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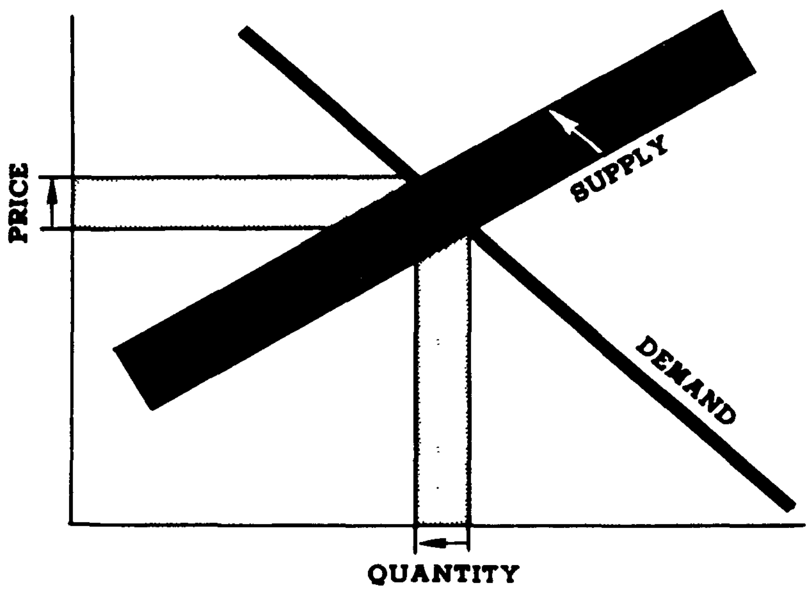
ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES

NONFERTILIZER PHOSPHATE MANUFACTURING INDUSTRY



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

EPA 230/1-74-043

ECONOMIC ANALYSIS

OF

PROPOSED EFFLUENT GUIDELINES

FOR THE

NONFERTILIZER PHOSPHATE MANUFACTURING INDUSTRY

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Prepared for
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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 contractor's 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 proposal 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 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 Contract No. 68-01-1533, Task Order No. 14 by Development Planning and Research Associates, Inc. Work was completed as of September, 1974.

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 is not an official EPA publication. It 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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EXECUTIVE SUMMARY

INTRODUCTION

This report analyzes the economic impacts of proposed water pollution controls on non-fertilizer phosphate manufacturing. It is one of a series of studies prepared under the supervision and review of the Office of Planning and Evaluation, U. S. Environmental Protection Agency, as required by the Federal Water Pollution Control Act Amendments of 1972.

Under the provisions of Sections 304 and 306 of the Federal Water Pollution Control Act, EPA has proposed effluent guidelines which apply to the manufacture of defluorinated phosphate rock, defluorinated wet process phosphoric acid and sodium tripolyphosphate derived from wet acid. The purpose of this study is to evaluate the potential economic impacts of those guidelines prior to their implementation.

The report describes and analyzes the industry structure for the manufacturing of the three products by examining:

1. their number and types of firms and plants,
2. their age, location, and technological state
3. their financial data apropo of model plant configuration, and
4. their pricing policies and supply and demand relationships.

Then, pollution control costs are superimposed on the model plant financial profiles to determine microeconomic effects, such as price increases expected and potential closures. Macro impacts on the industry are then analyzed for effects on employment, communities, balance of payments and related matters.

The data for the study was provided by industry sources which supplied descriptive material about firms and plants. Published governmental and private reports provided additional information for both micro and macro analysis.

I. INDUSTRY SEGMENTS

Two four-digit Standard Industrial Classification code numbers are included in this report:

SIC 2819 Industrial inorganic chemicals
SIC 2874 Phosphatic fertilizers

SIC 2819 includes sodium phosphates and potassium phosphates. This report considers only sodium tripolyphosphate derived from wet process phosphoric acid. Industrial phosphate products derived from furnace acid are covered in a separate EPA report.

SIC 2874 encompasses the broad category of phosphatic fertilizers, many of which have been reported in other EPA studies. Certain non-fertilizer phosphate chemicals produced from phosphatic rock acidulation, specifically, defluorinated phosphatic rock and defluorinated wet process phosphoric acid (principally superphosphoric acid), are considered in this report.

This report is organized around three segments:

(1) Defluorinated phosphate rock
(2) Defluorinated wet process phosphoric acid
(3) Sodium tripolyphosphate derived from wet acid

Defluorinated phosphate rock (DFP)

Four firms produce DFP at four plant locations: two in Florida, one in Texas and one in Montana. Three of the companies are large, diversified and highly integrated; the fourth is a small phosphatic mining company. Ranging in size from 25,000 to 310,000 tons of annual capacity, the four plants have a combined estimated annual capacity of 510,000 tons of DFP (18.5% P equivalent). Two plants were built between 1960 and 1965 and two between 1966 and 1970.

DFP is produced by subjecting a combination of sand, about 32% of P_2O_5 wet acid and soda ash or caustic soda and phosphate rock to high temperatures (nearly 3,000° F). The kilns used require a fairly large investment.

Approximately 103 persons are employed a the four plants.

Defluorinated wet phosphoric acid

Ten firms produce defluorinated wet phosphoric acid at eleven plant locations. These are all integrated chemical or petrochemical companies, and all but one are large, diversified enterprises.

The eleven plants having a combined estimated annual capacity of 913,000 tons of P_2O_5, range in size from 13,000 tons to 180,000 tons of annual capacity. Florida and Louisiana have three plants, Idaho has two and North Carolina, Texas and Utah have one each. Two of the plants were built between 1960 and 1965, five between 1966 and 1970 and three since 1970. The age of one is undetermined.

Three different processes can be used to produce defluorinated wet phosphoric acid. Nine of the eleven plants employ either a vacuum evaporation process (seven plants) or a submerged combustion process (two plants). The other two are believed to be using a steam sparging process to defluorinate wet acid without concentrating it into a superphosphoric acid. Little is known about this process, which will be referred to in this report as "auxiliary process." The defluorinated acid plants require less investment in plant and equipment than do the DFP plants.

An estimated 133 persons are employed in the superphosphoric acid plants and 25 in the auxiliary process acid plants for an estimated total employment in this segment of 158.

Sodium tripolyphosphate (STPP)

Only one firm produces STPP from wet process phosphoric acid in the United States. A large, integrated chemical corporation, with a 140,000 tons per year (STPP) plant is located in Illinois and was built in 1960. It competes with 14 other STPP plants which use furnace acid. It is very large in comparison to other STPP plants. Using a complex chemical process in which wet acid is reacted with caustic soda, it employs an estimated 21 persons.

II. FINANCIAL PROFILE

Non-fertilizer phosphate manufacturing must be viewed in the context of the fertilizer industry, an industry which generally has a history of wide cyclical fluctuations in prices and profitability. After a stable period of reasonable earnings in the early 1960's, the industry overexpanded and suffered declining prices and earnings from 1966 through 1969. By 1973, industry sources were reporting pretax and preinterest margins of 9.7 percent on sales, which probably equates to about 4 percent on sales and 7 percent on net worth, a comparatively low return on net worth.

The published data for a five-year period for fertilizer companies indicates an "average" corporate profile of about 27 percent long-term debt to total invested capital, earnings on common stock of just under 6 percent and a dividend yield of about 3.6 percent. A weighted average cost of capital, based on these findings, ranges from 5.5 to 7.4 percent.

In the absence of specific plant data, DPRA constructed pro forma income and expanse statements for model or representative plants in each segment. These model plants budgets, which do not purport to reflect precisely the financial conditions of existing plants, show that most of the operations are reasonably profitable.

Defluorinated phosphate rock model plants range from a break even (or slight losss) position in the smallest (75 TPD) unit to estimated after-tax returns on invested capital of 5.3 to 8.5 percent for the larger unit (225 TPD). Estimated cash flows are substantial for the larger plants.

Defluorinated wet phosphoric acid (SPA) production is unprofitable in the smallest (75 TPD) model plant, while the two larger units (150 and 450 TPD) yield after-tax returns on invested capital of 7 and 19 percent. The small plant has a negative cash flow; the others have reasonably strong cash flows.

The two model plants for defluorinated acid (auxiliary process) have after-tax returns on invested capital of 6 and 11 percent with modest cash flows.

STPP--The STPP model plant shows an after-tax return on invested capital of 9 percent with a modest cash flow.

With the foregoing profit picture, the large diversified firms should have no difficulty raising the necessary capital to finance new investment in pollution control facilities. At the same time, on an individual plant basis, lack of profitability for the smallest DFP and acid plants would make new investment unlikely.

III. PRICING

Marketing determinants for all three phosphate segments in this study are complicated by the fact that demand for the products is derived from the demand for other end-products. DFP is used as a livestock feed supplement; thus, the demand for livestock products ultimately determines DFP demand. Some 40 percent of all defluorinated wet process phosphoric acid output goes into dicalcium phosphates for feed supplements. The remaining 60 percent is used in fluid fertilizers which depend on the demand for agricultural products. STPP demand is derived primarily from the market for soaps and detergents. Obviously then, the prices for non-fertilizer phosphate products are determined in large part by the pricing patterns of other products.

The demand for livestock products is expected to grow at one or two percent per annum, with feed phosphates growing at a faster rate of 6 to 8 percent as nutritional requirements and livstock production techniques continue to change. Liquid fertilizer demand is also growing more rapidly than general agricultural demand and indicates a possible growth in demand for SPA of 10 to 15 percent.

Prices for DFP and defluorinated acid can be expected to rise under these pressures. DFP prices averaged $72.25 per ton at Florida plants in 1973 (pre-decontrol). SPA has little price character of its own, being tied directly to wet ortho acid prices and to dical and fluid fertilizer prices. Quoted prices ranged from $153 to $199 per ton ($P_2O_5$) in 1973.

STPP has been declining in usage since 1970, due largely to a concern over the use of phosphates in soaps and detergents. Even so, price has risen slightly to an estimated $153 per ton (f.o.b. plant) in 1973 as output fell. Future price behavior is most uncertain.

IV. IMPACT METHODOLOGY

The fundamental methodology used in the impact analysis is the same as that normally used in capital budgeting studies of new investments. The model plant budgets provide the basic data for the analysis.

The model plants though not precisely representative of any single plant operation, reflect the financial and physical characteristics of the industry. Adjustments to model plant budgets to reflect pollution control investment and annual operating costs permit pre-and post-pollution control economic analysis for impacts on prices, profitability and production.

Probable plant closures, a key part of the analysis, are determined through a net present-value analysis, by which expected future cash proceeds are discounted at the firm's estimated cost of capital rate. A net present-value of less than zero implies that the owner would be better off to liquidate his plant and reinvest the salvage proceeds at the cost of capital rate.

Price increases required to return the plant to pre-pollution control levels of profitability are then calculated to estimate expected price effects. An evaluation of ability to pass on required price increases follows.

Finally, a qualitative analysis of economic determinants indicates the broad macroeconomic effects on agricultural production, employment, communities and balance of payments.

A detailed description of the methodology appears in the Final Report.

V. POLLUTION CONTROL COSTS

Investment costs and annual operating expenses for the pollution controls necessary under proposed guidelines were furnished by the Effluent Guidelines Division of EPA. The development of these costs and full descriptions of the technologies appear in the Draft Development Document, separately published by EPA.

Proposed guidelines

Best practical technology (BPT) proposed effluent limitations guidelines, effective July 1, 1977, call for no discharge of process waste water for DFP and defluorinated acid segments, except under certain conditions. Containment and cooling ponds must be designed to hold the precipation from the 10-year, 24-hour rainfall event as established by the U.S. Weather Service for the plant location. When rainfall in excess of the 10-year, 24-hour storm occurs, the excess may be discharged. The plant may also discharge processed waste water during any calendar month in which the volume of water exceeds the difference between that month's rainfall and the mean evaporation for that month as established by the U. S. Weather Service for the preceding 10-year period. Any process water discharged under both exceptions must be treated to reduce suspended solids, phosphates and fluorides to acceptable levels, as specified by the Effluent Guidelines Division of EPA.

The STPP segment, which cannot use containment ponds, must continuously treat the end-process waste water to reduce contaminants to acceptable levels.

The recommended EPA technology for pollution control at DFP and defluorinated acid plants consists of containment and cooling ponds large enough to hold contaminated process water which is recirculated, and contaminated (pond) water treatment facilities for double-liming and settling any waste water to be discharged under the exceptions permitted. In some locations, a diversion ditch will be required to keep runoff water away from the pond dikes. STPP plants need only the contaminated (pond) water treatment facilities.

Best available technology (BAT) guidelines, effective in 1983, are the same as BPT, except that containment ponds must be large enough to hold the runoff from the 25-year, 24-hour rainfall event for the plant location. The exceptions for discharge are similar to BPT. EPA has recommended increasing BPT dike heights by an amount sufficient to hold the larger volumes of water. For STPP, there are no additional BAT requirements.

New source performance standards for plants built after January 1, 1974, are identical to BAT for DFP and defluorinated acid.

In place technology

EPA estimates that all of the DFP plants currently meet the guidelines, though one plant may require a diversion ditch. Eight of the 11 defluorinated acid plants either treat discharged water or do not discharge at all; one of the three remaining plants does not appear to have any land available for building a pond. The STPP plant in this study does not have treatment facilities in place.

Effluent control costs

EPA furnished cost parameters for investment and annual operating costs for pollution controls. The major investment is for pond construction, estimated at $15,977 (1973 dollars) per acre of pond. The pond estimated at .26 acres per daily ton of product for DFP and .26 acres per daily ton of P_2O_5 for defluorinated acid. Diversion ditches are estimated at $3.00 per linear foot of ditch.

Contaminated (pond) water treatment facilities are estimated at $399,000 (1973 dollars) for double-liming 1,000 gallons per minute. Plants below 450 tons per day capacity can use a 500-gallons per minute facility, at a cost of $263,000.

Annual operating costs for containment and cooling ponds have been estimated by EPA as consisting only of interest on borrowed funds and 20-year straight-line depreciation. EPA made no allowance for maintenance of ponds and dikes; there may be some very small annual costs for maintenance which have not been included in the cost summary. DPRA has assumed that the entire investment would be borrowed at 10 percent interest.

Costs for treating waste water include \$2.50 for lime and \$.05 for electricity per 1,000 gallons treated. Interest at 10 percent and 10-year straight-line depreciation, plus 4 percent of investment for operation and maintenance complete the annual costs for contaminated (pond) water treatment.

Table 1 presents incremental investment and annual operating costs for model plants which are representative of those in each segment which do not now have the technology in place. It is important to note that emergency treatment (caused by rainfall in excess of the 10-year or 25-year storm) can be expected no more often than once in 10 or 25 years. Thus, BPT normal operating costs represent more accurately expected incremental costs.

It should be further noted that phosphate plants are normally built with containment and cooling ponds and that not all of the pond costs can be reasonably attributed to pollution controls. Table 2 shows annual pollution control costs as a percent of 1973 model plant total operating costs.

VI. IMPACT ANALYSIS

The expected impacts of pollution controls will occur in the defluorinated acid and STPP segments. The major capital expenditures required by the three defluorinated acid plants which do not have treatment in place may force their closure by 1977 (one of these three and one other plant with in place controls might close under 1973 baseline conditions). The STPP plant may also be forced to close. No impact is foreseen on DFP plants because they currently meet treatment standards.
None of the segments can expect to pass-on pollution control costs directly because of the large amount of technology in place. This includes the STPP plant that competes with furnace acid type STPP plants which will not incur pollution control costs.

Price effects due to pollution control should be minimal. Cost increases cannot be passed on in the form of higher prices, but potential baseline and pollution control induced closures could reduce output and cause an approximate 4 percent price increase for DFP and defluorinated acid. This supply-induced price increase of 4 percent must be viewed in the context of an even higher demand-induced increase. Demand can be expected to grow 8 to 12 percent per year in defluorinated acid, producing significant upward pressure on prices. At some indeterminant point, higher prices will attract new defluorinated acid capacity--probably large SPA plants; inevitably, this new capacity will cause future price reductions.

Table 1. Investment and annual operating costs for pollution control facilities for selected model plants

	BPT Investment			BPT Annual Operating Costs				BAT			BPT(N) + BAT	
	Pond & Ditch	CPWT 1/	Total	Normal O & M	Int.	Deprec.	Total	Emergency 2/ O & M	In-vest.	Annual Cost	In-vest.	Annual Costs
	\$000											
Defluorinated acid												
(Vacuum process)												
75 TPD	348	263	611	44	30	43	117	34	31	3	642	120
(Auxiliary process)												
100 TPD	461	263	724	80	36	49	165	45	41	4	765	169
300 TPD	1,366	263	1,629	224	88	108	420	134	123	12	1,752	932
STPP		399	399	842	20	40	902	0	0	0	399	902

1/ Contaminated (pond) water treatment process.

2/ Can be expected no more than once in 10 or 25 years.

Table 2. Annual pollution control operating costs compared to baseline (1973) total operating costs for selected model plants

Plant Configuration	Base-line	BPT(N) 1/		BAT		BPT(N) + BAT 1/	
	$000	$000	% Base	$000	% Base	$000	% Base
Defluorinated acid							
(vacuum process)							
75 TPD	3,109	117	3.8	3	neg.	120	3.9
(auxiliary process)							
100 TPD	3,926	165	4.2	4	neg.	169	4.3
300 TPD	10,285	420	4.1	12	neg.	432	4.2
STPP	20,164	902	4.5	0	0	902	4.5

1/ Only normal treatment costs have been compared since emergency treatment can be expected to occur only once in 10 or 25 years.

It is likely that this new capacity will assure the likely closure of those existing defluorinated acid plants which do not now have pollution control technology in place.

STPP prices may increase 1.5 to 2.0 percent to reflect increased raw materials costs due to pollution controls, but the wet acid STPP cannot expect to recover its direct pollution control costs.

Production effects due to pollution control are expected in the defluorinated acid and STPP segments. Three acid plants and the STPP plant may be forced to close. One of the small 75 TPD acid plants has a negative cash-flow under baseline (1973) conditions. A second one reportedly has no land available for pond construction; in any event, pollution control investment and operating costs produce a negative cash flow for the model plant in this sub-category, even with a 4 percent price increase. The third plant is believed to be having trouble (from under utilization of capacity) with baseline conditions and could be negatively impacted by pollution controls. Not enough data are available to judge this plant adequately, but it may have to close. These three plants account for about 16 percent of defluorinated acid capacity; one additional plant, representing about 2 percent of capacity, might close under baseline conditions. Total supply should not be significantly affected, however, because the segment operated at an estimated 80 percent of capacity in 1973.

Closure of the STPP plant would result in a loss of about 120,000 tons of production or about 12 to 13 percent of 1973 output. Present under-utilized furnace acid plants could absorb the loss.

Employment effects resulting from closures would be minimal. An estimated 39 jobs in defluorinated acid plants and 21 in the STPP plant may be lost, an infinitisimal number of the 40,000 to 45,000 persons employed in the fertilizer industry.

Community effects are negligible. The potentially impacted plants are in large trade areas where the loss of one plant and 20 or 50 jobs would not appear critical. Some displaced workers would be absorbed into other phosphate plants.

Balance of payments would also be impacted only slightly. Imports of dicalcium phosphates (30,000 tons in 1973) might increase slightly, and their dollar value is minor. STPP exports might decline slightly, but again, dollar values would be insignificant.

In general, the proposed effluent guidelines should have no significant impact on future industry growth. Newer DFP and acid plants were built with control technology. Future plants are likely to be large structures discharging minimum effluents. The proposed standards should have little effect on decisions to invest in new plants. No new STPP plants, using wet process acid, are expected; currently.

VII. LIMITS OF THE ANALYSIS

The data used in the preparation of this report have been carefully evaluated for reliability and are believed to be generally accurate. There are, however, variances in local conditions, technologies and management techniques which will cause specific plant operations to vary from the model plant.

There will be a range of possible error of ± 10 percent in the number, location, capacity and age of plants and ± 15 percent in prices. Investment values may vary by ± 20 percent, while plant operating costs are subject to ± 10 percent. It should also be noted that the pond size recommended by EPA has been questioned by industry sources and that pond costs may, therefore, be overstated.

The range of errors would not, however, affect significantly the basic conclusions in the report. At the same time, several critical assumptions which appear throughout the report were used as a basis for the analysis and any change in those assumptions could change the results of the analysis Especially important are assumptions about prices, capacity utilization, raw materials costs, operating expenses and the future movement of costs and prices.

There are also some unanswered questions concerning the future of the phosphatic fertilizer industry which can affect the segments under study in this report. Will phosphate capacity expand in the 1970's? Will the energy shortage prevent full utilization of phosphate capacity? Will environmental concerns over the use of STPP in soaps and detergents intensify or lessen? These and other questions must remain unanswered at this time.

I. INDUSTRY SEGMENTS

This report on nonfertilizer phosphate manufacturing includes segments from Standard Industrial Classification Numbers 2819 (Industrial Inorganic Chemicals) and 2874 (Phosphatic Fertilizers). Specific segments within these classifications are as follows:

SIC 2819 - Industrial Inorganic Chemicals. Limited to phosphate compounds derived from elemental phosphorus
--sodium phosphates and pyrophosphates
--potassium phosphates and pyrophosphates

SIC 2874 - Phosphatic Fertilizers
Limited to non-fertilizer phosphate chemicals produced from phosphate rock acidulation
--defluorinated phosphate rock
--defluorinated phosphoric acid
--defluorinated mono and diammonium phosphates

The study's analysis will be organized about three primary segments:

(1) Defluorinated phosphate rock
(2) Defluorinated wet phosphoric acid (principally superphosphoric acid)
(3) Sodium tripolyphosphate derived from wet acid

Potassium phosphate and defluorinated mono- and diammonium phosphates have been excluded from this study. Potassium phosphate from wet-acid is not known to exist. Defluorinated mono- and diammonium phosphates are derived from superphosphoric acid; therefore, it is the SPA which is defluorinated. Sodium phosphates derived from furnace phosphoric acid have been studied in a separate EPA report on industrial phosphates. 1/

A. Types of Firms by Segment

1. Size and Number of Firms by Product

Defluorinated Phosphate Rock

Four firms operate four establishments for producing defluorinated phosphate rock:

1/ Economic Analysis of Proposed Effluent Guidelines: The Industrial Phosphate Industry, EPA-230/1-73-021, August 1975.

Defluorinated Phosphate Rock (18.5% P Equivalent)

Company		Capacity (1,000 T)
Borden, Inc. Borden Chemical Smith-Douglass Div.	Plant City, Fla.	310
Occidental Pet. Corp. Occidental Chem. Co. Div.	White Springs, Fla.	100
Olin Corporation	Pasadena, Texas	75
Rocky Mountain Phosphate Corporation	Garrison, Montana	25 1/

1/ This plant may have one additional idle 25,000 ton kiln.

Defluorinated Wet Phosphoric Acid

There are ten firms known to be producing defluorinated wet phosphoric acid in eleven plant locations. Eight of the ten companies are defluorinating wet acid in the manufacture of superphosphoric acid. Two others, Freeport Sulphur and Beker, produce a defluorinated wet acid through an auxiliary process. There may be three or four other superphosphoric acid plants operated by other firms that cannot be positively identified at this time. The list which follows represents the best available information:

Wet Process -- Superphosphoric Acid Producers

Company	Location	Year Built	Capacity (Tons P_2O_5)	Process
Allied Chem.	Geismar, La.	1967	145,000	Submerged Combustion
Farmland Ind.	Pierce, Fla.	1971	130,000	Vacuum Evap.
I. M. C. 1/	Bonnie, Fla.	1965	165,000	Falling Film
North Idaho Phos.	Kellogg, Idaho	1964	13,000	Falling Film
Occidental Chem.	White Springs, Fla.	1966	50,000	Submerged Combustion
Simplot, J. R.	Pocatello, Idaho	1971 (repl.)	35,000	Vacuum Evap.
Stauffer Chem.	Pasadena, Texas	1966	25,000	Vacuum Evap.
Stauffer Chem.	Garfield, Utah	1967	40,000	Vacuum Evap.
Texas Gulf	Lee Creek, N.C.	1971	180,000	Falling Film
			783,000	

Defluorinated Phosphoric Acid Producers

Freeport Sulphur	Uncle Sam, La.	1969	100,000	Auxiliary
Beker Chem.	Taft, La.	Unknown	30,000	Auxiliary
			130,000	

1/ Operated as a part of a C F Industries phosphate complex.

Sodium Tripolyphosphates

Only one known United States firm produces sodium phosphate from wet phosphoric acid. The Olin Corporation has a plant at Joliet, Illinois, producing sodium tripolyphosphate (STPP) at an estimated annual capacity of 140,000 tons.

2. Level of Integration and Diversification

The firms in all three segments are typically large diversified chemical companies, with both backward and forward integration. Some producers are specialty chemical companies, but generally, product sales of these three segments constitute a small portion of company revenues. The level of diversification varies from a highly diversified firm such as Borden to a specialized firm such as Rocky Mountain Phosphate Corporation.

B. Types of Plants by Segment

The analysis of plants which follows is by size, location, age, technology, efficiency and level of integration. Plant data are from EPA and industry sources.

1. Size

Defluorinated Phosphate Rock

The four plants in this segment were listed by size under Section I-A. Three sizes are apparent:

Tons Per Year	No. Plants
25,000	1
75,000 - 100,000	2
310,000	1

The large plant accounts for 61 percent of total capacity in this segment.

Defluorinated Wet Phosphoric Acid

The size distribution of the eleven plants in this segment is as follows:

Tons Per Year	No. Plants	Total Capacity (Tons P_2O_5)
Up to 25,000	2	38,000
26,000 - 50,000	4	155,000
51,000 - 150,000	3	375,000
151,000 and over	2	345,000
	11	913,000

The two largest plants have 38 percent of the capacity and the five largest have 79 percent. As noted earlier, there may be three or four additional operating plants.

Sodium Phosphate

The Olin Corporation has a large sodium phosphate plant at Joliet, Illinois, producing an estimated annual capacity of 140,000 tons. Although all other STPP producers use furnace acid, it is useful to compare the Olin plant to the 14 other STPP plants. The most common sizes are 50,000, 75,000 and 100,000 tons per year of STPP, with the median at 75,000. The largest of the 14 is 125,000 tons per year. Thus, by this standard, the Olin plant is almost double the size of the typical plant and is by far the biggest of all STPP plants.

2. Location

Table I-1 shows the location of plants for each segment by state.

Defluroinated Rock

Florida with two of the industry's four plants has 80 percent of the deflourinated rock capacity.

Defluorinated Acid

Florida and Louisiana each have three SPA plants, with 41 and 30 percent respectively of total SPA capacity. The largest SPA plant is in North Carolina, with a large unit in Louisiana.

Table I-1. Location of plants by number, capacity and product.

	U.S. Total	N. C.	Fla.	La.	Texas	Ill.	Mont.	Idaho	Utah
	(No. plants - 000 tons capacity)								
STPP	1-140					1-140			
Def. Rock	4-510		2-410		1-75		1-25		
Def. Acids									
SPA	9-783	1-180	3-345	1-145	1-25			2-48	1-40
Aux.	2-130			2-130					

Utah and Texas each have small units.

STPP

Illinois has the only STPP plant using wet acid.

3. Age

Table I-2 presents the ages of the various plants by segment and by size range.

Defluorinated Rock

Two, the smallest and the largest, of the four plants were built in 1960. The other two were built in 1969 and 1970.

Defluorinated Wet Phosphoric Acid

Only two of the plants were built before 1966 -- the smallest (13,000 TPY) and one of the largest (165,000 TPY). Four were built between 1966 and 1970 and three in 1971-72. These last three account for 38 percent of the capacity.

STPP

The Olin plant was built in 1960.

4. Technology and Efficiency

Manufactured defluorinated phosphate products--dical and defluorinated acids--have emerged largely from the recognition of the technical requirements for phosphorous in livestock nutrition and the unavailability of this product in feedstuffs, organic sources (bone meal) and low fluorine phosphate rock. Parallel to the feed requirement has been the growing liquid fertilizer industry which requires high analysis and clean phosphoric acid.

Table I-2. Age of plants by product and size range.

	000 Tons per Year Capacity										Total	
	0-25		26-50		51-100		101-150		151-			
	No.	Cap.	No.	Cap.	No.	Cap.	No.	Cap.	No.	Cap.	No.	Cap.
STPP												
1960							1	140			1	140
Defl. Rock												
1960-65	1	25							1	310	2	335
1966-70					2	175					2	175
Total	1	25			2	175			1	310	4	510
Defl. Wet Acid (SPA)												
1960-65	1	13							1	165	2	178
1966-70	1	25	2	90			1	145			4	260
1971-			1	35			1	130	1	180	3	345
Total	2	38	3	125			2	275	2	345	9	783
Defl. Wet Acid (Aux.)												
1969					1	100					1	100
Unknown			1	30							1	30
Total												130

To meet these feed and fertilizer needs, the superphosphoric acid (SPA) industry emerged during the 1960's. Superphosphoric acid in general terms is concentrated phosphoric acid generally in excess of 70 percent P_2O_5, relatively free of impurities, and composed of some polyphosphate molecules. Additionally, the concentration to superacid also defluorinates the 54% wet process orthophosphoric acids. The only other known sources of defluorinated wet acid are the two plants which defluorinate wet process orthoacid through steam sparging rather than concentration to SPA.

Defluorinated Phosphate Rock

Rock defluorination results from heating raw phosphate rock to temperatures of nearly 3000° F. without fusion (melting and blending). The primary processes involve heating phosphate rock, silica (sand), about 32% P_2O_5 wet acid, and soda ask or caustic soda. Within this general procedure several variations exist among the four companies producing defluorinated rock. Three of the companies report their own process patents (although there is pending litigation concerning patent infringements).

Defluorinated Wet Acid

The defluorination of wet acid is accomplished through concentration of 54% orthoacid and steam sparging, although only two units (130,000 TPY capacity) of the eleven producers and 913,000 TPY capacity use this latter process.

Concentration - The concentration of wet phosphoric acid results from the evaporating (concentrating) 30-32% P_2O_5 from the basic to 52-54% acid--the commercial acid concentration--and then concentrating 54% acid to SPA as separate process. It is this latter process to which this study is directed. Two primary commercial processes are used--vacuum evaporation and submerged combination.

Vacuum evaporation has, in turn, two variations--Swenson and falling film. All features use evaporation under vacuum using single effect long tube evaporators operating at high velocities. The advantages of the vacuum process are that fume scrubbing is relatively easy and the recovery of fluorine is complete. This process does require a cheap steam source; thus, its use is generally restricted to integrated phosphate complexes. Maintenance and cleaning requirements are also significant in vacuum evaporation. Superacid from this procedure is generally less than 70-72% P_2O_5 and slightly higher in fluorine content.

In submerged combustion, the orthoacid is evaporated by forcing hot combustion gases (about 1300° F.) directly through the acid. Fluorine and P_2O_5 are vaporized, making scrubbing necessary to control air pollution and to minimize phosphate losses. Submerged combustion produces a higher P_2O_5 concentration and a lower fluorine content acid. The costs of submerged production may be slightly lower, although the number of plants using vacuum evaporation outnumbers submerged combustion plants by seven to two.

Steam Sparging - The two defluorinated acid plants not producing SPA apparently steam sparge a mixture of orthophosphate acid and silica gel in an open tank. Little else is known about this process, although the plants are part of large phosphate complexes in Louisiana.

Sodium Tripolyphosphate

Only one plant does not manufacture sodium tripolyphosphate (STPP) from furnace acid. This study includes the one plant using wet process orthophosphoric acid. The chemistry of these polyphosphates in general is highly complex. The general process requires the reacting of phosphoric acid with caustic soda involving definite temperature controls with heating for a substantial time between 300° and 500° C. and slow cooling. Following the initial reaction is a mix tank, the material is dried, calcined (dehydrated), and then stabilized in a chilling or tempering unit.

C. Number of Plants and Employment

There are no precise data on employment in the segments under study. Because published census reports are not sufficiently refined to permit identification of these small segments, employment, based on manpower requirements and operating variables used in the model plant configurations, has been estimated. The labor inputs were obtained through industry sources and provide a reasonabl basis for estimating employment by segment. The estimates, rough at best, are presented in Table I-3.

Table I-3. Estimated number of employees by segment

Segment and tons per day	Number of plants	Production workers	Other	Total
Defluorinated rock phosphate				
75	1	9	6	15
225	2	30	14	44
900	1	37	7	44
Subtotal	4	76	27	103
Superphosphoric acid				
75	2	16	12	28
150	3	24	21	45
450	4	32	28	60
Subtotal	9	72	61	133
Defluorinated acid				
100	1	4	3	7
300	1	11	7	18
	2	15	10	25
Sodium tripolyphosphate				
450	1	14	7	21
Total		177	105	282

D. Relationship of Segments to Total Industry

The relationships of the segments under study to the total industry in which they operate can be shown by comparing the number of plants, production and employment to industry totals.

Defluorinated phosphate rock and defluorinated wet process phosphoric acid plants supply raw materials to two basic industry groups: animal feeds and fertilizers. However, the two segments are an integral part of the phosphate fertilizer industry. It is, thus, necessary to show their relationship to the fertilizer industry rather than the feed industry.

1. Defluorinated phosphates

Number of plants

This study compares the number of plants producing defluorinated phosphate products, including superphosphoric acid, to the total fertilizer industry. This is the most logical comparison, since no separate published data are available for the phosphatic fertilizer subclassification.

There are an estimated 768 fertilizer plants (excluding nitric and sulfuric acid plants and dry blenders and liquid mixers). Plants in each segment of this study are shown below as a percentage of that total. As noted earlier, there may be three or four additional SPA plants.

Product	No. Plants	% Total
Defluorinated phosphate rock	4	<1
Defluorinated wet process phosphoric acid (incl. SPA)	11	1.4
Total	15	2.0

Production

The 15 plants produced an estimated 863,000 tons of P_2O_5 in 1973 of the total U. S. production of 6.4 million tons of P_2O_5 for farm use. The percent of total P_2O_5 production for each segment is as follows:

	000 tons P_2O_5	% total
DFP*	197	3.1
Defluorinated acid	666	10.4
Total	863	13.5

*/ 465,000 tons DFP, 18.5% P.

Employment

DPRA developed an earlier estimate 1/ of 40,000 - 45,000 employees in the fertilizer industry. The estimated employees as a percent of 40,000 is shown below

	No. Employees	% Total
DFP	103	0.3-
Defluorinated acid	147	0.4-
Total	250	0.6+

2. Sodium tripolyphosphate

Number of plants

The one plant using wet acid to produce STPP can be compared to other STPP producers or to the total number of establishments in SIC 2819 (Inorganic Chemicals, not elsewhere classified). This broad comparison has little significance because of the wide diversity of products.

The Olin plant is one of 15 STPP producers and one of 718 establishments in SIC 2819. 2/

1/ David, M. L., et al., Economic Analysis of Proposed Effluent Guidelines for Fertilizer Industry, EPA-230/1-73-010, Nov. 1973.

2/ U. S. Industrial Outlook 1974 with Projections to 1980, U. S. Dept. of Commerce, Washington, D. C., 1973, p. 98.

Production

The Olin plant produces an estimated annual capacity of 140,000 tons of STPP, 12 percent of the estimated 1,175,000 tons of STPP.

Employment

The exact number of employees in the Olin plant is not known. SIC 2819 has an estimated 73,000 employees and Olin, with an estimated 80 plants has been reported to have 29,000 employees. 1/ Using the model plant estimate, an STPP plant of 140,000 tons capacity would have approximately 21 employees, an insignificant number.

1/ Economic Analysis of Proposed Effluent Guidelines, The Industrial Phosphate Industry, Environmental Protection Agency, Office of Planning and Evaluation, Washington, D. C., August, 1973, p. 10.

II. FINANCIAL PROFILE

Financial data relating to individual operating plants are not available. There are published financial data for the large, publicly held companies, but since these are generally widely diversified corporations, the data do not reflect accurately the phosphate divisions of the firms.

Given this limitation, model plant budgets provide the most reasonable insight into the financial aspects of the various operations. Model plant configurations, matched to the size and product combinations of typical operating plants, have been established in each of the segments and are presented in Table II-1.

The nonfertilizer phosphate industry under study is primarily composed of firms that are predominately fertilizer manufacturers. Consequently, the fertilizer industry financial data is representative of segments of the phosphate industry and will be used insofar as these data are available.

A. Plants by Segment

Before looking at the financial profiles as represented by model plant data, some observations about the phosphate industry and the three segments in this study are in order.

For perspective, it is helpful to look at Table II-2. This table shows sales and operating ratios for producers of basic fertilizer products, as reported by the Fertilizer Institute, and include only the fertilizer segment of the 36 to 40 companies which participate in the annual survey. They cover most of the industry's production and sales. Significantly, these same companies are fully integrated and are involved in defluorinated phosphate rock and wet acid derivatives to varying degrees. The ratios for cost of goods sold, sales, general and administrative expenses and profit before interest and taxes provide excellent check points for model plant construction. The Fertilizer Institute report also furnishes indirectly industry ratios for capital structure, long-term interest, and return on sales, net worth and invested capital.

1. Industry Profitability

The fertilizer (phosphate) industry is experiencing a major upswing in prices and profitability. After a stable period of reasonable earnings during the early 1960's, the industry suffered declining prices and earnings

Table II-1. Model plant configurations by segment

Segment	Capacity	Annual operating days	Annual production
	(TPD)		(tons)
Defluroinated rock phosphate [1/]	75	167	12,500
	75	300	22,500
	225-I	300	67,500
	225-II	300	67,500
Superphosphoric acid (wet process)	75	264	19,800
	150	264	39,600
	450	262	118,000
Defluroinated ortho phosphoric acid	100	260	26,000
Sodium tripolyphosphate	450	300	135,000

[1/] I and II denote locational differences for the 225 TPD size.

Table II-2. Averages of certain financial ratios for selected fertilizer companies, 1960 - 1973

	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960
Net sales	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cost of goods sold	78.1	79.8	81.3	83.3	89.6	85.9	79.3	77.8	76.6	76.1	75.6	76.2	75.8	76.4
Gross margin	21.9	20.2	18.7	16.7	10.4	14.1	20.7	22.2	23.4	23.9	24.4	23.8	24.2	23.6
S.G.&A. expense (total)	12.7	15.1	15.7	18.9	18.9	17.4	15.8	13.7	13.0	13.1	12.7	12.7	12.2	11.7
Pretax and pre-interest margin	9.7	5.9	3.9	(2.2)	(8.5)	(3.3)	4.9	8.5	10.4	10.8	11.7	11.1	12.0	11.9

Source: The Fertilizer Institute, "Financial Survey," and "Fertilizer Financial Facts," December 31, 1971 and June 30, 1972.

from 1966 through 1969. 1/ (See Table II-2). Certain basic producers actually incurred negative pre-tax margins on sales in 1968, 1969 and 1970. The uptrend began in 1970 after six years of declining margins. The pretax and pre-interest margin in 1973 rose to 9.7 percent after declining to negative 8.5 percent in 1969. There is still a substantial gap between 9.7 percent and the 12.0 percent margin of 1961.

Comparing the industry's 1972 profitability to other manufacturing industries as published by Fortune magazine, 2/ the industry does not fare well. In the Fortune industry medians report, the range in return on stockholders' equity was from 5.9 percent in the textile industry to 16.0 percent in foods and cosmetics. The 36 basic producers reported by the Fertilizer Institute had a pre-tax and pre-interest return on net worth of 10.9 percent. After estimating interest and taxes, the return on equity drops to 4.3 percent--lower than any other industry in the Fortune Survey. Chemicals, as an industry earned 9.0 percent. Return on sales (net profit after taxes as a percent of sales) reflects only a slightly better performance for the industry. The Fortune range was from 2.2 percent for the food industry to 12.8 percent for mining. The pre-tax and pre-interest margin for the fertilizer companies was 5.85 percent; the estimated after-tax profit was 2.3 percent. Chemicals earned 4.4 percent on sales in the Fortune survey.

1/ The data on the fertilizer industry in this section is from "Fertilizer Financial Facts" and "Financial Survey," furnished by the Fertilizer Institute. Data on basic integrated producers (Group II) reflect reports from 40 companies in 1973 and 36 companies in 1972, with a variable number reporting on different items. Profits are reported only before taxes and interest. Liabilities are not reported. However, the ratio of profits before taxes and interest to sales, to invested capital and to net worth are given, along with dollar figures for total assets, net sales, net operating income before taxes and interest. From these ratios and dollar values, it is possible to calcul. te long-term debt. The after-tax profit has been calculated by assuming 6 percent interest on long-term debt and a 48 percent federal income tax on after interest profit. This results in an after-tax profit of 2.3 percent on sales and 4.3 percent on net worth for 1972 and 4.1 percent on sales and 7.2 percent on net worth for 1973.

2/ "Industry Medians," Fortune, May, 1973, p. 244.

These comparisons reveal that in 1972, even though the industry's earnings improved over the previous five years, the earnings picture was extremely low in comparison to other manufacturing industries. At the same time, the trend is sharply upward for fertilizers, and 1973 price and production increases given certain evidence of improved profit margins.

2. Capital Structure

Similar data problems were encountered for capital structure ratios. The basic chemical industries group has a fixed debt to net worth ratio of about .4 against a total liabilities to net worth ratio of .8 in 1970 and 1971. [1/] The 36 basic producers group reported by the Fertilizer Institute in 1972, the only data available, indicated a fixed debt to net worth ratio of about .4, but against an indicated total liabilities to net worth ratio of 1.1, suggesting that current liabilities are somewhat higher in the fertilizer industry than in basic chemicals.

3. Cost of Capital

An estimated cost of financing new investment has been derived from an analysis of the financial reports of the publicly held companies. This method has an obvious shortcoming: the companies for the most part are widely diversified corporations whose earnings and capital structure reflect multi-product operations. In spite of this weakness, there are no better available data for estimating cost of capital.

The methods used to estimate the cost of capital involved a computation of debt and equity ratios to total invested capital and the calculation of five-year averages for dividend yield and earnings on common stock.

The estimated averages were as follows:

Common equity/Invested capital	.731
Long-term debt/Invested capital	.269
Dividend yield, 5-year average	.0357
Earnings on common stock, 5-year average	.0596

In estimating the cost of capital, other assumptions were made: (1) long-term interest rates average 7.5 percent, (2) the corporate tax rate is 48 percent and (3) the growth rate in dividends will be at least equal to the annual inflation rate, which is estimated at 5 percent.

1/ Almanac of Business and Industrial Financial Ratios, 1971 Edition, Prentice-Hall.

The cost of equities was derived by two methods -- the dividend yield method and the earnings-stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

The E/P method is simply

$$k = E/P$$

where

E = earnings
P = stock price

The E/P method is a further simplification of the dividend method. The latter assumes future earnings as a level, perpetual stream.

The after tax cost of debt capital was estimated from reported (annual financial reports and financial statistics) company outlays for interest expenses and multiplied by .52 -- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities [1/] to total asset ratios.

The average cost of capital for the fertilizer (phosphate) industry was estimated using the equity and debt data reported earlier as follows:

[1/] It is recognized that liabilities contain non-interest bearing liabilities, but its weight is believed to be an adequate proxy for the weight of debt.

Dividend Yield plus Growth	Weight	Cost	Growth	Wtd. Cost
Equity	.731	.0357	.05	.063
Debt (7.5% x 52%)	.269	.0390	--	.011
Av. Cost of Capital				.074

Earnings/Price				
Equity	.731	.0596		.044
Debt (7.5% x 52%)	.269	.0390		.011
Av. Cost of Capital				.055

Thus, the estimated range of the cost of capital is 5.5 to 7.4 percent.

4. Pro Forma Income Statements - Model Plants

Table II-3 contains pro forma income statements and financial returns for selected model plants in each of the segments. This table includes the model plant configuration which most nearly resembles the "average" or "typical" operating plant based on the plant data in Section I-B. Other model plant pro forma statements appear in the Appendix. The assumptions on which the various direct and indirect expenses have been calculated also are included on these separate pro forma statements.

The reader must be cautioned again that the model plant estimates are based upon best available information concerning industry practices and procedures. While the estimates are reliable guides, they can by no means be taken literally for any given operating plant.

In an overview of the pro forma income and financial data shown in Table II-3, it should be noted that with the exception of defluorinated rock, these non-fertilizer phosphate segments have very low invested capital relative to sales. This situation is typical in the basic fertilizer industry; however, it should be remembered that with the exception of defluorinated phosphate rock, these industry segments are involved in the further processing of wet process phosphoric acid. This situation is further amplified in examining the portion which raw materials represent of sales. Defluorinated phosphate rock raw materials represents approximately 43 percent of sales. However for superphosphoric acid and defluorinated wet acid, raw materials represent 84 percent of sales, and sodium tripolyphosphate raw materials represent 77 percent of sales.

Table II-3. Pro forma income statements and financial returns for selected model plants by industry segments (1973 dollars)

	Defluorinated phosphate rock 225 TPD		Superphosphoric acid 450 TPD		Defluorinated wet acid 300 TPD		Sodium tripolyphosphate 300 TPD)	
	($1,000)	% sales	($1,000)	% sales	($1,000)	% sales	($1,000)	% sales
Invested capital	4,820	--	2,825	--	1,350	--	2,886	--
Sales	4,995	100	18,054	100	10,557	100	20,655	100
Direct expenses								
Raw materials	2,122	43	15,192	84	8,884	84	15,887	77
Labor and supervision	218	4	114	1	156	1	284	1
Other	318	6	386	2	518	5	1,801	9
Subtotal	2,658	53	15,692	87	9,558	90	17,972	87
Indirect expenses	1,423	29	1,146	6	679	[illegible]	2,012	10
Total operating expenses	4,081	82	16,838	93	10,237	97	19,984	97
Depreciation	345	7	170	1	42	neg.	165	1
Interest (long-term)	87	2	19	neg.	6	neg.	15	neg.
TOTAL COSTS	4,513	90	17,027	94	10,285	97	20,164	98
Net income before tax	482	10	1,027	6	272	3	491	2
Net income after tax	257	5	541	3	148	1	262	1
Cash flow	602	12	711	4	490	2	427	2
Net income before tax as percent of invested capital	10	--	36	--	20	--	17	--
Net income after tax as percent of invested capital	5	--	19	--	11	--	9	--

Note: Percentages may not add due to rounding.

Annual Profits After Taxes

Defluorinated Phosphate Rock - The 225 ton per day plant producing 67,500 tons of product shows a net income after tax of $257,000 on sales of nearly five million dollars and invested capital of approximately $4,800,000. This model is probably representative of two of the four DFP plants in the United States. There is a very small unit of 75 tons per day which would appear to be in a break-even or slight loss position. The fourth plant is a very large unit, approximately 940 tons per day capacity. Given the scale of economies present in this industry, it would appear that the large unit would be quite profitable.

Superphosphoric Acid - The bulk of the SPA production is represented by the 450 ton per day plant shown in Table II-3. At the apparent current differential between ortho acid prices and SPA prices on equivalents (P_2O_5), the large SPA plant would appear to be yielding after taxes a 19 percent rate of return on invested capital and 3 percent on sales. The industry has a number of smaller plants, represented more nearly by the 75 ton and a 150 ton per day units. Based on the model plant estimates contained in the Appendix, there may be two to four small plants that are very marginal. Middle sized plants, composed of plants of 35 to 50 thousand tons, would appear to be profitable, although at much reduced level relative to the large plants shown in Table II-3.

Defluorinated Wet Acid - Table II-3 presents a cost estimate and rate of return estimate for a 300 ton per day defluorinated wet acid unit. Little information is available about this o. e unit; thus, the data shown in Table II-3 is merely indicative. Based on the same P_2O_5 equivalent price as used for SPA, this unit would demonstrate profitability, after taxes, between the medium and large size SPA units. Although the after-tax rate of return is 11 percent, it should be noted that this represents only $148,000 after taxes.

If this product can not be sold on the same basis as SPA, this unit could be quite marginal.

Sodium tripolyphosphate - Sodium tripolyphosphate plants using furnace acid are reported to be quite marginal due to the high cost of acid and the depressed prices of the detergent market. With the apparent lower acid cost from wet acid, it appears that this unit would be generating a profit of $262,000 or 9 percent on invested capital.

It should be noted that the input price of phosphoric acid was taken at a predecontrolled market level. Since the sodium tripolyphosphate plant using wet acid produces wet acid on site, it may be that the internal transfer price is low enough to raise profitability.

Annual Cash Flow

Annual cash flow in relation to sales in this segment can be considered to be quite low, ranging from $711,000 for a large superphosphoric acid plant to $190,000 per year for the defluorinated wet acid unit.

Although these plants are relatively new, most dating since 1960, the life expectancy of phosphate plants is relatively short. As a consequence these plants, excepting DFP units, tend to be largely depreciated and are expected to have a low book value of assets. Further, the plant investment in the acid derivative segments is quite low; thus, there are few depreciable assets.

5. Invested Capital - Model Plants

Investment has been estimated for each of the model plant configurations, including replacement value, salvage and book value. The assumed construction dates for each of the models were as follows:

	Capacity (TPD)	Year built
Defluorinated rock phosphate	75	1960
	225	1969
Superphosphoric acid	75	1967
	150	1968
	450	1969
Defluorinated acid (wet process)	300	1969
Sodium tripolyphosphate	450	1960

These ages are typical of those found in these segments. Salvage value of the sunk investment is low because much of the equipment (plant) component is composed of labor and engineering. Salvage values were estimated on the following basis:

	Percent of total	Salvage as a percent of original cost	Weighted salvage as a percent of original cost
Defluorinated phosphate rock			
Land	100	100	100
Plant			
Process equipment and buildings	25	25	6.25
Labor-construction	33	0	0
Field expense	12	0	0
Engineering and fees	30	0	0
Total	100	--	6.25
Other segments			
Buildings and land	6	21	1.26
Process equipment	25	25	6.25
Labor construction	31	0	0
Field expense	12	0	0
Engineering and fees	26	0	0
Total	100	--	8.0 (rounded)

Net working capital,[1/] assumed at 10 percent of sales, has a 100 percent salvage value. Table II-4 presents salvage values, along with 1973 estimated replacement costs and estimated book values.

6. Cost Structure - Model Plants

The pro forma tables in the Appendix present the fixed and variable cost structures for each of the segments. Table II-3 shows these for selected model plants. These costs have been calculated as a percent of sales. Raw materials represent a higher percentage of sales for acid derived production (77-84 percent) than they do in other segments. Raw materials costs for DFP are the lowest of any of the segments (43 percent). Direct costs range from 87 to 90 percent for the acid derived product and only 53 percent for the DFP segment.

Again, the reader is referred to the parameters set forth in the Appendix tables to see how these various costs were developed.

1/ Current assets minus current liabilities.

Table II-4. Estimated replacement, book and salvage values, for model plants by segment

Model plant and tons/day	Replacement	Book	Salvage
	--------------	$1,000	--------------
Defluorinated rock phosphate			
75	3,440	515	440
225-I	7,350	4,820	1,490
225-II	6,880 1/	4,430 1/	1,020 1/
Superphosphoric acid			
75	1,005	515	355
150	1,685	1,035	690
450	3,855	2,825	1,970
Defluorinated ortho phosphoric acid			
300	1,555	1,350	1,095
Sodium tripolyphosphate			
450	6,786	2,886	2,446

1/ Reflects locational difference and site value.

B. Distribution of Data

Table II-5 is a summary of the after-tax profits, return on invested capital, return on sales, and cash flows for all of the model plant configurations.

As shown in Table II-5, the smaller units, in the multiple plant situations, appear to be marginal, for they exhibit negative returns and cash flows. Although the larger SPA plants are profitable in the models, the rate of return on invested capital is misleading because invested capital is quite low. Thus the absolute levels of after tax income and cash flows are relatively low. Attention is drawn once again to the fact that cash flows do not greatly exceed after-tax profits.

The STPP plant in this study is one of a kind. However, there are 14 STPP plants utilizing furnace acid as a P_2O_5 source. These units, due to high P_2O_5 costs, are reported to be showing losses. 1/

C. Ability to Finance New Investment

The ability of a firm to finance new investment for pollution abatement is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) new equity capital through the sale of new common or preferred stock; (3) internally generated funds -- retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors is the financial condition of the individual firm. For debt financing, the firm's credit rating, earnings record over a period of years, stability of earnings, existing debt-equity ratio and the lenders' confidence in management will be major considerations. New equity funds through the sale of securities will depend upon the firm's future earnings as anticipated by investors, which in turn will reflect past earnings records. The firm's record, compared to others in its own industry and to firms in other similar industries, will be a major determinant of the ease with which new equity capital can be acquired. In the comparisons, the investor will probably look at the trend of earnings for the past five or so years.

1/ Economic Analysis of Proposed Effluent Guidelines - the Industrial Phosphate Industry, EPA, EPA-230/1-73-021, Aug. 1973.

Table II-5. Ranges of after tax profits, financial returns and cash flows of model plants by segment

Model and tons per day	After tax profits $1,000	% of invested capital	% of sales	Cash flows $1,000
Defluorinated rock phosphate				
75 - 50% utilization	<217	< 0	< 0	< 67 >
75 - 90% utilization	< 16>	< 0	< 0	134
225 - I	257	5	5	602
225 - II	375	8	8	720
Superphosphoric acid				
75	< 80 >	< 0	< 0	< 26>
150	70	7	1	156
450	541	19	3	711
Defluorinated orthophosphoric acid				
300	148	11	1	190
Sodium tripolyphosphate	262	9	1	427

Internally generated funds depend upon the margin of profitability and the cash flow from operations. Also, in publicly held corporations, stockholders must be willing to forego dividends in order to make earnings available for reinvestment.

The condition of the firm's industry and the general economy are also major limiting factors in attracting new capital. The industry will be compared to other manufacturing industries in terms of net profits on sales and on net worth, supply-demand relationships, trends in production and consumption, the state of technology, impact of government regulation, foreign trade and other significant variables. Declining or depressed industries are not good prospects for attracting new capital. At the same time, the overall condition of the domestic and international economy can influence capital markets. A firm is more likely to attract new capital during a boom period than during a recession. On the other hand, the cost of new capital will usually be higher during an expansionary period. Furthermore, the money markets play a determining role in new financing; for instance, 1973 has been viewed as an especially difficult year for new equity issues.

These general guidelines can be applied to the phosphate industry by looking at general economic data, industry performance and available corporate records.

The general economic outlook for the next few years has been clouded over by the uncertainties surrounding economic policies and the critical shortages of many basic resources, especially energy. The lack of certainty in policies has also been intensified by political instabilities. Such intangibles make accurate forecasting impossible.

In any event, the rate of economic growth slowed in the fourth quarter of 1973 and the first quarter of 1974. Recovery to the historic annual rate of 3.5 percent will probably not occur prior to the last half of 1974. Even then, continued concern with energy problems and inflation will exert heavy influence on growth rates. Unemployment will undoubtedly rise in 1974 and will require a period of adjustment to new growth rates and patterns. Inflation, which soared in late 1973 to annual rates of 8 and 9 percent, cannot be expected to drop below 5 or 6 percent in the immediate future.

These conditions will strongly affect capital availability and costs. In the search for new energy sources and new production technologies, both public and private institutions will continue to exert a heavy demand on capital funds and will more than offset the decline in private investment demand resulting from economic slowdown. This will keep upward pressure on money rates. In addition, inflation will push interest rates higher as lenders demand a larger inflation premium. For the next few years, capital funds are likely to be available; however, their rates will approach the historic high levels of 1969-70 when long-term, high grade corporate bonds yielded 9 to 10 percent. The cost of financing new investment will be high compared to that of the 1950's and early 1960's.

Section II-A contains a discussion of the profitability, capital structure and cost of capital for the industry and for the segments under consideration.

On balance, it would appear that the phosphate industry as a whole should not experience serious problems in financing new investment although the industry appears to have a cyclical earnings pattern. The picture is confused further by the dominance of large diversified firms. These firms should not be hampered by a lack of credit or a shortage of capital. At the same time, on an individual plant basis, lack of profitability for the smallest sized acid plants would make new investment unlikely, even if the parent firm possessed adequate resources.

III. PRICING

A. Price Determination

Markets for the three phosphate manufacturing segments under study are complex and distinct. Further, these segments manufacture intermediate agricultural and industrial products; thus the demand for these products is a derived one, that is, it is a function of the products in which these goods are used. The following pricing discussion will include a discussion of the demand for these goods. The overall pricing discussion is organized by product -- defluorinated phosphates and sodium tripolyphosphate under each will be a discussion of demand, supply, and prices.

It should be noted at the outset that published use and production data for these industries are at best sketchy: these segments are new, they are of minor importance in the total phosphate industry, and they are used only as intermediate products.

The first section discusses three products: defluorinated rock phosphate, superphosphoric acid from wet process acid and defluorinated wet process acid. For simplicity, the latter two will be treated together. A discussion of sodium tripolyphosphate follows that

1. Defluorinated Phosphates

The demand for defluorinated rock phosphate (DFP) is derived from the demand for feed phosphates, and the demand for defluorinated acids is derived primarily from that for feed phosphates and liquid fertilizers. Some small quantities of the defluorinated acids go into industrial uses.

Livestock Feed Requirements

Livestock feed involves literally hundreds of different feedstuffs ranging from the traditional pasture and corn to modern antibiotics, hormones and phosphates. Much of the feed is prepared directly on the farm using farm grown materials, although the prepared animal feeds industry produce a substantial quantity - probably in the order of 75,000.000 tons per annum. Because of this diversity, a comprehensive data series on feed consumption is not available. The USDA estimate concentrate and roughage consumption does offer a rough indicator of overall consumption, but it excludes mineral and vitamin premixes and other critical, but minor feedstuffs.

Table III-1 presents estimates of concentrate consumption from 1966 through 1973. As shown, beef cattle and swine are the largest consumers of concentrates. The relative importance of concentrates and roughages by species is as follows:

Species	Feedstuffs composition (10 year average)	
	Concentrates	Roughages
	(pct)	(pct)
Dairy	32.6	67.4
Cattle on feed	69.2	30.8
Other beef cattle	8.1	91.9
Sheep and goats	9.1	90.9
Chickens	96.4	3.6
Broilers	100.0	0.0
Turkeys	95.5	4.5

Historically, concentrate consumption is growing at a 2 percent annual rate. Consumption by beef cattle is growing significantly, while that by other species is growing at much slower rates. These patterns, in general, follow expectations based upon the demand for livestock products.

The demand for meat products is anticipated to continue growing between one and two percent per annum. Egg consumption is projected to grow at about one percent; dairy products are expected to grow only slightly, due to declining per capita consumption. The meat products increase will vary by species with pork increasing at just over one percent and poultry products growing over two percent. These projected consumption growth rates are summarized below:

Meats	Percent annual growth - 1980	
	Per capita consumption	Total 1/
Beef	.7	1.7
Pork	.3	1.3
Lamb and mutton	.7	1.7
Chicken	1.2	2.2
Turkey	1.2	2.2
Eggs	.1	1.1
Dairy products	- .65	.35

1/ Includes a 1 percent per annum population effect

Source: Derived from George, P. S. and G. D. King, Consumer Demand for Food Commodities in the United States with Projections to 1980, Calif. Agric. Exper. Stat., Giannini Foundation Monograph No. 26, March, 1971.

Table III-1. Consumption of concentrates by kind of livestock, 1966-1973

Specie	1966 1/	1967 1/	1968 1/	1969 1/	1970 1/	1971 2/	1972 2/	1973 2/	1980 3/
	Year beginning October 1								
	Million Tons								
Dairy	28.9	29.4	29.1	25.6	26.6	25.6	26.8	27.0	27.2
Beef cattle	36.0	37.7	42.5	49.6	48.2	51.5	54.8	55.0	61.6
Swine	53.3	53.7	54.8	56.3	57.6	56.8	55.2	53.0	61.0
Hens, pullets & chickens raised	23.1	23.0	23.1	24.1	23.7	22.6	22.8	23.0	24.9
Broilers	14.0	13.7	13.7	13.7	13.9	14.2	13.9	14.5	16.9
Turkeys	6.0	5.1	5.3	5.6	5.2	6.1	6.2	6.6	7.5
Other	11.5	11.6	15.9	19.5	17.6	18.0	18.3	18.3	20.3
Total	172.8	174.2	184.4	194.4	192.8	194.8	198.0	197.4	219.4

1/ Allen, Geo. C. and Earl F. Hodges, National and State Livestock Feed Relationships, 1972 Supplement to Bul. No. 446, ERS, USDA, June 1972, Washington, D. C.

2/ Estimated by DPRA.

3/ Projected by DPRA.

Though the rate of growth at the retail level should translate back directly to the producer level, if one assumes a steady state system, it should be noted that these growth rates may not track directly back to the producer level. As nutritional and genetic research provides ways of achieving improved feed conversions, (i.e., more production per unit of feed), and as higher product conversions are realized, particularly in the area of meat, less feed will be required per unit of final output. These changes will likely be slow in coming; thus the market growth rates should be reasonable indicators.

Based upon these indicators we have projected concentrate consumption for 1980 as shown in Table III-1. Dairy consumption is expected to grow only slightly. Poultry feed consumption is expected to grow moderately. Most growth is assignable to beef and swine concentrate consumption.

Feed Phosphate Requirements

Prior to World War II, phosphorous deficiencies in livestock were not widely recognized and phosphorous largely came from organic sources, i.e., grains and forages, packing house by-products (tankage and bone meal), and fish meal. Declines in phosphate content of crops due to soil mineral depletion and new research findings, gave rise to the inorganic feed phosphate market.

Early inorganic phosphates were largely phosphate rock and colloidal phosphate (soft rock phosphate) from mine washings. In the 1930's it was discovered that the high fluorine content of these materials caused fluorosis (an accumulative poisoning process, in livestock. Solutions to the fluorine problem started with defluorination of superphosphates (in the early 1940's) followed closely by the defluorination of rock phosphate. (This process reduces the fluorine content to .2 percent compared to the 4 percent fluorine content of rock.)

In the 1950's, feed grade dicalcium phosphate was introduced. This product, dical, is a combination of mono, di and tricalcium phosphates and is generally produced from deflorinated ortho phosphoric acid and limestone.

Comprehensive consumption data on feed phosphates is sketchy. The best published estimate of feed phosphate consumption, in our opinion, is shown in Table III-2. In 1951 domestic consumption was about 340,000 tons of 18% P material equivalent. By 1960 consumption had risen to 650,000 tons and by 1970 doubled once again to 1,300,000 tons. The bulk of this growth has been dicalcium phosphate and defluorinated phosphate rock, which in 1970 represented 75 percent of the total. A number of other phosphate sources are used as shown in Table III-2. With the exception of phosphoric acid and ammonium polyphosphate and mono- and di-ammonium phosphate, these products are expected to decline in absolute consumption levels largely because of comparative cost disadvantages.

Table III-2. Estimated available tonnage of phosphorus feed supplements in the U.S. for the calendar years 1951, 1960, 1970

Product	1951	1960	1970
	tons		
Dicalcium Phosphate	56,333	252,778	625,000
Defluorinated Phosphate	80,167	216,667	350,000
Sodium Tripolyphosphate	--	--	35,000
Phosphoric Acid and Ammonium Polyphosphate	--	--	105,000
Mono- and Di-Ammonium Phosphate	--	--	15,000
Steamed Bone Meal	86,667	46,944	20,000
Imported Rock Phosphate	80,889	86,667	100,000
Soft Rock Phosphate	28,889	43,333	40,000
Other Phosphate	6,500	3,611	10,000
Total	339,445	650,000	1,300,000

Note: Tonnage figures are in terms of 2,000 pounds of material containing 18% P.

Source: Henry Highton, "U. S. Market is Growing for Feed Phosphorus Supplements," World Feeds and Protein News, March/April, 1971.

Phosphorus requirements vary by livestock species and reflect both the ration composition and physiological requirements. Generally, roughages have a low phosphorus content and it decreases even further with maturity. Grains, grain products and high protein ingredients have a much higher phosphorus content and, for instance in cattle rations, little supplementation is required. The requirements for phosphorus in poultry and swine are well established, while in the ruminants these requirements are not precisely known.

The actual use of phosphates in rations varies by species. In the case of poultry where more nutritional knowledge is available, the use of feed phosphates generally approach known technical requirements. Baring technological breakthroughs, the use of feed phosphates in poultry should generally follow the demand for poultry products. In the ruminants, less is known about the availability of and the animals' requirements for phosphorous, as its availability is apparently a function of vitamin D levels, pH and the calcium ratio. In the case of dairy cattle, phosphorous levels probably approach known requirement levels. However, in beef cattle, it is generally believed that actual phosphate levels are somewhat below the technical requirements stated by researchers.

Without consumption data and related detailed use data, an exacting study would be required to make market projections. Such a study is beyond the scope of this report; thus, it is necessary to resort to some general indicators of growth.

Nutritionists report that a prepared concentrate ration should generally contain an 18 percent P equivalent content by specie as follows:

Specie	18% equivalent (pct)
Dairy	1.0
Beef	1.0
Swine	1.3
Hens, pullets	1.75
Broilers	1.0
Turkeys	1.5
Other	1.0

Application of these relationships indicate a market potential in 1970 of 2.3 million tons of 18 percent P equivalent compared to an actual market of 1.3 million tons. By 1980, the market potential would be in the order of 2.6 million tons. Thus the future market for feed phosphate will be a function of the feed consumption growth and movement toward the technical potential.

Defluorinated Phosphate Rock - Traditionally defluorinated phosphate rock has been used primarily in poultry feeds (generally in the Southeastern poultry industry), although there are no technical reasons why DFP could not be used in livestock rations. Fragmentary estimates of consumption indicate that DFP has improved its share of the market from about 27 percent in 1970 to 29 percent in 1973. Meanwhile, current phosphate shortages [1/] have perhaps contributed to strengthening DFP's position in the market; indeed, it seems probable that DFP could improve its market position to 33 percent by 1980. This would be equivalent to about 800,000 tons or a growth rate of 8.5 percent.

The annual feed phosphate market in 1980 may be roughly estimated. Poultry feeds contain virtually all of the P requirement. Dairy and swine, although not yet at the total P requirement, will probably reach the technical requirement by 1980. Rapid changes in feed phosphate use are occurring in beef feeding, but it seems unlikely that they will reach their technical potential by 1980. These assumptions and that concerning the expected growth of the livestock industry indicate an annual feed phosphate market by 1980 of 2.4 million tons, an annual growth rate of about 6 percent.

With the exception of liquid phosphates (phosphoric acid and ammonium phosphates) and sodium tripolyphosphates, the bulk of the growth in feed phosphates will probably be composed of defluorinated phosphate rock and dicalcium phosphate. By 1980 these two products should compose about 80 to 85 percent of the feed phosphate market.

Dicalcium Phosphate - Estimated consumption of dicalcium phosphate is reported as shown in Table II-3. [2/] Until 1973, when shortages of raw materials occurred, dical consumption had grown steadily since 1960. Current reports indicate that a severe shortage of feed phosphates arose in 1973, leaving feed producers short by as much as 40 percent of the required amounts. The sharp drop in production reported in 1973 substantiated these reports. Apparently dical producers have not been able to obtain sufficient quantities of defluorinated acid to meet market demands. The supply problem undoubtedly reflected the general scarcities in the United States which were accentuated by the more profitable export prices after August 15, 1971 of phosphates under price controls and commitments to fertilizer manufacturers in acid. New wet-acid sources coming on stream in 1974-75 should alleviate the problem somewhat.

1/ 1973 is a difficult year, for the large reduction in the Peruvian anchovy catch created the need for substituting inorganic phosphates for phosphates previously obtained from this source. Also recent shortfalls in dicalcium phosphate have strengthened DFP use.

2/ Some industry contacts have suggested that dical consumption is under reported due to increasing quantities of 21 percent P dicalcium phosphate

Table III-3. Estimated production and consumption of calcium phosphate, dibasic, 18.5% P, feed grade, 1960-1973

Calendar year	Production	Imports	Exports	Estimated consumption
	('000 tons)			
1960	235	6	N.A.	241
1961	250	11	N.A.	261
1962	251	10	N.A.	261
1963	240	5	N.A.	245
1964	242	7	N.A.	249
1965	263	3	N.A.	266
1966	290	22	N.A.	312
1967	392	6	N.A.	398
1968	416	21	N.A.	437
1969	496	15	N.A.	511
1970	594	33	N.A.	627
1971	662	23	N.A.	685
1972	692	27	N.A.	719
1973	620 1/	30 1/	N.A.	650 1/

1/ Estimated by DPRA.

Source: Current Industrial Reports, Inorganic Chemicals, Series M28A, Bureau of the Census, U. S. Dept. of Commerce, Washington, D. C. and FT 135 and FT 246 Imports...., Bureau of the Census, U. S. Dept. of Commerce, Washington, D. C.

In the longer run, we expect that dical market share will be maintained at the 50 percent level. This would mean an annual market of about 1.2 million tons by 1980, and a 6 to 6.5 percent growth rate.

Liquid Fertilizer Demand

Approximately 56 percent of wet process superphosphoric acid goes into liquid fertilizer mixtures. Liquids have been rising as a percent of total mixtures, as revealed in Table III- 4 . This table also shows how grade 10-34-0, which is the largest single grade of ammonium phosphate liquid fertilizer, has increased in relationship to all liquid mixtures. Although the 10-34-0 consumption data reportedly is for direct application of this grade, it is not known how much of this quantity may really be used in fluid mixtures nor how much additional 10-34-0 is consumed in other mixtures. According to U.S.D.A. reports, relatively little P_2O_5 is consumed in direct application materials (about 6 percent of total P_2O_5 in fluid fertilizers).

Future long-term demand for liquid phosphate fertilizers will undoubtedly continue to expand in spite of a recent leveling off. Data for the 1972-1973 fertilizer year are not available, but indications are that growth of liquid mixtures in calendar year 1973 had been curtailed by shortages of super and ortho wet acids, occasioned in part by export pressures. As new ortho wet acid capacity comes on stream in 1974-75, as anticipated, it is reasonable to expect liquid fertilizer consumption to resume the growth pattern of the past ten years. Growth will be affected by many factors, especially the availability of wet acids and the relative price and supply of solid ammonium phosphates. Assuming that the historic relationships remain the same, the liquid mixture market should grow at an annual rate of 10 to 15 percent through 1980. The annual growth rate from 1968 through 1972 was 14 percent. Grade 10-34-0 grew at a 27 percent annual rate in those same years.

2. Defluorinated Phosphate Rock

Demand for DFP was discussed earlier in this chapter. It will be summarized here.

Table III- 4. Selected data for liquid fertilizer consumption, 1963 - 1972

Fertilizer year	Liquid mixtures	Total mixtures	Liquid as % total	10-34-0 grade	10-34-0 as % liquids	Price 10-34-0
	(mil. tons)	(mil. tons)		(000 tons)		($/ton)
1963	0.8	16.7	4.8	n.a	n.a.	n.a.
1964	0.9	17.5	5.1	n.a.	n.a.	n.a.
1965	1.0	17.8	5.6	45	4.5	n.a.
1966	1.4	18.7	7.5	52	3.7	n.a.
1967	1.8	20.0	9.0	92	5.1	n.a.
1968	2.0	19.8	10.1	138	6.9	99.00 1/
1969	2.2	19.5	11.3	189	8.6	88.40 1/
1970	2.5	19.2	13.0	234	9.4	88.30 1/
1971	2.9	19.6	14.8	300	10.3	91.00
1972	3.4	19.4	17.5	361	10.6	91.40

1/ Western states only. Other prices are average U.S. retail price paid by farmers.

Source: Commercial Fertilizers, SpCr7, SRS, USDA, Washington, D. C., various numbers, Agricultural Prices, Pr 1, SRS, USDA, Washington, D. C. various numbers; Edwin A. Harre and John N. Mahan, "The Supply Outlook in Blending Materials," TVA Fertilizer Bulk Blending Conference, August 1-2, 1973, No. Y-62, Tennessee Valley Authority, Muscle Shoals, Ala., Aug. 1973.

Demand

Consumption data on DFP are sketchy at best. One source [1/] reported its use in selected years as follows:

1951	80,167
1960	216,667
1970	350,000

Generally, the demand for DFP is derived from that for poultry and eggs, since about 95 percent of domestic use of DFP is in pou'try feeds. Laying hens utilize the largest amount, followed by broilers and turkeys. The remaining amounts go into beef cattle and swine feeds. (Poultry feed requirements were discussed under "Livestock Feed Demand.") Generally, the use of phosphates in poultry feeds has reached a technical saturation level; consequently, future demand will reflect increases in poultry production and not changes in nutritional requirements. Tr complex demand-interrelationships of poultry products with meat and dairy products make demand forecasting precarious. However, based on these projections, DFP consumption should rise at a 6 percent rate.

Supply

The four producers of DFP have a capacity of 510,000 annual tons of product. Estimated production in 1972 was at just over 90 percent of capacity at 465,000 tons. Since approximately 15,000 tons went into export trade, apparent consumption was about 450,000 tons. Time series data on DFP production are not available. With minor variations for foreign trade and annual inventories, it is reasonable to assume that annual production roughly matches annual consumption.

Prices

Prices for DFP are affected somewhat by related prices of dicalcium phosphate, since the two products are rather interchangeable for livestock feeding. It would appear that DFP prices would be relatively inelastic in view of the minor position which DFP contributes to feed costs. Recent price history can be seen in the following quoted wholesale prices which do not reflect discounts or required variations:

1/ Henry Highton, U. S. Market is growing for feed phosphorus supplements, World Feeds and Protein News, March/April 1971, p. 8.

Deflorinated rock price \$/ton - 18% P, feed grade, bags, carload, Plant City, Florida

1960	66.25 - 63.50
1965	62.25
1966	65.25
1967	65.25
1968	65.25
1969	65.25
1970	6[illegible].25 - 65.25 1/
1971	72.25 1/
1972	72.25 1/
1973	72.25 1/

1/ Coronet, Fla.   Note: Bulk prices are \$5.00 per ton less

Source: Chemical Pricing Patterns, Schnell Publishing Co., N.Y., N.Y., and Chemical Marketing Reporter, various issues.

3. Defluorinated Wet Process Phosphoric Acid

The defluorination of wet process phosphoric acid occurs primarily in superphosphoric acid plants. (One plant does not concentrate wet ortho phosphoric acid in its defluorination process. Little is known about the actual level of operation of this one plant or about the end use of its defluorinated acid. It seems reasonable to assume that its primary market is dicalcium phosphate for livestock feed.) The following discussion about supply and prices includes both superphosphoric acid (SPA) and defluorinated wet process acid, although, for simplicity, reference will be to SPA.

Unfortunately, reliable time series data for SPA are not presently available; consequently the estimate of demand and supply positions for 1973 is based on information from government and industry sources.

Demand

The demand for SPA is derived primarily from the markets for liquid mixed fertilizers and feed grade calcium phosphates (dical). These have been described earlier. Some SPA is used in solid fertilizers, liquid feed supplements and firefighting chemicals.

The 1973 estimated dical market of 620,000 tons of product (18.5% P) required 263,000 tons of P_2O_5, of which approximately 220,000 tons came from wet process SPA plants. The rest came from limited amounts of furnace acid and defluorinated wet process acid.

Fluid fertilizers used an estimated 574,000 tons of P_2O_5, of which 376,000 tons came from wet acid SPA plants. The remainder came from furnace acid and ortho acid.

Combining the fluid fertilizer and dical demand projections, it is estimated that the demand for wet process superphosphoric acid will expand at a substantial rate -- from 8 to 11 percent.

Other uses (including liquid livestock feed phosphates and fire fighting liquids) accounted for about 70,000 tons of P_2O_5.

These estimates were derived from the following:

		1973 Tons P_2O_5
Capacity		626,000
783,000 tons @ 80% operating rate		
Demand		
Dical (620,000 tons, 18.5% P)		
IMC	350,000	148,000
Others	270,000	115,000
		263,000
Fluid Fertilizers		574,000
Other SPA uses		70,000
Total P_2O_5 Required		907,000
Less Wet Acid Source		626,000
Other P_2O_5 Sources 1/		281,000

1/ Furnace superphosphoric acid, merchant ortho acid and defluorinated wet ortho acid.

Supply

The estimates which follow are for superphosphoric acid derived from wet process ortho acid. (Furnace acids are included in the discussion only as they are a part of the supply of P_2O_5 for liquid fertilizers and dical producers.) Based on industry sources and published government statistics, DPRA has estimated that SPA producers operated at 80 percent of capacity in 1973. The plant list reported earlier, with an annual capacity of 783,000 tons, would indicate an output of approximately 626,000 tons of P_2O_5. There may be an additional three or four plants producing some SPA in the United States, but it is not possible to confirm this at this time. There is also one plant which produces an indeterminant amount of defluorinated wet process ortho acid. The operating level of SPA plants is limited principally by the availability of ortho phosphoric acid, which was in short supply in 1973. With dical and liquid fertilizer producers under supplied with SPA, operating levels would probably increase sharply with new sources of wet ortho acid.

Prices

Historic price data for superphosphoric acid are not precise. Quoted prices for 75 percent acid, f.o.b., plant, are listed below for the 1955-73 period. These are prices per 100 pounds of acid. They do not reflect discounts nor do they represent transfer prices used for intercompany transactions.

Superphosphoric acid quoted prices, 1955 - 1973
(75% P_2O_5, tanks, f.o.b. plant)

	$/100 lbs	$/ton P_2O_5
1955	$5.35	$143
1960	5.60	149
1965	5.60	149
1970	6.25	167
1971	6.95	185
1972	6.95	185
1973	7.45	199

Source: Chemical Pricing Patterns, Schnell Publishing Company, New York, N.Y., 1971 and Chemical Marketing Reporter, Schnell Publishing Company, various issues.

SPA prices are directly tied to wet ortho acid prices as well as to fluid fertilizer and dical prices. As an intermediate product, SPA has very little price character on its own account. On the one hand, wet ortho acid price to SPA producers is in part a function of alternative uses of wet ortho acid. Recent export pressures, with price premiums, have created domestic shortages; after price decontrol in October, 1973, acid prices rose sharply. On the end-use side, fluid fertilizer prices have also increased substantially. For example, the average U.S. retail price of 10-34-0 stood at $91.40 per ton in April, 1972. This rose to $102.00 in April, 1973and to $108.00 in September, 1973. Post-decontrol prices have risen even further. Rising dical prices also reflect the shortages of SPA, although not to the same extent as the prices of fluid fertilizers. Pre-decontrol dical prices remained reasonably steady down to July, 1973. There is evidence that dical prices increased by as much as 60 percent from July to December, 1973.

Prices for SPA appear to be relatively inelastic, especially in that portion moving into feed phosphates. With the phosphates supplement constituing such a minor portion of total feeds (about one percent of weight), increases can be passed on with little effect on consumption. There may be a somewhat different degree of elasticity for liquid fertilizer prices, since liquids compete with dry blends and direct application materials. With all fertilizers in short supply, it is difficult to offer valid judgments about price behavior. It is reasonable to assume, however, that small price increments resulting from pollution abatement costs would probably have minimal effects on liquid fertilizer use.

4. Sodium tripolyphosphate

Demand

The demand for STPP is derived primarily from the soap and detergent market. About 90 percent of output has traditionally gone into this end use. Small amounts are used in water treatment, oil drilling and livestock feeds. About five percent of STPP production has been exported annually. Table III-5 presents estimated consumption.

Demand rose rapidly during the 1950's and 1960's. In the late 1960's, increasing concern over the effects of the phosphorus in detergents on algae growth in lakes stopped the expansion of demand. Difficulties in developing an acceptable alternative have left STPP in a dominant though slightly weakened position. Consumption has slipped somewhat from the 1970 peak of about 1,130,000 tons to an estimated 926,000 tons in 1973.

Future demand is geared to developments in the soap and detergent industry. If a suitable substitute can be found, environmental considerations may lead to sharply reduced use of STPP in soaps and detergents. The current status of research and development in the industry and of the public policy regarding restraints on the use of STPP are sufficiently indefinite to prevent meaningful forecasts at this time.

Supply

Sodium tripolyphosphate is largely processed from furnace acid produced on site, with the Olin Corporation plant at Joliet, Illinois being the only one using wet acid. The supply picture for STPP must include other sodium phosphate products such as monobasic, disbasic, tribasic, meta, tetrabasic and acid pyro. Of these products, only tetrabasic enters the same basic end use as tripoly (STPP)--as a building block for soaps and detergents. Tripoly accounts for over 80 percent of the sodium phosphate production and for about 95 percent of the sodium phosphates used in soaps and detergents.

Production of STPP in 1973 1/ amounted to 973,600 tons of material containing 563,000 tons of P_2O_5. This represented a drop of 7.3 percent from 1972. Estimated capacity in 1973 stood at 1,175,000 tons, a utilization rate of approximately 83 percent, compared to 89 percent in 1972. Table III-5 presents the growth of the STPP supply from 1960 through 1973.

The Olin plant is a part of this larger supply picture. The largest producer, it has about 12 or 13 percent of the total STPP capacity. It should possess some advantages from its size and its use of wet acid.

Prices

The average of high and low annual prices of STPP carload lots at the plant with equalized freight charges are presented in Table III-5. There has been reasonable stability up to 1970, followed by increases in 1971

1/ Using the fertilizer year, July 1, 1972 - June 30, 1973.

Table III- 5. Estimated production, exports, consumption and prices of sodium tripolyphosphate, 1960 - 1973

	Production 000 tons material	Exports 1/	Consumption 2/	Price 3/	\$/ton P_2O_5
1960	690	35	655	\$8.03	\$278
1965	923	46	871	7.18	248
1970	1,190	60	1,130	7.90	273
1971	1,040	52	988	8.35	289
1972	1,031	52	974	8.35	289
1973	974	48	926	8.85	306

1/ Estimated at 5 percent of production. Imports are negligible.

2/ Production less exports. Stocks are assumed even throughout the time period.

3/ 100 lb. bags, car load, works, freight equalized.

Sources: Current Industrial Reports, Series M28A, Bureau of the Census, U. S. Dept. of Commerce, Washington, D. C.
Chemical Pricing Patterns and Chemical Marketing Reporter

and 1973. The increases reflect in part the price recovery of phosphate fertilizers and the sharply rising costs of doing business in the 1970's. The post-decontrolled price has risen even more dramatically, with a February, 1974, quote of $10.75 per 100 pounds.

It should be noted that these are quoted prices which do not reflect discounts and transfer prices. Pricing is apparently highly competitive in this segment. The Olin plant, using wet acid instead of furnace acid, should have some raw material cost advantage over the other producers who use higher cost furnace acid. Furthermore, the Olin plant, as the largest STPP producer in the U.S., should have additional pricing advantages because of the economies of scale.

B. Expected Price Changes

The earlier discussion of prices included indications that prices for feed phosphates, superphosphoric acid and sodium tripolyphosphate have recently risen sharply. Further short-run substantial increases will probably occur because of the short supply of basic phosphate materials in relationship to world fertilizer demand. Domestic shortages have doubled increased fertilizer prices.

The future is clouded. International trade, inflation, environmental controls, and fuel shortages are a few of the unknown variables which create confusion about price trends in the phosphate industries.

Among the developments which could ease price pressures is proposed new wet process phosphoric acid capacity. Since dical and liquid fertilizer producers are currently experiencing severe shortages of SPA, major increments to wet acid supply should reverse the upward trend of phosphate products prices. New capacity is expected in 1974 and 1975. This may allow SPA producers to increase output to capacity and could even encourage new SPA facilities.

As noted earlier, dical and liquid fertilizer supply falls far short of potential demand. This market pressure should protect SPA producers from drastic price drops.

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

This study's economic impact analysis utilizes the basic industry information developed in Chapters I-III and the pollution abatement technology and costs to be provided by Environmental Protection Agency. The impacts examined include:

Price effects
Financial effects
Production effects
Employment effects
Community effects
Other effects

The required impact analysis is not a simple sequestial analysis; rather it employs interacting feedback steps. The schematic of the analytical approach is shown in Figure IV-1. Due to the fundamental causal relationships among the financial and production effects and the other impacts, a greater emphasis is devoted to plant closure analysis.

Fundamentally, the impact analysis is similar to that usually done for any capital budgeting study of new investments. The problem is one of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits. The analysis is complicated by the fact that benefits and investments will accrue over a period of time and that, in practice, the analyst can not reflect all of the required impondurables, which by definition must deal with future projections. In the face of imperfect and incomplete information and of time constraints, the industry segments are described in the form of financial budgets of model plants. Key non-quantifiable factors were considered in the interpretation of the quantified data. Actual financial results will deviate from the model results, and these variances will be considered in interpreting the findings based on model plants.

A. Fundamental Methodology

The fundamentals for analysis are basic to all impact studies. The core methodology is described here as a unit with the specific impact analysis discussed under the appropriate heading following this section.

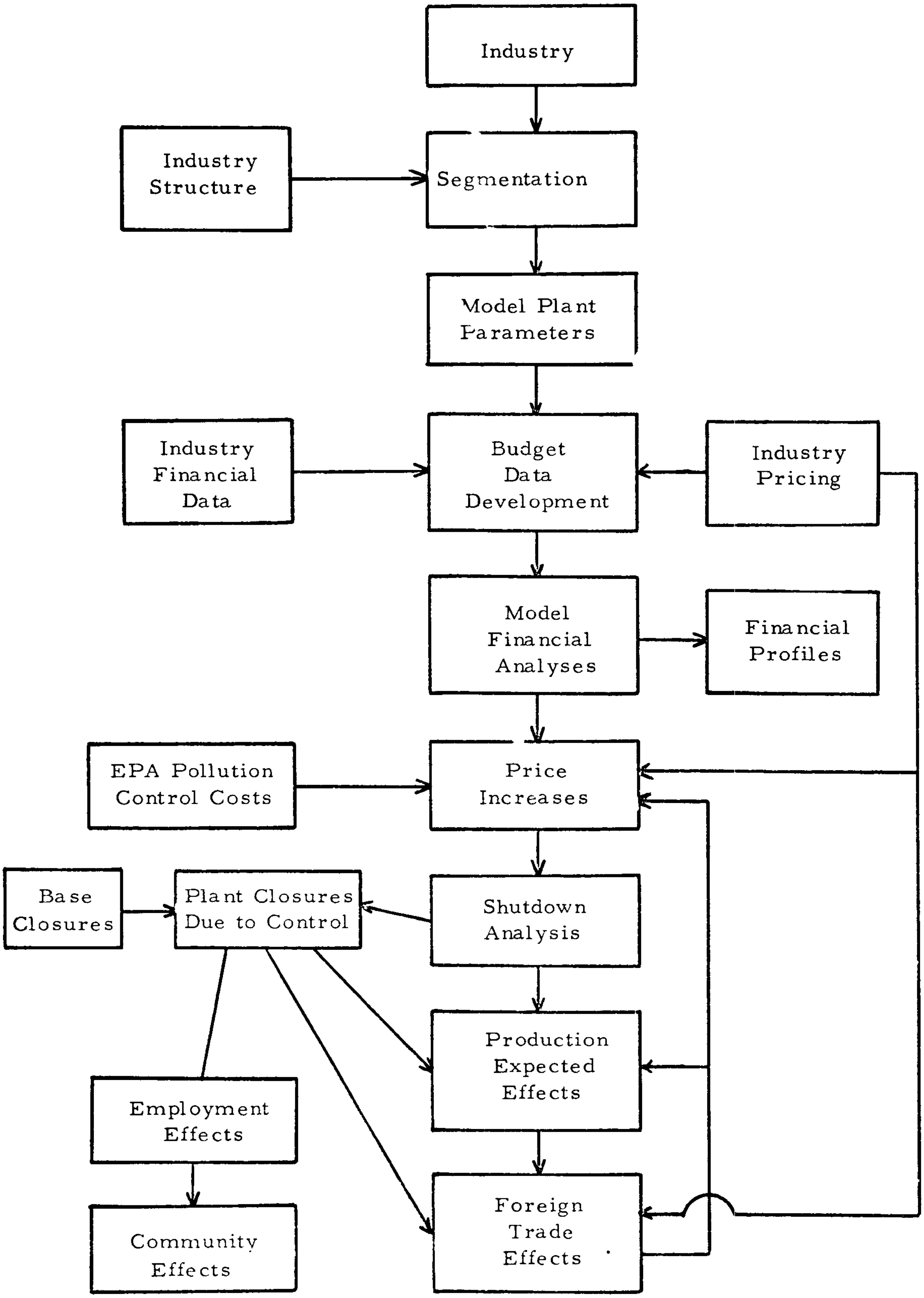

Figure IV-1. Schematic of impact analysis of effluent control guidelines.

The core analysis for this inquiry was based upon synthesizing the physical and financial characteristics of the various industry segments through representative model plant projections. Estimated financial profiles and cash flows are presented in Chapter II. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes, which are a function of the cost of pollution control, and the ability to pass along these costs in higher prices. In reality, closure decisions are seldom made on a set of well-defined and documented economic rules. They include a wide range of personal values, external forces such as the ability to obtain financing, or the relationship between a dependent production unit and its larger cost center whose total costs must be considered.

Such circumstances include but are not limited to the following factors:

1. Inadequate accounting systems or procedures. This is especially likely to occur in small, independent plants which do not have effective cost accounting systems.

2. Insufficient production unts. This is especially true of plants where the equipment is old and fully depreciated and the owner has no intention of replacing or modernizing them. Production continues as long as labor and materials costs are covered and/or until the equipment fails entirely.

3. Personal values and goals associated with business ownership that override or ameliorate rational economic rules. This complex of factors may be referred to as the value of psychic income.

4. Production dependence. This is characteristic of a plant that is a part of a larger integrated entity and it either uses raw materials being produced profitably in another of the firm's operating units wherein an assured market is critical or, alternatively, it supplies raw materials to another of the firm's operations wherein the source of supply is critical. When the profitability of the seco d operation offsets the losses in the first plant, the unprofitable operation may continue indefinitely because the total enterprise is profitable.

5. Temporary unprofitability. This may be found whenever an owner-operator expects that losses are temporary and that adverse conditions will change. His ability to absorb short-term losses depends upon his access to funds through credit or personal resources not presently utilized.

6. Low (approaching zero) opportunity costs for the fixed assets and for the owner-operator's managerial skills and/or labor. As long as the operator can meet labor and materials costs, he will continue to operate. He may even operate with gross revenues below variable costs until he has exhausted his working capital and credit.

7. Plant site appreciation. This factor describes those conditions in which the value of the land on which the plant is located is appreciating at a rate sufficient to offset short-term losses.

These factors are generally associated with proprietorships and closely held enterprises rather than publicly held corporations.

While the above factors are present in and relevant to business decisions, it is argued that common economic rules are sufficient to provide useful and reliable insight into potential business responses to required investment and operating costs in pollution control facilities.

The following discussion presumes investment in pollution control facilities. However, the rules presented apply to on-going operations. In the simplest case, a plant will be closed when variable expenses (Vc) are greater than revenues (R) since by closing the plant, losses can be avoided.

A more probable situation is where $VC < R$ but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation a plant would likely continue to operate as contributions are being made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlay. Identification of plants where $TCc > R$, but $Vc < R$ leads to an estimate of plants that should be closed over some period of time if revenues do not increase. However, the timing of such closures is difficult to predict.

The next level is where $TCc < R$. So long as $TCc < R$, it is likely that plant operations will continue if the capitalized value of earnings $(CV)_k$ at the firm's (industry) cost of capital is greater than the realizable value (S) of sunk plant investment. If $S > CV$ or $CV - S > O$, the firm could realize S in cash and reinvest and be financially better off, assuming reinvesting at least at the firm's (industry) cost of capital.

Computation of CV involves discounting the future earning flows to present value through the discounting function:

$$NPV = \sum_{n=1}^{t} A_n (1+i)^{-n}$$

where

NPV	=	net present value
A_n	=	a future value in n^{th} year
i	=	discount rate at cost of capital
n	=	number of conversion periods, i.e., 1 year, 2 years, etc.

It should be noted that a more common measure of profitability is return on investment (ROI) where profits are expressed as a percent of invested capital (book value), net worth or sales. These measures should not be viewed so much as different estimates of profitability compared to present value measures but rather these should be seen as an entirely different profitability concept.

The data requirements for ROI and NPV measures are derived from the same basic financial information although the final inputs are handled differently for each.

1. Returns

For purposes of this analysis, returns for the ROI analysis have been defined as pre-tax and after-tax income and for the NPV analysis as after-tax cash proceeds. The computation of each is shown below:

Pre-tax income = $(R-E-I-D)$

After-tax income = $(1 - T) \times (R - E - I - D)$

where

T	=	tax rate
R	=	revenues
E	=	expenses other than depreciation and interest
I	=	interest expense
D	=	depreciation charges

Interest in the cash proceeds computation is omitted since it is reflected in the discount rate (the after-tax cost of capital). Depreciation is included in the NPV measure only in terms of its tax effect and is then added back to obtain cash flow.

A tax rate of 22 percent on the first $25,000 income and 48 percent on amounts over $25,000 was used throughout the analysis. Accelerated depreciation methods, investment credits, carry forward and carry back provisions were not used due to their complexity and special limitations.

2. Investment

Investment is normally thought of as outlays for fixed assets and working capital. However, in evaluating closure of an on-going plant with sunk investment, the value of that investment is its liquidation or salvage value (opportunity cost or shadow price). 1/ For this analysis, sunk investment was taken as the sum of liquidation value of fixed assets plus net working capital (current assets less current liabilities) tied up by the plant (see Chapter II for values). This same amount was taken as a negative investment in the terminal year.

The rationale for using total shadow priced investment was that the cash flows do not include interest expenses with interest charges reflected in the weighted cost of capital. This procedure requires the use of total capital (salvage value) regardless of source. An alternative would be to use as investment, net cash realization (total less debt retirement) upon liquidation of the plant. In the single plant firm, debt retirement would

1/ This should not be confused with a simple buy-sell situation which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment may take on a different value.

be clearly defined. In the case of the multi-plant firm, the delineation of the debt by the plant would likely not be clear. Presumably this could be reflected in proportioning total debt to the individual plant on some plant parameter (i.e. capacity or sales). Under this latter procedure, interest and debt retirement costs would be included in the cash flows.

The two procedures will yield similar results if the cost of capital and the interest charges are estimated on a similar basis. The former procedure, total salvage value, was used as it gives reasonable answers and simplifies both the computation and explanation of the cash flows and salvage values.

Replacement investment for plant maintenance was considered to be equal to annual depreciation. This corresponds to the operating policies of some managements and serves as a good proxy for replacement in an on-going business.

Investment in pollution control facilities are from estimates provided by EPA. Only incremental values are used in order to reflect in-place facilities. Only the value of the land for control was taken as a negative investment in the terminal year.

The above discussion refers primarily to the NPV analysis. Investment used in estimating ROI was taken as invested capital--book value of assets plus net working capital.

3. Cost of Capital - After Tax

Return on invested capital is a fundamental notion in U.S. business. It provides both a measure of the actual performance of a firm as well as its expected performance. In the latter case, it is also called the cost of capital and this, in turn, is defined as the weighted average of the cost of each type of capital employed by the firm--in general terms, equities and interest bearing liabilities. There is no methodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

Estimated cost of capital for the industries under study are contained in Chapter II and will not be repeated here.

4. Construction of the Cash Flow

The cash flow used in the analysis of BPT (Best Practical Technology) and BAT (Best Available Technology) effluent control costs and will be constructed as follows:

1. Sunk investment (salvage market value of fixed assets plus net working capital) taken in year t_o, assumed to be equivalent to 1976,

2. After tax cash proceeds taken for years t_1 to t_n

3. Annual replacement investment, equal to annual current depreciation taken for years t_1 to t_n.

4. Terminal value equal to sunk investment taken in year t_n.

5. Incremental pollution control investment taken in year t_o for 1977 standards and year t_6 for 1983 standards.

6. Incremental pollution expenses taken for years t_1 to t_n for 1977 standards and years t_7 to t_n for 1983 standards. if additive to the 1977 standards.

7. Replacement investment taken in year t_n on incremental pollution investment in BPT on assumption of life of facilities as provided by EPA.

8. No terminal value of pollution facilities to be taken in year t_n. Land value will probably be assumed to be very small and/or zero, unless the costs provided indicate otherwise.

The length of the cash flow will depend upon the life of the pollution control technology provided by EPA. It is anticipated that the length of the cash flow will be equal to the life of control equipment specified for 1983 installation.

Construction of the cash flows for analyzing new source standards costs is similar to BPT and BAT, except that plant investments, costs and returns are based on current values.

B. Price Effects

As shown in Figure IV-1, price and production effects have interrelated impacts. In fact, the very basis of price analysis is the premise that prices and supplies (production) are functionally related variables which are simultaneously resolved (thus the feedback loop shown in Figure IV-1).

The determination of the price impact requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance exerted by large firms in the industry, market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coordination within the industry, relationship of domestic output with the world market, existence and nature of complementary goods, cyclical trends in the industry, current utilization of capacity and, exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and the diversity of the factors involved in determining the market price, a purely quantitative approach to the problem of price effects was not feasible for this study. Hence, the simultaneous considerations suggested above were made. The judgment factor was heavily employed in determining the supply response to a price change and alternative price changes to employed.

The segments of the phosphate industry are particularly troublesome in terms of price analysis due to the fact that their products are intermediate and often integrated into a larger complex. As a consequence, prices tend to be academic values, since the internal transfer price may be much different (usually lower) than reported market prices. Nonetheless, some insights can be gained by estimating the required price increase to leave the model plant as well off after pollution control, according to costs provided by EPA, as before. The required price increase can be readily computed using the NPV analysis described above for incremental pollution cash flow and sales.

Application of the above NPV procedure to pollution control costs yielded the present value of those costs (i.e., investment plus operating cost less tax savings excluding interest expenses). Given this, the price increase required to pay for pollution control was calculated as

$$P = \frac{(PVP)\ (100)}{(1-T)\ (PVR)}$$

where:

P	=	required percentage increase in price
PVP	=	present value of pollution control costs
PVR	=	present value of gross revenue (sales) starting in the year pollution control is imposed
T	=	tax rate appropriate following imposition of pollution control

The next step was to evaluate the required price increases against expectations regarding the ability to raise prices. As pointed out above, this was a function of a number of factors. In cases where a few large plants represent the bulk of production, their required price increase will likely set the upper limit. For the products in this study, other factors were overriding. These include expected price changes for basic fertilizer materials due to future supply-demand conditions, impacts such as pollution control, and the declining consumption of these products, per se. From this analysis, which was quantitative, an initial estimate of expected price increases was made.

Following this is the initial shutdown analysis (production curtailment). The decrease in production is evaluated in the light of its impact on prices and if warranted by production decreases, the expected price increase is revised upward.

C. Shutdown Analysis

The basic shudown analysis is based upon the technique described above under Section A and the expected price increase from the preceding step. In addition to this analysis, analyses are also made to establish estimated plant closures without the imposition of pollution control or so-called "baseline" closures. This analysis involves the same financial analysis technique, without pollution control, and factoring in other information such as trends in the industry itself and in competing products.

Based on the results of the NPV analysis of model plants, likely closures are identified where $NPV < O$. Segments or plants in the industry are equated to the appropriate model (on interpolation) results. Mitigating items, such as association with a complex, captive raw material sources, unique market advantages and existing in-place controls and the ability to finance new non-productive investment are factored in quantitatively to obtain an estimate of likely closures. If BAT costs differ from BPT costs, closure estimates are required for each condition. Because this analysis is inexact, these closure levels will be estimated -- high, medium, and low probability.

The analysis of new source standards is of the conventional NPV feasibility analysis based upon expected prices. In this case, it is a matter of whether new plants are built without vs. with effluent controls.

The impact of these closures is evaluated as the next step (see Figure IV-1). When production impacts are sufficient, the expected prices are re-evaluated and the shutdown analysis repeated.

D. Production Effects

Potential production effects include changes of capacity utilization rates, plant closures, and the stagnation of the industry. Plant closures may be offset in total or in part by increases in capacity utilization on the part of plants remaining in operation. Expected new production facilities are estimated. The end result is an estimated production under the conditions presumed for the above closure analysis.

The estimated production under these expectations feeds-back into the price analysis to verify or revise expected price changes.

E. Employment Effects

Given the production effects of estimated production curtailments--potential plant closings and changes in industry growth--a major consideration arises in the implications of these factors upon employment in the industry. The employment effects stemming from each of these production impacts in terms of jobs lost are estimated using the model plant information.

F. Community Effects

The direct impacts of job losses upon a community are immediately apparent. However, in many cases, plant closures and cutbacks have a far greater impact than just the employment loss. These multiplier effects are reflected in evaluating payroll losses and income multipliers.

In addition to these direct and indirect impacts on communities, broader potential impacts are evaluated. In the phosphate industry, losses could result in increased food costs through curtailed farm production (assuming a lack of substitutes). Such production curtailments have widespread implications to the economy and to the feed and fiber industries.

G. Other Effects

Other impacts such as direct balance of payments effects are also included in the analysis.

V. EFFLUENT CONTROL COSTS

The water pollution control costs used in this analysis were based on cost data furnished by the Effluents Guidelines Division of the Environmental Protection Agency from a study by Davy Powergas, Inc. [1/]

For the purposes of the impact analysis, three levels of effluent controls were considered for each segment of the fertilizer industry studied. The levels were as follows:

BPT	-	Best practicable control technology currently available - to be achieved July 1, 1977.
BAT	-	Best available technology economically feasible -- to be achieved by July 1, 1983.
NSPS	-	New source performance standards - to be applied to all new facilities that discharge directly to navigable waters and to be met by approximately January 1, 1974.

A fourth level - new source pretreatment standards - which would be applied to all facilities that use municipal systems constructed after promulgation of the proposed guidelines was not considered in this report. Cost data were not provided for these standards.

It is further noted that for defluorinated phosphate rock (DFP) and defluorinated wet phosphoric acid the new source performance standards (NSPS) are equal to the BAT standards. No NSPS standards have been furnished for sodium tripolyphosphate (STPP).

A. Proposed Control Standards and Technologies

The proposed technologies are summarized in Table V-1. The standards are discussed below.

1/ U. S. Environmental Protection Agency, Draft Development Document for Effluent Limitations Guidelines and Standards of Performance - Other Non-Fertilizer Phosphate Chemicals, prepared by Davy Powergas, Inc.

Table V-1. Summary of pollution control technology by segment

Product and process	BPT Containment pond	BPT CPWT 1/	BAT Increase dike height	NSPS BPT plus BAT
DFP	X	X	X	X
Def.Acid				
Vacuum evaporation	X	X	X	X
Submerged combustion	X	X	X	X
Auxiliary	X	X	X	X
STPP		X		

1/ Contaminated (pond) water treatment process

1. Defluorinated phosphate rock (DFP)

Best practical technology - The proposed effluent limitations guideline for DFP plants require that there be no discharge of process waste water, except under certain conditions described below. To meet this standard each plant should have a containment and cooling pond large enough to hold the process waste water. This waste water is recirculated and would not normally require discharge.

The exceptions permitted are as follows:

(1) An impoundment that is designed to contain the precipitation from the 10-year, 24 hour rainfall event established by the U. S. National Weather Service for the plant location may discharge water from precipitation in excess of the 10-year, 24-hour rainfall when such an event occurs.

(2) During any calendar month, the impoundment may discharge a volume of process water equal to the difference between the volume of precipitation which falls during that month and the mean evaporation for the month as established by the U.S. Weather Service for the preceding 10-year period.

(3) Any water discharged unde: the exceptions in paragraphs (1) and (2) above shall not exceed he following requirements:

Parameter	Concentration (ppm)
Suspended solids	25
Phosphorus (P)	35
Fluoride (F)	15

The pH of the discharged water shall be within a range of 6.0 to 9.0 at all times.

To achieve the reduction of containments consistent with paragraph (3) above, pond water can be treated with lime to neutralize phosphorus and fluorides. Solids are then to settle, prior to discharge. Two separate settling ponds are needed for contaminated water treatment--one each for calcium fluorides and for calcium phosphates.

Standards require DFP plants to treat contaminated water when rainfall exceeds evaporation or when storms cause pond levels to rise above an acceptable water level. Generally, a 24-inch freeboard for containment ponds is needed (60-inches of freeboard required in Florida). Thus, the volume of water normally treated will depend upon the amount of net rainfall (excess of precipitation over evaporation). Emergency treatment would be required only when excessive rainfall occurs in a short time period. Rainfall considerations are discussed more fully under the section on abatement costs.

In certain locations, depending on topography and rainfall factors, an additional need is the construction of diversion ditches around the perimeter of the containment ponds to keep run-off water from adjacent ground away from the pond dike. A recommended ditch is six feet deep. It would be six feet wide at the top and would taper to three feet wide at the bottom.

Best available technology - BAT guidelines are the same as for BPT, except that containment ponds must be designed, constructed and operated to contain the precipitation from the 25-year, 24-hour rainfall event as established by the U.S. National Weather Services for that plant location. On existing ponds, the dike height must be increased sufficiently to contain the precipitation from the 25-year rainfall event. For cost purposes, a six-inch differential for BAT over BPT dike height was used by EPA.

As with BPT, BAT guidelines permit discharge when rainfall exceeds evaporation or during a storm in excess of the 25-year 24-hour storm. Any water to be discharged must be treated by using the contaminated (pond) water treatment process described above.

New source performance standards (NSPS) - NSPS for DFP plants are the same as BAT standards.

2. Defluorinated wet phosphoric acid

BPT, BAT and NSPS for defluorinated acid plants are identical to those for DFP plants; however, the volume of water treated for "normal rainfall discharge" will be greater than for DFP plants because the concentration of wet phosphoric acid produces a net gain of water. Water volumes will be discussed under "Effluent Control Costs."

3. Sodium tripolyphosphate

Best practical technology - The contaminated water treatment process described above is proposed for a wet acid STPP plant. The recirculation of process waste water is not feasible in STPP production because of the more demanding water quality requirements in the manufacturing process; therefore, the STPP plant discharges continuously and must use an end-of-process treatment to meet effluent limitations. This results in the treating of a much larger volume of water in comparison to that of DFP and acid plants with containment ponds.

Best available technology - Contaminated water treatment is also the best available technology; thus, BAT is identical to BPT.

B. Present Effluent Control Status

Table V-2 summarizes, by segment, the present status of treatment technology.

1. DFP

EPA indicates that the four DFP plants probably meet BAT standards. Two discharge during rainy seasons and treat the water prior to discharge. The other two plants do not discharge. One DFP plant may require a diversion ditch.

2. Defluorinated wet phosphoric acid

EPA reports that eight of the eleven defluorinated acid plants have containment and cooling ponds in place or under construction. Thus, all but three plants either treat discharged contaminated water or do not discharge at all. Although information is not available on dike heights, it is assumed that the eight plants with ponds in place conform to BAT standards. Two of the plants will require diversion ditches.

Of the three remaining plants, one apparently does not have land available for constructing a containment pond and would need to use a continuous treatment process. The other two presumably have land available.

Table V-2. Summary of in-place technology by segment

Segment	Total no. plants	In place	Not in place
DFP	4	4 1/	0
Def.Acid	11	8 2/	3 3/
STPP	1	0	1

1/ One plant may need to construct a diversion ditch

2/ Two plants may need to construct a diversion ditch

3/ One plant does not appear to have available land

3. STPP

The STPP plant at Joliet reportedly has a simple settling tank and will need to install the entire Contaminated (Pond) Water Treatment Technology to meet BPT and BAT standards.

C. Effluent Control Costs

1. Cost data

EPA furnished investment and operating cost data in August, 1971, dollars, based upon a survey of plants in each industry segment. DPRA has inflated costs to reflect 1973 dollar values, using the EPA Sewage Plant Treatment Cost index.

2. Investment costs

Best practical technology

Defluorinated phosphate rock - The BPT investment for pollution control for defluorinated rock consists of the cost of constructing a containment pond to hold the waste water plus the cost of contaminated (pond) water treatment facilities. The size of the pond is a function of the daily production capacity. EPA has furnished parameters for estimating pond size and costs as follows:

Acres per daily ton of product	.26
Cost per acre (1971)	$13,983

In addition, plants with run-off problems must provide a ditch around the retention pond to divert run-off. The cost of such a ditch has been estimated by EPA as $3.00 per linear foot. The number of feet is calculated from the formula

$$(\sqrt{\text{No. of acres}} \times 832') + 200'.$$

(one acre has a perimeter of 832 feet. The additional 200 feet permit the ditch to be built 50 feet from the dike.)

Contaminated (pond) water treatment investment costs cover lime handling and storage, piping, pumps and two settling ponds. The representative size used in estimating costs is a 1,000 gallons per minute treatment facility. Plants below 450 ton per day size can probably use a 500 gallon per minute treatment facility, with investment costs adjusted to reflect economies of scale. 1/

1/ $$\frac{\text{Cost A}}{\text{Cost B}} : \left(\frac{\text{Cap A}}{\text{Cap B}}\right)^{.6}$$

Table V-3 presents these investment costs in 1973 dollars for each of the model plants in this segment.

Defluorinated wet process acid - The BPT investment for pollution control for defluorinated acid plants is similar to DFP plants. The size parameter for constructing a containment pond is different, however, because of differing process water requirements.

EPA has furnished the following:

Acres per daily ton of P_2O_5	.28
Cost per acre (1971)	$13,983

Costs for diversion ditches and contaminated (pond) water treatment facilities have been calculated for acid plants as for DFP plants. Table V-3 also shows these costs for the various model plants.

STPP - Investment costs for STPP are shown in Table V-3. These are for contaminated (pond) water treatment facilities.

Best available technology

For DFP and acid plants, BAT investment, as reported in Table V-4, consists solely of the costs of raising the dike height for ponds by six inches. In some instances, the stated cost may not fairly reflect the actual expense of raising the dike height, but no further cost data are available. Since BAT and BPT are the same for sodium tripolyphosphate, there are no additional costs for STPP.

New source performance standards

NSPS investment costs are simply BPT plus BAT in the DFP and defluorinated acid segments. These are presented in Table V-4. Since no NSPS are proposed for STPP, no costs are provided.

3. Annual operating costs

No direct operating costs have been assigned to the containment ponds although there may be minor maintenance expenses; thus, annual charges are for depreciation and interest. Depreciation has been estimated at 5 percent of original cost, based on a 20-year pond life with no salvage value. Interest is assumed at 10 percent per annum on average pollution control investment to approximate the average annual interest costs over the life of the project. These costs are shown in Table V-5.

Table V-3. Investment in pollution control facilities for best practical technology by process and by segment

Plant configuration	Containment and cooling pond		CPWT 1/	Total investment
(Product and TPD)	Pond	Ditch		
	---- $000 -----			
DFP				
75	312	12	2/	324
225	935	20	263	1,218
Def. Acid (vacuum)				
75	336	12	263	611
450	2,013	29	399	2,441
Def. Acid (submerged)				
150	671	17	263	951
450	2,013	29	399	2,441
Def. Acid (aux.)				
100	447	14	263	724
300	1,342	24	263	1,629
STPP				
450	3/	3/	399	399

1/ Contaminated (pond) water treatment process.

2/ Not applicable because of negative water balance for this location.

3/ CPWT includes two settling tanks, no containment pond is used.

Table V-4. Incremental investment in pollution control facilities for BPT, BAT and NSPS

Plant configuration	PT	BAT	NSPS (BPT + BAT)
(Product and TPD)	-------------	$000	-------------
DFP			
75	324	23	346
225	1,218	69	1,287
Def. Acid (vacuum)			
75	611	31	642
450	2,441	184	2,625
Def. Acid (submerged)			
150	951	61	1,012
450	2,441	184	2,625
Def. Acid (aux.)			
100	724	41	765
300	1,629	123	1,752
STPP			
450	399	1/	1/

1/ Not applicable

Table V-5. Annual operating costs for BPT pollution control by segment and process

Plant configuration	Containment Pond			CPWT 1/ Normal				CPWT emergency	Total Costs	
	Deprec-iation	Interest	Sub-total	Operating cost 2/	Deprec-iation	Interest	Sub-total	additional operating cost	Normal	Emergency
(Product and TPD)										
DFP										
75	16	16	32	3/	3/	3/	3/	3/	32	3/
225 I	48	48	96	139	26	13	178	157	274	431
225 II	48	48	96	79	26	13	118	157	214	371
Def. Acid (vacuum)										
75	17	17	34	44	26	13	83	34	117	151
450 I	102	102	204	311	40	20	371	201	575	776
450 II	102	102	204	372	40	20	432	201	636	837
Def. Acid (submerged)										
150	34	34	68	100	26	13	139	67	207	274
450	102	102	204	323	40	20	383	201	587	788
Def. Acid (aux.)										
100	23	23	46	80	26	13	119	45	165	210
300	68	68	136	224	40	20	284	134	420	554
STPP										
450	3/	3/	3/	842	40	20	902	3/	902	3/

1/ Contaminated (pond) water treatment process

2/ Includes electrical energy at $.05/mg and raw materials at $2.50/mg plus 4 percent of investment for operations and maintenance

3/ Not applicable.

Operating costs for contaminated (pond) water treatment are also shown in Table V-5. Energy and raw materials costs for liming are the major significant factors. Combined, these costs amount to $2.55 per thousand gallons of water treated. All incremental costs for BPT, BAT and NSPS are summarized in Table V-6.

As noted earlier, the volume of water requiring contaminated water treatment varies by plant location, size and rainfall factors. To determine the acceptable water discharge for normal treatment, any net increase in process water resulting from the manufacturing process is added to the excess of rainfall over evaporation for the particular plant location. Only the vacuum evaporation process produces a net process water increase, estimated at 116 tons of water per day for a 200 ton (P_2O_5) per day acid plant. The submerged combustion process has an estimated net use of 14 tons per day for a similar sized plant.

In estimating water volume from rainfall in excess of evaporation, EPA has specified that the rainfall run-off area may be up to 130 percent of the pond size; consequently annual rainfall in a location was multiplied by 1.3 to obtain the number inches of run-off for one acre of pond area.

Average annual evaporation data had to be adjusted for differences in surface water area and pond area. Cross-dikes and gypsum piles presumably occupy 20 percent of the pond area. Annual pond evaporation was estimated by multiplying annual average evaporation for that location by .8 to obtain the number of inches of evaporation for one acre of pond area. Table V-7 presents rainfall-evaporation data for each location, adjusted for the run-off and evaporation factors.

Volume of excess rainfall water for each plant was then estimated by multiplying the number of pond acres times the inches of rainfall in excess of evaporation times 27,000 gallons per acre inch. This volume must be adjusted for change in process water amounts. Estimated water volumes are shown in Tablve V-8.

For emergency treatment, the volume of water was calculated on the assumption that excess rainfall during a storm would not exceed 29 inches--one inch less than the freeboard under BAT standards. This would overstate the volume somewhat for BPT standards, both in terms of freeboard and 10-year, 24-hour storm, but the estimate provides an upper limit for emergency treatment. Emergency treatment volumes are shown in Table V-8.

Table V-6. Summary of annual pollution control operating costs for BPT, BAT and NSPS by segment and process

Plant configuration	BPT		BAT	NSPS	
	Normal	Normal plus emergency		Normal	Normal plus emergency
(Product and TPD)	$000				
DFP					
75	32	32	2	34	34
225 I	274	431	7	281	438
225 II	214	371	7	221	378
Def. Acid (vacuum)					
75	117	151	3	120	154
450 I	575	776	18	593	794
450 II	636	837	18	654	855
Def. Acid (submerged)					
150	207	274	6	213	280
450	587	788	18	605	806
Def. Acid (aux.)					
100	165	210	4	169	214
300	420	554	12	432	566
STPP					
450	902	1/	0	1/	1/

1/ Not applicable

Note: Emergency treatment would be an annual cost only once in 10 or 15 years.

Table V-7. Rainfall-evaporation data for plant sites

State	Annual rainfall	Effective rainfall (X 1.3)	Annual evaporation	Effective evaporation (X.8)	Net effective rainfall
	inches				
Louisiana	58	75	49	39	36
North Carolina	52	68	41	33	35
Florida (A)	52	68	50	40	28
Florida (B)	52	68	45	36	32
Texas	46	60	53	42	18
Idaho	12	16	36	29	-13
Utah	16	21	44	35	-14

Source: Climatic Atlas of the United States, U. S. Department of Commerce, Environmental Data Service, Washington, D. C., June, 1968.

Note: Florida (A) and (B) denotes two geographic locations with substantially different evaporation rates.

Table V-8. Annual volume of water treated in contaminated (pond) water treatment process by segment, process, plant size and location

	Defluorinated rock		Vacuum evaporation process			Submerged combustion process		Auxiliary process	
	Fla. (B) 225 TPD	Texas 225 TPD	Texas 75 TPD	Fla. (A) 450 TPD	N.C. 450 TPD	Fla. (B) 150 TPD	La. 450 TPD	La. 100 TPD	La. 300 TPD
	thousand gallons								
Normal treatment									
Process water change	none	none	3,393	20,358	20,358	1,092	2,063	Unknown	Unknown
Net effective rainfall	50,544	26,852	9,639	95,256	119,070	36,288	122,472	27,213	81,648
Volume treated	50,544	26,852	13,032	115,614	139,428	35,196	120,409	27,213	81,648
Emergency									
29" pond rise	61,601	61,601	13,146	78,876	78,876	26,309	78,876	17,528	52,618

It is important to note that emergency treatment may never be required; the probability of a storm in excess of the 10-year or 25-year rainfall event is very low. Therefore, the costs for emergency treatment have been shown separately and should be viewed accordingly.

Annual costs for continuous discharge treatment for STPP are based not on rainfall but on the volume of process water required in manufacturing. EPA estimates 2,400 gallons of water per daily ton of product; thus, the STPP model plant (daily capacity of 450 tons and operating 300 days per year) discharges 324 million gallons of water annually.

NSPS annual costs -- For DFP and defluorinated acid plants, NSPS operating costs are the sum of BPT and BAT costs. These were shown for these two segments in Table V-6.

4. Comparison of pollution control costs to base costs

Tables V-9 and V-10 relate pollution control investment costs and operating costs to baseline conditions.

Pollution control investment costs are high as a percent of base plant book values for all segments. They are especially large for acid plants, amounting to two to six times book values. When compared to replacement investment values, investment costs are also high for defluorinated acid plants; for DFP plants, the costs are from 11 to 20 percent of replacement values. STPP shows the lowest ratio to replacement costs--8 percent.

Annual operating costs for pollution control as a percentage of base operating costs are shown in Table V-10. The percentages range from 1.6 to 6.1, and most frequently around 4 percent for BPT (normal) costs. Emergency treatment costs amount to an additional 1.1 to 3.8 percent of base costs, while BAT costs are negligible for all segments.

In considering pollution control costs, three important points are apparent. (1) Nearly every defluorinated rock and acid plant is a part of a larger phosphate complex and uses a common containment pond; thus, the investment in a pond is probably greatly overstated for the model plants. (2) The large volumes of process water required by acid plants make containment ponds economically desirable in most locations without regard to pollution controls; it is not reasonable, therefore, to attribute the entire pond costs for pollution controls. (3) Only three plants do not currently have ponds.

Table V-9. Comparison of pollution control investment requirements by segment

Plant configuration	Base [1/]	BPT		BAT		NSPS (BPT + BAT)		
	$000	$000	% Base	$000	% Base	$000	% Base	% Replace [2/]
(Product and TPD)								
DFP								
75	315	324	103	23	7	346	110	11
225 I	4,320	1,218	28	69	2	1,287	30	19
225 II	3,950	1,218	31	69	2	1,287	33	20
Def. acid (vacuum and submerged)								
75	215	611	284	31	14	642	298	91
150	430	951	221	61	14	1,012	235	94
450	1,020	2,441	239	184	18	2,625	257	128
Def. acid (auxiliary)								
100	118	724	614	41	35	765	649	382
300	295	1,629	552	123	42	1,752	594	350
STPP	820	399	49	0		3/		8 [4/]

1/ Fixed assets only, book value

2/ Fixed assets only, current (1973) replacement value of base plants

3/ Not applicable

4/ BPT and BAT as percent of Replacement value of base plant

Table V-10. Annual pollution control costs compared to base operating costs (including capital charges) by segment

Plant configuration	Base $000	BPT $000	Normal % Base	BPT Emergency $100	BPT Emergency % Base	BAT $000	BAT % Base	NSPS $000	Normal % Base	NSPS Emergency $000	NSPS Emergency % Base
(Product and TPD)											
DFP											
75 I	1,329	32	2.4	1/		2	neg.	34	2.6	1/	
75 II	2,018	32	1.6	1/		2	neg.	34	1.7	1/	
225 I	4,513	274	6.1	157	3.5	7	neg.	281	6.2	438	9.7
225 II	4,084	214	5.2	157	3.8	7	neg.	221	5.4	378	9.3
Def. Acid (vacuum)											
75	3,109	117	3.8	34	1.1	3	neg.	120	3.9	154	5.0
450 I	17,027	575	3.4	201	1.2	18	neg.	593	3.5	794	4.7
450 II	17,027	636	3.7	201	1.2	18	neg.	654	3.8	855	5.0
Def. Acid (submerged)											
150	5,936	207	3.5	67	1.1	6	neg.	213	3.6	280	4.7
450	17,027	587	3.4	201	1.2	18	neg.	605	3.6	806	4.7
Def. Acid (auxiliary)											
100	3,926	165	4.2	45	1.1	4	neg.	170	4.3	214	5.5
300	10,285	420	4.1	134	1.3	12	neg.	433	4.2	566	5.5
STPP	20,164	902	4.5	1/	1/	0	0	1/	1/	1/	1/

1/ Not applicable

Note: Emergency treatment would be an annual cost only once in 10 or 25 years.

VI. IMPACT ANALYSIS

The impacts considered in this analysis are the following:

A. Price effects
B. Financial effects
C. Production effects
D. Employment effects
E. Community effects
F. Balance of payments effects

These effects were analyzed for each of the segments under study and were based on the industry data developed in Part I of this study and on the pollution control data presented in Chapter V. The methodology for the analysis was described in Chapter IV of Part I.

A. Price Effects

The pricing of non-fertilizer phosphate materials was discussed in Chapter III in detail. The discussion indicated that the products of the study's three segments have a derived demand, that they are intermediate products used as raw materials in a wide variety of industrial and agricultural production. Accordingly, their prices are determined, in part, by the pricing patterns of the end-products. Livestock feed requirements are the basic determinants of demand for defluorinated phosphate rock. These same feed requirements also help determine defluorinated phosphoric acid prices. However, about 60 percent of defluorinated acid (superphosphoric acid) goes into fluid fertilizers, fertilizer demand is also a major factor in defluorinated acid pricing. Sodium tripolyphosphate demand is primarily derived from the soap and detergent market.

The price impacts of pollution controls must be placed in the perspective of anticipated prices which will prevail in 1977 and 1983; however, predicting future prices for the products under study has become extremely difficult in the light of recent price behavior. Prices for phosphate products were generally depressed from 1968 through 1970 because of the industry's over capacity. After prices recovered in late 1970 and 1971, the Federal government froze prices in August, 1971 and retained controls until October, 1973. When controls were lifted in late 1973, the phosphate industry experienced rapidly rising prices under heavy U.S. and world fertilizer demand. 1974 prices are now abnormally high and one can expect an increased supply in the next few years.

Trends in the phosphate industry indicate that prices will continue to respond to cyclical patterns of supply-demand adjustments. Price-cost relationships when supply and demand are approaching equilibrium best reflect normal or average conditions. For this reason, pre-decontrol 1973 prices appear representative of 1977-1983 prices. If the higher price to cost relationships of 1974 should prevail, then pollution control costs take on even less significance.

The effects of pollution controls on non-fertilizer phosphate prices are expected to be minor for all three segments even though annual pollution control costs represent a moderate percentage of baseline costs. These were compared in Table V-10. Table VI-1 relates abatement costs to 1973 prices for the various model plants, and Table VI-2 presents required price increases to restore pre-control levels of profitability to the impacted model plants.

Long-run increases of this magnitude are not likely because of the large amount of in-place technology and the competitive market structure for the various segments. The DFP plants all currently meet the no discharge standards and their cost structures already reflect abatement costs. One plant may need an inexpensive $12,000 diversion ditch.

In the defluorinated phosphoric acid segment, eight of the eleven plants meet the no-discharge standard and should not incur additional costs. The eight include the newer and larger plants, indicating that pollution control costs are incorporated into current costs and prices. Hence, the three plants which do not now have pollution control facilities can not expect to pass on additional costs unless there is a general price increase.

Prices will probably rise slightly because of decreased supplies of defluorinated acid. The discussion of "Production Effects" shows that supply may drop by as much as 7-18 percent due to baseline and pollution control closures. Although the price elasticity is unknown, it is assumed to be close to that for fertilizers (estimated at -.6 in the short run and -1.8 in the long run). Thus, price increases of 12 percent in the short run and 4 percent in the long run may be expected, given stable demand.

But this price increase resulting from possible closures must be viewed alongside the anticipated growth in demand for defluorinated phosphate products. As noted in Chapter III, demand for dicalcium phosphates for livestock feed supplements is expected to grow at a 6 to 6.5 percent annual rate while liquid fertilizer demand may increase at a 10 to 15 percent annual rate. This produces a possible demand growth for defluorinated wet phosphoric acid of 8 to 12 percent per annum, if the market remains split 40 percent - 60 percent between dicalcium phosphates and liquid fertilizers.

Table VI-1. Annual pollution control costs per ton of product by segment related to base price

Plant configuration (Product and TPD)	Base Price	Annual pollution control costs BPT (N)	BPT (N+E)	BPT BAT (N)	BPT/BAT (N+E)
	$ per ton				
DFP					
75	89.00	2.56	1/	2.72	1/
75	89.00	1.42	1/	1.51	1/
225 I	74.00	4.06	6.40	4.16	6.49
225 II	71.00	3.17	5.50	3.27	5.60
Def. Acid (vacuum)					
75	153.00	5.96	7.68	6.11	7.83
450 I	153.00	4.87	6.58	5.03	6.73
450 II	153.00	5.39	7.11	5.54	7.26
Def. Acid (submerged)					
150	153.00	5.23	6.97	5.38	7.12
450	153.00	4.97	6.68	5.13	6.83
Def. Acid (auxiliary)					
100	153.00	6.38	8.08	6.54	8.23
300	153.00	6.10	8.04	6.28	8.22
STPP					
450	153.00	6.68	1/	6.68	1/

1/ Not applicable

Note: (N) and (E) refer to normal and emergency water treatment. Emergency treatment would be an annual cost only in 10 or 25 years.

Table VI-2. Required price increase to restore profitability to pre-pollution control levels

Product (tons per day capacity)	BPT (N) 6.5	BPT (N) 7.5	BPT/BAT (N) 6.5	BPT/BAT (N) 7.5
	----------------	percent	----------------	
DEF Acid				
Vacuum	3.7	7.3	3.8	7.4
75	3.7	7.3	3.8	7.4
Auxiliary				
100	4.6	4.9	4.7	5.0
300	4.1	4.3	4.2	4.3
STPP				
450	4.4 1/	4.4 1/	2/	2/

1/ These percentages are rounded to the nearest tenth. The increase is slightly higher for the 7.5 percent discount rate than for the 6.5 percent rate.

2/ Not applicable.

Thus, increased demand will exert upward pressure on defluorinated acid prices. Marginal plants would operate profitably under these conditions. However, at some point, higher prices will attract new defluorinated acid capacity. Prices will then fall, once again making the marginal plants likely candidates for closure.

The response of prices to increased demand cannot be estimated with any degree of certainty because of critical unknown factors. Substitutability of defluorinated phosphate rock for dical in livestock feed and of other phosphate sources for SPA in liquid fertilizers will occur under severe price pressures; cross-elasticity coefficients are not known. Also, the proportion of wet phosphoric acid going into SPA as opposed to other fertilizer products cannot be reliably determinated.

Given these uncertainties, it seems reasonable to conclude that defluorinated acid prices will rise somewhat more than the 4 percent caused by supply curtailment but probably not enough over the long run to prevent the probable closures discussed below under "Production Effects."

The situation for STPP is somewhat different. The plant included in this study is but one of 15 STPP plants. It uses wet-process phosphoric acid while the other 14 plants process furnace acid. They are not expected to have any direct pollution control investments or annual costs, except for the increased raw material costs of $1.90 per ton from furnace acid plant pollution abatement. [1/] Therefore, the wet acid STPP plant must be price competitive with other producers who have only minor raw material cost increases (1.3 percent). This will undoubtedly be offset by cost increases for wet acid. Under these conditions, it does not appear likely that the STPP plant can pass through any of its direct pollution control costs.

B. Financial Effects

1. Profitability

The impact of pollution controls on the profitability of model plants is shown in Table VI-3. Without price increases those plants needing to install control facilities will feel a substantial impact.

1/ See Economic Analysis of Proposed Effluent Guidelines, The Industrial Phosphate Industry, EPA-230/1-73-021. Washington, D. C., August 1973.

Table VI-3. Annual cash flows, return on investment and return on sales before and after pollution controls, assuming no price increase

Product (tons per day capacity)	Baseline			BPT (N)			BPT (E)			BPT/BAT (N)			BPT/BAT (E)		
	Cash flow	ROI	ROS	Cash flow	ROI	ROS	Cash flow	ROI	ROS	Cash flow	ROI	ROS	Cash flow	ROI	ROS
	$000	%	%	$000	%	%	$000	%	%	$000	%	%	$000	%	%
DFP															
75 I	-677	-50.9	-19.5												
75 II	134	-3.1	-.8												
225 I	602	5.3	5.1												
225 II	720	8.5	7.8												
Def. Acid (vacuum)															
75	-26	-15.5	-2.6	-101	-24.2	-6.6	-134	-28.3	-7.7	-102	-24.2	-6.7	-135	-28.1	-7.8
450 I	711	19.2	3.0												
450 II	711	19.2	3.0												
Submerged															
150	156	6.8	1.2												
450	711	19.2	3.0												
Auxiliary															
100	51	6.6	.9	-47	-13.2	-2.9	-92	-18.3	-4.0	-49	-13.3	-3.0	-94	-18.3	-4.1
300	190	11.0	1.4	9	-6.5	-1.3	-125	-12.7	-2.6	2	-6.8	-1.5	-132	-12.7	-2.7
STPP															
450	427	9.1	1.3	-206	-13.3	-2.0									

Note: (N) and (E) refer to normal and emergency water treatment. Emergency treatment would occur only once in 10 or 25 years.

The 75 TPD defluorinated acid (vacuum evaporation process) plant has a decrease in cash flow from -$26,000 to -$101,000 under BPT (normal conditions), with much greater decreases under emergency conditions. BAT adds very little to the decrease in cash flow--only $1,000. Returns on book investment and on sales, already negative under baseline conditions, become even more negative.

The auxiliary process acid plants experience severe financial impacts under BPT (N). The 100 TPD plant has a decrease in cash flow of $98,000 -- from $51,000 to -$47,000. ROI and ROS move from positive to negative. The 300 TPD plant loses $181,000 in cash flow, with ROI moving from a positive 11.0 percent to a negative 4.2 percent. ROS falls from 1.4 to -1.2 percent. Emergency treatment facilities add a major impact.

The STPP plant experiences the greatest financial impact. Its cash flow drops from $427,000 to -$206,000, while ROI and ROS decline sharply from moderately positive to negative levels.

Financial impacts can also be viewed through net present value (NPV) analysis. The NPV of a plant before pollution control is compared to the NPV after controls, assuming no price increase. Table VI-4 presents these values.

The discount rate used to compute NPV is the estimated cost of capital. This rate was reported in Chapter IV, Part I, for the industry in a range of 5.6 to 7.4 percent. This is the historic cost range of capital, based on an estimated embedded interest cost of 7.5 percent. Since pollution control facilities will probably be financed with borrowed funds at future interest rates higher than the historic rates, a rate of 10 percent was used for the incremental investment. This will raise slightly the embedded debt cost. Accordingly, the estimated costs of capital for impact analysis has been increased to 6.5 to 7.5 percent. NPV's in Table VI-4 are based on these rates. The analysis assumes a 20-year life for each project.

The impacts of BPT (normal condition) are severe for each of the four impacted plants. The 75 TPD vacuum evaporation process acid plant moves from a -$900,000 NPV to -$2,127,000. The two auxiliary process acid plants have positive baseline NPV's and large negative BPT values. BAT increases the negative NPV's slightly. The effect of emergency treatment on NPV's cannot be calculated, since it cannot be expected to occur more often than once in 10 or 25 years.

Table VI-4. Net present values of model plants before and after pollution controls, assuming no price increase

Product (tons per day capacity)	Baseline		BPT (N)		BPT/BAT (N)	
	6.5	7.5	6.5	7.5	6.5	7.5
	----------	----------	----------	----------	----------	----------
DFP						
75 I	-1,713	-1,620				
75 II	391	317				
225 I	3,505	3,090				
225 II	5,144	4,655				
DEF. Acid						
Vacuum						
75	-900	-869	-2,127	-2 047	-2,148	-2,067
450 I	5,244	4,650				
450 II	5,244	4,650				
Submerged						
150	626	508				
450	5,244	4,650				
Auxiliary						
100	138	85	-1,385	-1,375	-1,413	-1,402
300	1,015	827	-1,815	-1,910	-1,899	-1,990
STPP						
450	1,782	1,398	-5,490	-5,355		

2. Availability of capital

There are no precise financial data available to assess the ability of each of the model plants to finance pollution control investment. Model plant data shows that the 75 TPD vacuum evaporation acid plant has a negative baseline cash flow and should not be able to borrow the necessary funds. The other three impacted plants have substantial baseline cash flows, but unless they can retain a price increase, their ability to borrow is highly questionable. The large negative NPV's shown in Table VI-4 support this statement.

Table VI-5 presents another approach for assessing the ability to finance pollution controls. Baseline net cash proceeds are compared to the annual net cash required for pollution controls. This methodology requires several assumptions. The baseline net cash proceeds are the baseline after-tax income plus one-third of annual baseline depreciation. The remaining depreciation is reinvested annually to maintain plant productivity. The annual cash requirements for pollution controls consist of the annual pollution operating costs plus 10 percent interest on the pollution control debt (100 percent of investment borrowed) and the repayment of the principal over 20 years. From this amount, the tax-savings from pollution control expense and interest are deducted. The resulting cash requirement is a minimal amount which includes no return whatsoever for equity in the existing plant.

If the annual pollution control cash requirement exceeds the baseline cash flow, the enterprise cannot service the debt and would not be able to borrow the funds for pollution control.

In each of the four model plant illustrations in Table VI-5, the annual cash requirements for pollution controls far exceed the baseline net cash proceeds; thus, financing would be economically unfeasible without price increases.

Based solely on data in Tables VI-4 and VI-5, the impacted model plants cannot finance new investment. This conclusion could be modified by the status of the plants in the overall corporate enterprises to which each belongs. It is not uncommon for profitable large corporations to continue to operate economically unprofitable units in integrated plant complexes, so long as the total enterprises are profitable. Since this factor cannot be determined, it is not possible to assess with certainty the ability of the model plants to finance new investment.

Table VI- 5. Annual pollution control cash requirements [1] compared to baseline net cash proceeds [2]

Product (tons /day capacity)	Baseline net cash proceeds	BPT (N) Pollution control cash requirement	BPT (E) Pollution control cash requirement	BPT/BAT (N) Pollution control cash requirement	BPT/BAT (E) Pollution control cash requirement
Def. Acid					
Vacuum					
75	-267	129	162	133	166
100	51	160	205	165	210
300	190	307	441	322	456
STPP					
450	427	678	3/	3/	3/

1/ Baseline net cash proceeds are after-tax income plus one-third of annual depreciation.

2/ Annual pollution control cash requirements are annual pollution control operating costs plus debt service requirements for 20 year, 10 percent loans on pollution control investment, minus tax savings. Contaminated (pond) water treatment requires reinvestment at the end of 10 years.

3/ Not applicable

Note: (N) and (E) refer to normal and emergency water treatment. Emergency treatment would be an annual cost only once in 10 or 25 years.

C. Production Effects

The effects of pollution controls on production are significant. The methodology described in Chapter IV of Part I to evaluate closures underlies the present discussion. It must be recognized that existing plants do not fit the model plants precisely; therefore, the analysis which follows must be qualified by variances among existing plants. In spite of this limitation, the economic models provide the best available data for forming judgments about potential closures.

1. Potential closures

Tables VI-3 and VI-4 presented the fundamental data for analysis closure potentials. In this section, closures are estimated for baseline conditions, after BPT controls and, finally, after BAT controls.

Baseline closures - There are two model plants which show baseline negative cash flows and negative net present values (NPV's). These are the 75 TPD (50 percent utilization) defluorinated rock plant and the 75 TPD defluorinated acid plant. Under 1973 conditions, these model plants are potential baseline closures.

When the 75 TPD DFP plant moves to 90 percent utilization, it has positive cash flow and NPV; there does not appear to be a high probability of closure, even though return on investment is negative. Thus, the one small DFP operating plant which falls in the 75 TPD category is rated as a medium probability for baseline closure. Since pollution control technology is in place, BPT and BAT controls will have no further impact.

The model 75 TPD defluorinated acid plant has both a negative cash flow and a negative NPV. This indicates a high probability of baseline closure if there is no price increase. There are two operating plants in this category.

It must be noted that any lasting significant change in 1973 price-cost relationships resulting from the distorted 1974 price structure, could make these baseline closures unlikely.

BPT closures -- The negative impact of pollution controls will fall only on those plants without technology in place. Based on EPA estimates, there are four such plants: one small defluorinated acid (vacuum evaporation process plant), the two auxiliary process acid plants and the one STPP plant.

BPT normal treatment requirements produce large negative NPV's for the representative model plants in each of the four plant categories. Without price increases these plants would have to close.

One of the defluorinated acid plants reportedly has no available land for constructing a containment and cooling pond. In order to meet BPT standards, such a plant would have to treat continuously its process water before discharge. There is not sufficient information available about the manufacturing process to determine treatment costs, but it is probable that continuous treatment would be equal to or greater than BPT (normal) contaminated (pond) water treatment. The conclusions of the closure analysis would not be affected by the substitution of continuous treatment for normal BPT treatment.

The effects of an expected 4 percent price increase for defluorinated acid are shown in Table VI-6. The small vacuum process plant would have a negative NPV of $794,000 to $813,000, and the small auxiliary process plant would show a negative NPV of $405,000 to $466,000. Thus, even with a price increase, they are still likely to close. The 300 TPD auxiliary process plant has its NPV restored to a positive $393,000 to $675,000 under BPT (normal) and may not close with a 4 percent increase. It should be noted, however, that this plant may already be operating at only 69 percent of capacity, indicating that there may be other considerations which could outweigh pollution control factors. This particular plant must be regarded as a medium possibility for closure.

No price increase is expected for STPP; therefore, the net present value analysis indicates that the one STPP plant should close. As stated earlier, a 4.5 percent price increase could restore this plant to its previous level of profitability. It is, of course, possible that STPP prices could rise by that amount through conditions unrelated to pollution abatement. This seems unlikely in view of the pollution control concerns over detergents manufactured with STPP. This plant must be classified as a highly probable closure. Table VI-7 summarizes potential closures.

In summary, one small DFP plant has a medium probability and two small defluorinated acid plants have a high probability of closure under baseline conditions. Under BPT, assuming a 4 percent price increase for defluorinated acid and no price change for STPP, one additional acid plant (auxiliary process) and the STPP plant have a high probability of closure and one other acid plant (auxiliary process) has a medium probability of closure. Thus, BPT pollution controls may result in closure of two acid plants and one STPP plant.

Table VI-6. Net present values of model plants before and after pollution controls, assuming a 4 percent price increase

Product (tons per day capacity)	Baseline		BPT (N)		BPT/BAT (N)	
	6.5	7.5	6.5	7.5	6.5	7.5
Def. Acid						
Vacuum						
75	433	365	-794	-813	-815	-833
Auxiliary						
100	1,118	994	-405	-466	-433	-493
300	3,505	3,130	675	393	591	313

Table VI-7. Probability of closures under baseline and BPT (normal) conditions, assuming a 4 percent price increse for defluorinated acid

	Total no. plants	Baseline			BPT (N)		
		High	Medium	Very low	High	Medium	Very low
DFP	4	0	1	3	0	1	3
Def. Acid	11	2	0	9	1 1/	1	7
STPP	1	0	0	1	1	0	0

1/ Excludes two baseline closure

BAT closures - BAT adds insignificantly to investment and annual costs; therefore, no closures will be attributable to BAT requirements.

Finally, in assessing production impacts, it must be stated again that plants which are a part of a larger phosphate complex may be kept in operation, even though economic analysis may indicate closure. The financial condition of the total enterprise is the overriding consideration in management's final decision whether or not to invest in pollution control facilities.

2. New Source Performance Standards

Table VI-8 contains baseline and NSPS (normal) net present values for selected model plants. Only larger plants have been analyzed, since the economies of scale basically preclude the future building of smaller plants. Replacement investment costs (1973 dollars) were used in this analysis, with containment and cooling pond costs included in the investment figures. (It should be noted that BPT pond size at .26 to .28 acres per ton of daily production, greatly exceeds the size actually needed for process water retention, cooling and recirculation.) Only contaminated (pond) water treatment has been added to baseline investment and operating costs in estimating the NPV's of model plants under new source performance standards.

Under baseline conditions, three of the model plants have negative baseline NPV's--the 225 TPD defluorinated rock plant, the 150 TPD acid plant and the STPP plant. Plants of these sizes and types are not likely to be constructed in the future.

After applying NSPS (normal treatment), one additional model plant incurs a negative NPV--the 300 TPD auxiliary process acid plant. Its NPV changes from a positive value of 555,000 (or $367,000) to a negative value of $1,009,000 (or $1,159,000). NSPS would probably preclude the future construction of such a plant.

Emergency treatment involves no additional investment costs and would be expected to occur once in 25-years (or even less often); therefore, NSPS (emergency) costs would have no influence on future building decisions.

In summary, the NSPS can be expected to have an impact on construction of new auxiliary process plants but with so little known about the manufacturing process, even this statement must be qualified. As for other subsegments, NSPS should not be a significant factor since only larger plants are likely to be built in the future. As Table VI-8 shows, a 450 TPD acid plant would be profitable.

Table VI-8. Net present value of selected model plants before and after NSPS

Product (tons per day capacity)	Baseline		NSPS (N)	
	6.5	7.5	6.5	7.5
	$000			
DFP				
225 II	-716	-1,205	-1,817	-2,258
DEF Acid				
Vacuum				
450 I	3,359	2,765	1,052.8	572.9
450 II	3,359	2,765	704	250
Submerged				
150	-369	-487	-1,310	-1,379
450	3,359	2,765	985	510
Auxiliary				
300	555	367	-1,009	-1,159
STPP				
450	-2,558	-2,942	1/	1/

1/ Not applicable

3. Production Curtailment

Production losses from baseline closures could amount to about 4 percent of defluorinated acid capacity. Another 3 percent of capacity can be expected to close under BPT (normal), with an additional 11 percent listed as a medium probability for closure. BPT (emergency) and BAT will have no significant production impacts. The loss of from 7 to 18 percent of capacity might not significantly reduce total production, because the remaining plants have excess capacity. The segment operated at only 80 percent of capacity in 1973.

STPP production may drop by 120,000 tons per year if the wet acid plant should close. This is 12 to 13 percent of 1973 production, but underutilized capacity in the industry could absorb the difference.

D. Employment Effects

The number of employees in each of the three segments were reported in Chapter I as follows:

DFP	103
Defluorinated acid	158
STPP	21
Total	282

Pollution controls may eliminate 39 jobs in the acid segment and 21 in the STPP segment. The actual effect would probably be less than this amount because some workers would be absorbed into other on-site plants. It is not possible to estimate how many jobs would be lost, but assuming that half of the potentially affected workers are transferred within the company, the loss of jobs would amount to an 11 percent of estimated employment in these three segments.

In the perspective of the entire fertilizer industry, the 30 to 60 jobs represent less than 0.15 percent of total employment.

E. Community Effects

Community effects should be of minor significance. The number of employees in the impacted plants is relatively small. Considering the size of the communities and the amount of their industrial activity, the job losses would be minor. Workers would be absorbed by other phosphate plants.

The broader economic impacts on the communities are more difficult to evaluate. The loss of several millions of dollars of trade could have repercussions in the business and financial establishments which supply goods and services to the closed plants. In individual cases severe hardship would be realized, but the size and diversity of the local communities suggest, however, that the long-run effects of actual closures would be relatively minor.

F. Balance of Payments Effects

The defluorinated phosphate products included in this study are not of much significance in foreign trade. The U. S. imports about 30,000 tons of dicalcium phosphates for feed supplements and exports about 50,000 tons of STPP. Any decline in U. S. production of defluorinated phosphoric acid could encourage increased dicalcium phosphate imports, but the possible loss of defluorinated acid capacity of some 50,000 to 75,000 tons (P_2O_5) would probably not result in appreciable additional imports of dicalcium phosphate because much of the slack would be taken up by other U. S. plants. Even if imports doubled, the amount of dollars involved (1973 prices) would be less than $3,000,000.

STPP exports have declined steadily since 1970, as has U. S. production. Pollution controls would probably not contribute to any further decline. The dollar amount of STPP exports is relatively insignificant--an estimated $7,500,000 in 1973.

In summary, pollution controls would have only minor effects on balance of payments, possibly resulting in an increase in imports of phosphates of less than $3,000,000.

VII. LIMITS OF THE ANALYSIS

A. General Accuracy

The data used in this study were drawn from published government reports, corporate annual reports and industry sources. Every effort was made to verify the data. Plant investment costs, operating costs and prices were reviewed with various companies for validation.

The use of the model plant concept requires a synthesizing of data to develop representative model plant profiles. Locational factors will produce plant to plant variances, as will differences in management techniques.

Even with these variances, however, the data yield a generally accurate depiction of the fertilizer industry, and they provide an accurate basis for evaluating the impact of increased effluent controls on the industry.

B. Possible Range of Error

Estimated ranges of error for data used in this study are presented below:

		Error Range (%)
1.	Number and location of facilities	± 10
2.	Capacity and age	± 10
3.	Price information for products and raw materials	± 15
4.	Sunk investment value	± 20
5.	Plant operating costs	± 10
6.	Plant closures	± 10

Pollution control costs were furnished by EPA and are assumed to be accurate. Containment and cooling pond size in various model plants were estimated at .26 acres per daily ton of product for DFP and at .28 acres per daily ton of P_2O_5 for defluorinated acid plants. There is some indication from industry sources that the size factor may be high and that pond costs may be overstated.

Of greater importance than the possible overestimation of pond size is the possible error in estimated process waste to be treated in the various plants. Water volumes are a function of plant size, tne type of process used, and in local rainfall-evaporation factors. The contaminated (pond) water treatment investment and operating costs have been estimated by DPRA using EPA data on process water requirements and treatment costs combined with weather service data on rainfall and evaporation. This could result in a range of error in DPRA's estimated operating costs for contaminated water treatment of $\pm$ 25 percent.

C. Critical Assumptions

Several critical assumptions were used in this study. Any change in any of these assumptions would change the results of the analysis. These assumptions were discussed throughout the report. Some of the major ones are presented below.

1. All plants within a product segment and size category were assumed to have similar manufacturing and salvage values; however, locational, management and economic factors would necessitate variations.

2. Where more than one plant falls into a segment size group, all plants in that group were assumed to operate at equal capacity utilization rates.

3. Prices and plant net-backs were minor exceptions assumed to be uniform for all plants in a segment

4. Raw material costs were generally estimated at a uniform level for plants in each segment.

5. Sales and general and adminis rative expenses were assumed similar for all plants within a segment.

6. Each model plant has been designed as a stand alone enterprise in terms of investment and operating costs. Most of the operating plants in these three segments are located in complexes and may have slightly different costs, especially for administrative overhead.

7. Two of the defluorinated acid plants do not concentrate wet phosphoric acid. These are identified as "auxiliary process"

plants. Little is known concerning these data about operating costs and manufacturing process. No technology or cost data were provided by EPA for this process. It was assumed, for purposes of analysis, that the control standards and technology were the same as for the other defluorinated acid plants.

D. Remaining Questions

The future of the phosphate industry poses a major question for the segments in this study. Phosphate capacity is expected to expand in the mid-1970's, but currently, wet phosphoric acid is in short supply. Some plants have had difficulty obtaining sufficient quantities of acid to meet feed phosphate needs as high fertilizer demand in the U.S. and abroad has claimed most phosphate output. There is some question about the phosphate industry's ability to obtain all of the electrical energy it needs to meet its manufacturing requirements. Future defluorinated acid supplies and prices can be seriously influenced by these developments in phosphates.

There are also apparent changes emerging in livestock and poultry production which pose unanswered questions about the future of feed phosphates. There may be significant shifts in feeding practices and technologies which could cause either greater or lesser demands for defluorinated phosphate feed supplements. It is too early to know the direction of these shifts.

At the same time, the effects of pollution controls on soaps and detergents manufacturing leave sodium tripolyphosphate production uncertain. Since nearly all of the STPP output goes into detergents, the future of this segment depends heavily on policy decisions regarding the use of phosphates in cleaning agents.

In addition, there are broad agricultural policy questions such as marketing restraints and price controls which will influence the future of non-fertilizer phosphates. Further, domestic inflation leaves many unanswered questions concerning the availability of capital, cost of capital, and operating costs.

APPENDIX

Appendix Table 1. Pro forma income statement and financial returns for model plants - defluorinated phosphate rock

	Units	Unit cost	Units/ton	75 TPD 50% utilization	75 TPD 90% utilization	225 TPD - I	225 TPD - II
Production	Tons	--	1	12,500	22,500	67,500	67,500
				$1,000			
Sales	Tons	1/	1	1,112	2,002	4,995	4,792
Direct expenses							
Phosphate rock	Tons	2/	.95	299	538	907	522
Phosphoric acid (54%)	Tons	67.50	.20	169	304	911	911
Soda ash	Tons	45.00	.10	56	101	304	304
Power	Set	.50	1	6	11	34	34
Natural gas	MCF	.80	5	50	90	270	270
Cooling water	M gal	.05	4	2	4	14	14
Operating labor	man hours	3.85	3/	36	65	109	109
Supervision and fringes	Set	100.00%	--	36	65	109	109
Subtotal				654	1,178	2,658	2,273
Indirect expenses	Basis						
Maintenance, refractories and other supplies	4% of replacement plant investment			128	128	250	250
Taxes and insurance	3% of replacement investment			97	97	206	192
Plant and labor overhead	100% of labor and supervision			98 4/	130	218	218
Selling, general and administrative	15% of sales			167	300	749	719
Subtotal				490	655	1,423	1,379
Total expense				1,144	1,833	4,081	3,652
Depreciation	$ 5//ton of annual capacity			150	150	345	345

continued--

Appendix Table 1. (continued)

	Units	Unit cost	Units/ton	75 TPD 50% utilization	75 TPD 90% utilization	225 TPD - I	225 TPD - II
Interest (long term)	1.75% of sales			35	35	87	87
Total costs				1,329	2,018	4,513	4,084
Net income before tax				<217>	<16>	482	708
Income tax				0	0	225	333
Net income after tax				< 217>	<16>	257	375
Cash flow				<67>	134	602	720
				pct			
Return on invested capital							
Before tax				< 0	< 0	10.0	16.0
After tax				< 0	< 0	5.3	8.5
Return on sales							
Before tax				< 0	< 0	9.6	14.8
After tax				< 0	< 0	5.1	7.8

1/ Bulk price, $89, 89, 74, 71 respectively

2/ $25.15, $25.15, $14.15, $8.15 respectively

3/ .75, .75, .42, .42 respectively

4/ 75% of $130,000

5/ 6.00, 6.00, 4.60, 4.60 respectively

Appendix Table 2. Estimated invested capital for model plants - defluorinated phosphate rock

		75 TPD			225 TPD-1			225 TPD - II		
		Current	Salvage	Book	Current	Salvage	Book	Current	Salvage	Book
		$1,000								
Plant										
Land		40	40	25	600	600	500	150	150	130
Plant and equipment		3,200	200	290	6,250	390	3,820	6,250	390	3,820
Total		3,240	240	315	6,850	990	4,320	6,400	540	3,950
Working capital	(1)	111	111	111	500	500	500	480	480	480
	(2)	200	200	200						
Total invested capital	(1)	3,351	351	426	7,350	1,490	4,820	6,880	1,020	4,430
	(2)	3,440	440	515	--	--	--	--	--	--

Note: Investment does not distinguish among fluidized bed and kiln processes. Fluidized bed requires slightly higher investment than kiln.

Appendix Table 3. Pro forma income statement and financial returns for model plants - superphosphoric acid

	Units	Unit cost	Units/ton	75 TPD	150 TPD	450 TPD
Production	Tons P_2O_5	--	1	19,800	39,600	118,000
				----------	$1,000	----------
Sales	Tons P_2O_5	153 3/	1	3,029	6,058	18,054
Direct expenses						
Phosphoric acid (54%)	Tons P_2O_5	125.00	1.03	2,549	5,098	15,192
Fuel (natural gas)	MCF	.60	1.80	21	43	127
Electricity	KWH	.01	70	14	28	83
Process water	M gal	.05	15	15	30	88
Chemicals (caustic soda, etc.)	Set	.75	1	15	30	88
Operating labor	man hour	1/	4.50	57	57	57
Supervision and fringes	Set	100%	--	57	57	57
Subtotal				2,728	5,343	15,692
Indirect expenses						
Maintenance and supplies	7% of replacement investment			49	76	144
Taxes and insurance	3% of replacement investment			21	32	62
Plant and labor overhead	100% of labor and supervision			114	114	114
Selling, general and administrative	$7/ton			139	277	826
Subtotal				323	499	1,146
Total expenses				3,051	5,842	16,838
Depreciation	$ 2/ / TPD capacity			54	86	170

continued--

Appendix Table 3 (continued)

	Units	Unit cost	Units/ton	75 TPD	150 TPD	450 TPD
Interest (long term)				4	8	19
Total costs				3,109	5,936	17,027
Net income before taxes				<80>	122	1,027
Income tax				--	52	486
Net income after taxes				< 80>	70	541
Cash flow				<26>	156	711
Return on invested capital				---------- pct ----------		
Before tax				< 0	12	36
After tax				< 0	7	19
Return on sales						
Before tax				< 0	2	6
After tax				<0	1	3

1/ .64, .32 and .11 respectively

2/ $720, $570 and $380 respectively

3/ This plant net back price of $153 per ton is based on a $28 differential between ortho acid and SPA. A higher price for SPA, which may be indicated by list price data, would not result in larger margins for model plants, since the cost of ortho acid would rise by an equal amount. In fact, use of the $28 differential may result in some slight overstatement of profits for the model plants.

Appendix Table 4. Estimated invested capital for model plants - superphosphoric acid

	75 TPD			150 TPD			450 TPD		
	Current	Salvage	Book	Current	Salvage	Book	Current	Salvage	Book
	$1,000								
Plant	705	55	215	1,080	85	430	2,050	165	1,020
Working Capital	300	300	300	605	605	605	1,805	1,805	1,805
Total invested capital	1,005	355	515	1,685	690	1,035	3,855	1,970	2,825

Appendix Table 5. Pro forma income statement and financial returns for model plant - defluorinated wet process acid 1/

	Units	Unit cost		100 TPD	300 TPD
Production	Tons	--	1	26,000 3/	69,000
				---- $1,000 ---	
Sales	Tons	$153 2/	1	3,978	10,557
Direct expenses					
Phosphoric acid (54%)	Tons P_2O_5	$125	1.03	3,348	8,884
Silica gel and heat	Set	$ 7.50	1	195	518
Operating labor	Manhours	$ 4.50	4/	35	78
Labor and supervision	Set	$100%	--	35	78
Subtotal				3,613	9,558
Indirect expenses					
Maintenance	5% of replacement investment			10	25
Taxes and insurance	3% of replacement investment			6	15
Plant and labor overhead	100% of labor and supervision			70	156
Selling, general and administrative	$8 and $7 per ton respectively			208	483
Subtotal				294	679
Total expenses				3,907	10,237
Depreciation	$170 and $140/TPD capacity respectively			17	42
Interest (long term)				2	6
Total costs				3,926	10,285
Net income before tax				52	272
Income tax				18	124
Net income after tax				34	148
Cash flow				51	190
Return on invested capital				--- pct ---	
Before tax				10	20
After tax				6	11
Return on sales					
Before tax				<1	3
After tax				<1	1

1/ These estimates must be considered as indicative as little is known about manufacturing costs of this method of defluorination.

2/ Actual sales price unknown. Assumed to be equal to P_2O_5 from SPA.

3/ 260 and 230 days production respectively

4/ .30 and .25 respectively

Appendix Table 6. Estimated invested capital for model plant - defluorinated wet process acid (300 TPD)

	Current		Salvage		Book	
	100TPD	300 TPD	100 TPD	300 TPD	100 TPD	300 TPD
	$1,000					
Plant	200	500	16	40	118	295
Working capital	400	1,055	400	1,055	400	1,055
Total invested capital	600	1,555	416	1,095	518	1,350

Appendix Table 7. Pro forma income statement and financial returns for model plant - 450 TPD sodium tripolyphosphate (wet acid)

	Units	Unit cost	Units/ton	
Production	Tons	--	1	135,000
				---$1,000 ---
Sales	Tons	$153 1/	1	20,655
Direct expenses				
Phosphoric acid 75% H_3PO_4	Tons	67.50 2/	1.087	11,372
Soda ash	Tons	45.50	.735	4,515
Supplies	Ton	.50	1	75
Power	KWH	.01	38.9	58
Fuel (natural gas)	MMBTU	.80	13.9	1,668
Operating labor	Man hours	4.50	.21	142
Supervision and fringes	Set	100.00%	--	142
Subtotal				17,972
Indirect expenses				
Maintenance	5% of replacement investment			236
Taxes and insurance	3% of replacement investment			142
Plant and labor overhead	100% of labor and supervision			284
Selling, general & administrative	$10 per ton			1,350
Subtotal				2,012
Total expenses				19,984
Depreciation	$1.10/TPY capacity			165
Interest (long term)				15
Total costs				20,164
Net income before tax				491
Income tax				229
Net income after tax				262
Cash flow				427

Appendix Table 7 (continued)

	Units	Unit cost	Units/ton	Acid Price
				(pct)
Return on invested capital				
Before tax				17
After tax				9
Return on sales				
Before tax				2
After tax				1

1/ From Economic Analysis of Proposed Effluent Guidelines, The Industrial Phosphate Industry, EPA-230/1-73-021, Washington, Aug. 1973.

2/ Includes $10.00 per ton clarification.

Appendix Table 8. Estimated invested capital for model plant - 450 TPD sodium tripolyphosphate (wet acid)

	Current	Salvage	Book
		$1,000	
Plant	4,720	380	820
Working capital	2,066	2,066	2,066
Total invested capital	6,786	2,446	2,886

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA 230/1-74-043	2.	3. Recipient's Accession No.
4. Title and Subtitle Economic Analysis of Proposed Effluent Guidelines - Nonfertilizer Phosphate Manufacturing Industry			5. Report Date September, 1974 (Date of completion) 6.
7. Author(s) Milton L. David, C. Clyde Jones, J. M. Malk			8. Performing Organization Rept. No. 139
9. Performing Organization Name and Address Development Planning and Research Associates, Inc. P. O. Box 727 Manhattan, Kansas 66502			10. Project/Task/Work Unit No. Task Order No. 14 11. Contract/Grant No. 68-01-1533
12. Sponsoring Organization Name and Address Environmental Protection Agency Waterside Mall 4th and M Street, S. W. Washington, D. C. 20460			13. Type of Report & Period Covered Final Report 14.

15. Supplementary Notes

16. Abstracts

This study of nonfertilizer phosphate manufacturing industry study, SIC 2819 and 2874, specifically involved three segments--4 defluorinated phosphate rock (DFP) plants, 11 defluorinated wet phosphoric acid plants and 1 sodium tripolyphosphate (STPP) plant. Most of the plants are reasonably profitable. Pricing of these products is complex in that their demand is derived, i.e. feed phosphates, liquid fertilizers, soaps and detergents. Feed phosphates and liquid fertilizer markets together are expected to grow at 8 to 12 percent per annum. STPP use is declining. Because of the amount of in-place pollution control technology, direct pass-on of control costs is not expected. The 4 DFP plants currently meet control requirements and should not be impacted. Three defluorinated acid plants may close due to pollution control regulations although one of these may close under baseline conditions. The STPP plant may close in face of impending pollution control guidelines.

17. Key Words and Document Analysis. 17a. Descriptors

Pollution, water pollution, industrial wastes, fertilizers, phosphates, sodium, tripolyphosphate, defluorinated rock phosphate, defluorinated phosphoric acid, feed phosphates, economic, economic analysis, discounted cash flow, demand, supply, prices, fixed costs, variable costs, community, production capacity, fixed investment

17b. Identifiers/Open-Ended Terms

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06 Biological and Medical Sciences, H-Food

17c. COSATI Field/Group

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16. Abstracts (continued)

Associated production curtailments and employment impacts (60 jobs) are estimated to be minor.