

D. Employment Effects

Given these findings, there is little reason to expect significant adverse effects on employment in the cement industry nationally as a result of the imposition of water pollution control standards. As suggested above, in the discussion of secondary effects of price increases, the probability is that adverse effects on production and employment, to the extent they may occur are likely to be highly localized in nature, as well as limited in effect.

To provide a more detailed market-by-market analysis of production and employment effects would require far greater data than was obtained for this study on individual plant scale, economics, and finances.

E. Resultant Community Effects

As indicated above, the major community effects will be clean water and its attendant benefits, as neither plant closings nor unemployment are likely to result per se from the imposition of water pollution control requirements.

F. Effects on International Trade

Portland cement is neither imported nor exported in sufficient quantity to affect in any meaningful way our balance of payments situation. Although the quantity of cement imported has increased every year since 1968, imports in 1972 amounted to less than five million tons, or 5.3% of domestic output. This quantity was valued at less than one million dollars. Exports have not exceeded 200,000 tons annually for at least the past five years.

These increases in imports, although very likely concentrated in water oriented markets, suggest that tightness of local supply relative to growing demand may have been the primary factor at work. Satisfying water pollution abatement requirements, it has been suggested earlier in this report, is not likely to result in curtailment of supply in local markets, nor is it likely to result in significantly increased prices. Thus, there is relatively little likelihood that disproportionate increases in imports of cement are likely to occur as a result of meeting water pollution abatement requirements.

VII. LIMITS OF THE ANALYSIS AND IDENTITY OF MAJOR INFORMATION SOURCES

This study covers only 123, or 73% of the 167 plants and an estimated 80% of the total capacity and production in the cement industry. The 123 plants that are analyzed include 88 plants with RAPP applications in 1970 or 1971 and 35 plants surveyed by Southern Research Institute through questionnaires and plant visits during the spring of 1973. Information on the cement industry as a whole was obtained from the published sources listed in the Bibliography. The major sources for company financial data were publications of Dun and Bradstreet and Standard & Poor and annual reports of cement-producing companies, as well as trade journals. Cement price information was also obtained by telephone contacts with a limited number of personnel of companies involved in the cement industry.

A. Accuracy

Verification by spot checks of the data reported by plants in questionnaire responses and RAPP applications revealed a number of minor discrepancies in the technical report that have been corrected for this report. Most of these errors involved changes of 10 tons more or less in capacity and daily production. More significantly, two plants, originally classified as nonleaching plants have been reclassified as leaching plants because they use a wet-scrubber process. As a result, all references in this economic impact report to plants by pollution categories are deemed to be correct. None of these revisions, however, substantially affected the conclusions reached in this study.

B. Range of Error

There are two major possible sources of error that could not be avoided within the time and cost limitations of this study. One is the use of price information as of a specific date. Current prices, as reported in Engineering News Record vary by locality from month to month. One month prices, whether reported as FOB city, by mill, or by area, may reflect only a temporary local situation. The use of an average price, however, whether by locality or over time, would tend to distort regional prices or conceal price trends. The decision to use the latest available prices was considered to be the most expedient method of resolving the issue.

The second significant source of error arises from the technique used to estimate the proportion of a company's net profits before taxes, value of current assets, and cash flow that might be allocated to cement plants by pollution categories. Some companies make no distinction between cement and other operations, some do not separate cement from other construction materials, and a few report net profits, as well as net sales, from their cement plants. The majority, however, report revenues from cement sales, either by amount, or as a percentage, of total sales. This percentage was applied to the net profits, current assets, and cash flow of companies to determine the amount that might be allocable to cement operations. The amount computed was then divided by the total number of cement plants owned by a company to obtain an admittedly rough estimate of the average finances per plant in that company. This methodology is simple, but the explicit use of sales as a measure of the contribution of cement activities to the overall financial structure should be subjected to further validation.

C. Critical Assumptions - Sensitivity to Overall Conclusions

The critical assumptions in this study, to which the conclusions of this study are tied, involve the following points:

- nature of effluent discharges, nature of requirements for achieving essentially no discharge of pollutants, and nature of control technologies.

- costs, both capital and annual, for controlling pollutants for attaining essentially no discharge of pollutants; such costs are implicitly dependent on the available technology

- local or regional nature of cement markets and dispersion of polluting and nonpolluting cement plants in many local or regional markets across the nation

- oligopolistic nature of, including product homogeneity and, in most local or regional markets, the probability of price leadership

- high frequency of polluters among moderate and large-size companies that are apparently enjoying fairly good profits and cash flow

- relatively strong demand for cement compared to supply in the nation and in many local or regional markets currently, a condition that is expected to continue for some time
- proclivity of cement companies to modernize and expand capacity, rather than build new plants

Taken together, these points and the introduction of quantifying and qualifying facts about them, lead to the conclusion that generally, across the nation, the economic impact of costs for achieving water pollution control standards will tend to be negligible, and that problems that do arise will tend to be minor in their effects and highly localized. A relaxation of the assumptions will necessarily force changes in the conclusions.

D. Unanswered Questions

The primary unanswered questions pertain to the following:

- the actual additional costs that are likely to be experienced by individual plants in their effort to meet standards
- the specific economic character, including price levels, of the many local cement markets and the actual role of polluting and nonpolluting plants in these markets
- the actual financial status of the various polluting plants and their parent companies

The nature of the information available thus far and presented in this report, however, leads to the conclusion that the conclusions about the economic impact of water pollution standards are reasonable and defensible.

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Martin Marietta Corporation
Medusa Corporation
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National Gypsum Company
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Universal-Atlas Division, United States Steel Corporation

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This report assesses the economic impact of estimated costs for water pollution controls on the cement industry. The analysis is based on a segmentation of cement plants by the alternative controls required to achieve essentially pollutant-free effluent discharges by 1977 or 1983, and on the financial ability of companies with polluting plants to meet the proposed standards. The conclusions reached, based on the data available, are that the imposition of pollution controls may strain the internal financial resources of some companies and will probably result in very limited increases in cement prices, but will not lead to plant shut-downs or increases in unemployment provided the demand for cement continues at present levels.

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17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

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