FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

THE ECONOMICS OF CLEAN WATER

U. S. DEPARTMENT OF THE INTERIOR

CLEAN WATER

THE ECONOMICS OF CLEAN WATER

Summary Report

U. S. Department of the Interior
Federal Water Pollution Control Administration
March 1970

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UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

APR 3 1970

Dear Mr. President:

I am transmitting to the Congress the third report on the national requirements and cost of water pollution control as required under Section 16 (a) of the Federal Water Pollution Control Act, as amended.

The decade of the 1970's, a decade which will address itself to improving the quality of man's environment, will see great strides toward the effort to abate water pollution. The enclosed report entitled "The Economics of Clean Water" represents our current estimates of the investment levels necessary to attain applicable water quality standards.

This report, along with the two previously submitted, contributes to closing the information gap in terms of the overall magnitude, geographical, and financial dimensions, all of which are essential to the development of national policies and programs directed toward achieving water quality standards in an efficient and effective manner.

The alternatives analyzed in the course of this study, especially those aspects contained in Volume I, presented valuable background for development of proposals on aid to municipal treatment works presented to the Congress in the President's Environmental Message and subsequent legislation.

There are four parts to this year's report. The first is a summary of major findings and conclusions of the analysis. The second, Volume I, contains the details of the analysis. The third, Volume II, is a profile of animal wastes. The fourth and last section, Volume III, is an industrial profile of the inorganic chemicals industry.

Sincerely yours,

Walter J. Hickel

Secretary of the Interior

Hon. Spiro Agnew
President of the Senate
Washington, D. C. 20510

Enclosure

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Hon. John W. McCormack
Speaker of the House of
Representatives
Washington, D. C. 20515

Enclosure

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THE ECONOMICS OF CLEAN WATER

INTRODUCTION

This is the third in a series of reports to the Congress on the subject of the cost of treating liquid wastes that the Secretary of the Interior is charged to deliver annually, under the terms of the Federal Water Pollution Control Act.

The first report in the series attempted to draw together and evaluate in gross fashion all available information on water-borne waste sources, treatment technology, and control deficiencies. The second report examined the processes of providing physical capital for waste treatment--the interaction of funds over time under the influence of developing technology, shifting regulatory requirements, rising demand, and normal replacement conditions.

This report combines the concept of investment processes developed in the second report with the generally held concept of an investment gap that was evaluated in the first report. Its product is the definition of a rate of investment that will close the gap for municipal and industrial waste treatment within a five year period, given the continued pertinence of today's regulatory and technological conditions. Detailed studies of the pollutional impact of the inorganic chemicals industry and of concentrated animal populations are submitted as separate sub-reports.

The report considers several issues germane to the policy decisions required with the expiration of current municipal grants legislation. The alternatives and conclusions reached in this report are intended to be illustrative and suggestive, not statements of policy. Economic analysis can provide insights into the consequences of alternative actions, but the political process must in the final analysis mold the necessary decisions within the context of total national interests and values.

A number of subsidiary issues are considered, including the influence of industrial waste discharges on public investment outlays, the influence of location on unit investment, the status of broadly integrated regional waste handling systems, the incidence of recapitalization, the influence of price levels on investment, and patterns of change in the real cost (i.e., costs adjusted for price levels changes) of waste treatment facilities. Consideration of these and

other sub-questions was consistently pointed to their relationship to the problem of deriving a normative annual level of investment, one appropriate to five year attainment of an investment equilibrium in the public waste treatment sector; and the force of Federal assistance programs on investments is a minor theme that pervades the report.

This is a summary report. Detailed information is contained in three appendix volumes, Volumes I through III. Volume I (Detailed Analysis) contains the detail of the comprehensive assessment of the Nation's municipal sewage systems. Volume II (Animal Waste Profile) contains a study of the animal feeding industry which describes the scope of the problem and possible measures of control. Volume III (Inorganic Chemicals Industry Profile) is an industrial profile covering the description of the industry and the costs to attain various levels of pollution abatement over the five year period through 1974.

Background

History

Section 16(a) of The Federal Water Pollution Control Act, as amended, requires the Secretary of the Interior to deliver to the Congress on January 10, 1968, an estimate of the five year costs of treating municipal, industrial and other effluents, and to update the report annually thereafter.

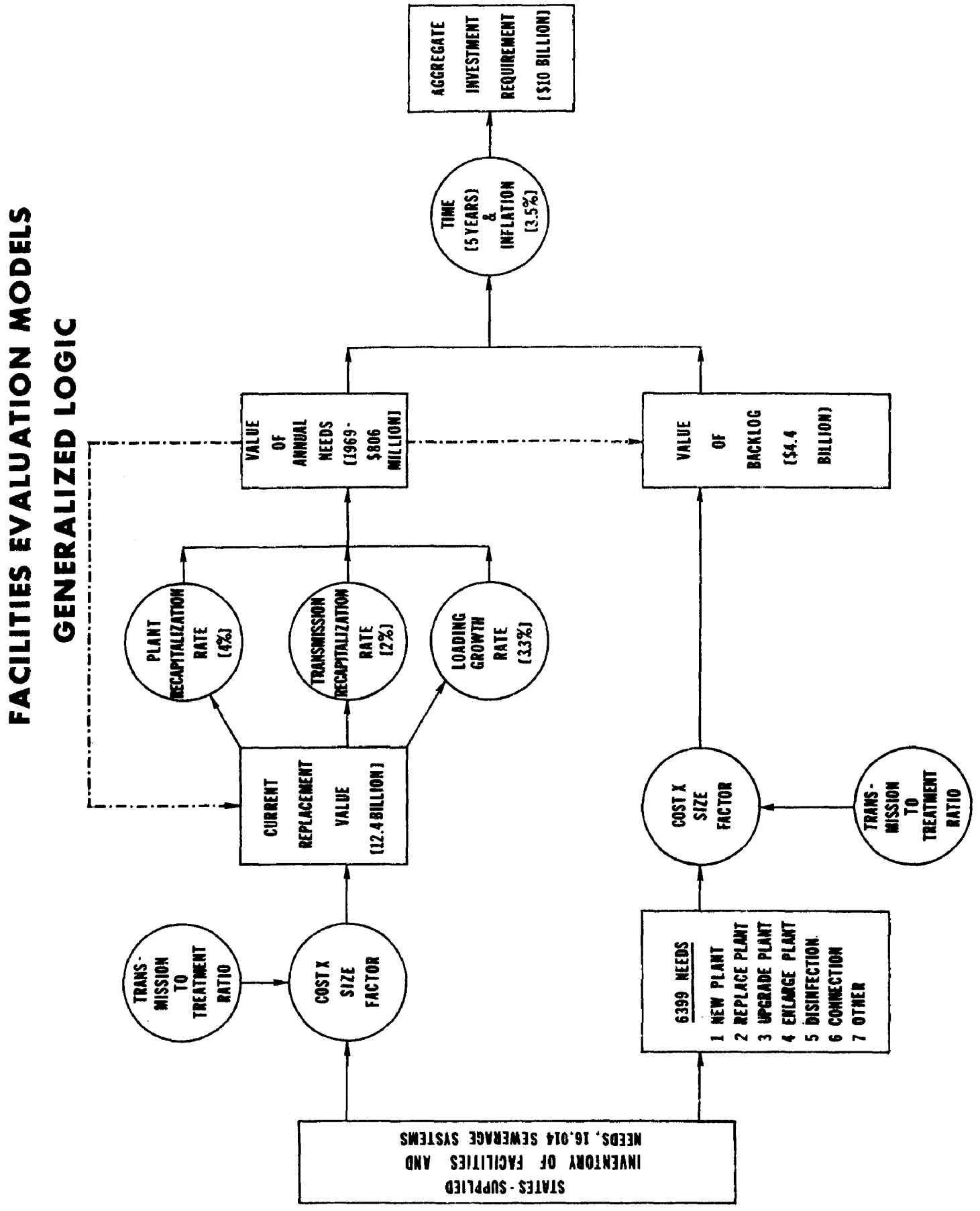
The current report is the third in the series. The first, that assessed municipal investment requirements for the period 1969 to 1973 to be $8.7 billion, was critized by twelve States for estimating too low and by two States for estimating too high. The second report, without reassessing the five year need, examined the influences that determine investment levels, and concluded that the critical factors were to be found in the dynamics of the situation--in the interaction of investment with time-conditioned growth, replacement, and demand for higher efficiencies. It was also found that regional cost differences, transmission cost, and influence of industrial waste loadings were more important matters than had been previously believed.

This report consists primarily of a comprehensive reassessment of the nation's municipal sewage treatment needs and costs. Each reported need associated with those systems was evaluated individually on the basis of the kind and normal size of the project required to eliminate it and the average unit cost of components required. In addition, adjustments were made to reflect the higher than average costs that occur in some States. Expected future needs and unreported needs were also evaluated in terms of observed statistical relationships between capital supply and growth and replacement factors. The report also deals with industrial investment requirements, historical investment, Federal cost-sharing, priority systems, public treatment of industrial wastes, and status of regional waste handling systems.

Method

The analysis was based on the 1968 Municipal Waste Inventory and on investment outlays reported for the period 1952-1969. Because of the large number of calculations involved, most of the operations were performed on a digital computer, with three separate programs developed for the purpose. The basic logic is described in the accompanying figure.

Figure 1


FACILITIES EVALUATION MODELS
GENERALIZED LOGIC
STATES - SUPPLIED
INVENTORY OF FACILITIES AND
NEEDS, 16,014 SEWERAGE SYSTEMS
6399 NEEDS
1 NEW PLANT
2 REPLACE PLANT
3 UPGRADE PLANT
4 ENLARGE PLANT
5 DISINFECTION
6 CONNECTION
7 OTHER
COST X SIZE FACTOR
TRANS-MISSION TO TREATMENT RATIO
CURRENT REPLACEMENT VALUE (12.4 BILLION)
COST X SIZE FACTOR
TRANS-MISSION TO TREATMENT RATIO
PLANT RECAPITALIZATION RATE (4%)
TRANSMISSION RECAPITALIZATION RATE (2%)
LOADING GROWTH RATE (3.3%)
VALUE OF ANNUAL NEEDS (1969 - $806 MILLION)
VALUE OF BACKLOG ($4.4 BILLION)
TIME (5 YEARS) & INFLATION (3.5%)
AGGREGATE INVESTMENT REQUIREMENT ($10 BILLION)

Results derived were compared to point by point estimates for specific projects developed by each of the States. Agreement was extremely close for total national values, though differences occurred with respect to individual States.

Limitations

The over all reliability of the national assessments presented in the report is considered to be high; but that reliability is due in some measure to built-in statistical factors that are not distributed equally below the national level. For that reason, in the case of certain States the results of the model are of questionable accuracy. While the reported evaluations and projections may be applied with considerable confidence at the macroeconomic level, caution should be used in interpreting them with respect to any individual State; and it should be recognized that projections and economic assumptions have an inescapable element of uncertainty.

Conclusions

Investment Trends

The over-all level of investment is rising steadily, though some States had begun to cut back their investment in the last three years. Investment of $880 million in 1969 did little more than cover replacement and growth needs developed in the same year. The distribution of Federal assistance, by favoring low population States, may have contributed to an imbalance in investment in the past; and delays caused by local governments that wait for State financial participation seem to be a factor in low relative investment in some States. More than offsetting these influences is a major rise in investment in other States as a result of active programs of State participation in financing construction.

Investment Needs

On January 1, 1970, the nation's municipal waste-handling systems presented the need for the investment of $4.4 billion, and were generating additional needs at the rate of over $800 million a year. With expected growth of the system, and inflation occurring at an average rate of 3.5% a year, total investment requirements will conservatively amount to $10 billion over the five years 1970-74 if all existing deficiencies are remedied and no new deficiencies are allowed to occur.

The underlying determinant of need is population, but other factors have an influence, particularly for the short run. Local design practice, nature of industrial specialization, climate and geology, and the extent to which controls have previously been achieved all bear upon the level of investment required. Needs are very

unevenly distributed, even on a per-capita basis; and the heaviest incidence of requirements is found in the Northeast quartile of the United States, where waste treatment prevalence lags, and unit costs of construction are at least twice the national average.

Current estimates by Federal agencies of their budget requests for construction of waste collection, treatment, and disposal facilities amount to almost $0.25 billion. No evaluation of these costs has been presented in previous cost estimate reports.

Federal Cost Sharing

Financial constraints on local governments, perhaps reinforced by expectations of Federal assistance, have created a general dependence on Federal revenues; and any expansion of local government services may be expected to require increasing Federal assistance--particularly under conditions of money market constraint. At the present time, the Federal share of all local waste-handling costs (including operating charges and sewer installation investments) is 18%, or about the same as the over-all level of Federal assistance to local governments for all purposes. While Federal waste treatment plant construction grants have in the past been very effective in eliciting investment response, that effectiveness has steadily declined. Where $13.70 of total investment for waste-handling works was made in 1960 for every dollar of FWPCA grants, by 1967 that ratio had slipped to $5.20 per FWPCA dollar as a result of a larger average Federal share of the cost of most projects, the meaningful inclusion of large projects that received little assistance under earlier forms of the Act, and continuing decline in sewer installations--a form of activity that receives very little Federal assistance.

Priority Systems

Although the Federal Water Pollution Control Act requires that applications for construction grants be rated on a priority basis, the priority system has been ineffective in directing funds to the most useful projects. Since there is no requirement that priorities be established for every potential project, States restrict the system to applicants for funds. In consequence, allocation of funds has in most cases been unguided by effective priority considerations. Willingness of the community to proceed with a project is the operative allocation mechanism.

Public Treatment of Industrial Waste

Roughly half of the water and an even larger portion of the polluting materials discharged through public sewerage systems is of industrial origin, if one includes commercial, service industry, and dry process factories. The recent tendency for large wet process factories to connect to public systems is generally realized to

have efficiency and economy benefits, but also to serve as a means of shifting private costs to the public sector. Recognizing that inequities are associated with any solutions to the apparent problem, it is concluded that the most desirable policy would be to continue to accept all industrial wastes that can be treated in municipal plants but to establish user fees that create a correspondence between the fee paid by each user of the system and the cost incurred to collect and treat his wastes.

Regional Waste Handling Systems

There are great advantages in theory to establishing coordinated river basin organizations for the purpose of managing the handling and treatment of wastes. But while the establishment of such systems is generally encouraged, none exists in full scale in the U. S. today. The reason appears to be a resistance on the part of State and local governments and on the part of industry to the establishment of such special purpose governmental units, unresponsive to other social purposes.

Related kinds of systems are, however, developing in the U. S. Metropolitan sewerage services are practically universal today. Moreover, some of the States are in the process of creating State-wide systems that coordinate financing, planning, and operation of sewerage services. Both trends are considered to be desirable, in that they have many of the potential advantages of river basin systems and are suited to American political behavior.

Status of Prior Investment Estimates

Public Waste Treatment, Transmission, and Disposal

The current estimate of the expectable amount of the investment required within the next five years for facilities to comply with water quality standards is about $10 billion.

The estimate differs from the $8.7 billion estimate presented to the Congress in 1968 for two reasons. 1) Two years of sub-standard investment, together with two years of growth, replacement, and greater than anticipated inflation, have caused a real increase in the required amount of investment. 2) FWPCA has improved its knowledge of the situation in two years. In particular, the current estimate is considered to reflect more accurately: a) ratio of transmission and outfall costs to treatment plant costs, b) influence of location on construction costs, c) annual effects of growth and recapitalization, and d) level of industrial connections to public systems.

Collecting Sewers

No change has been made in the $1.2 billion a year estimate presented in the initial report.

Separation of Storm Sewers

Activity in this area continues to take place largely in the area of research and development. Absence of a scientific concensus on the nature of the problem and control procedures suggests that the extremely broad $15 billion to $49 billion estimate provided in 1968 continues to reflect the clearest evaluation of the potential investment consequences of this very undefined problem.

Industrial Waste Treatment

The current estimate of the five year investment requirement associated with treatment of industrial wastes is a probable value of $3.3 billion, in a range of $2.2 billion to $4.4 billion--the breadth of the range indicating the variety of technological possibilities. The assessment is essentially the same as that presented in the 1968 report, but updated to include the estimated effects of investment, growth of demand, recapitalization requirements, and inflation in the intervening period. While lack of an industrial waste inventory precludes meaningful improvement of the estimate, information made available over the last two years generally corroborates its validity.

Industrial Cooling Facilities

The estimate of the cost of comprehensive controls is $1.9 billion, a simple updating of the 1968 estimate. The figure must be assumed to represent a maximum value, since no regulatory concensus (such as the secondary waste treatment requirement) has been reached for thermal controls.

Sediment Control and Acid Mine Drainage Reduction

No information has appeared to justify the modification of the $1.7 billion to $6.6 billion range developed earlier. The physical situation is materially unchanged, and the validity of the estimates depends upon those conditions.

Inorganic Chemicals Industry

Inorganic chemicals include a broad variety of products, mostly bulk-produced intermediates but including a number of final products. Growth of demand varies among the segments of the industry, but production growth has consistently been 1.5 to 2.0 times the growth of GNP. Production tends to follow location of raw materials, and is concentrating in the Southwest and Midwest. Inorganic dissolved solids, suspended solids, and extremes of acidity or alkalinity are characteristic of process wastewater; and waste treatment methods are limited to physical and chemical methods. Current materials removal efficiency of the total industry waste treatment system is estimated to be only 27%--less than half of that for municipal waste or organic chemicals, where biological treatment processes are possible--though widespread application of neutralization effects a substantial reduction of pollutional effects that is not accompanied by materials reduction. Current replacement value of waste treatment facilities is estimated to be about $300 million, and operating charges are estimated to amount to more than $80 million a year. To sustain the current level of treatment through 1974 is estimated to require expenditure of an incremental $200 million and to add more than $50 million a year to operating charges.

Animal Feeding Industry

Locational concentration is the principal technological development of the industries whose raw materials are animals. Development of large beef fattening operations is the most obvious manifestation of the trend, but fewer and large dairy, swine fattening, and poultry producing activities is also part of the development. Roughly half of the beef cattle marketed today are fattened in ten States; and in those States, the majority of the animals are sold from the relatively few feedlots with capacities of 1000 head or more.

Such large concentrations of animals pose a potential source of water pollution, particularly in that they tend to occur in arid or semi-arid regions where intermittent flushing rains combine with low streamflow. Control measures vary, ranging from such simple expedients as ditching around lots (to reduce incidence of polluted runoff) to sophisticated techniques such as adjusting feeding cycles and animal concentrations to climatic cycles, to regular hydraulic flushing with collection and treatment of wastewater. There is no single method of control that combines the desirable features of low cost, dependability, and climatic relevance. Significant is the fact that the problem is seldom clear cut, but only potential; with lot size, climate, type of feeding, and soil conditions all relevant to the situation of any unit.

TABLE 1

Water pollution control investments moved to a new high in 1968, in spite of a decline in outlays for industrial waste treatment and collecting sewers.

Table 1

Comparative Investment Outlays for
Waste-Handling Purposes, 1967 & 1968

Investment Category	Investment (millions of current dollars)	
	1967	1968
New Waste Treatment Plants	149	180
Expansion, Upgrading, Replacement	213	189
Interceptors & Outfalls	188	284
Collecting Sewers	606	550
Industrial Waste Treatment	564	529
Total Capital Outlay	1,720	1,732

TABLE 2

Estimated public investments for water pollution control facilities have increased steadily in recent years, with State financial assistance becoming an increasingly effective incentive. In a number of States, however, investments during the last three years have reflected a reduction from the level of the previous five years.

TABLE 2

Estimated Annual Public Investment
for Waste Treatment Plants and
Ancillary Works, by State

	Average, 1962-66	1967	1968	1969 est.	1967-69 Avge / 1962-66 Avge
Alabama	6.6	12.6	4.3	18.5	179%
Alaska	0.3	0.1	4.0	0.2	478%
Arizona	5.8	5.4	2.9	5.9	82%
Arkansas	6.4	10.7	3.2	10.5	127%
California	34.0	43.0	34.9	41.1	117%
Colorado	7.4	3.0	4.6	10.5	82%
Connecticut	8.2	17.7	7.9	71.5	395%
Delaware	2.2	-	1.0	1.4	36%
District of Columbia	6.8	13.6	3.2	6.4	114%
Florida	10.6	9.4	16.8	29.6	175%
Georgia	8.7	13.2	4.5	22.7	155%
Hawaii	5.5	4.4	-	0.5	30%
Idaho	0.9	1.3	0.7	1.9	144%
Illinois	30.9	45.3	33.5	33.2	121%
Indiana	16.8	24.4	27.1	10.3	123%
Iowa	7.3	8.2	13.1	14.6	164%
Kansas	5.3	5.2	11.1	4.5	131%
Kentucky	7.0	4.0	4.4	10.9	92%
Louisiana	11.2	7.6	4.5	11.0	69%
Maine	3.3	1.4	5.7	10.0	173%
Maryland	7.7	20.2	17.3	31.0	297%
Massachusetts	12.4	6.7	13.4	28.1	130%
Michigan	21.1	7.6	30.4	5.7	69%
Minnesota	10.4	8.6	13.3	13.3	113%
Mississippi	4.3	2.7	2.7	2.4	60%
Missouri	21.1	15.2	26.5	12.8	86%
Montana	1.3	0.5	1.3	1.3	79%
Nebraska	4.8	4.5	2.0	3.0	66%
Nevada	3.5	3.4	0.4	0.2	38%
New Hampshire	3.1	2.0	6.0	1.9	106%
New Jersey	15.9	30.0	10.5	40.2	169%
New Mexico	3.4	4.0	0.4	3.5	77%
New York	40.6	33.3	115.0	97.0	201%
North Carolina	14.8	18.7	10.8	17.3	105%
North Dakota	0.8	0.8	0.3	0.4	63%
Ohio	23.5	26.1	35.1	41.9	146%
Oklahoma	4.0	6.5	5.5	14.6	222%
Oregon	5.5	3.2	3.3	7.6	85%
Pennsylvania	23.8	42.6	65.3	90.2	277%
Rhode Island	2.8	1.0	1.2	1.9	49%
South Carolina	5.2	4.6	10.5	26.0	263%
South Dakota	1.5	2.9	0.2	1.8	109%
Tennessee	10.5	5.1	19.9	18.6	138%
Texas	17.5	14.9	17.1	38.2	134%
Utah	2.8	1.9	0.1	1.2	38%
Vermont	3.4	1.8	2.4	3.9	79%
Virginia	10.7	20.9	10.4	25.0	175%
Washington	20.5	3.8	20.9	4.6	48%
West Virginia	6.2	1.2	3.0	4.0	44%
Wisconsin	18.2	13.4	17.1	20.7	94%
Wyoming	0.2	-	-	0.8	133%
Puerto Rico	1.8	3.8	-	6.5	191%
Totals	508.9	542.4	652.1	880.8	136%

TABLE 3

Almost eighty percent of the Nation's sewered population is located in States where per-capita public investment for waste treatment is rising. For the most part, instances of investment stability or relative decline correlate with a lesser incidence of untreated waste and wastes with only primary treatment.

TABLE 3

Comparative Categorization of States
by Recent Investment Behavior

	Percent of National Total						Average Annual Per-Capita Investment*			
	Sewered Population	Sewered Pop. w/o Treatment	Sewered Pop. w/Primary Trtmt.	Investment 1952-66	Investment 1967-69	Current Investment Requirements	1952-55	1956-61	1962-66	1967-69
States with major increases (150% or more of 1962-66 average) in investment in 1967-69:										
Alabama, Alaska, (Connecticut), Florida, Georgia, Iowa, (Maine), (Maryland), (New Jersey), (New York), Oklahoma, (Pennsylvania), South Carolina, Virginia, Puerto Rico	35.6	42.1	38.0	32.9	48.9	40.2	(1.95) 1.60	(2.40) 2.42	(2.88) 3.20	(5.37) .6.98
States with increases (111-149% of 1962-66 average) in investment in 1967-69:										
Arkansas, California, District of Columbia, Idaho, Illinois, (Indiana), Kansas, (Massachusetts), Minnesota, Ohio, Tennessee, Texas, Wyoming	42.6	30.2	38.1	39.4	33.9	32.0	(1.64) 1.34	(2.57) 2.60	(2.85) 3.16	(3.11) 4.04
States with substantially unchanged (90-110% of 1962-66 average) investment in 1967-69:										
Kentucky, New Hampshire, North Carolina, South Dakota, Wisconsin	5.1	3.3	3.3	7.7	6.4	6.7	(1.77) 1.45	(3.63) 3.67	(5.82) 6.46	(4.91) 6.38
States with declining (75-89% of 1962-66 average) investment in 1967-69:										
Arizona, Colorado, Missouri, Montana, (New Mexico), (Oregon), (Vermont)	5.3	4.8	3.9	6.9	5.8	7.0	(1.21) 0.99	(2.37) 2.39	(6.02) 6.68	(4.29) 5.58
States with sharply declining (74% or less than 1962-66 average) investment in 1967-69:										
(Delaware), Hawaii, Louisiana, (Michigan), Mississippi, Nebraska, Nevada, North Dakota, (Rhode Island), Utah, (Washington), West Virginia	12.6	20.0	17.5	14.3	6.8	14.1	(1.34) 1.10	(2.56) 2.59	(4.50) 5.00	(2.12) 2.76
United States Totals	100.0	100.0	100.0	100.0	100.0	100.0	(1.67) 1.37	(2.54) 2.56	(3.33) 3.70	(3.91) 5.08

* Per-capita investment based on 1968 sewered population, Constant (1957-59) Dollars in Parentheses

Note: States which provide financial assistance are underlined and States with funded assistance programs are indicated by parantheses.

TABLE 4

Industrial investments for environmental protection -- 50% to 55% of the total is for water pollution control -- rose strongly over the previous year during 1969, if first quarter projections are to be believed. In 1968, however, such projections proved to be a very unreliable guide.

TABLE 4

Industrial Pollution Control Investments,
as Reported by McGraw Hill
(Millions of Dollars)

INDUSTRY	Projected 1968	Actual 1968	Planned 1969
Iron & Steel	$ 144	$ 123	$ 184
Nonferrous metals	37	13	51
Electrical machinery	116	38	47
Machinery	41	58	83
Autos, trucks & parts	66	29	49
Aerospace	8	14	15
Other transp. equipment (RR Equipment., ships)	3	12	17
Fabricated metals & instruments	41	40	57
Stone, clay & glass	40	33	56
Other durables	89	28	93
TOTAL DURABLES	585	388	652
Chemicals	112	104	126
Paper & pulp	91	91	104
Rubber	6	6	11
Petroleum	102	157	160
Food & beverages	32	15	31
Textiles	26	13	19
Other nondurables	40	2	10
TOTAL NONDURABLES	409	388	461
ALL MANUFACTURING	994	776	1,113
Mining	83	49	71
Electric & gas utilities	481	223	284
ALL INDUSTRY	$1,558	$1,048	$1,468

TABLE 5

Waste treatment requirements are dynamic. New needs are constantly being generated out of the inescapable pressures of replacement and growth.

TABLE 5

Normative Assessment of Annual Capital Needs Generated in 1962 and 1968

A-Millions of 1957-59 Dollars

	1962	1968
Replacement Value of Trtmt.Plants	2975.2	4132.7
Recapitalization @ 4%	119.0	165.3
Replacement Value of Assctd.Works	3498.9	4847.0
Recapitalization @ 2%	69.8	69.9
Loading growth at 3.3%	213.3	296.3
Incremental Recapitalization for plants to be upgraded at 4%	22.9*	25.5*
Annual Needs developed in year	425.0	584.0

B-Millions of Current Dollars

	1962	1968
Replacement Value, Plants	3183.5	5703.1
Recapitalization @ 4%	127.3	228.1
Replacement Value, Assctd.Works	3743.8	6688.9
Recapitalization @ 2%	74.7	133.7
Loading Growth @ 3.3%	228.2	408.9
Incremental Recapitalization for plants to be upgraded at 4%	24.5*	35.2*
Annual Needs	454.7	805.9

*Value considered to be associated with primary treatment capacity required to be upgraded to secondary treatment.

TABLE 6

Deficiencies associated with the Nation's public waste handling systems have increased steadily -- both in number and in terms of population affected -- as the system has expanded. The nature of deficiencies has changed, with major and minor upgrading requirements progressively replacing the need for new plants. The condition is considered to be expectable, entirely consistent with the realities of an expanding economy and the growing maturity of our waste handling systems.

TABLE 6

Increase in State Government Defined
Waste Treatment Needs Over Time*

Kind of Need	Number of Systems			Population Served (000's)		
	1957	1962	1968	1957	1962	1968
New Plants	2549	2143	1586	13,504.0	13,058.4	9,575.3
Replacement	973	853	625	3,101.6	3,888.2	1,719.9
Enlargement	688	809	1003	15,315.9	24,849.0	27,861.6
Additional Treatment	753	821	2130	7,687.0	8,215.8	36,327.5
Chlorination	41	42	723	598.1	201.4	2,937.8
Improved Operation	329	332	209	887.3	1,068.2	888.8
Connection	57	45	123	676.4	482.3	1,019.7
Total No. Needs	5390	5045	6399	41,770.3	51,763.3	80,330.6
Total Systems	10,511	11,006	13,849	98,361.9	118,371.9	139,726.7
% w needs	51.3	45.8	46.2	42.5	43.7	57.5
New Facilities 1/	3579	3311	2334	17,282.0	17,428.9	12,314.9
Major Upgrading 2/	1441	3071	3133	23,002.9	33,064.8	64,099.1
Minor Upgrading 3/	370	374	932	1,485.4	1,269.6	3,826.6

*Source: Municipal Waste Inventory, 1957, 1962, 1968

1/ New Plant, replacement, connection
2/ Enlargement, additional treatment
3/ Chlorination, improved operation

TABLE 7 A through C

Although the Nation entered 1970 with about $4.4 billion of waste treatment needs, it will require $10 billion to eliminate such needs within five years, due to the dynamic effects of growth recapitalization, and price level changes. At lower levels of investment, the reduction of accumulated needs takes longer to accomplish: and with investments of less than $1.5 billion a year it is mathematically impossible to achieve a state of investment equilibrium.

TABLE 7
Water Qualitv Standards-Related Public Investments
(Values in Millions of Current Dollars)

A- Five Year Backlog Elimination Schedule

Year	"Backlog" at year end	Growth	Recapitalization	Investment
1969	4438.4			
1970	3441.8	437.2	410.9	2000.0
1971	2489.5	467.4	459.9	2000.0
1972	1584.5	499.7	508.1	2000.0
1973	730.0	534.3	555.7	2000.0
1974	0	571.2	602.5	1929.3
1975		610.7	648.4	1259.1

Total indicated investment, 1970-1974:	9929.3*
"Backlog"	4882.3
Growth	2509.8
Recapitalization	2537.1
*Includes an Inflation Component of: 928.8	

B-Stretchout Schedule

Year	"Backlog" at year end	Growth	Recapitalization	Investment
1969	4438.4			
1970	3741.8	437.2	410.9	1700.0
1971	3091.0	467.4	450.8	1700.0
1972	2489.0	499.7	490.1	1700.0
1973	1939.0	534.3	528.6	1700.0
1974	1444.3	571.2	566.2	1700.0
1975	1008.5	610.7	602.9	1700.0
1976	635.3	653.0	638.6	1700.0
1977	328.9	698.1	673.2	1700.0
1978	93.4	746.4	706.6	1700.0
1979	0	798.0	738.8	1630.2
1980	0	853.2	769.5	1622.7

C-Deficiency Schedule

Year	"Backlog" at year end	Growth	Recapitalization	Investment
1969	4438.4			
1970	4041.8	437.2	410.9	1400.0
1971	3692.5	467.4	441.8	1400.0
1972	3393.5	499.7	472.0	1400.0
1973	3148.0	534.3	501.4	1400.0
1974	2959.3	571.2	529.9	1400.0
1975	2831.0	610.7	557.4	1400.0
1976	2767.0	653.0	583.9	1400.0
1977	2847.9	698.1	609.2	1400.0

TABLE 8

State by State estimates of investment intentions over the next five years total $10.2 billion -- very close to the amount indicated by FWPCA analysis to be necessary to reduce in five years the accumulation of needs built up in the past. One third of the States report investment intentions that fall within FWPCA's range of estimate. Half fall below the range -- though in twenty-one cases the deviation is considered to be expectable, in that it is due to local variations in construction procedures and lack of anticipation of either price level increases or probable increases in real costs. Similarly, the cases of six States that report investment intentions that exceed the range of expectable requirements are explainable in terms of expanded time frames or accelerated construction programs. However six States -- Alabama, Hawaii, Idaho, New Mexico, Pennsylvania, and West Virginia -- report investment intentions inexplainably below the level of their probable requirements; and three States -- New York, New Jersey, and Maryland -- report expenditure intentions that far exceed that which can be explained by the conditions and needs that each has reported in the Municipal Waste Inventory.

TABLE 8

Comparison of State Investment Intentions and Derived Value of Needs
(Millions of Dollars)

	State Intentions	Programmed Needs	Intentions Fall Within Range	Intentions Exceed Range	Intentions Below Range
Alabama	35.0	224.3 - 165.5			≥130.5
Alaska	12.0	12.2 - 7.6	X		
Arizona	86.0	46.1 - 35.1		≥ 39.9	
Arkansas	33.0	118.6 - 72.6			≥ 39.6
California	651.8	838.5 - 738.1			≥ 86.3
Colorado	133.0	143.7 - 103.1	X		
Connecticut	280.5	187.7 - 147.1	X (a)		
Delaware	28.0	17.7 - 12.5		≥ 10.3	
District of Columbia	355.0	68.2 - 19.4	X (a)		
Florida	200.0	209.5 - 157.7	X		
Georgia	150.0	250.5 - 198.3			≥ 48.3
Hawaii	14.4	44.0 - 32.4			≥ 18.0
Idaho	0.5	75.5 - 58.1			≥ 57.6
Illinois	437.2	493.7 - 396.9	X		
Indiana	152.6	337.6 - 282.8			≥130.2
Iowa	33.3	160.3 - 122.3			≥ 89.0
Kansas	61.0	250.9 - 118.3			≥ 57.3
Kentucky	62.6	102.6 - 54.4	X		
Louisiana	140.0	206.3 - 104.1	X		
Maine	140.9	206.6 - 114.2	X		
Maryland	236.9	63.7 - 29.5		≥173.2	
Massachusetts	438.0	586.7 - 356.5	X		
Michigan	253.7	311.7 - 249.3	X		
Minnesota	136.3	193.3 - 114.1	X		
Mississippi	40.0	141.0 - 82.2			≥ 42.2
Missouri	390.0	359.1 - 195.3		≥ 30.9	
Montana	13.5	63.7 - 42.1			≥ 28.6
Nebraska	62.0	119.0 - 88.4			≥ 26.4
Nevada	28.6	38.6 - 30.0			≥ 1.4
New Hampshire	138.0	150.4 - 93.6	X		
New Jersey	880.0	343.4 - 262.8		≥536.6	
New Mexico	9.9	50.1 - 38.7			≥ 28.8
New York	1900.1	1323.6 - 788.6		≥576.5	
North Carolina	69.3	254.5 - 199.1			≥129.8
North Dakota	22.0	38.9 - 31.9			≥ 9.9
Ohio	432.5	511.8 - 429.8	X		
Oklahoma	65.3	123.0 - 94.0			≥ 28.7
Oregon	135.0	146.1 - 114.5	X		
Pennsylvania	432.0	1122.8 - 720.8			≥288.8
Rhode Island	51.5	96.7 - 72.9			≥ 21.4
South Carolina	75.0	121.8 - 96.0			≥ 21.0
South Dakota	27.0	48.2 - 39.2			≥ 12.2
Tennessee	105.5	184.9 - 115.7			≥ 10.2
Texas	525.0	502.9 - 441.5		≥ 22.1	
Utah	11.7	82.4 - 68.6			≥ 56.9
Vermont	70.0	117.5 - 83.9			≥ 13.9
Virginia	151.0	152.8 - 117.4	X		
Washington	160.0	198.5 - 146.5	X		
West Virginia	44.3	140.3 - 101.1			≥ 56.8
Wisconsin	243.7	275.0 - 231.4	X		
Wyoming	12.0	38.3 - 19.1			≥ 7.1
Guam	6.2	---		≥ 6.2	
Puerto Rico	28.9	61.3 - 36.1			≥ 7.2
Virgin Islands	15.4	4.4 - 2.6		≥ 11.0	
TOTAL	10217.1	11960.9 - 8473.7			

(a) Programmed needs adjusted for recent accelerated level of starts or state intentions, excluding year 1975, bring two sets of estimates into agreement.

TABLE 9

The level of deficiency estimated to occur in industrial waste treatment (other than treatment required to reduce thermal pollution) is currently about $1.5 billion. As in the case of public deficiencies, their elimination within five years will require a substantially larger investment, because of the effects of recapitalization, growth, and price level factors.

TABLE 9

Water Quality
Standards-Related Manufacturers' Investment
For Waste Treatment
(Values in Millions of Current Dollars)

Year	"Backlog" at Year End	Growth	Recapitalization	Investment
1969	1513.2			
1970	1129.5	139.4	118.5	650.7
1971	817.3	150.8	138.0	650.7
1972	526.4	163.1	156.9	650.7
1973	258.0	176.4	175.2	650.7
1974	--	190.8	192.8	650.7
1975	--	206.3	209.7	416.0

Total indicated Investment*	= 3253.5
"Backlog"	1651.6
Growth	820.5
Replacement	781.4
*Includes an Inflation Component of	330.0

TABLE 10

Total Federal assistance to communities for waste-handling purposes has been rising steadily. At this time it amounts to 18% of such outlays -- almost exactly the relationship that exists between all Federal aid and State and local governments expenditures. Assistance is unbalanced, in that the bulk of it takes the form of FWPCA grants for waste treatment plant construction, with little direct assistance for sewer installation and none for operating and maintenance purposes.

TABLE 10

Relation of Federal Assistance to Total Estimated
Public Waste-Handling Expenditures
(Millions of Dollars)

Annual Average Outlay for Period	Investments		Operating Charges		Total
	Treatment Works	Collection Works	Treatment Works	Collection Works	
1956-61, Total	339	317	95	170	921
Federal Share	45	-	-	-	45
1962-66, Total	515	375	135	195	1210
Federal Share	105	-	-	-	105
1967, Total	551	504	170	200	1424
Federal Share	203	50	-	-	253
Percent Federal in Period					
1956-61	13	-	-	-	5
1962-66	20	-	-	-	9
1967	37	10	-	-	18

TABLE 11

As financial constraints have progressively impinged on local governments, it has become necessary to expand the relative proportions of funds provided by Federal government in extending water pollution controls. So, as total investment has risen, the multiplier effect exercised by Federal funds has been consistently reduced.

TABLE 11
Dollars of Total Investment
Per Dollar of Federal Construction Grants

Year	Total Investment	Sewer Investment	Treatment Plant Investment
1957	11.54	4.94	6.60
1958	13.40	6.20	7.20
1959	13.24	6.72	6.52
1960	13.78	7.18	6.60
1961	9.54	4.75	4.79
1962	8.92	3.55	5.37
1963	10.04	4.05	5.99
1964	8.62	3.96	4.66
1965	6.40	2.74	3.66
1966	6.13	2.66	3.47
1967	5.20	2.49	2.71

TABLE 12

It is a requirement of the Federal Water Pollution Control Act that applications for Federal grants be accorded a priority by State government. Though all States weigh water pollution abatement objectives strongly, in most cases priorities are assessed only for those making grant applications. Even in the case where the priority system is general, there are no mechanisms for forcing needed construction decisions. A community's readiness to construct, then, is more important than priority in determining the disposition of Federal funds.

TABLE 12

PRIORITY SYSTEM CRITERIA

	POLLUTION ABATEMENT								FINANCIAL							PLANNING/READINESS							Priorities Assessed Independent of Grant Applications		
	Comp. Plan	Health Hazard	WQS	Trtmt. Reqd.	Abatmt. Needs	Water Uses	Vol. Waste	Inter/ Intra	Finan. Status	Inc-ome	Const. Cost	Ass. Val.	Bond. Debt	Pop.	Other	Site Acqd.	Engr. Rept.	Plans Apprvd.	Finacng. Arrangd.	Contract Awarded	Implmntn. Plans	Grant Appl.for	Yes	No	Unk.
Alabama						X					X					X		X	X					X	
Alaska				X	X					X	X	X		X							X		X		
Arizona		X	X	X	X				X	X	X	X	X											X	
Arkansas		X			X	X	X	X																X	
California		X		X	X	X	X					X	X		X				X						X
Colorado			X		X							X	X												X
Connecticut					X	X	X			X	X		X				X	X	X				X		
Delaware	X		X			X				X			X		X									X	
District of Columbia(a)																									
Florida		X	X	X	X	X					X							X	X	X					X
Georgia	X	X			X						X							X	X					X	
Hawaii			X									X				X		X	X					X	
Idaho				X	X					X	X	X									X			X	
Illinois				X	X	X					X	X		X				X	X					X	
Indiana		X		X	X	X				X								X						X	
Iowa		X				X				X	X						X	X					X		
Kansas		X			X	X					X				X										X
Kentucky		X				X	X	X							X		X	X	X			X		X	
Louisiana		X		X	X	X				X					X									X	
Maine		X	X	X	X	X					X				X			X	X			X	X		
Maryland				X	X						X	X	X		X			X	X					X	
Massachusetts		X				X					X				X									X	
Michigan		X			X	X					X		X		X				X					X	
Minnesota					X	X				X	X							X	X	X				X	
Mississippi		X			X	X				X	X					X	X	X	X						X
Missouri			X	X	X	X					X				X			X	X						X
Montana				X	X						X	X									X		X		
Nebraska		X		X	X	X		X			X			X	X			X	X						X
Nevada		X		X	X	X									X				X					X	
New Hampshire		X	X			X				X	X				X			X					X		
New Jersey	X				X	X	X								X										X
New Mexico				X						X	X												X		
New York			X	X	X					X			X											X	
North Carolina					X						X	X	X			X		X	X					X	
North Dakota						X					X						X		X					X	
Ohio				X	X	X				X	X													X	
Oklahoma			X	X	X						X	X						X	X			X	X		
Oregon	X			X	X	X					X	X						X	X					X	
Pennsylvania					X	X					X	X						X						X	
Rhode Island					X	X					X						X	X	X	X					X
South Carolina				X	X	X					X		X				X	X	X					X	
South Dakota						X		X									X	X	X				X		
Tennessee		X		X	X	X					X		X			X		X	X					X	
Texas				X	X	X	X								X	X		X	X					X	
Utah		X						X		X	X	X	X				X	X	X					X	
Vermont		X	X			X					X				X		X	X	X				X		
Virginia			X	X	X	X			X					X										X	
Washington			X		X	X					X	X	X				X	X							X
West Virginia			X		X	X				X	X												X		
Wisconsin				X	X	X				X	X		X											X	
Wyoming		X			X	X		X					X							X				X	
Puerto Rico		X			X	X				X				X	X										X

(a) Priority system not applicable

TABLES 13-14

An unfortunate effect of the lack of effective priorities is to channel funds away from the larger cities that include the most significant concentrations of pollution. The "readiness to proceed" test brings applications from those communities in weak bargaining situations vis a vis State regulatory agencies. The net result is that funds have flowed in almost reverse correlation to population. And though over half of FWPCA grants have gone to metropolitan areas, they have been made available largely in the smaller suburban places rather than in central cities.

TABLE 13
Distribution of FWPCA Grants by Size of Community
as of January 31, 1969

Population Size	$ Million	% of Grants
Less than 2,500	173.1	15.3
2,500 - 5,000	128.1	11.3
5,001 - 10,000	155.9	13.7
10,001 25,000	215.7	19.0
25,001 50,000	150.6	13.3
50,001 125,000	143.9	12.7
125,001 250,000	62.5	5.5
250,001 500,000	36.2	3.2
500,001 and over	68.8	6.1
TOTAL	$1134.8	100.0

TABLE 14

Metropolitan & Non-Metropolitan Distribution
of FWPCA Construction Grants,
1956-1968

	Grants Offered	
	$Millions	Percent
Communities within SMSA's	659.4	59.7
Communities outside SMSA's		
Less than 2,500	111.2	10.1
2,500 - 4,999	74.0	6.7
5,000 - 9,999	78.5	7.1
10,000 - 24,999	103.0	9.3
25,000 - 49,999	77.9	7.1
TOTAL	1103.9	100.0

TABLE 15

Although the treatment of industrial wastes by public agencies has only begun to receive attention, the practice is well established. A very substantial portion of the hydraulic loading of the total national system of public treatment plants is of industrial origin -- the precise relationship varies according to the definition of "industry" that is employed. Because of the higher materials concentrations of industrial wastes, it is probable that well over half of all wastes removed or stabilized by public treatment are of industrial origin.

TABLE 15
Relative Domestic and Industrial
Loading of Municipal Waste Treatment Plants in 1968

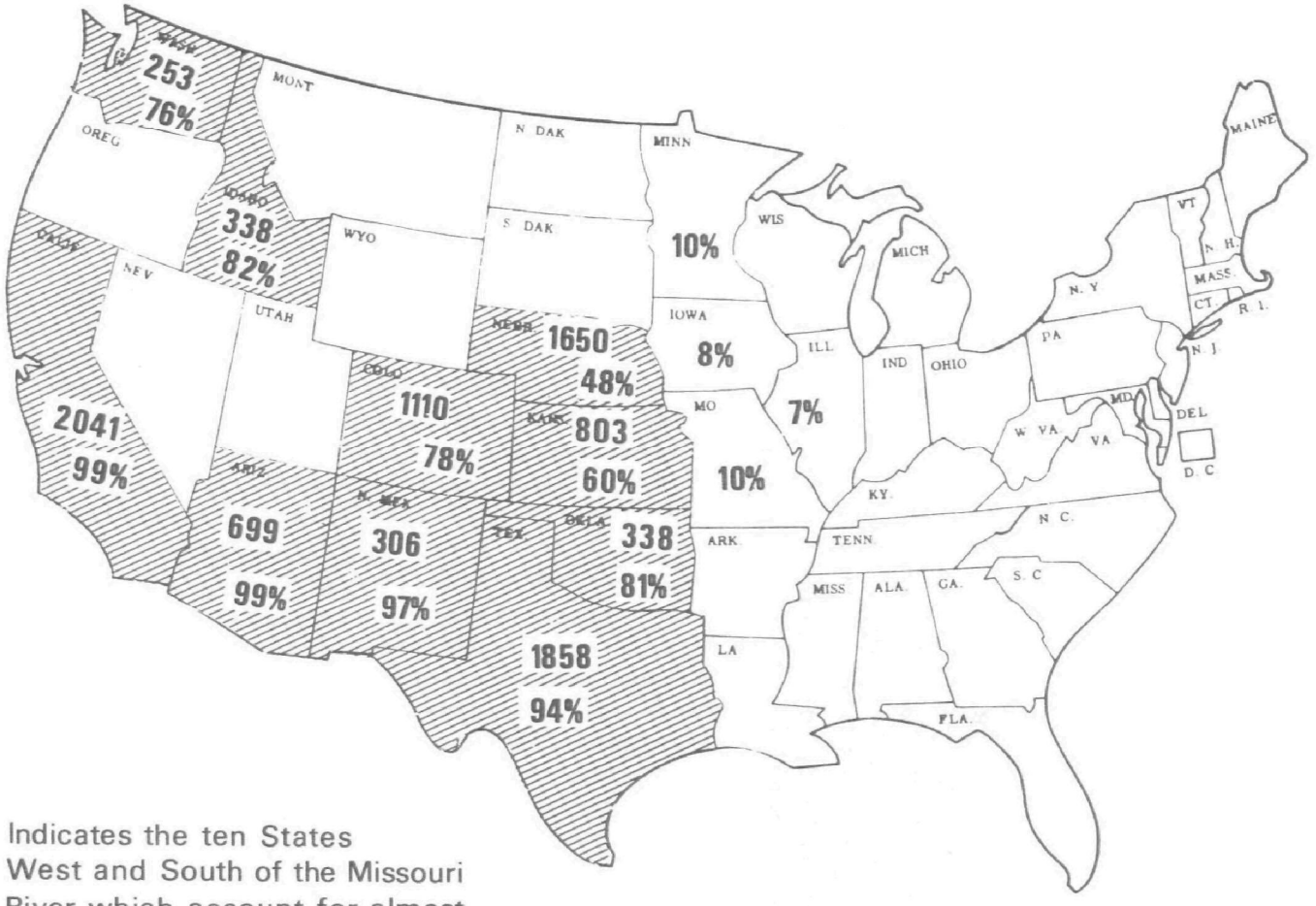
Community Population Category	Number of Plants	Million Gallons Per Day: Gross Indicated Loading	Domestic Component @ 100 G/C/D	Domestic Component @ 65 G/C/D	Industrial Remainder	Percent Industrial
under-500	1400	64.0	49.0	32.0	5.0- 2.0	23-50
500-999	1600	156.0	120.0	78.0	36.0- 78.0	23-50
1,000-2499	2400	588.0	420.0	273.0	168.0- 315.0	29-54
2,500-4999	1300	682.5	487.5	317.0	195.0- 366.0	29-54
5,000-9999	1000	1050.0	750.0	487.5	300.0- 562.5	29-54
10,000-24,999	800	2010.0	1400.0	910.0	610.0-1100.0	30-55
25,000-49,999	300	1687.5	1125.0	731.0	562.5- 956.2	33-57
50,000-99,999	160	2040.0	1200.0	780.0	840.0-1260.0	41-62
100,000-249,999	85	2677.5	1487.5	967.0	1190.0-1710.0	44-64
250,000-500,000	28	2100.0	1050.0	682.5	1050.0-1417.5	50-68
over 500,000	24	2700.0	1800.0	1170.0	900.0-1530.0	33-57
TOTAL	9100	15,756.0	9890.0	6430.0	5870.0-9325.0	37-59

FIGURE 2

Potential feed lot waste problems are highly concentrated. Forty-seven percent of beef animals sold are sold from lots with feeding capacity of 1000 head or more, and 88 percent of these cattle are sold from lots in ten States where large feeding operations predominate.

FIGURE 2

Number and Percentage of Cattle Marketed from Feedlots with Capacities of 1,000 Head and Greater --Selected States, 1968.



Indicates the ten States West and South of the Missouri River which account for almost 90 percent of all cattle marketed from lots with capacities of 1,000 head and greater.

Top number shown in each State refers to thousand head of cattle marketed from lots with capacities of 1,000 head and greater.

Percentages shown refer to the percent of cattle marketed from feedlots with capacities of 1,000 head and greater.

TABLE 16

Investment and operating costs associated with two levels of waste treatment have been calculated for the inorganic chemicals industry, the levels representing current industry efficiency and complete removal of contaminants. Because of the nature of the wastes, there are no intervening technologies. An almost infinite number of configurations of elements are possible within the range, depending on the degree of waste treatment required for individual plants.

TABLE 16

Projected Inorganic Chemical Industry
Costs for Waste Treatment

Cumulative Capital Costs in Millions of Current Dollars [1/]

% Removal	1969	1970	1971	1972	1973	1974
27	299.3	325.4	359.9	400.1	445.4	494.7
100	1808.4	1964.0	2173.2	2416.3	2689.0	2970.0

Annual Operating Costs in Millions of Current Dollars [1/]

% Removal	1969	1970	1971	1972	1973	1974
27	82.0	89.1	98.6	109.6	122.0	135.5
100	157.5	171.0	189.2	210.5	234.2	260.2

1/ Based on an average 3.6% annual increase in the price level and growth of production.

* U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 384-035