A REPORT ON THE

Costs and Benefits of a Phosphate Detergent Ban

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

Senate Document No. 9

COMMONWEALTH OF VIRGINIA
RICHMOND
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IN RESPONSE TO
SENATE JOINT RESOLUTION NO. 54

A REPORT
ON THE COSTS AND BENEFITS OF
A PHOSPHATE DETERGENT BAN

PRESENTED BY THE
STATE WATER CONTROL BOARD
CHESAPEAKE BAY COMMISSION
VIRGINIA COOPERATIVE EXTENSION SERVICE

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CHAPTER II. INTRODUCTION

Senate Joint Resolution No. 54, passed during the 1984 General Assembly Session, requested the State Water Control Board, Chesapeake Bay Commission, and Virginia Cooperative Extension Service to study the costs and benefits of a phosphate detergent ban in Virginia and the usefulness of such a ban in conjunction with other nutrient control strategies in the Chesapeake Bay and its tributaries. A Task Force was formed of staff from these agencies plus the Soil and Water Conservation Commission. The Task Force held a series of meetings and a public fact finding forum and reviewed numerous reports and studies nationwide from the private sector, governmental agencies, universities and foundations in the course of its work.

CHAPTER III. BACKGROUND

A. Water Quality

Those activities of man which introduce excessive nutrients into lakes and rivers cause what is termed nutrient enrichment. This is a condition which manifests itself in excessive growths of algae and other aquatic weeds, resulting in: 1) unsightly appearances of lakes and streams; 2) a decline in certain species of fish as well as recreational uses; 3) a noxious odor and unpleasant taste in the water when these plants die and decay; and 4) a demand on the dissolved oxygen in the water which stresses aquatic life and degrades water quality.

The focus of this study is the nutrient, phosphorus, because of the EPA Chesapeake Bay Program (CBP) findings that excessive phosphorus is present in the Chesapeake Bay and its tributaries.

THe CBP examined 30 years of nutrient data (1950-1980) to characterize conditions and trends in the Chesapeake Bay and its drainage area (Figure III-1) (Refer to end of Executive Summary for Figures and Tables). The presence of excessive phosphorus from non-point sources (run-off from agriculture, forest, and urban areas) and point sources (sewage treatment plants and industrial plants) has led to serious water quality problems such as algal blooms, low dissolved oxygen, and a reduction in water quality. There has also been a decreasing trend in living resources such as fresh water spawning fish, oysters, and submerged aquatic vegetation.

In Virginia's four major tributaries (Figure III-2), nutrient enrichment problems occur in the upper tidal fresh reaches, especially in the Rappahannock and the James. As a result, a State nutrient control strategy is needed to halt and steadily reverse these decreasing trends in water quality. Virginia's neighboring states of Maryland and Pennsylvania are working in complementary efforts to develop statewide nutrient control strategies.

The Chesapeake Bay Initiatives developed by the Secretary of Commerce and Resources address certain nutrient enrichment problems and were funded by the Virginia General Assembly. In fact, a substantial percentage of the $10 Million Initiative package was targeted to the nutrient enrichment problems. A working goal of 20% reduction in phosphorus loadings to Virginia tributaries has been established with a mixture of point source and non-point source control strategies to address the problems. Two strategies for dealing with the point source problem are: 1) upgrading sewage treatment plants (STPs) and 2) a phosphate detergent ban.

An update on phosphorus loads to the Chesapeake Bay from the four major river basins is included in Figure III-4. However, other state waters including the Chowan and many freshwater lakes and reservoirs are considered to be eutrophic, or having a high rate of nutrient input.

B. LAUNDERING & DETERGENTS.

There are three factors which primarily affect laundering: water, soils and detergents. In Virginia 64% of the population live in areas with soft water; 36% live in areas with water of varying degrees of hardness from medium hard to very hard. The hardness of the water affects the cleaning ability of the detergents as do water temperature and soil composition.

Detergents contain 2 major ingredients: surfactants, which act as the soil remover, and builders, which control water hardness. Phosphate is the builder most frequently used in granular detergents. Other builders include: sodium carbonate, NTA, citrate, sodium silicate and zeolites. Sodium carbonate is the most frequently utilized builder in non-phosphate, granular detergents. Liquid detergents do not contain phosphates or carbonates but may contain citrates as a builder.

Procter and Gamble (P & G) reports that levels of phosphates in detergents have decreased since 1970. The average phosphorus content of all detergents - both liquid and granular - was 11% in 1970; now it is estimated to be 5%. For example, among granular detergents sold in Virginia stores, phosphorus levels are as follows: Tide - 8.4%, Cheer - 8.2%, Oxydol - 7.4%, Gain - 6.1%, Fab - 6.0%, Bold - 5.9%, Ajax - 3.8%, Cold Power - 2.5%, All - 0.0%, Trend - 0.0%, Arm and Hammer - 0.0%.

In states where all types of detergents are sold, such as Virginia, 64% of the population use phosphate detergents. The nationwide average including the population in phosphate ban states is 50% phosphate users, 50% non-phosphate users.

The Task Force has received varying positions from detergent manufacturers regarding the performance and cost of detergents. According to

Procter and Gamble extensive efforts by the detergent industry have failed to find a satisfactory substitute for phosphate and research has shown that among those builders which are sanctioned for use in the U.S., phosphate remains the most effective choice in terms of performance and cost. Conversely, Lever Brothers and Purex Industries contend that their non-phosphate detergents provide comparable performance at a comparable price.

CHAPTER IV. PHOSPHATE DETERGENT BANS

A. History

As of November, 1984, 6 states and 3 major metropolitan areas in the U.S. have a phosphate ban in place. This represents 22% of the U.S. population. Most of these states are in the Great Lakes area where phosphate bans were enacted as part of nutrient control strategies in the 1970's. The States of Indiana, New York, Michigan, Vermont, Wisconsin and Minnesota as well as Chicago, Akron and Dade County, Florida, were surveyed by the Task Force to obtain the following ban information: the date the ban was enacted, products banned, products exempted, enforcement authority and general comments. Visits were made to Maryland and North Carolina to learn about their efforts toward enacting a ban.

B. 1 Results: Phosphorus Levels in Wastewater Discharges.

As a result of the CBP findings regarding phosphorus levels in wastewater discharges, EPA assumed a 30% reduction in phosphorus levels from a ban. The Soap and Detergent Association (SDA) has stated that decreases would be in the 20-25% range.

BASED ON THE RECENT DATA WHICH CLOSELY REFLECT THE DETERGENTS CURRENTLY ON THE MARKET, THE TASK FORCE CONCLUDES THAT A PHOSPHORUS DETERGENT BAN SHOULD REDUCE THE PHOSPHORUS LEVELS IN WASTEWATER BY 20-30%.

2. Results: On Water Quality

THE TASK FORCE HAS CONCLUDED THAT A PHOSPHATE DETERGENT BAN WOULD NOT BE EXPECTED TO SHOW SIGNIFICANT IMPROVEMENTS IN WATER QUALITY ESPECIALLY IN THE SHORT TERM OR IF USED WITHOUT OTHER NUTRIENT CONTROL STRATEGIES. HOWEVER, A BAN IS A VIABLE METHOD TO HOLD THE LINE, TO KEEP PHOSPHORUS LOADINGS FROM INCREASING BEYOND EXISTING LEVELS, AND TO THUS PREVENT FURTHER WATER QUALITY DEGRADATION.

3. Results: On Consumers

Consumer impacts fall into two categories: 1) changes in consumer laundry habits, and 2) carbonate deposition that may result on clothes and in washing machines.

Laundry Habits - According to P & G national consumer studies, the use of bleach, fabric softener and hot water is on average 5-7% greater in states with bans when compared to the rest of the country. Also, the costs assigned to these shifts in consumer behavior amount to an approximate 8% increase in laundering costs per average household ($11.30 in 1980 dollars).

The Task Force has reviewed and evaluated laundry habits and the related cost issues. Some concerns have arisen regarding the basis for these costs and whether they are attributable solely to the type of detergent used (phosphate v. non-phosphate). Although the Task Force has identified these concerns with the available data, the consumer costs presented by Procter and Gamble appear to be the only technically based figures available. In addition, the EPA Chesapeake Bay Program agreed to similar consumer cost impacts in their analysis of a phosphate detergent ban. THEREFORE, THE TASK FORCE AGREED TO USE THE PROCTER AND GAMBLE COST FIGURES ON LAUNDRY HABITS.

Carbonate Deposition - Sodium carbonate is the most widely utilized alternative to phosphates used in granular detergents. One potentially negative factor occurs when it is used in hard water. It may leave a residue on fabrics and washing machine parts whereas phosphates do not. P & G attributes its estimates of additional consumer costs for the carbonate deposition problem to additional fabric wear and an increase in washing machine-related service calls.

REGARDING THE PROJECTED FABRIC ABRASION COSTS, THE TASK FORCE DOES NOT BELIEVE THAT THE STUDIES AND OTHER INFORMATION SUBMITTED SUPPORTS ASSIGNING ANY CONSUMER COSTS IN SOFT WATER AREAS.

In the harder water areas, Procter and Gamble projects the following reduction in garment life:

Medium Hard	Hard	Very Hard
3.6%	6%	8.4%

A cost is estimated by multiplying these percentages by the annual household expenditure for washable clothing and other household items ($750 in 1983). The Task Force estimates are different from these costs because:

(i) The lab studies showed abrasion with cottons and blends (cotton portion only). Synthetic fabrics (such as nylon) did not show abrasive damage. A typical family washload is composed of about 25% synthetics.

(ii) There are factors other than fabric wear (i.e. fashion shifts, children outgrowing clothes, consumer desire for new or different clothes, etc.) which significantly impact consumer purchase of new garments.

IN THE ABSENCE OF ANY OTHER DATA, THE TASK FORCE BELIEVES THAT A MORE REASONABLE APPROACH TO ALLOW FOR THESE FACTORS IS TO USE ONE-HALF OF THE ANNUAL EXPENDITURE FOR WASHABLE ITEMS IN THE COST CALCULATIONS.

WITH RESPECT TO THE PROBLEMS OF INCREASED SERVICE CALLS AND SHORTER LIFE FOR WASHER PARTS, THE TASK FORCE BELIEVES THAT THE DATA DOES NOT SUPPORT ASSIGNING ANY COSTS IN SOFT WATER AREAS. Literature published by washing machine manufacturers does caution consumers of carbonate deposition problems, but they focus their discussion on washing in hard water.

In harder water areas, the Task Force estimates differ from Procter and Gamble's costs for two reasons:

(i) Data in the laundry habits study indicates that on the average there are two service calls during the life of a washing machine (10.8 years.) The Task Force has used this in its calculations and does not agree with a service call rate of every other year used by Procter and Gamble.

(ii) The manufacturer's estimates of a reduced part life of 15-25% was used by the Task Force. Procter and Gamble assumed that the parts in all machines would be replaced once during the life of the machine.

IN SUMMARY, THE TASK FORCE CONSIDERS CALCIUM CARBONATE DEPOSITION TO BE A POTENTIAL PROBLEM PRIMARILY IN HARD WATER AREAS. THE TASK FORCE BELIEVES THERE SHOULD BE A BETTER DATA BASE DEVELOPED FOR EVALUATING IMPACTS ON CONSUMERS FROM CARBONATE DEPOSITION, ESPECIALLY IN SOFT AND MEDIUM WATER HARDNESS AREAS.

4. Results: On Industry

The main concern expressed by detergent industry representatives about a phosphate detergent ban is their inability to offer the consumer the best products available. They also indicate that resulting consumer complaints are directed to the industry and not towards the governmental entity imposing the ban.

When a ban is imposed, the leading brand names continue to be marketed, but with a non-phosphate formulation.

Indirect costs to the industry may include:

a. Testing and research of phosphate substitutes;
b. New product introduction and marketing; and
c. Producing and carrying a greater line of brands or the same brands with varying levels of phosphorus content.

Furthermore, the industry supplying the ingredients used to make detergent builders would be impacted. Only 2% of the phosphate processed is used in detergents; the remainder is used primarily in fertilizers. The main phosphate form used in detergents is STPP, and about 90% of all STPP produced is used in laundry detergents.

CHAPTER V: VIRGINIA PHOSPHATE DETERGENT BAN

A. Benefits

1. A ban would reduce phosphorus loadings from municipal point sources by approximately 25%.
2. A ban would result in the following changes in 1983 total phosphorus loads in comparison to 1980 loads for both point and non-point sources:

	1983 Loads In Relation to 1980 Loads	
	Without a ban	With a ban
Potomac	-26.7%	-27.6%
Rappahannock	+ 3.6%	- 3.6%
York	+40.9%	+27.0%
James	+ 6.3%	-12.1%

In relation to the working goal of 20% reduction from the 1980 phosphorus loads, a ban by itself would not achieve this level of reduction in the Rappahannock, York, and James basins. In the Potomac the 20% reduction is achieved through phosphorus removal at the treatment plants and a ban would increase this reduction slightly.

3. A ban going into effect in 1985 would ensure that total phosphorus loadings in these Virginia river basins would not return to current levels in spite of population increases until:

Potomac	-	1986
Rappahannock	-	1993
York	-	1987
James	-	1997

4. A ban is an effective interim strategy because

   a) it can be implemented in a matter of months
   b) it requires no capital expenditures, and
   c) it is reversible.

However, as with most interim strategies, a ban alone will not solve the nutrient enrichment problem.

5. The nutrient enrichment problem in the bay and its tributaries (or any of Virginia's other waters) requires an overall program combining many different strategies.

   A ban can be one element in the overall program of nutrient control strategies.

6. A ban results in cost savings at municipal treatment plants which are required to remove phosphorus prior to discharge. These cost savings are due to reduced chemical usage and to reduced production of sludge requiring final disposal.

B. Cost and Effects

1. A ban would remove from the marketplace phosphate laundry detergent products currently purchased and used by many Virginia consumers. Brand names could still be marketed, but would require different chemical formulations.

2. Some consumers may make adjustments in their laundry habits. Adjustments may include the following:

   - Change in detergent brand or type
   - Change in amount of detergent used per load
   - Change in water temperature settings
   - Use of additional laundry additives and pre-soaks

3. When used in hard water, granular non-phosphate detergent could cause calcium carbonate deposition on clothes and washing machine parts.

4. Projected consumer costs resulting from a phosphate detergent ban can be seen in Tables V-2 and V-3.

C. Implementation Issues

1. Type of Ban - A phosphate detergent ban does not have to be statewide: Regional and municipal bans have been implemented successfully in other areas of the country. Table V-4 illustrates regional phosphate ban alternatives.

2. Exemptions - Other states have exempted certain products from the ban. They can be broken down into 2 categories.

   a) No alternative to phosphate products - machine dishwasher detergents are a prime example; and

   b) Other products not considered in the context of "household" - industrial cleaners, commercial laundries, food processing and dairy equipment, and hospitals.

Considerations should be given to certain product exemptions in any Virginia ban.

3. Enforcement - The Virginia Department of Agriculture and Consumer Services (VDACS) currently inspects products in retail grocery stores. Based upon correspondence received from the VDACS enforcement of a Virginia ban could be incorporated into current Department programs.

D. Summary of Other Phosphate Detergent Ban Pro's & Con's:

PRO'S:
- o increased citizen awareness of the ultimate impact of individual activities upon the Bay
- o decreased amounts of sludge which will ultimately have to be disposed of in land disposal sites.

CON'S:
- o possibly divert attention from taking other important steps in an overall nutrient control strategy such as point source control.
- o little, if any, reduction in nutrient loads to surface waters from septic tank areas of the State. (Although with failing septic tank/drainfield systems, surface water pollution may occur.) However, consumers in septic tank areas would still be covered and affected by a P ban.

CHAPTER VI: USEFULNESS OF A BAN IN CONJUNCTION WITH OTHER PHOSPHORUS CONTROL STRATEGIES

A phosphate detergent ban alone will not achieve the working goal of 20% reduction in phosphorus loads from the Virginia tributaries to the Chesapeake Bay. Other control strategies must be implemented to reach this goal. The two major strategy areas are: (1) point source controls; and (2) non-point source controls. How does a ban fit in with these two strategies?

Non-point source control strategies involve methods of reducing run-off from agricultural and urban areas. There are numerous agricultural and urban practices that can be implemented to reduce run-off. These methods could be implemented in conjunction with a phosphate detergent ban and would provide the benefit of additional reduction in phosphorus loadings to the Bay. At this time it is difficult to specifically quantify the costs and benefits derived from these methods. However, it is clear that non-point source controls involve costs and provide benefits which are strictly in addition to those associated with a ban.

In the area of point source controls, strategies consist mainly of two methods: (1) a phosphate detergent ban; and (2) phosphorus removal at sewage treatment plants. A phosphate detergent ban results in the reduction of phosphorus entering sewage treatment plants (STPs). Therefore, even without additional treatment, these plants discharge a reduced amount of phosphorus. Phosphorus removal at STPs involves additional treatment which results in significant reductions in the amount of phosphorus discharged. In this latter method the amount of phosphorus which enters a STP does not impact the amount which is discharged into the State's waterways; however, it does affect the cost of treatment. Therefore, in evaluating the usefulness of a ban in conjunction with phosphorus removal at STP's it becomes necessary to separate the environmental benefits (reduced phosphorus discharged) from the economic benefits (reduced cost of treatment). An additional factor compounding this evaluation stems from the fact that implementation of these two methods could be carried out over significantly different time frames. The following comparisons, analyses, and summary conclude the chapter on the usefulness of a ban in conjunction with other nutrient control strategies:

1. Under a phosphorus removal program, the treatment plants would be required to meet certain limits for phosphorus (P) in their effluents. The following data illustrates several effluent values which could be used in a phosphorus removal program and compare these to no P control and ban strategies:

Strategy	Phosphorus Concentration in Plant Effluent (mg/l)	% Removal in Relation to No P Control
o No P Control (Assume Secondary Effluent)	6.4	-
o Phosphate Detergent Ban	4.8	25
o Levels of Phosphorus Removal	2.0	69
	or	
	1.0	84
	or	
	0.2	97

Phosphorus removal at sewage treatment plants removes a much greater percentage of P than does a ban. However, unlike the relationship between a ban and non-point source control, phosphorus removal at treatment plants is not additive to the reduction in phosphorus achieved by a ban. If a ban is in effect in the service area of a treatment plant removing phosphorus, there will be no environmental benefit (i.e. reduction in P discharged to State waters) associated with the ban. Since the ban would reduce the phosphorus level in the wastewater influent to the treatment plant, there could be an economic benefit since the cost of phosphorus treatment could decrease.

2. In order to fully appreciate how a ban could be used in conjunction with phosphorus removal at sewage treatment plants, the Task Force has developed cost estimates for providing phosphorus removal at Virginia's major sewage treatment plants discharging to the tributaries of the Chesapeake Bay. Table VI-1 presents estimates for the capital costs to provide phosphorus removal facilities at these plants.

The Task Force believes the most important aspect of this cost information is the magnitude of the capital cost involved. Clearly, such a large scale capital improvements program will require a lengthy time period (on the order of a decade) to complete. Design and financing considerations plus the construction of the number of plants involved each contribute in making this a long-term program.

As stated in Chapter V, a ban can be implemented in a matter of a few months. Thus, a ban can be used during the time the treatment plants are being upgraded to hold the line on phosphorus loads until phosphorus removal can begin.

The Task Force has purposely not shown a direct comparison between the costs of phosphorus removal and the consumer costs associated with a ban because these two strategies should not be viewed as "either/or" options. A ban's primary benefit is to be used in a nutrient control program as the initial step while the major step, phosphorus removal, is being put in place.

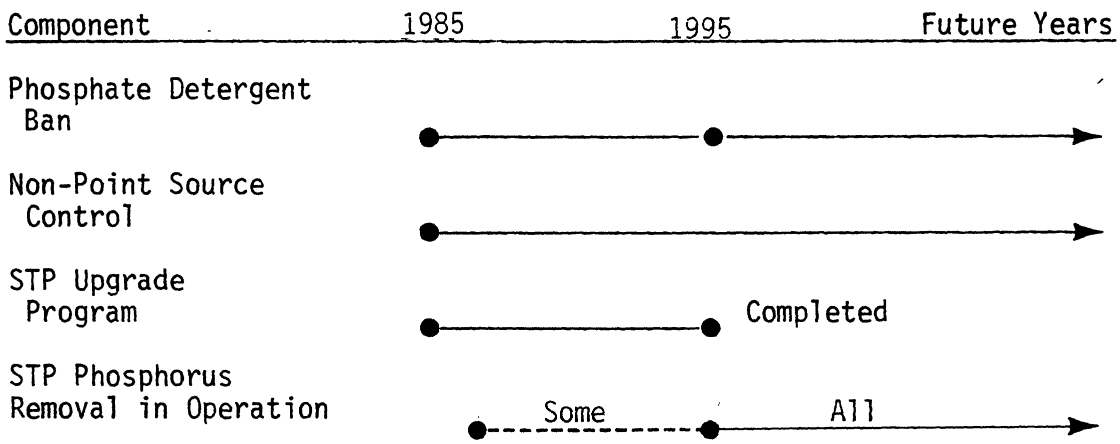
3. If a ban is adopted and phosphorus removal at the treatment plant is either in operation or subsequently begins operation, then the primary environmental benefit of the ban is not achieved. However, the ban does provide some economic benefit due to cost savings in the operation of the treatment plants.

   The Task Force received estimates of these cost savings from the SDA, the Washington Suburban Sanitation Commission, and EPA and also provided an independent evaluation of costs as seen in Table VI-2. Because of the wide variation in these projected costs, each has been presented to demonstrate the range of costs involved.

   When both phosphorus removal and a ban are in place, the pros and cons for and against a ban are primarily economic. In these circumstances a ban might save $2.94/household/yr. in sewage treatment costs, but might cost $13.26/household/yr. in added laundry costs (according to Task Force estimates). However, it should be pointed out that there is little chance of all STP's in Virginia being upgraded for phosphorus removal because of the high capital costs, so there would still be some phosphorus loading reduction. Another factor which must be considered is the sludge disposal problem which is becoming increasingly complex across Virginia. Some of the cost savings at STP's due to a ban are a result of reductions in the cost of final sludge disposal. A ban would help alleviate some of the pressure on sludge disposal sites.

Summary

The Task Force concludes that the usefulness of a phosphate detergent ban in conjunction with other nutrient control strategies can best be illustrated by this time line:



A ban can be implemented in 1985, with immediate reduction in phosphorus loads achieved.

Non-point source control is an on-going program that should continue over the long term.

Phosphorus removal at sewage treatment plants (STPs) requires large scale capital improvements which may take 10 years to complete.

Phosphorus removal at STP's could begin as each plant is upgraded. Full operation of phosphorus removal could begin in 1995. At that time, a decision can be made whether to continue or terminate a state or regional ban.

CHAPTER VII. A REVENUE SOURCE FOR UPGRADING SEWAGE TREATMENT PLANTS: PHOSPHATE DETERGENT USER FEE

As discussed earlier in this report, in order to achieve a substantial reduction in phosphorus loads to the Bay's tributaries, sewage treatment plants (STP's) would need to provide phosphorus removal. The Chesapeake Bay Initiatives include a STP improvement program for long-term funding (1986-1994). The cost estimates for this program were approximately $110 million.

During the course of the Task Force's evaluation of a phosphate detergent ban, an alternative approach to the phosphorus loading problem as it relates to detergents was explored. This alternative is to place a user fee or excise tax on the wholesale distributor of phosphate detergents. The revenues collected from such a fee or tax could be used specifically to help pay for the costs of upgrading and/or operating phosphorus removal facilities at STP's. In Appendix E of this report, this concept is suggested in the Wisconsin "Information Verification Project on the Phosphate Ban Controversy."

The Soap and Detergent Association (SDA) has stated that: (1) nutrient enrichment from phosphorus is a problem in the Chesapeake Bay and its tributaries as outlined in the EPA Chesapeake Bay Program Study; (2) the problem can be dealt with most effectively at STP's, not through a ban; and (3) up to 25% of the phosphorus which goes into STP's comes from laundry detergents. Through the use of a fee or tax to pay for part of the capital and/or operating and maintenance costs of phosphorus removal at STP's, the soap and detergent industry would be paying for the part of the problem that their products are causing. With the use of this tax alternative there would be no ban on the sale of phosphate detergent in Virginia stores.

The Task Force has performed a preliminary cost analysis to estimate the amount of revenues which could be generated by such a tax. The amount of the tax should relate directly to the share of the problem contributed by the detergent industry. There are two options:

(i) Use 25% of the total cost of total phosphorus removal at the STP because 25% is the percentage of the plant influent phosphorus originating from detergents; or

(ii) Use the actual O & M cost of removal of the detergent phosphorus (this is less than 25% due to the sizing of STP units and various chemical reactions involved).

The Task Force estimates that an excise tax or user fee upon phosphate detergents could generate approximately $5.8 million/year.

Table VII-1 presents the results of a statewide phosphate detergent user fee to recover cost of treating detergent phosphorus at STP's. Table VII-2 suggests funding sources for STP upgrade programs.

EXECUTIVE SUMMARY CONCLUSION:

The Task Force completed its work by the December 1, 1984, deadline and submitted it to the State Water Control Board, Chesapeake Bay Commission, and Virginia Cooperative Extension Service. This report represents a consensus of all members of the Task Force.

The report provides in the background chapter: (1) a legislative history of SJR 54, water quality considerations, the Chesapeake Bay Program findings, the Virginia Chesapeake Bay Initiatives and nutrient loading problems in the Bay; (2) an explanation of laundering and detergents including the components of detergents, their functions and effects upon water and soils, the use of phosphate versus non-phosphate detergents, the general performance of detergents and trends within that industry.

The next chapter of the report details the history of phosphate bans in the U.S., the results of a ban on phosphorus levels in wastewater, on water quality, on consumers and on industry.

An analyses follows of a Virginia phosphate detergent ban including: (1) the benefits; (2) the costs and effects; (3) implementation issues; and (4) a summary of other pros and cons.

The following chapter discusses the usefulness of a ban in conjunction with other phosphorus control methods and provides various cost estimates of various strategies.

The final chapter provides an alternative to a phosphate ban: a user fee or excise tax upon the wholesale distributor of phosphate detergents to offset the costs of installing phosphorus removal of STP's.

The Task Force believes that in the preparation of this report it has fulfilled the requirements of SJR 54 and recommends that the appropriate governmental agencies adopt it as submitted.

Figure III-1

Chesapeake Bay Drainage Area

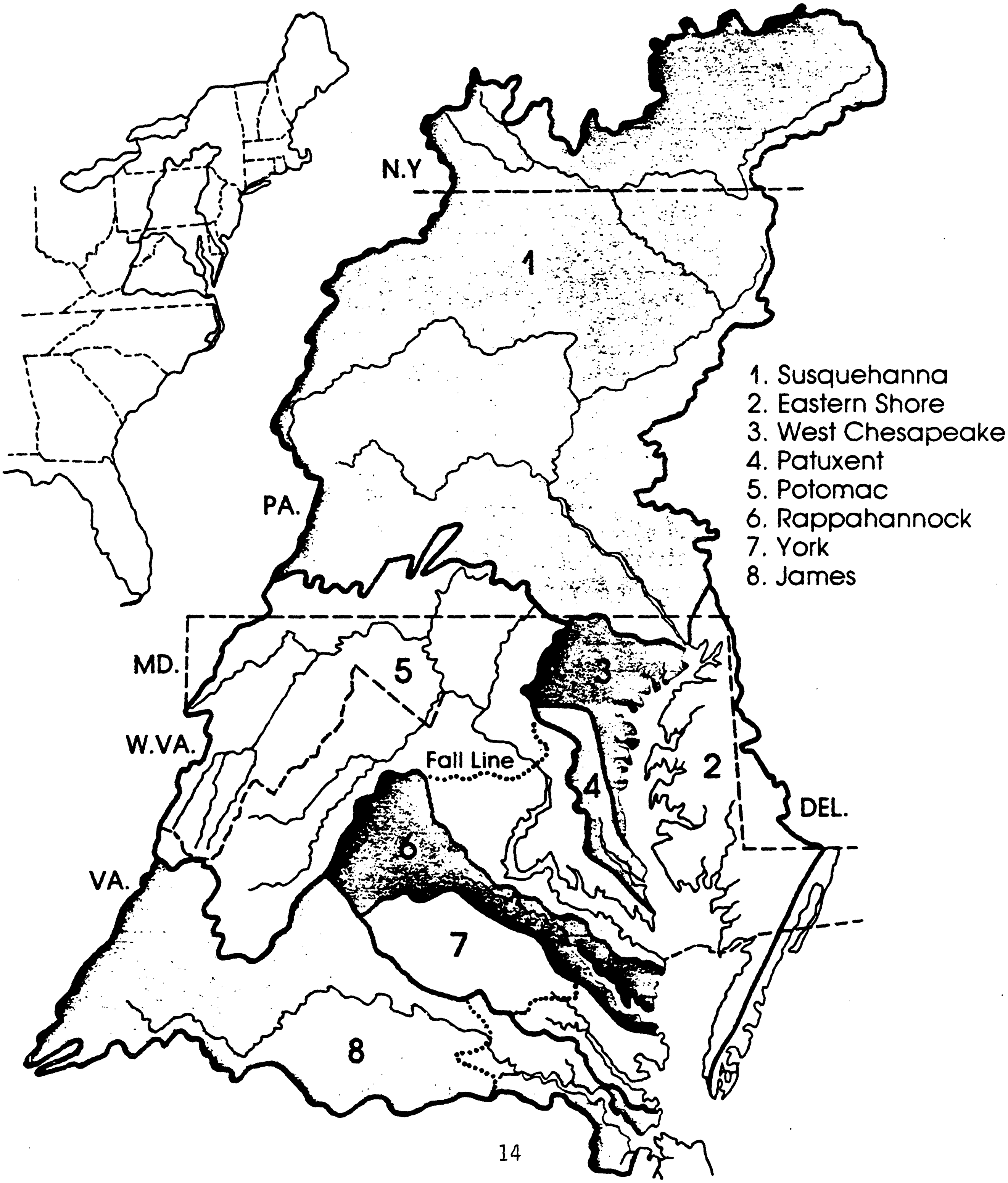


FIGURE III -2

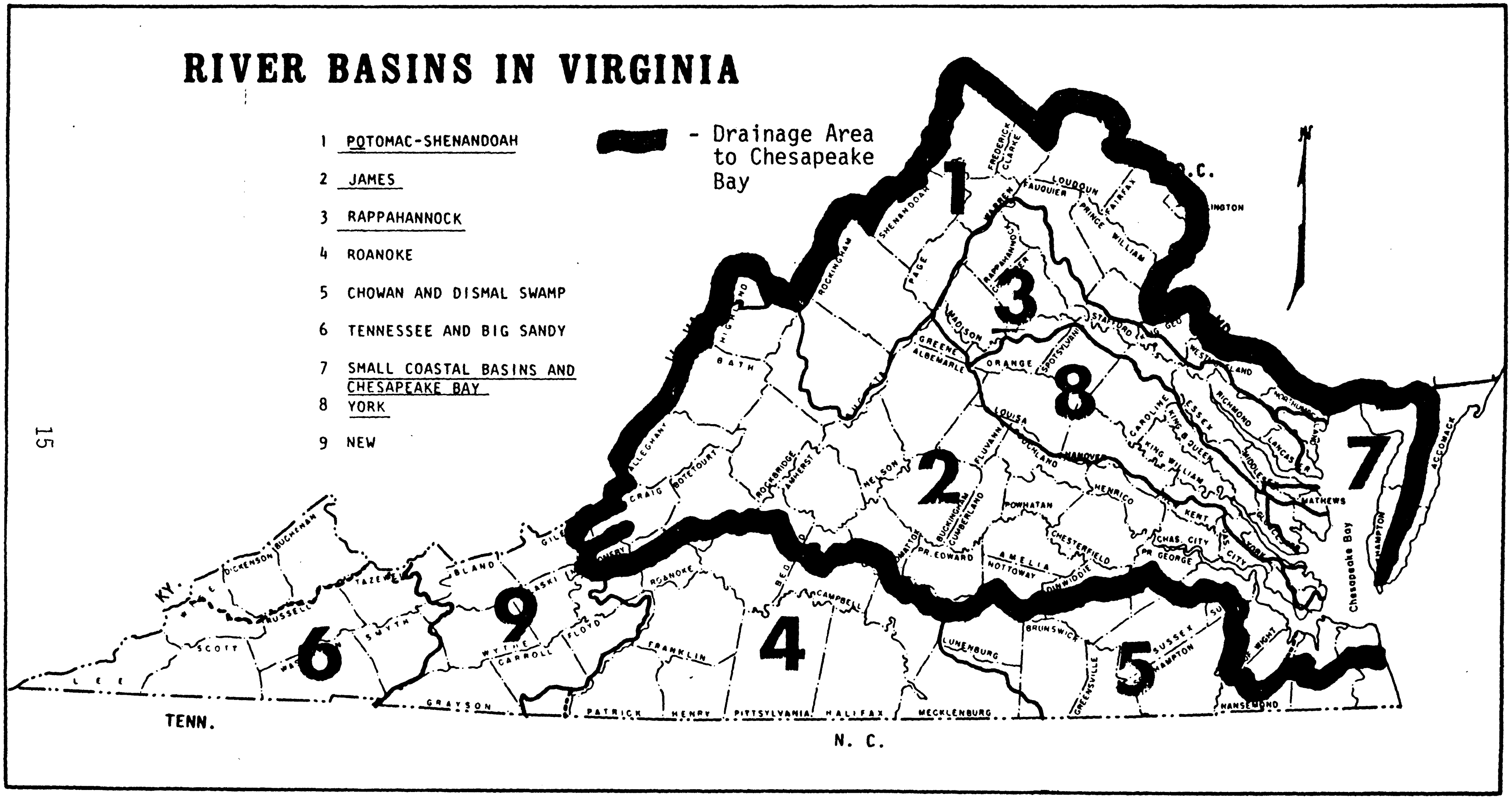

RIVER BASINS IN VIRGINIA
1 POTOMAC-SHENANDOAH
2 JAMES
3 RAPPAHANNOCK
4 ROANOKE
5 CHOWAN AND DISMAL SWAMP
6 TENNESSEE AND BIG SANDY
7 SMALL COASTAL BASINS AND CHESAPEAKE BAY
8 YORK
9 NEW
- Drainage Area to Chesapeake Bay
KY.
TENN.
N. C.
Chesapeake Bay

FIGURE III-4
PHOSPHORUS LOADS TO CHESAPEAKE BAY FROM FOUR MAJOR RIVER BASINS

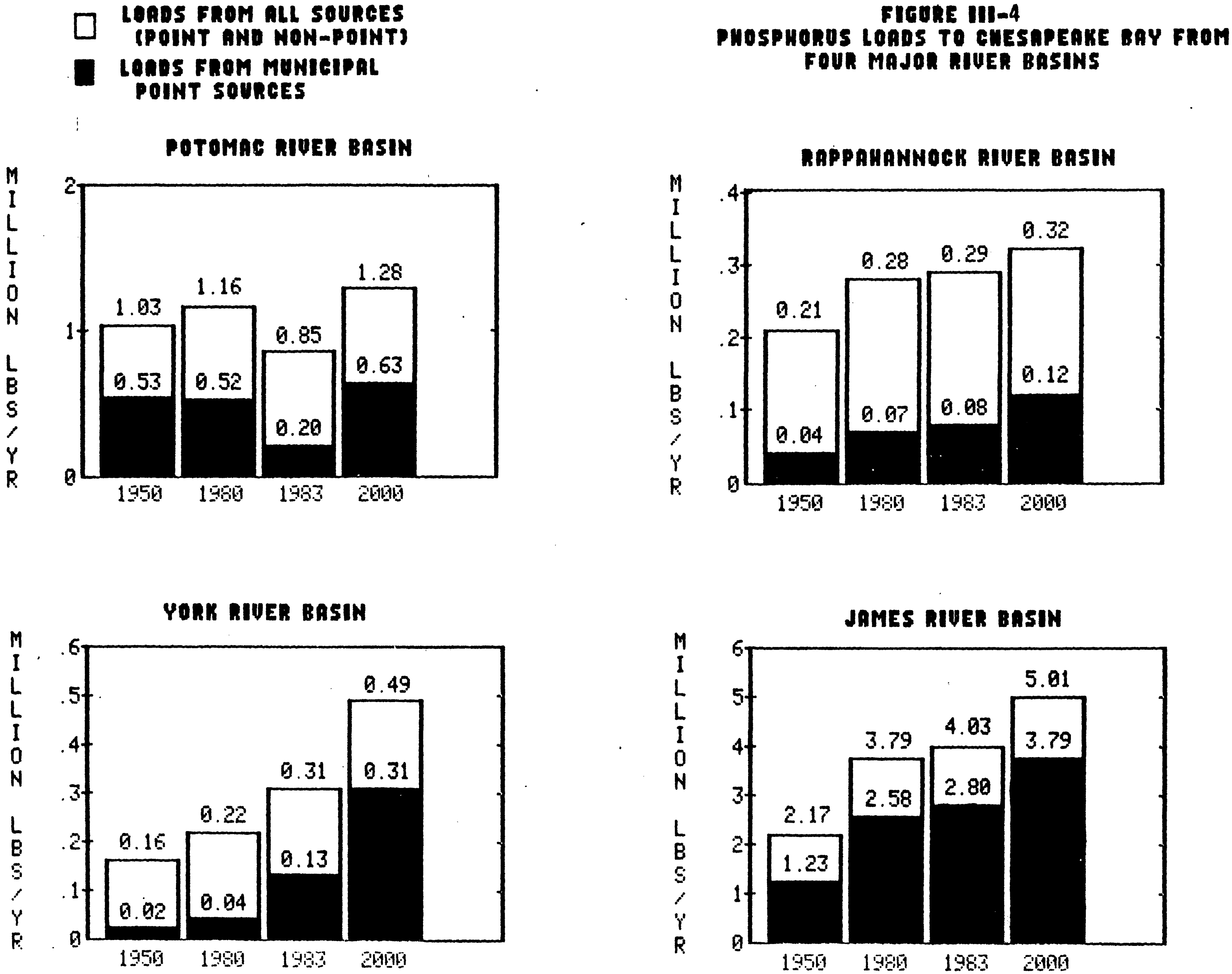


TABLE V-2

CONSUMER COSTS FOR A PHOSPHATE DETERGENT BAN BY WATER HARDNESS CATEGORY

$/Household/Year (January 1983 Dollars)

Water Hardness Category:		Soft	Medium	Hard	Very Hard
Percent of VA Population		64.4	23.0	8.0	4.6
Laundry Habit Adjustments	Procter and Gamble and Task Force	5.59	13.52	13.52	13.52
Increased Fabric Wear	Procter and Gamble	5.05	15.16	25.28	35.39
	Task Force	0	7.56	12.60	17.64
Washing Machine Repair and Replacement	Procter and Gamble	4.37	13.11	21.86	30.60
	Task Force	0	2.74	4.57	6.40
TOTALS	Procter and Gamble	15.02	41.79	60.66	79.51
	Task Force	5.59	23.82	30.69	37.56

TABLE V-3

CONSUMER COSTS FOR A PHOSPHATE DETERGENT BAN STATEWIDE AVERAGE

$/Household/Year (January 1983 Dollars)

Cost Projection By	Laundry Habits	Carbonate Deposition Fabric Wear	Carbonate Deposition Machine Repair/Part	Total
EPA	10.43	0	0	10.43
Procter and Gamble	8.41	10.40	8.99	27.80
Task Force	8.41	3.56	1.29	13.26

TABLE V-4

REGIONAL PHOSPHATE DETERGENT BAN ALTERNATIVES

Regional Ban	Population (1980)	Average Consumer Cost (Task Force Estimate) ($/Household/Year)	Phosphorus Loading Reduction to Virginia Bay Tributaries (lbs/yr)	Reduction in Total Current Phosphorus Loading to Virginia Bay Tributaries* (Percent)	Cost Per Pound of Phosphorus Removed by Ban ($/lb)	Comments
A. Statewide	5,346,000	$13.26	760,000	13.9	No calculation. Total phosphorus loading reduction statewide not known.	Also results in phosphorus reduction to other nutrient sensitive waters, such as the Chowan River.
B. Entire Chesapeake Bay Watershed	3,788,000	$13.54	760,000	13.9	$24.45	Same reduction to Bay tributaries as in A with fewer people impacted.
C. Chesapeake Bay Watershed East of Fall Line	2,842,000	$11.64	650,000	11.9 (18.5% of loads east of Fall Line)	$18.44	Major plants in Potomac Basin east of Fall Line remove phosphorus so some cost savings realized as compared to D and E.
D. Rappahannock/York/ James Basins East of Fall Line	1,720,000	$11.92	650,000	10.9 (20.5% of loads to these tributaries)	$11.43	Same reduction to Bay tributaries as in C with fewer people impacted.
E. James River Basin East of Fall Line	1,507,000	$11.13	600,000	10.9 (21.3% of loads to James River below Fall Line)	$10.13	Lowest cost. Fewest people impacted.

*Total phosphorus loading from Virginia tributaries is 5,480,000 lbs/year.

TABLE VI-1

COSTS OF PHOSPHORUS REMOVAL AT MAJOR
VIRGINIA (>1 MGD) SEWAGE TRATMENT PLANTS[a]
(January 1983 Dollars)

Basin	# of Major Plants	Total Current Design Flow (MGD)	Capital Costs* (Million $)	O&M Costs (Million $/Year)	Equivalent Annual Cost[d] (Million $/Year)	Total Annual Per Capita Cost[e] ($/Capita/Year)
Potomac	16[b]	190[b]	14.1	16.1[c]	17.5	13.4
Rappahannock	5	12	6.4	1.2	1.8	21.7
York	3	19	7.7	1.9	2.7	20.6
James	18	295	104.0	28.0	38.5	18.9
TOTALS	42	516	132.2	47.2	60.5	17.0

[a]Source: EPA-Chesapeake Bay Program Report for Costs for Upgrading the Operating Plants

[b]Seven of these plants (27 mgd) need to be upgraded with phosphorus removal.

[c]Includes O&M costs for plants still to be upgraded as well as O&M costs for plants currently with phosphorus removal.

[d]Sum of annual O&M costs and capital costs expressed as a uniform annual amount over 20-year period using a discount rate of 7.875 percent.

[e]Used 145 gallons/capita/day to develop estimate of population served.

*Note: For this analysis capital costs are based on upgrading 33 major STPs throughout these basins at their current design flow and are expressed in terms of 1983 dollars. A cost estimate of $200 million has previously been presented to the General Assembly. That estimate was based on providing phosphorus removal at 32 STPs (18 majors and 14 minors) primarily east of the fall line at their projected year 2000 design flow . Costs were expressed in total cumulative dollars (including inflation) spent over a ten year upgraded program (therefore, approximately a year 1990 dollar figure).

TABLE VI-2

TOTAL ESTIMATED O & M COST
SAVINGS RESULTING FROM A BAN
AT MAJOR TREATMENT PLANTS
WITH PHOSPHORUS REMOVAL
(Millions of Dollars/Year)

Basins	SDA [a]	WSSC [b]	EPA Criteria/ Virginia O&M Costs [c]	Task Force [d]
Potomac	0.66	1.98	2.42	0.68
Rappahannock	0.04	0.12	0.18	0.12
York	0.07	0.21	0.29	0.19
James	1.02	3.06	4.20	2.80
TOTALS	1.79	5.37	7.09	3.79

AVERAGE COST SAVINGS
PER HOUSEHOLD
($/Household/Year)

TOTALS	1.38	4.16	5.49	2.94

a. Using SDA's savings estimate of $0.50 capita/year
b. Using the Washington Suburban Sanitary Commission's savings estimate of three times SDA estimate - use $1.50 capita/year.
c. The EPA Chesapeake Bay Program used a cost savings estimate of 15% of annual O & M costs. Use that percentage with the estimated annual O & M costs from Table VI-1.
d. The Task Force used cost savings estimates of 10% of annual O & M costs for plants meeting 1 mg/l, but only 3% for plants meeting 0.2 mg/l.

Assumptions:

All major sewage treatment plants have phosphorus removal.

TABLE VII-1

PHOSPHATE DETERGENT USER FEE

Tax on Phosphate Detergent which would Recover Costs of Treating Detergent Phosphorus at Sewage Treatment Plants

Various Estimates	Annual Cost To Treat Detergent Phosphorus ($/Household)[a]	Tax on Phosphate Households ($/Year)[b]	Tax ($)			Phosphate Revenues Generated ($ Million)[e]
			Pound[c]	20 oz Box[d]	5 lb,4 oz Box[d]	
SDA	1.38	2.06	0.02	0.03	0.10	2.7
Task Force	2.93	4.39	0.05	0.06	0.26	5.8
WSSC	4.17	6.21	0.07	0.09	0.37	8.0
EPA Criteria/Virginia O&M Costs	5.49	8.19	0.09	0.11	0.47	10.6
25% Total Cost[e]	11.73	17.51	0.20	0.25	1.05	22.7

[a]For the first four estimates see Table VI-2 for O & M costs of treating detergent phosphorus at Virginia treatment plants. The fifth estimate is based on using 25% (which is the percentage of the detergent phosphorus component in raw sewage) of the total annual cost to remove phosphorus (from Table VI-1: $17/capita/year). Thus, $17 x 2.76 persons/household x 0.25 = $11.73/household.

[b]Approximately two-thirds of Virginia households currently use phosphate detergent. Thus, these households would pay, through a tax on the phosphate detergent, the cost of removing the detergent phosphorus at the treatment plant. For the Task Force estimate,$2.94/household ÷ 2/3 = $4.39/household.

[c]Consumers do 8.1 washloads/week (P & G data) and assuming detergent usage of 3 1/3 oz./load. the annual amount of detergent used per household is: 8.1 loads/week x 52 weeks/year x 3.33 oz/load x 1 lb/16 oz. = 88 lbs. of detergent/household/year. Thus, the tax per pound would be (using the Task Force estimate): $4.39/household/year ÷ 88 lbs./household/year = $0.05/lb.

[d]A 20 oz. box of phosphate detergent retails for about $1.00 and a 5 lb. 4 oz. box for about $3.50.

[e]This analysis assumes a statewide tax. Regional options could be investigated.

TABLE VII-2

FUNDING SOURCES FOR TREATMENT PLANT UPGRADE PROGRAM

Revenue generated by a detergent tax, even with the lower estimates of $3 to $6 million, provides a substantial percentage of the funds needed to implement point source phosphorus controls at major sewage treatment plants located in the Chesapeake Bay tributaries.

Total Capital Cost to Upgrade Treatment Plants *	-	$200 million
Years to Complete Upgrade Program	-	10
Cost to State per Year	-	$15 million
State - 75 percent		
Local - 25 percent		
Source of Funds		
Detergent Tax	-	$3-6 million
Supplemental General Fund Appropriation	-	$9-12 million

* See note on Table VI-1.

CHAPTER II

INTRODUCTION

Senate Joint Resolution No. 54, passed during the 1984 session of the Virginia General Assembly, requested that a report be submitted to the Governor and General Assembly by December 1, 1984, on the costs and benefits of imposing a ban on phosphate detergents. The Resolution further requested that the report include an analysis of the usefulness of a phosphate detergent ban in conjunction with other means of achieving goals for the reduction in phosphorus discharges in various segments of the Chesapeake Bay and its tributaries. The complete text of the resolution is contained in Appendix A.

The Resolution requested the following agencies to prepare the report:

State Water Control Board
Chesapeake Bay Commission
Virginia Cooperative Extension Service

At the recommendation of the Secretary of Commerce and Resources a task force of the named agencies was created with the addition of the Soil and Water Conservation Commission. The State Water Control Board was designated the lead agency. Appendix B lists the individual members of the Task Force.

Task Force Activities

The task force held its initial meeting on July 20, 1984. Prior to and following that meeting the six states and three major municipalities that currently have a ban in effect were contacted for information. Board staff also visited state representatives in Maryland and North Carolina where detergent bans had been considered in the 1984 session of their legislatures. The task force agreed that a public fact-finding meeting would be useful to allow all interested parties to submit their comments and data relative to the costs and benefits of a phosphate detergent ban. The public meeting was held on August 21, 1984 in Richmond and Appendix C summarizes the information presented at the meeting and received in writing for the record.

The task force has reviewed and evaluated numerous reports and documents prepared by many public and private organizations, including:

Washington Council of Governments
Soap and Detergent Association (SDA)
Procter and Gamble (P & G)
EPA - Chesapeake Bay Program
EPA - Region V
Washington Suburban Sanitary Commission (WSSC)
Cornell University
VPI & SU
University of Virginia
Great Lakes Commission
FMC Corporation

Whirlpool Corporation
General Electric
Speed Queen
Purex Corporation
Lever Brothers
Wisconsin Center for Public Policy
Various State and Local Agencies in Michigan; Wisconsin; New York; Vermont; Indiana; Minnesota; Chicago, Illinois; Akron, Ohio; Dade County, Florida; Maryland; North Carolina.

The final report has been a collaborative effort of all task force members and is supported by the entire Task Force.

With the submission of this report, the Task Force believes it has satisfied the requirements of Senate Joint Resolution No. 54.

CHAPTER III

BACKGROUND

A. Water Quality

1. General

Those activities of man, which result in the introduction of excessive nutrients into lakes and streams, are responsible for a number of significant and largely undesirable changes. This nutrient enrichment manifests itself in excessive growth of algae and other aquatic weeds, leading to unsightly appearance in lakes and rivers, decline in particular species of fish life and a decline in recreational uses. As these algae die, they generate a noxious odor and unpleasant water taste and appearance. The dead algae also exert a demand on the dissolved oxygen in the water which, in turn, stresses the aquatic life and degrades the overall water quality.

There are many nutrients required for the growth of aquatic plants and algae. Although phosphorus and nitrogen are most often implicated as being of primary importance, there are others such as iron, magnesium, calcium, silica, sulphur, manganese, sodium, potassium and carbon, which are also involved in the metabolism of aquatic plants. They enter water continuously from rainfall, decomposition of aquatic weeds and animals and release from sediments. Human activities can substantially increase nutrient input by discharges of municipal sewage and industrial wastes and the surface runoff from agricultural land and urban areas.

Any one of these nutrients can become the limiting nutrient (that is, the nutrient in shortest supply) under conditions where the other major elements are present in over abundance. For example, mixed algal populations contain carbon (C), nitrogen (N), and phosphorus (P) in a weight ratio of approximately 41C, 7.2N and 1P. This means that if an environment offers 82 weight units of carbon, 14.4 of nitrogen, and only 1 unit of phosphorus, growth will be limited by a deficiency of phosphorus because there is only one-half as much as needed to permit the full growth potential of the other nutrients. (90)

In freshwaters, phosphorus is most often the limiting nutrient so management strategies can conveniently focus on phosphorus control. In the oceans, nitrogen is usually considered the most limiting nutrient, but there is little concern over managing nutrient inputs to the ocean. In between, such as with the Chesapeake Bay estuary, we might expect to see characteristics of both the freshwater and saltwater environments. Indeed, it appears that when and where riverine influences dominate, the Bay tends to be phosphorus-limited. When and where the oceanic influences dominate, the Bay is nitrogen limited. (7)

Past concerns over nutrient enrichment of Virginia's waters have focused primarily in several specific areas, such as: the Occoquan Reservoir in Fairfax and Prince William Counties; Smith Mountain Lake in Franklin, Bedford, and Pittsylvania Counties; and the Virginia embayments to the Potomac River below Washington, D.C. down to the Route 301 bridge. With the publication of EPA's Chesapeake Bay Program findings, the concern over nutrient enrichment has broadened to cover the entire Bay and its tributaries (Potomac, Rappahannock, York, and James) especially east of the fall line.

The remainder of this section will describe these and other Virginia waters with respect to the nutrient enrichment problem.

2. Chesapeake Bay Program: Findings and Plan of Action

The Chesapeake Bay Program has examined thirty years of nutrient data (1950-80) in an effort to characterize trends and present conditions within the Chesapeake Bay and its drainage area (see Figure III-1). Nutrients (nitrogen and phosphorus) enter the system from a variety of point and nonpoint sources, i.e., sewage treatment and industrial plants, atmospheric inputs, and runoff from agricultural, forest, and urban areas. The combination of these sources, natural background levels, and the fact that very little of the nutrients entering the Bay escape the system has led to a serious problem of excessive nutrients. Elevated levels have resulted in an increasing number of algal blooms, algal biomass, occurrences of low dissolved oxygen, and a reduction in water clarity. Simultaneously, there has been a decreasing trend in living resources such as freshwater spawning fish, oysters, and submerged aquatic vegetation. These trends indicate that reductions in the nutrient loads to the system would result in long term improvements.

In order to develop and evaluate nutrient control strategies, the Chesapeake Bay Program determined the contribution from both point and nonpoint sources in the Bay and in the river basins. Using a computer model, relative nutrient contributions were determined for wet, dry and average years of rainfall. For the purposes of this report, only phosphorus loading figures will be presented based on an average year of rainfall.

In Virginia, there are four major river basins - the Potomac, the Rappahannock, the York, and the James - which contribute varying loads of phosphorus from both point and nonpoint sources. Essentially, in all four river systems, phosphorus is the limiting factor in the fresh water portion and nitrogen is the limiting factor in the saline waters. Information concerning these systems is summarized below (7) (Figure III-2 shows the outline of each entire river basin):

- o The Virginia portion of the Potomac River basin drains approximately 5,747 square miles from its headwater in Augusta and Highland Counties to its mouth at the end of the Northern Neck. The basin is dominated by forested land (56 percent) with 7 percent urban land use. The Potomac contributes 1,157,000 pounds of phosphorus annually based on 1980 loadings. Of this amount 61 percent of the loadings are from point sources and 29 percent from nonpoint sources.

- o The Rappahannock River basin draings approximately 2,631 square

Figure III-1

Chesapeake Bay Drainage Area

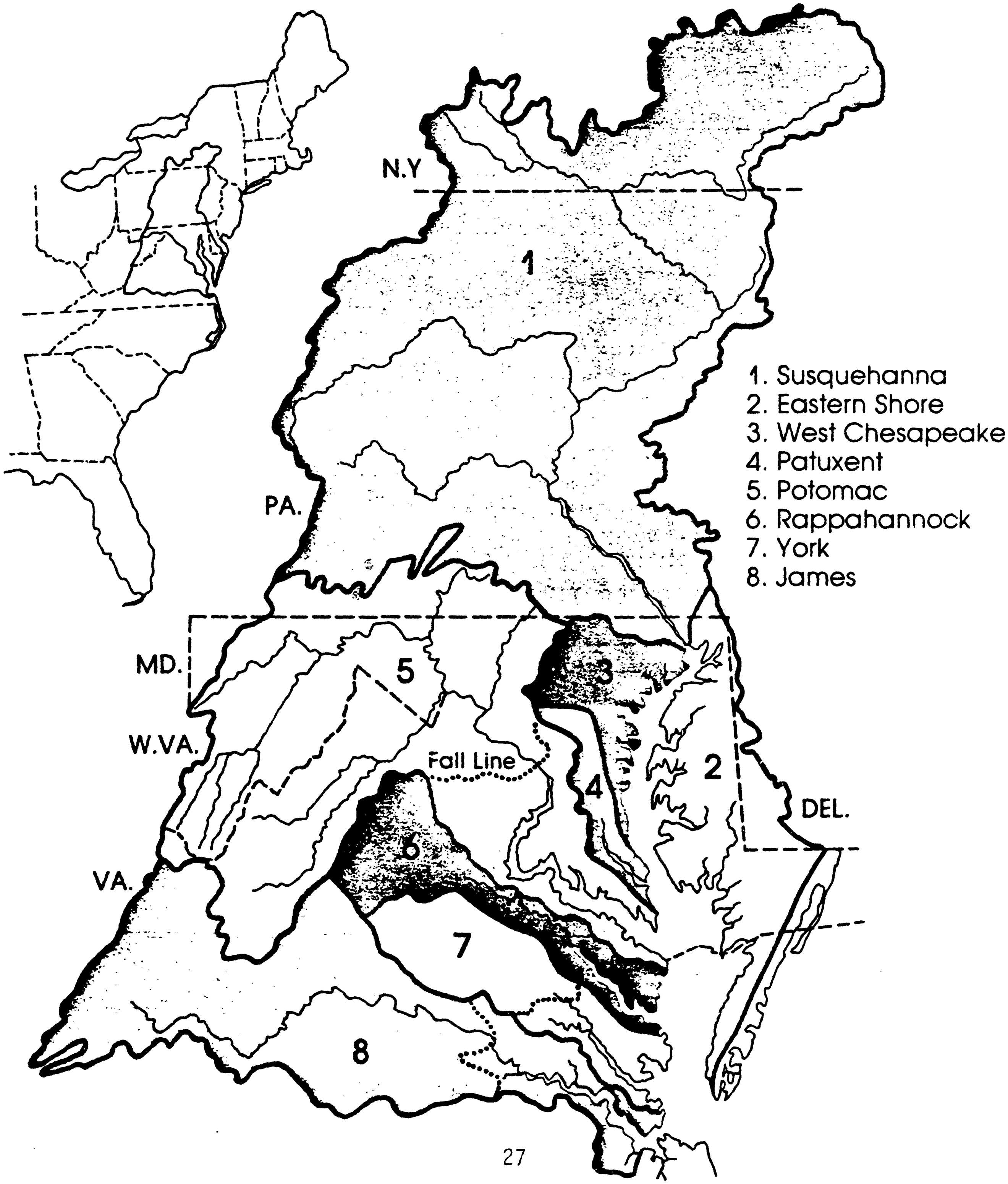
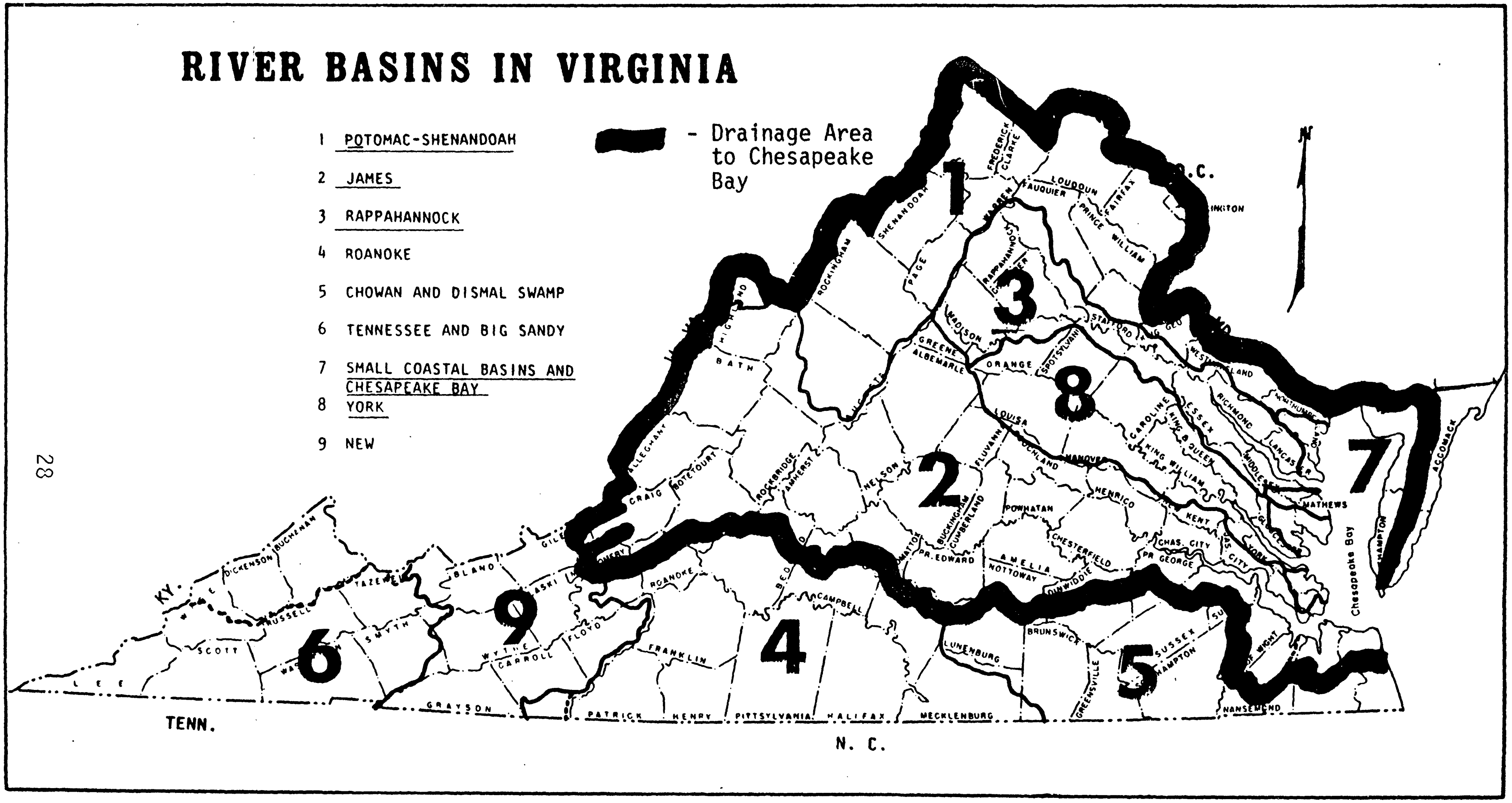


FIGURE III -2


RIVER BASINS IN VIRGINIA
1 POTOMAC-SHENANDOAH
2 JAMES
3 RAPPAHANNOCK
4 ROANOKE
5 CHOWAN AND DISMAL SWAMP
6 TENNESSEE AND BIG SANDY
7 SMALL COASTAL BASINS AND CHESAPEAKE BAY
8 YORK
9 NEW
- Drainage Area to Chesapeake Bay
N
D.C.
MD.
KY.
TENN.
N. C.
Chesapeake Bay
FREDERICK
CLARKE
LOUDOUN
FAUQUIER
PRINCE WILLIAM
SHENANDOAH
ROCKINGHAM
PAGE
MADISON
GREENE
ALBEMARLE
ORANGE
SPOTSYLVANIA
STAFFORD
LOUISA
CAROLINE
ESSEX
RICHMOND
LANCASTER
MIDDLESEX
MATHEWS
ACCOMACK
NORTHAMPTON
BATH
ALLEGHANY
BOTETOURT
CRAIG
ROCKBRIDGE
AMHERST
NELSON
FLUVANNA
BUCKINGHAM
CUMBERLAND
POWHATAN
HANOVER
HENRICO
KING WILLIAM
KING & QUEEN
KENT
CHAS. CITY
YORK
CHESTERFIELD
AMELIA
NOTTOWAY
DINWIDDIE
PR. GEORGE
PR. EDWARD
CAMPBELL
ROANOKE
FRANKLIN
FLOYD
CARROLL
WYTHE
BLAND
SMYTH
TAZEWELL
RUSSELL
DICKENSON
BUCHANAN
SCOTT
LEE
GRAYSON
PATRICK
HENRY
PITTSYLVANIA
HALIFAX
MECKLENBURG
LUNENBURG
BRUNSWICK
GREENSVILLE
SUSSEX
SOUTHAMPTON
NANSEMOND

miles from its headwaters in the Piedmont Province to its mouth near Deltaville. It is dominated by forested land (64.3 percent) with only 0.6 percent urban land use. It is one of the least impacted areas, but has revealed losses in beds of submerged aquatic vegetation and significant declines in the landings of freshwater finfish. The river contributes 278,000 pounds of phosphorus annually to the Bay. Point sources provide 39 percent of the load while nonpoint sources contribute 61 percent.

- The York River basin drains approximately 2,986 square miles from the upper reaches of the Pamunkey and Mattaponi Rivers to its mouth a Gloucester. Although it is a relatively unimpacted area, there were drastic declines of shad and herring during the 1970's and current conditions reveal that the declines in the landings of freshwater-spawning finfish continue. The basin is dominated by forested land (70.6 percent) with urban areas representing only about 0.2 percent of the land use. It contributes 221,000 pounds of phosphorus annually to the Chesapeake Bay System. Point sources account for 35 percent of the load while 65 percent is from nonpoint sources.

- The James River drains approximately 10,195 square miles from the Virginia-West Virginia state lines to its mouth at Hampton Roads. It is dominated by forested land (72.6 percent) with 3.2 percent urban land use. The James contributes approximately 3,791,000 pounds of phosphorus of the total 13,758,000 pounds annually entering the entire Bay system. Of this amount, 81 percent of the loads are point sources and 19 percent is nonpoint sources. Below the fall line the dominance of point source loading is even higher with a 93 percent share of the loading.

Figure III-3 shows the level of nutrient enrichment in each of these basins below the fall line. The upper tidal fresh portions of the Rappahannock and James rivers show high enrichment levels.

As a result of the EPA/Chesapeake Bay Program findings, a working goal has been established of a 20 percent reduction in phosphorus loads (based on 1980 loading figures) while holding the 1980 nitrogen loads from Virginia's tributaries to the Chesapeake Bay. Virginia's approach to these criteria will involve a combination of strategies on a basin by basin approach. It is recognized that each of the river basins is unique and requires the selection of strategies which will provide the most benefit. The strategies listed below are some examples of options being considered in each of the river basins:

- Phosphate Detergent Ban
- Phosphorus and nitrogen limitations at wastewater treatment plants
- Improved administration of current control programs
- Chesapeake Bay Initiatives
- More thorough effluent monitoring
- Upgrading of all primary treatment plants to secondary treatment levels
- Implementation of Best Management Practices (BMP's)

Figure III-3

Nutrient Enrichment Levels

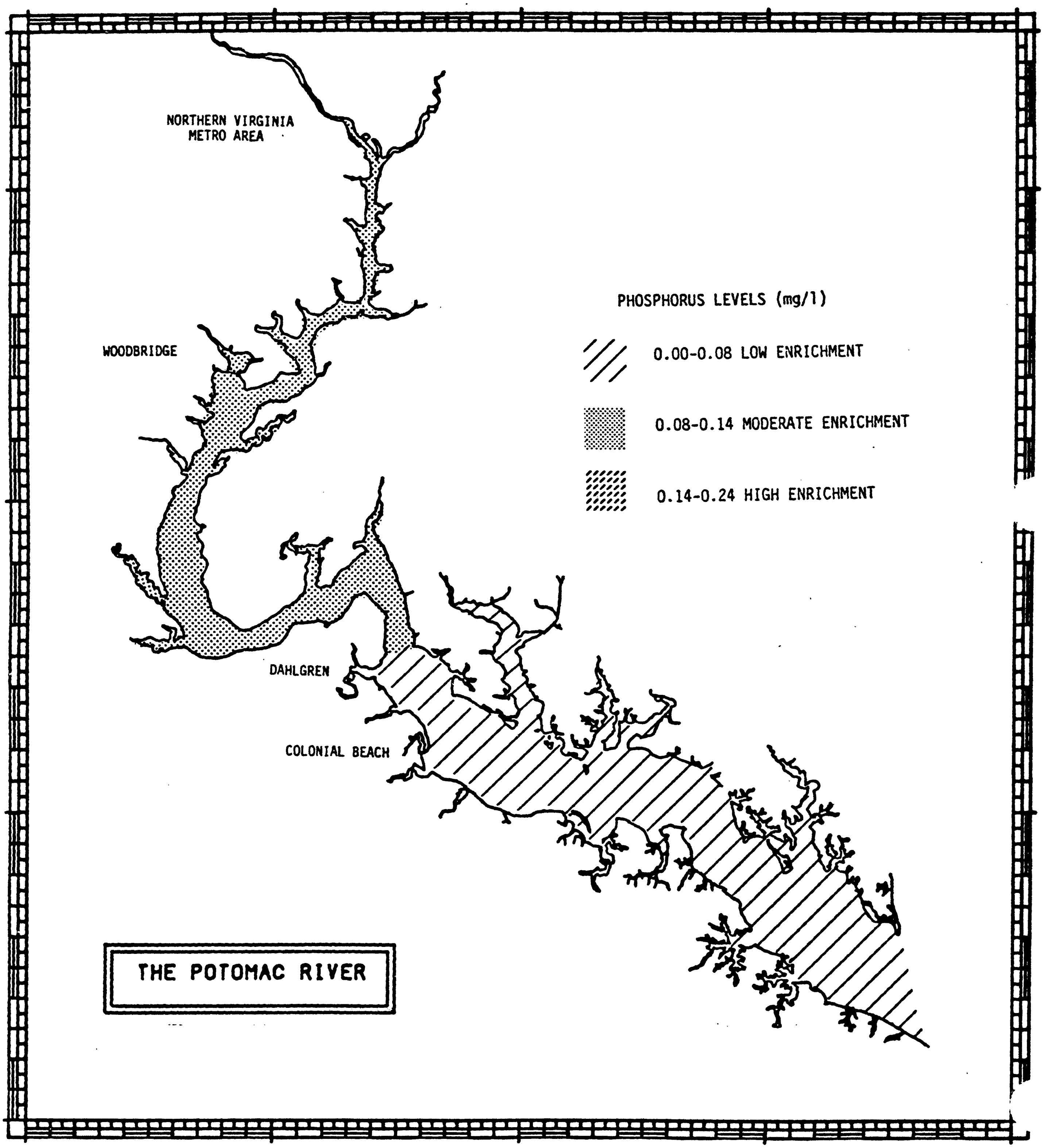


Figure III-3 (continued)

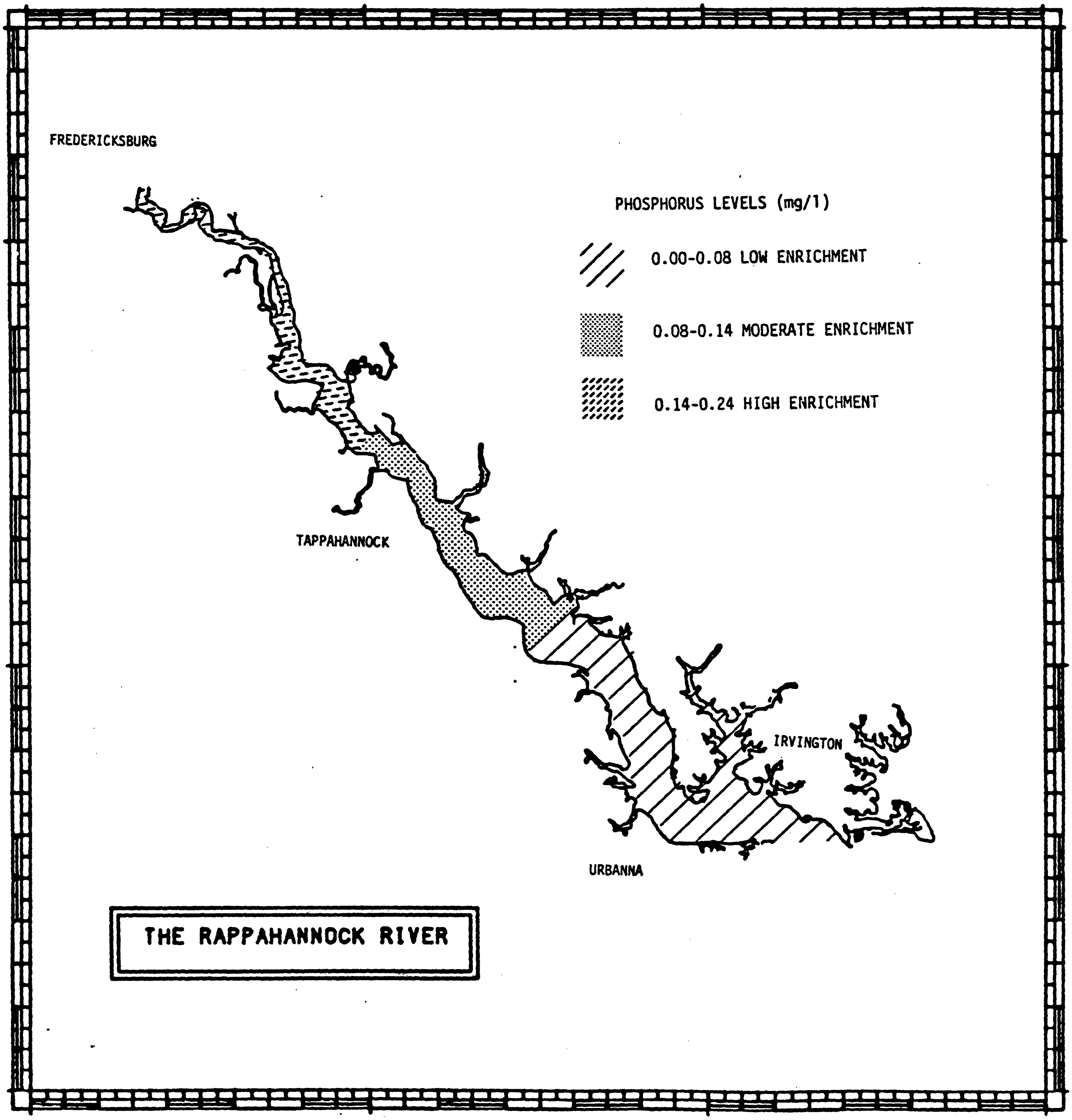


Figure III-3 (continued)

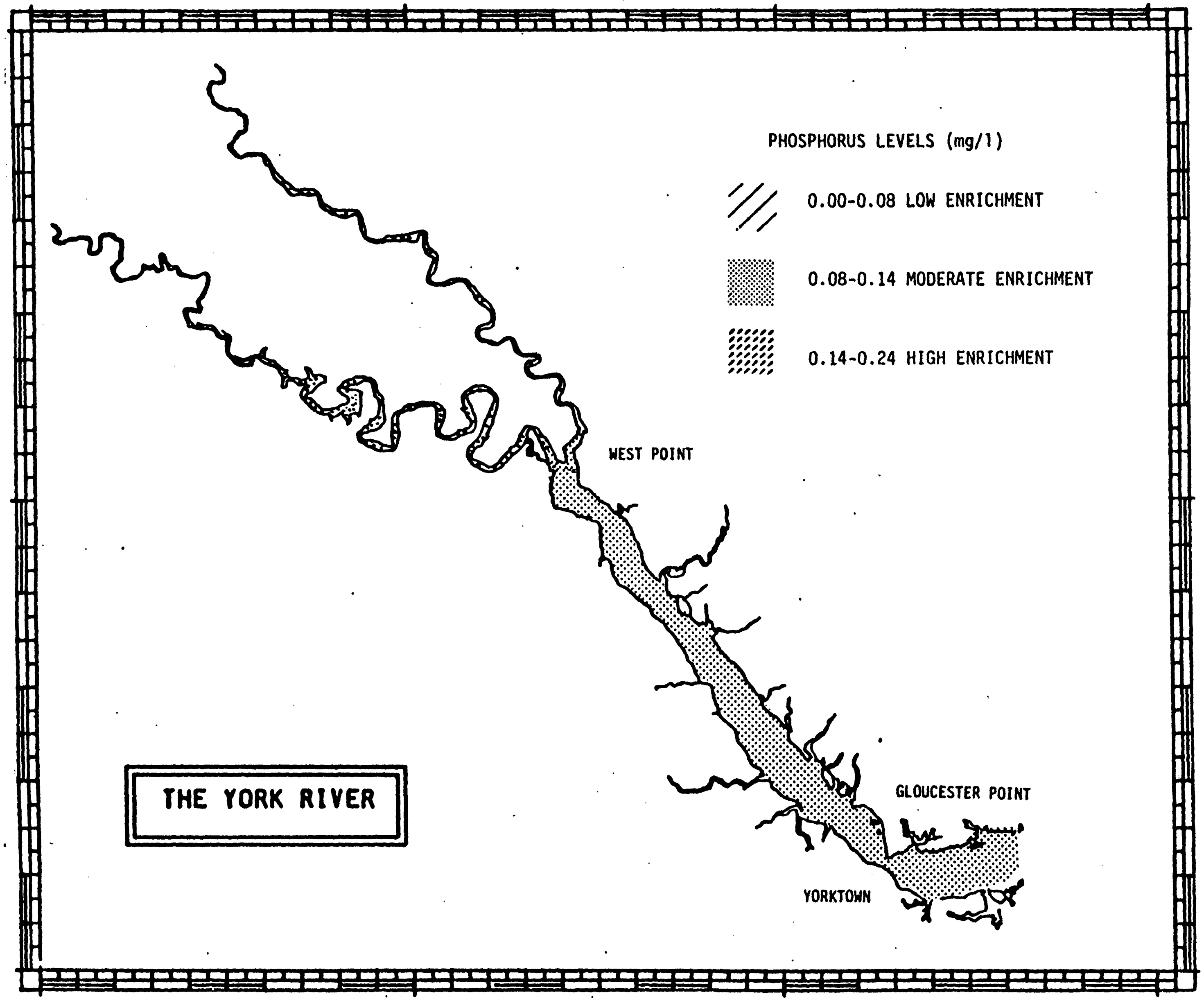
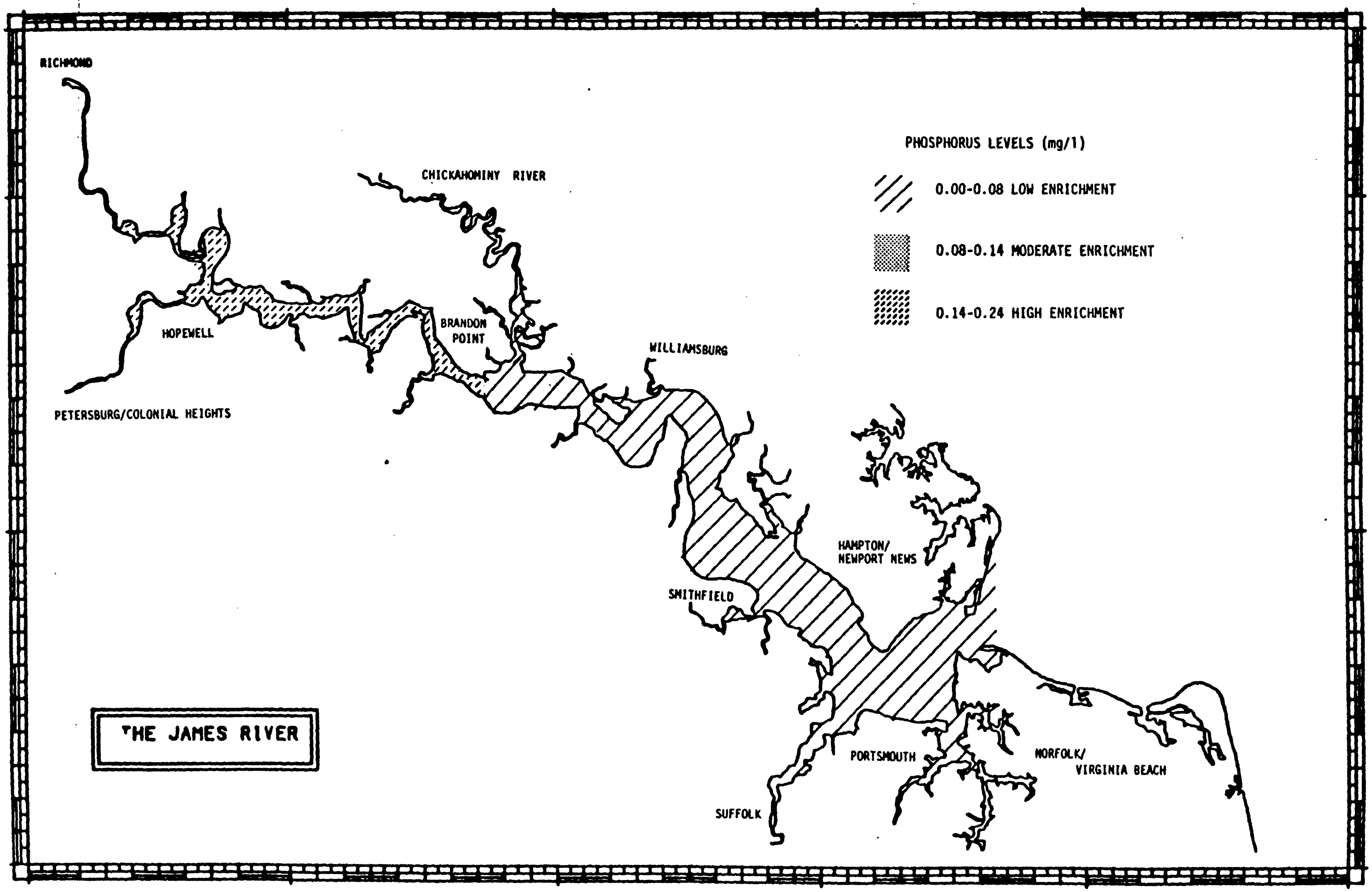


Figure III-3 (continued)



- o Orientation of BMP's toward nutrient removal
- o Education Programs

The overall strategy is to reduce nutrient loads and concentrations to levels which will reverse the current water quality trends. Although there is still scientific uncertainty about what course of action should be taken to correct these problems, there is a sufficient amount of evidence currently available that justifies actions to limit nutrient loads.

The Chesapeake Bay Initiatives which were funded by the 1984 Virginia General Assembly address certain nutrient enrichment problems. Out of the $10,440,000 appropriated for the FY 84-86 biennium for all of the Initiatives, about 74 percent goes to programs which relate wholly or partially to the nutrient enrichment problem. Initial projections for future years show a dramatic increase in necessary funds, especially in the area of nutrient control at sewage treatments plant. Table III-1 lists the specific programs relating to the nutrient enrichment problems.

The Virginia Initiatives are designed to address three general goals for the Bay:

(i) To improve and protect water quality and resources in the Chesapeake Bay.

(ii) Accommodate growth in an environmentally sound matter.

(iii) Cooperate with other governmental entities having a stake in the health of the Bay.

Maryland has developed a package of sixteen programs which address many of the same areas that have been developed for the Virginia Initiatives. Essentially, their program for the Chesapeake Bay has earmarked $13.8 million for operating cost and $22 million in new construction for point source and nonpoint source programs. Pennsylvania's program has allocated its monies for nonpoint source controls in the lower Susquehanna River basin. This is due to the fact that the majority of land use in the lower basin is agricultural and forest. Their program amounts to two million dollars for FY 85. Pennsylvania has previously agreed to remove phosphorus from sewage treatment plants in the lower Susquehanna as part of the "Upper Bay Phosphorus Policy."

3. <u>Nutrient Loads To The Bay</u>

Figure III-4 shows the phosphorus loads for each river basin for the years 1950, 1980, 1983 and 2000 (104). The phosphorus loadings from nonpoint source and industrial point sources are assumed to be constant between 1980 and 2000. Therefore, any increases or decreases reflect changes in municipal point source loads only. NOTE: As in the EPA-Chesapeake Bay report, loadings expressed in pounds/year refer to the loading during the eight month period of March to October.

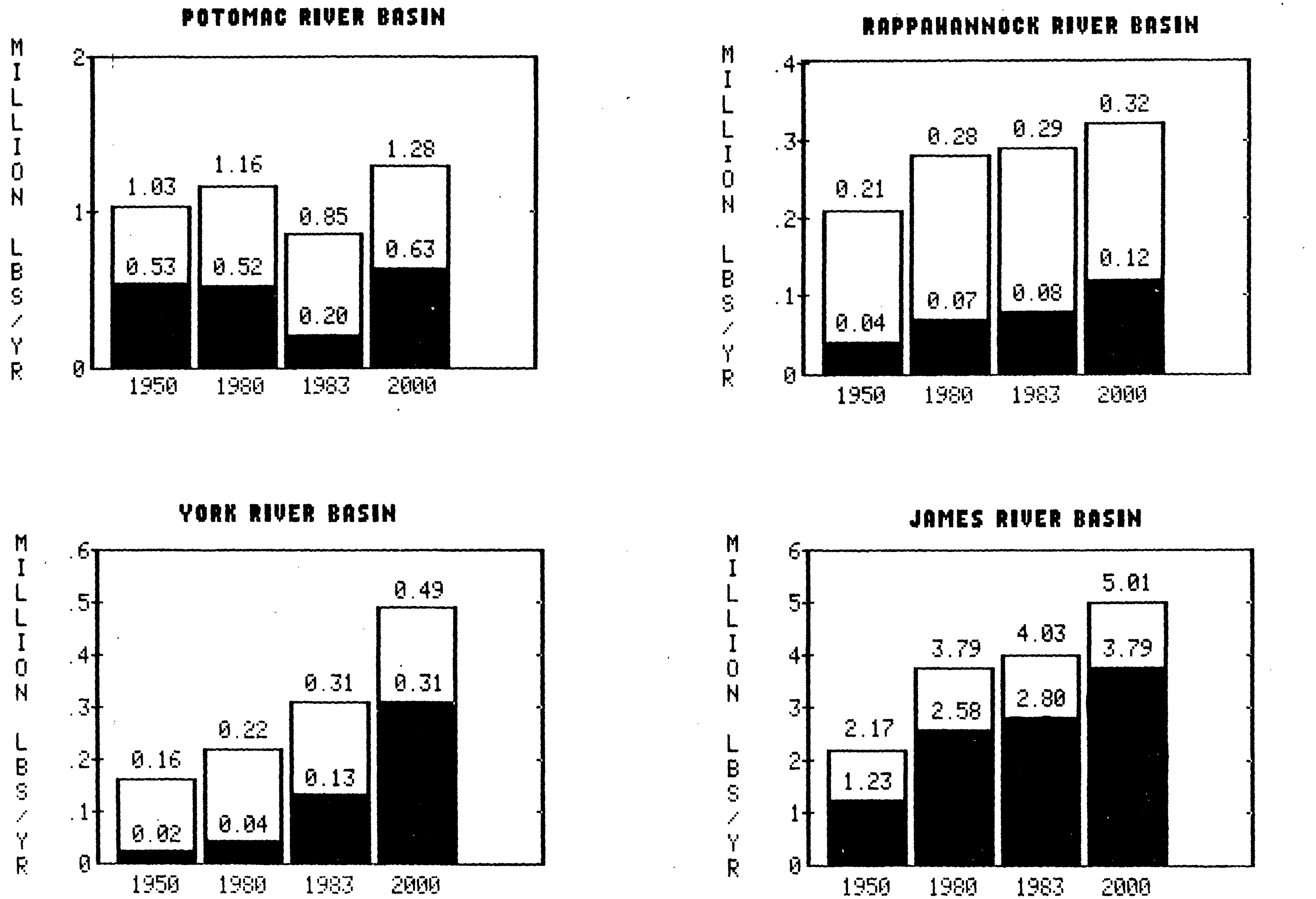
TABLE III-1

Chesapeake Bay Initiatives	Funds Allocated For 1984-86 Biennium ($-Millions)	Initial Projections For 1986-94 ($-Millions)
Agricultural BMP	2.5	7.0
Urban BMP	0.75	2.85
Sewer Line Infiltration and Inflow Renovation Program	0.45	20.0
Shoreline Residential Sanitation Load Grant Program	0.3	1.2
Water Quality and Habitat Resource Monitoring	0.3	3.2
Coordinated Data Base Management	0.3	0.8
Chesapeake Bay Education Program	0.25	0.25
Environmental Conditions - Management and Coordination of Bay Plan		0.075
Submerged Aquatic Vegetation Reestablishment Program	0.15	0.075
Research Grants for Marine Research	1.7	1.0
James River Water Quality Monitoring	0.4	-
Youth Conservation Corps - Bay Clean-up Projects	0.3	-
Virginia Water and Sewer Assistance Authority	0.225	-
Environmental Public Service Announcements	0.04	-
Sewage Treatment Improvement Program	-	107.5
TOTALS	7.74	143.875

FIGURE III-4
PHOSPHORUS LOADS TO CHESAPEAKE BAY FROM FOUR MAJOR RIVER BASINS

LOADS FROM ALL SOURCES (POINT AND NON-POINT)

LOADS FROM MUNICIPAL POINT SOURCES



In the Potomac basin, several major municipal plants have instituted or greatly improved the operation of phosphorus removal facilities since 1980. Therefore, a decrease in 1983 loading is expected.

In the Rappahannock Basin, a 15 percent increase in municipal loading between 1980 and 1983 is about 40 percent over the annual rate of increase predicted by EPA.

In the York, the extraordinary increase in municipal loads since 1980 is due to the new Hampton Roads Sanitation District (HRSD) York River plant which is now the largest major plant in the basin.

In the James basin, a 9 percent increase in municipal loading between 1980 and 1983 closely matches the predicted rate of increase. The loading increase would have been greater except for the fact that the new HRSD-Atlantic and York River plants exported approximately 1,200 pounds per day out of the basin.

4. Potomac River and Embayments

In the late 1950's and 1960's the upper Potomac River estuary and its embayments were degraded to a serious extent by pollutants originating primarily in the Metropolitan Washington area. The problems included:

(i) High levels of organic pollutants;

(ii) Low dissolved oxygen concentrations;

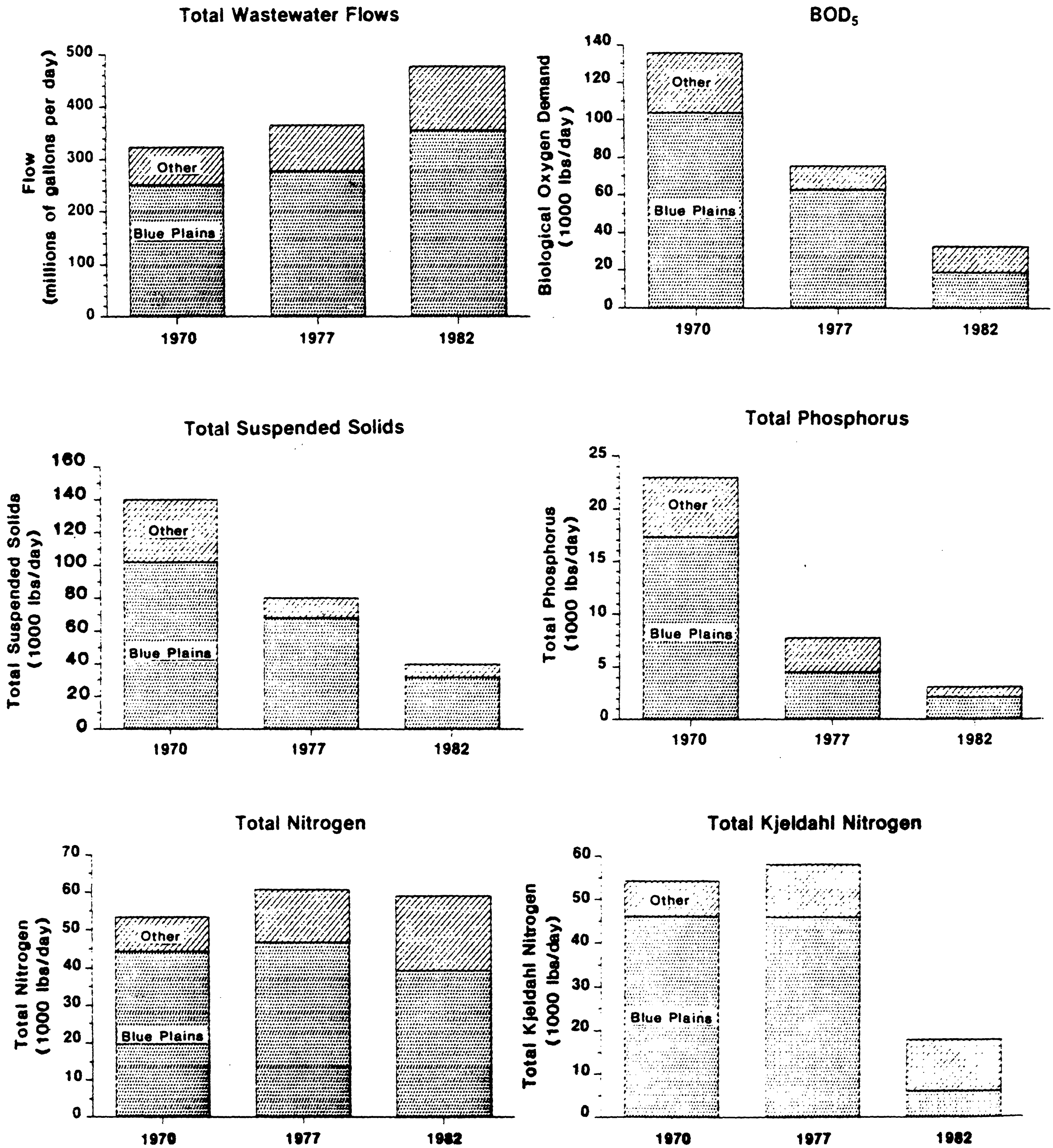
(iii) High concentrations of nitrogen and phosphorus compounds;

(iv) Extensive blooms of blue-green algae that formed mats of material on the water surface.

In response to these problems, the Federal Water Quality Administration (now EPA) prepared a study that recommended dramatic reductions of pollutants in the area. The States of Virginia and Maryland and the District of Columbia agreed and efforts were begun.

The expenditure of vast amounts of funds during the 1970's, about $1 billion in the Metropolitan Washington region for the construction of new and upgraded wastewater treatment facilities, has had a positive effect on the water quality in the Potomac. Figure III-5 shows the dramatic reduction in pollutant loadings, especially phosphorus, that occurred between 1970 and 1982. From the late 1960's the estuary has shown a demonstrable trend toward increasing water quality and by 1982 most of the waters met the applicable instream standards, the waters were aesthetically pleasing, recreational use increased; some species of game fish were returning, and the vast blooms of mat forming blue-green algae were gone.

Figure III-5
Wastewater Flow and Loadings to the Upper Potomac Estuary* (78)
(1970, 1977, 1982)



However, in July 1983, the Potomac River and several of its embayments experienced a bloom of blue-green algae. The bloom was sufficient to cause a scum of floating algae thus creating serious aesthetic problems.

Since this event was completely unexpected and contrary to a 10-year trend, the regulatory agencies having jurisdiction over Potomac waters were very concerned. Acting as a cooperating group, Virginia, Maryland, the District of Columbia, and EPA commissioned a study of the conditions during 1983 and selected a panel of nationally recognized experts to analyze the data in an effort to explain the causes of the anomalous conditions during 1983. Their work is scheduled to be complete by January, 1985. Hopefully, the algae bloom conditions during 1983 can be explained and a recurrence can be avoided.

5. James River Monitoring Program

A comprehensive monitoring program for the Upper James River Estuary was put into effect in July 1983 under the coordination of the Richmond Regional Planning District Commission (28). The system encompasses 25 monitoring points on the main stem of the James River (from just above Richmond to below the confluence with the Chickahominy River) and on the Appomattox River. In addition, 14 municipal and industrial discharges provide effluent analyses to aid in the assessment of water quality conditions and impacts in the rivers.

The major problem indicated is oxygen depletion in the James River, observed to be greatest at two points: below Richmond just above the Proctors Creek sewage treatment plant, and below Hopewell near Brandon Point. On three occasions dissolved oxygen concentrations were measured below the Virginia standard of 4.0 milligrams/liter (mg/l).

Algae populations, as indicated by chlorophyll a concentrations, were routinely found to peak below Hopewell. These concentrations were indicative of substantial algal activity, although not of a serious algal bloom. The algal population had a pronounced effect upon dissolved oxygen concentrations, and variations of up to ±6 mg/l were observed. The peak activity coincided with the availability of essential nutrients in the water column.

Based on the low flow, dry weather conditions of the survey (which corresponds to the period of most stress on the aquatic environment), approximately 1600 pounds of total phosphorus per day come across the Fall Line at Richmond. The discharges in the Richmond/Tri Cities area contribute an additional 5,200 pounds of total phosphorus per day which represents about 1/3 of the phosphorus load estimated by EPA coming from the entire James River basin from all sources.

It has been suggested by some that light rather than nutrients might be limiting algal activity in portions of the river. However, this is not at all clear from the data at hand. From a nutrient standpoint, nitrogen is abundant, giving greater importance to phosphorus levels as a limiting factor to algal growth. Maximum turbidity levels in the James River occur near Jamestown Island and below. The data indicates algal activity just below Hopewell. Even if light was shown to be limiting at times, it would be less likely to be so under low flow conditions.

6. Other Waters Impacted by Nutrients

a. Chowan

The lower Chowan River in North Carolina has experienced periodic blooms of blue-green algae in nuisance proportions over the past decade (113). Although water quality studies to date have failed to establish clear cause and effect relationships for this problem, it is believed that overly abundant nutrients play a major role.

The many factors that are potentially associated with the algal blooms make for a complex situation. The Chowan system drains Piedmont and Coastal Plain areas and its land use is primarily forest and agricultural crops. About three-fourths of the drainage area is in Virginia and one-fourth is in North Carolina. The problems occur, however, primarily in the estuarine portion, all of which is located in North Carolina. Municipal and industrial point sources in both Virginia and North Carolina, as well as agricultural runoff, contribute to the total nutrient load of the river.

The Chowan River Basin 208 Project was completed for the State Water Control Board in September, 1983. The project involved a study and the development of data to define point and nonpoint sources of nutrients as well as an evaluation of several nonpoint source control strategies.

The State Water Control Board is currently in the process of completing and adopting the Chowan Nutrient Control Plan. The Plan outlines both point and nonpoint source measures to be taken now and in the future. Also included is a commitment to the necessary technical work to determine what water quality standard for phosphorus should be imposed for the river system.

b. Lakes/Reservoirs

The Commonwealth of Virginia has made water quality assessments of 161 publicly owned freshwater lakes, totaling some 68,000 acres. (This excludes federally owned impoundments which would have more than doubled the acreage.) Over one-third (56) of the lakes are considered eutrophic, that is, waters with a high rate of nutrient input and resulting high levels of organic production. This can be attributed to shallowness, the natural aging process and watershed nutrient contributions. The following list of nine lakes, classified as eutrophic, have point source discharges contributing to the problem:

Chickahominy Lake (Charles City/New Kent)
Falling Creek Reservoir (Chesterfield)
Crystal Lake (Nottoway)

Lake Fairfax (Fairfax)
Occoquan Reservoir (Fairfax/Prince William)
Claytor Lake (Pulaski)
Rivanna Reservoir (Albemarle)
Smithfield Water Works (Isle of Wight)
Lake Whitehurst (Norfolk)

B. Laundering and Detergents

1. General

Laundering is a complex household task. One way to view this task is by use of a systems approach. The interacting inputs to the system are the fabrics in the wash load, soil on these fabrics, water, detergent, and other laundry additives which are processed in a clothes washer. Detergent and other laundry additives provide chemical energy; heated water provides thermal energy; and the clothes washer contributes mechanical energy to the process. The outputs from the laundry system are clothes and other household articles that are restored to useable condition, and water and chemicals from laundry products that go down the drain. Effective laundering procedures help to extend the useful life of clothing and other household articles.

While all of the inputs are important in achieving success in laundering, selected aspects of three of the inputs--water, soils and detergents--will be discussed in this section.

2. Effects of Water and Soils on Laundering

a. Water Hardness

Hard water decreases the cleaning ability of anionic detergents. In addition, hard water makes some soils more difficult to remove. The degree of hardness can be expressed in milligrams per liter (mg/l) as calcium carbonate ($CaCO_3$). Water with a hardness level below 60 mg/l as $CaCO_3$ is generally considered soft water. Water with a hardness level above 121 mg/l as $CaCO_3$ is considered hard water.

Water can be softened by three means: 1) mechanical softeners, 2) packaged water softeners that form a precipitate with the water hardness ions, and 3) packaged water softeners that do not form a precipitate with the water hardness ions. Mechanical softeners are recommended in areas where water hardness exceeds 137 mg/l as $CaCo_3$. (72)

The majority of the total population of Virginia (71 percent) is served by surface water. Overall, about 64 Percent of the population of Virginia live in soft water areas. The remaining 36 percent of the population live in areas with water of varying degrees of hardness from medium hard to very hard (See Table III-2). This table does not reflect the persons who currently choose to soften their water supply by permanently installed mechanical softeners.

TABLE III-2

WATER HARDNESS IN VIRGINIA (63)

Hardness Ranges (mg/l as $CaCO_3$)	Population on Surface Water	Population on Groundwater	Total Population
0-60 Soft	3,092,146	394,808	3,486,954 (64.4%)
61-120 Medium Hard	762,307	480,649	1,242,956 (23.0%)
121-180 Hard	-	434,575	434,575 (8.0%)
Over 180 Very Hard	-	250,514	250,514 (4.6%)
TOTALS	3,854,453 (71.2%)	1,560,546 (28.8%)	5,414,999 (100%)

The hardness level in the groundwater is generally the lowest in the coastal plain area and increases progressively in the landward direction. In general, high hardness levels are found near the Blue Ridge mountains and Shenandoah Valley areas where limestone predominates from a geologic point of view. Water hardness level is also higher in the non-urban areas of the state served by ground water than in urban areas served by surface water. Figure III-6 shows the distribution of hardness levels in the ground water for the non-urban areas in Virginia on a county-by-county basis.

Note too that even when clothes are washed in soft water, some hardness minerals are introduced into the water by the soil on the clothes. Such soil may contribute hardness ions equivalent to 35-85 mg/l as $CaCO_3$. (84)

b. Iron Content in Water

Iron is a troublesome impurity in water. Even at low concentrations, 0.2 mg/l, it causes an orange stain on fabrics. Chlorine bleach makes dissolved iron insoluble and leaves particles of iron oxide suspended in the water. The suspended iron oxide particles then attach to fabrics and discolor them.

About 25% of the population in Virginia is served with water with an iron content of 0.2 mg/l or more. On the average, the ground water supply systems contain much higher iron concentrations than the surface water supply systems. Thus, the higher iron concentrations are found in the non-urban areas of the state not served by surface water supplies. Figure III-7 shows the

FIGURE III-6

Water Hardness In Virginia Groundwater

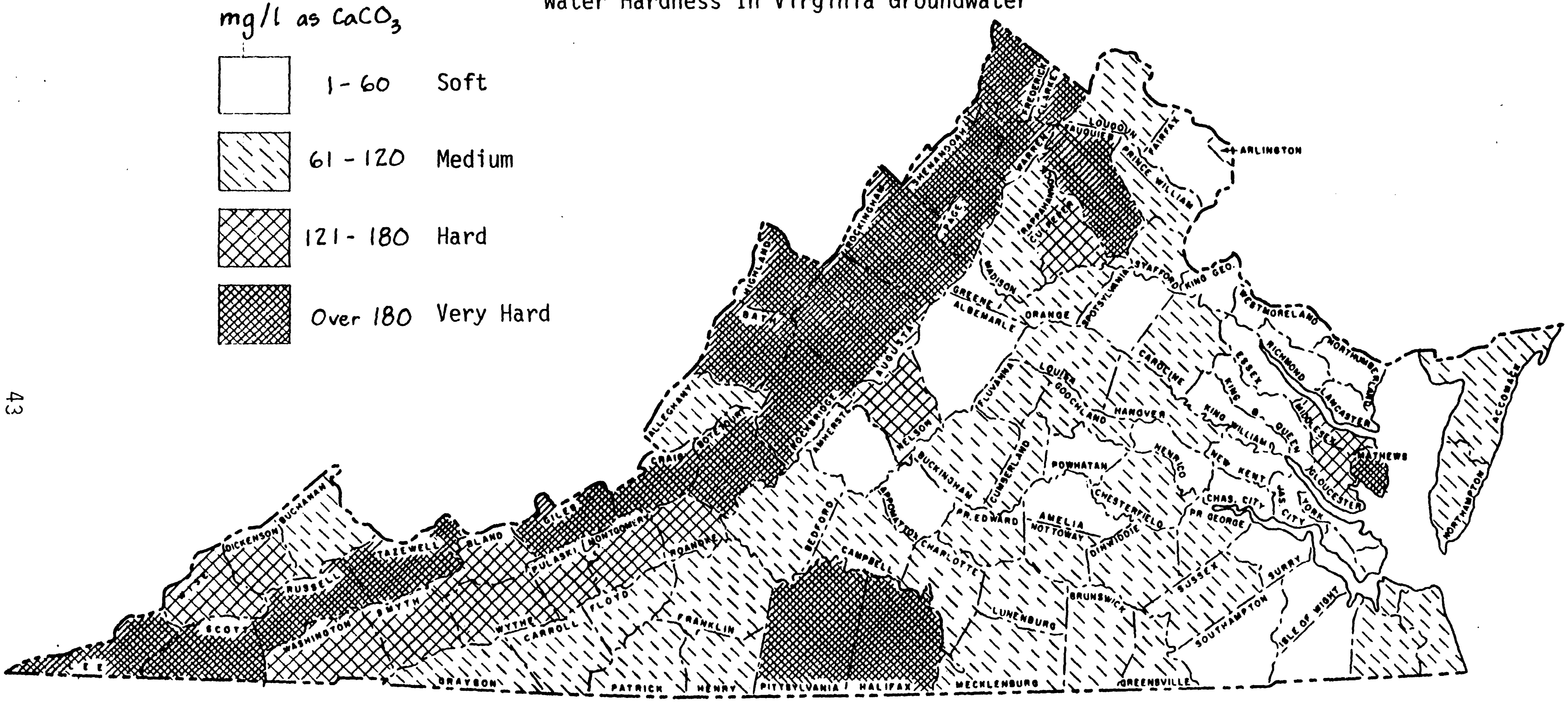
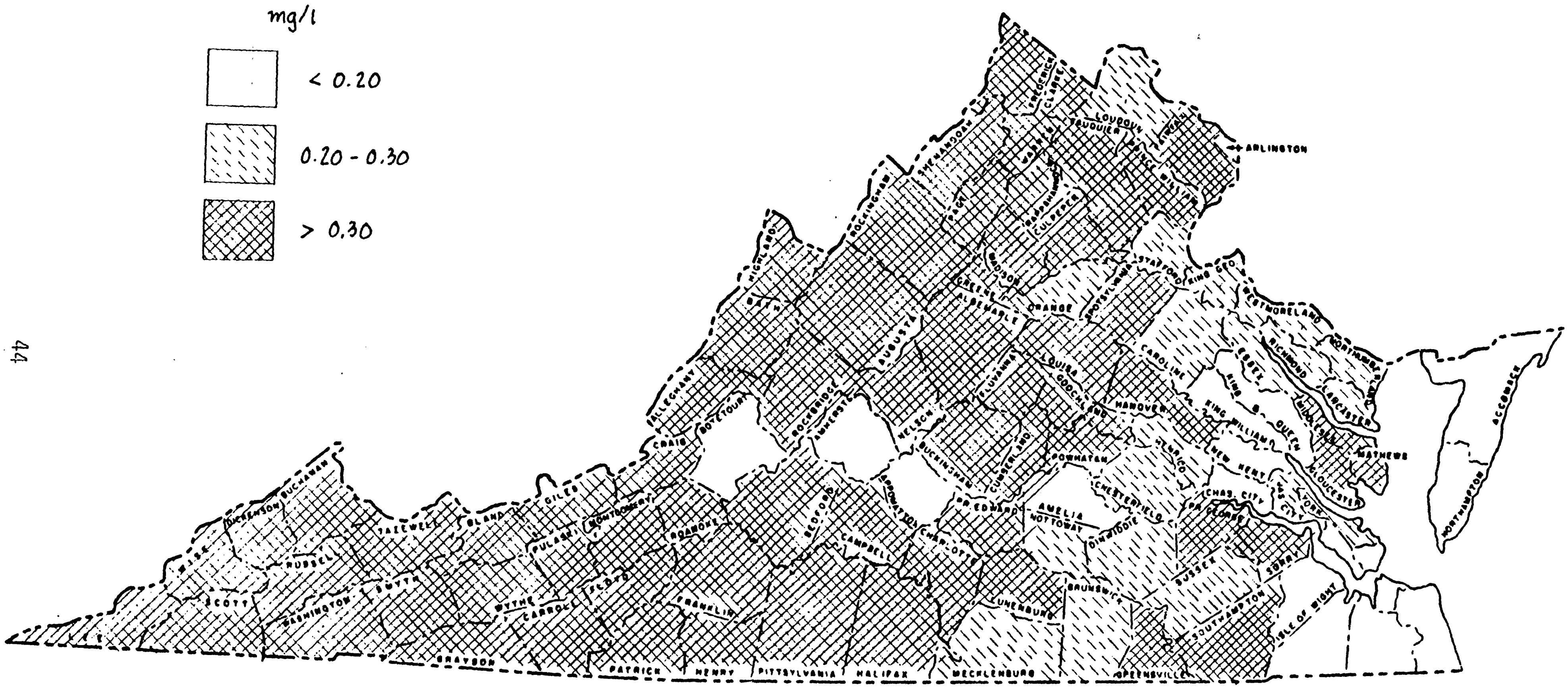


FIGURE III-7

Iron Levels In Virginia Groundwater



distribution of iron levels in the groundwater on a county-by-county basis.

c. Water Temperature

The water temperature used in laundering influences the amount of cleaning accomplished, the energy used, and in some cases, the extent of wrinkling and fading of colors. Higher temperatures generally remove more soil, require more energy to heat the water, may leave more wrinkles, and may remove more dye.

With the current need to reduce the cost of heating water, using warm water for washing and cold water for rinsing has been recommended for all but heavily soiled articles.

d. Soils

Soils involved in the laundry system are of four types: water soluble; insoluble, organic--soponifiable; insoluble, organic--not soponifiable and insoluble, inorganic. Table III-3 summarizes information on soils.

3. Components in Detergents and Their Function

The composition of laundry detergents varies with type of detergent and brand. In general, however, all laundry detergents contain surface-active agents and other ingredients to improve cleaning. Table III-4 lists the major components of laundry detergents.

Laundry detergents can be categorized as to the presence of builder(s) in the product. At the present time, all unbuilt laundry detergents, those containing no builder, are sold as liquids. The formulation of unbuilt laundry detergents differs from that of built laundry detergents. Table III-5 is a comparison of built and unbuilt laundry detergents.

4. Detergent Builders

The builder is the second most important ingredient in a detergent formula because it enhances or "builds" the cleaning efficiency of the surfactant by deactivating water hardness minerals. Builders soften water by sequestration, precipitation or ion exchange.

Phosphates, usually sodium tripolyphosphate, is the most frequently used builder. Phosphates soften water by sequestration --inactivating water hardness mineral ions and holding them tightly in solution. Phosphates also hold dissolved iron in the water in suspension which helps to prevent discoloration of fabrics.

The level of phosphate in detergents has been reduced by the industry since 1970. As reported by Procter and Gamble the level

TABLE III-3

Common Laundry Soils (53)

Soil groups	*Examples*	*Suggestions for removal*
Water-soluble soils	Salt, sugar, fresh tea and coffee, some components of perspiration, some proteins	Easily removed by water alone; hot water aids in dissolving soils.
Insoluble, organic soils—saponifiable	Oils; fats; fatty acids from food, the skin, hair dressings, and cosmetics	Removal more difficult as soil ages. Soap or detergent required for removal; heavy-duty laundry detergents more effective than mild detergents. Builders in detergents react with this soil; abundant detergent required to react with, solubilize, and emulsify this soil. Hot water speeds soil removal and results in more complete soil removal.
Insoluble, organic soils—not saponifiable	Mineral oil, car grease, some body oil, lint, skin particles, tar, wax, protein, dyes	Removal more difficult as soil ages. Soap or detergent required for removal; abundant detergent required to solubilize and emulsify this soil. Hot water speeds removal and results in more complete removal.
Insoluble, inorganic soils	Dust, mud, clay, smoke, soot, mineral ash, metals, metal oxides	These soils are often held on fabric by oily soils; need detergent to remove oil and release this soil. Soil not soluble in wash water; requires much agitation by washer for removal and adequate suspending agent in detergent to prevent redeposition.

TABLE III-4

Components Of Laundry Detergents (53)

Component	*Function*	*Comments*
Surfactants (surface-active agents)	Allow water to wet both the fabric and the soil quickly and thoroughly. Remove oily soil and emulsify or solubilize it. Remove particulate soil and help suspend it.	Both anionic and nonionic surfactants are used. Hard water diminishes cleaning ability of anionic surfactants. When the concentration is sufficiently high, surfactants form groups, called micelles, that solubilize oily soil.
Builders	Control water hardness. Increase and maintain alkalinity of wash water. React with (saponify) some oily soils. Suspend particulate soil.	Builders are commonly found in powdered detergents. Polyphosphates are the preferred builder because they serve all functions well and control hardness without forming a precipitate. Where use of phosphates in detergents is prohibited, as in New York State, sodium carbonate, sodium aluminosilicate, and sodium nitrilotriacetate (NTA) may be used as builders. In hard water carbonates form a crystalline precipitate, which adheres to fabrics, makes fabrics feel stiff and harsh, and changes the appearance of colored fabrics.
Suspending agents	Prevent redeposition of particulate soil.	Polyphosphates, NTA, and a special component called CMC help to suspend soil. The carbonates are not effective in preventing redeposition of soil.
Corrosion inhibitor	Protects metal parts of washer.	Without a corrosion inhibitor the detergent solution would attack or corrode some metal parts in washing machines.
Fluorescent whitening agents	Make white fabrics look whiter and colored fabrics brighter. Cover up yellowing of white fabrics.	Fluorescent whitening agents (FWA) "work" in the presence of ultraviolet light, such as is present in sunlight and light from fluorescent lamps. Invisible ultraviolet light is converted by FWAs to blue light, which improves the appearance of fabrics.
Coloring matter and fragrance	Provide a distinctive color and fragrance for a detergent product.	These are added for aesthetic purposes only.

TABLE III-5

COMPARISON OF BUILT AND UNBUILT LAUNDRY DETERGENTS (53)

Component	Built detergent	Unbuilt detergent
Surfactants	Lower concentration. Perhaps half as much as in unbuilt detergents. Anionic surfactants likely to predominate.	Higher concentration, perhaps twice as much as in built detergents. Nonionic surfactants likely to predominate.
Builders	High concentration of builders, usually alkaline.	No builders present.
Soil-suspending	Carboxylmethyl-cellulose (CMC), polyphosphates, NTA.	No phosphates or NTA; higher concentrations of CMC likely than in built detergents.
Fluorescent whitening agents	Built and unbuilt detergents similar.	
Coloring matter and fragrance	Built and unbuilt detergents similar.	

of phosphorus in all laundry detergents in 1970 was an average of about 11 percent; in 1984 it is about 5 percent (82). The levels of phosphorus in several granular detergents currently marketed in the Richmond area stores are:

Ajax	- 3.8 percent	Fab	- 6.0 percent
All	- 0 percent	Gain	- 6.1 percent
Arm & Hammer	- 0 percent	Ivory Snow	- 0 percent
Bold	- 5.9 percent	Oxydol	- 7.4 percent
Cheer	- 8.2 percent	Tide	- 8.4 percent
Cold Power	- 2.5 percent	Trend	- 0 percent

Liquid detergents, which do not contain any phosphorus, would also be included in calculating the overall average of five percent.

Sodium carbonate is a precipitating builder, removing water hardness ions by a nonreversible reaction forming an insoluble residue, calcium carbonate, which can adhere to fabrics and washer parts. Sodium carbonate does not hold iron in solution and is ineffective in preventing discoloration of fabrics caused by iron in the water(37).

Research done when flame resistant fabrics were introduced indicates that deposits from calcium carbonate can decrease the effectiveness of flame resistant fabric finishes. Fabrics with flame resistant finishes which are adversely affected by carbonate--built detergents may be labeled, "Use only phosphate detergents," or where they are not available consumers are advised to use unbuilt heavy duty liquid detergents, which do not contain carbonates (9,14,21,49).

Currently the approximate range of sodium carbonate in detergents in 20 to 70 percent, about the same level as in the 1970's. Efforts are being made by manufacturers to minimize residue formation with this builder by means other than just reducing the quantity of the sodium carbonate. For example, a representative of one manufacturer has said that his company's product contains "several different additives that prevent the precipitation of calcium carbonate in hard water." The company uses a "very sophisticated proprietary formula so that no carbonate buildup occurs with the use of their product" (73).

NTA (sodium nitrilotriacetate)is a sequestering builder. It is in limited use in the United States due to concerns about the possibilities of it being a carcinogen.

Citrate is another sequestering builder. It is not as strong a sequestrant as phosphate and NTA. It is used in some heavy duty liquid detergents.

Sodium silicate is a precipitating builder. Like sodium carbonate it removes water hardness ions by a nonreversible reaction and forms an insoluble residue.

Zeolite (sodium aluminosilicate) is an ion exchange builder. It ties up calcium hardness minerals, but needs an additional builder to control magnesium ions.

Consumers can determine which builder(s) and how much of them are in a detergent. Detergents are labeled as to the ingredients. Those containing phosphate provide specific information as to the amount contained. Those containing another builder usually identify it. Due to the distribution systems of some large supermarket chains, it is possible for non-phosphate formulations of detergents to be distributed in areas which do not have a ban. Since packaging is identical (i.e., national brands come in both phosphate and non-phosphate forms), it is important to check the label for phosphate content.

5. Use of Phosphate Vs Non-phosphate Detergents

In states where all types of detergents are sold, such as Virginia, 64 percent of the detergents used are the phosphate detergent type (80). Nationwide about 50 percent of the population are using phosphate detergents.

6. General Performance of Detergents

The performance of detergents varies due to a number of factors including the nature, proportion, and interaction of ingredients in the products, especially surfactants and builders. In 1978, Consumer's Research Magazine (CRM) studied the performance of 46 different detergents, both powdered and liquid and both phosphate and non-phosphate. The detergents were studied with three different water temperatures and with hard and soft water. The detergents were given an A rating for above average cleaning performance, B for average cleaning performance, and C for below average soil removal. Overall, the group of phosphate detergents performed better than the nonphosphate detergents, especially in hard water. On an individual basis there were phosphate and non-phosphate detergents that received C ratings. On the other hand, A ratings were given to both phosphate and non-phosphate detergents (51).

The study has several limitations:

1) Formulation of the detergents studied by CRM have changed since 1978 (although this is the most recently published study of a large number of detergents).

2) CRM's study used a single artificial soil which may react differently than the variety of natural soils found in a home laundry.

3) CRM's study used only one measure of soil removal--light reflectance; there are other aspects of laundering that must be considered.

4) CRM's study measured the detergents' performance after only one washing. Repeated washings are needed to demonstrate products' effectiveness in retaining the whiteness/brightness of fabrics; and preventing calcium carbonate deposition.

The Task Force has received varying positions from detergent manufacturers regarding the performance and cost of detergents. According to Procter and Gamble extensive efforts by the detergent industry have failed to find a satisfactory substitute for phosphate and research has shown that among those builders which are sanctioned for use in the U.S., phosphate remains the most effective choice in terms of performance and cost. Conversely, Lever Brothers and Purex Industries contend that their non-phosphate detergents provide comparable performance at a comparable price (11).

7. Trends in the Detergent Industry

Concern over the impact of phosphates in detergents on water quality has been considered as the fourth major shift within the detergent industry (54). The other three major shifts which have occurred within the industry are: (1) from soap to synthetic detergents, (2) from branched-chain to linear surfactants to solve the problem of biodegradability of detergents, and (3) from anionic surfactants to greater use of nonionic surfactants. Other trends which impact on the formulation of detergents are: (1) increased use of lower wash water temperatures as an energy-conserving measure and (2) inclusion of enzymes in laundry products.

CHAPTER IV

PHOSPHATE DETERGENT BANS

A. History

During the late 1960's and early 1970's both scientists and the general public became increasingly concerned about eutrophication in many of the nation's waterways, especially lakes. The evidence of eutrophication was the heavy growths of algae that made water murky and smelly, piled slimy masses of decaying vegetation on beaches, and even caused massive fish kills due to oxygen depletion as the water plants decomposed. Virginia's most notable algae "bloom" problem areas were the Occoquan Reservoir, Smith Mountain Reservoir, and the Potomac River and its embayments. Nationally, the Great Lakes received much attention due to their nutrient enrichment problems.

These problems were addressed with a combination of approaches. Millions of dollars were spent to provide phosphorus removal at sewage treatment plants. Nonpoint source control programs were initiated in many localities. Virginia was one of the first states to aggressively pursue these options in order to clean-up our enriched lakes and rivers.

In addition to these strategies, several states and municipalities also included a phosphate detergent ban as a means of reducing phosphorus loadings to their streams and lakes. Figure IV-1 shows the six states and the three major municipalities where phosphate detergent bans were adopted. Table IV-1 includes specific information on the bans such as effective date, products covered by the ban, exemptions and enforcement responsibility. A ban has generally meant that phosphate levels in laundry detergents are limited to trace levels or under 0.5 percent phosphorus.

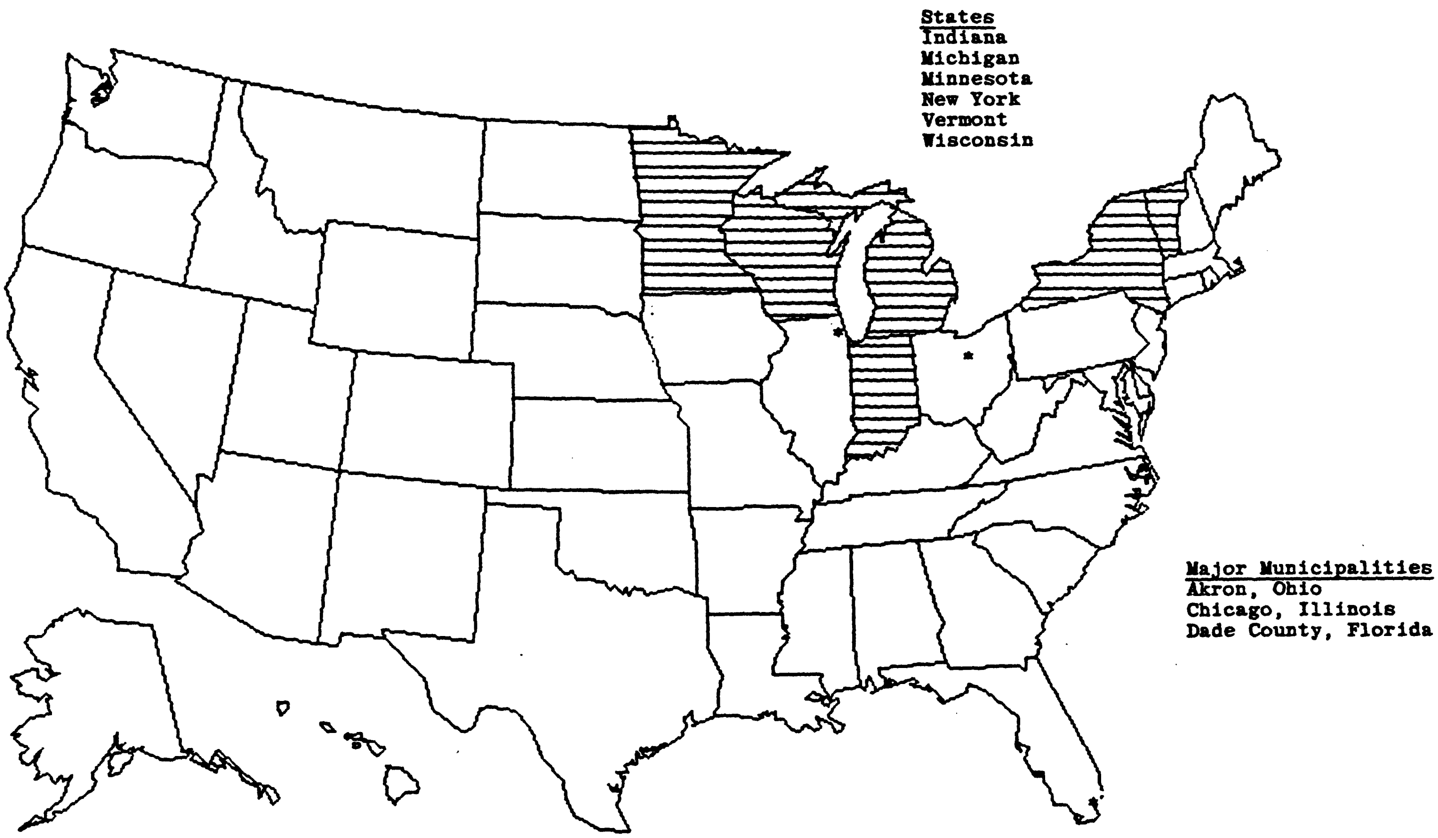
Several states (Maine, Florida and Connecticut) and municipalities limit the phosphate content in detergents to 8.7 percent phosphorus. In today's market few products exceed this percentage so these restrictions have little effect.

Restrictions on the levels of phosphate in detergents have also been enacted in other countries. Since 1973, Canada has restricted phosphorus levels to 2.2 percent in laundry detergents. In Japan, over 90 percent of the detergents sold are free of phosphates. In Europe, detergent phosphates are limited by law (Italy and Switzerland), by industry government agreement (Netherlands, Norway and Finland) and by voluntary guidelines to the consumer (West Germany) (54).

With the exception of Dade County, Florida, there is no indication that any of these states or localities have any plans to repeal their current bans. (A regional sewage treatment plant discharging to the Atlantic Ocean was recently completed in Dade County so there is no longer any discharge of sewage effluent to waters located within the County. The ban is currently in the process of being repealed.)

Figure IV-1

PHOSPHATE DETERGENT BANS



ABOUT 22% OF U.S. POPULATION IN BAN AREAS

TABLE IV-1

STATES AND LOCALITIES WITH PHOSPHATE DETERGENT BANS

State/ Locality	Date of Ban	Products Banned	Products Exempted	Enforcement By	General Comments
Indiana	1-73	Laundry detergents >0.5 percent P	Detergents used for: food processing and dairy equipment, machine dishwashers, hospitals and health care. Also phosphoric acid products and institutional detergents.	Indiana Stream Pollution Control Board responds to consumer calls. No intentional violations yet found.	First state to impose a ban.
New York	7-73	Laundry detergents >0.5 percent P ---------------- Cleaning products used in machine dishwashers, food and beverage processing equipment and dairy equipment. >8.7 percent P	Cleansing products used primarily in industrial manufacturing.	No agency specifically assigned.	Considering ban on use of NTA as an alternative builder.
Michigan	10-77	Laundry detergents >0.5 percent P ---------------- Cleaning agents used in machine dishwashers and industrial cleaners >8.7 percent P	None	Department of Natural Resources	In 1971, statute limited phosphate content to 8.7 percent and gave Water Resources Commission Authority to reduce level further. The Commission's decision was litigated to the State Supreme Court where it was upheld.

TABLE IV-1 (Continued)

State/ Locality	Date of Ban	Products Banned	Products Exempted	Enforcement By	General Comments
Vermont	4-78	Household cleaning detergents with P in amounts greater than trace levels. ---------------- Detergents used in dishwashers, for cleansing medical and surgical equipment, food and beverage processing equipment >8.7 percent P	Products used in agricultural production. Exclusions may be granted for products used in industrial manufacturing.	Department of Resources and Engineering. Relies primarily on consumer reports of violations.	Statewide review required on effectiveness of ban during 1981-82 session. Ban was continued.
Wisconsin	7-79 to 6-82 ------ Reinstated 1-84	Laundry detergents >0.5 percent P ---------------- Detergent used in machine dishwashers and for cleansing medical and surgical equipment. ---------------- Chemical water conditioning agents >20 percent P	Products used for industrial processes or for dairy equipment.	Department of Agriculture, Trade and Consumer Protection. Major suppliers police sales; with smaller companies some problems holding orders placed in a few cases.	Following reinstatement of the ban, the Wisconsin Center for Public Policy conducted an information verification project to solicit a scientifically informed lay panel's judgement on the issues in the controversy. Appendix D contains the findings, conclusions and recommendations from the study.
Minnesota	8-79	Laundry detergent >0.5 percent P ---------------- Chemical water softeners >20 percent P ---------------- Machine dishwasher detergents >11 percent P	Any product outside realm of household products.	Minnesota Pollution Control Agency, but discontinued spot checking because no violations ever found.	Ban was originally scheduled to be effective 1-77 but a temporary injunction halted effective date. Detergent industry generally complied with the ban while the challenge was litigated.

TABLE IV-1 (Continued)

State/ Locality	Date of Ban	Products Banned	Products Exempted	Enforcement By	General Comments
Chicago, Illinois	1973	Laundry detergents >0.5 percent P	Period of grace (until 12-85) for certain institutions, industrial detergents, commercial laundries and automatic dish-washer detergents.	Department of Con-sumer Services sends inspectors to stores - small companies sometimes violate.	Due to city distri-bution centers supplying suburban stores, phosphorus detergents are not available until 15-20 miles from city.
Akron, Ohio	6-72	Laundry detergents containing any phosphorus	Exemptions can be made for detergents for machine dishwashers, dairy equipment, beverage equipment, food processing and industrial cleaning.	Health Department, Environmental Health Division. Occasionally the inspectors find a a small brand in violation.	Several suburbs enacted bans because they are on the Akron sewerage system. Some problems in the beginning to insure non-phosphate detergent went to city stores and phosphate detergents went to suburban stores.
Dade County, Florida	1-72	Laundry detergents containing any phosphorus	Products used for cleaning of food processing and dairy equipment; phosphoric acid products; machine dishwasher detergents; institutional laundry detergents and some specialty products.	County inspectors the first year. After that, relied on consumer calls.	Should be repealed in early 1985 since no longer any sewage dis-charges into county waters.

Several of Virginia's neighboring states have recently considered a ban. Both the Maryland and North Carolina legislatures debated statewide bans during their 1984 sessions. In North Carolina the ban was approved overwhelmingly in the House, but not reported out of committee by the Senate. In Maryland a Senate committee deferred action on phosphate ban legislation until the 1985 session of the Maryland General Assembly.

B. Results

1. On Phosphorus Levels In Wastewater Discharges

In order to evaluate water quality impacts it first must be determined what reductions in wastewater phosphorus concentrations have occurred as a result of detergent bans. Studies conducted in states with bans indicated the following:

State	% Reduction In Phosphorus Loading At Sewage Treatment Plants		Time Period of Study
Indiana	50-60	(average-influent)	1971-74
New York	12.5-59	(range-influent)	1971-75
Minnesota	30	(average-effluent)	1975-80
Michigan	23	(average-influent)	1976-79
Vermont	40	(average-effluent)	1977-79
Wisconsin	1.7-23	(range-influent)	1978-81

As discussed in Chapter III the phosphate concentration in laundry detergents, and therefore the phosphorus levels in wastewater, have been decreasing over the past 10-15 years. Thus, the earlier studies tend to show higher reductions in wastewater phosphorus due to a ban.

In its Chesapeake Bay Program report, EPA assumed a 30 percent reduction in phosphorus levels whereas SDA has suggested decreases in the 20-25 percent range.

Based on the recent data which more closely reflect the detergents currently on the market, a detergent ban should reduce the phosphorus levels in wastewater by 20-30 percent.

2. On Water Quality

The effects of the existing bans on water quality have been more difficult to measure.

Conclusions from several studies are as follows:

a. Indiana

Report of Phosphorus Trends At Municipal Sewage Treatment Plants and In Indiana Streams For Years 1971-1974 Resulting From the Indiana Phosphorus Detergent Law And

Indicated Biological And Lumnological Benefits, The Division of Water Pollution Control, 1975.

This study looked at 11 stream stations, 2 lakes and one reservoir for comparison of before and after studies. The authors believed it was not possible to precisely determine the extent of the reduction on stream loadings because of nonpoint source loadings, natural yearly variations and upgrades of sewage treatment plants. Nevertheless, they estimated a 25-30 percent reduction in stream phosphorus loadings. Water column phosphorus levels in the two lakes (receiving discharges) were reduced between 14 to 68 percent during the survey period. No direct relationship was presented showing water quality improvements resulting from these reductions in phosphorus levels.

b. Vermont

Special Report to the Vermont General Assembly - Phosphorus Detergent Prohibition, Department of Water Resources and Environmental Engineering, March, 1981.

This study looked at 5 river sites and 2 lakes. A statistical analysis of the data indicated that the ban had a significant impact, of unknown magnitude, on phosphorus loads carried by rivers receiving treatment plant effluent as well as lake phosphorus concentrations at the locations most effected by treatment plant effluents. Preliminary analysis indicated that chlorophyll and transparency conditions at the lake stations affected by wastewater effluent did not consistently improve, relative to conditions at the control stations, following the implementation of the ban. The authors were not surprised by this lack of water quality improvement due to the modest phosphorus changes observed.

A model predicted that if the ban was discontinued, phosphorus concentrations would increase over the present day levels by as much as 30-80 percent when the wastewater treatment facilities reached their design capacity.

c. Michigan

John H. Hartig. Preliminary Effects of The Detergent Phosphorus Ban In Michigan, Department of Natural Resources, 1981.

This report reviewed data in Lakes Huron, Ontario and Erie as well as Saginaw River and Bay. It concluded that the ban was having a positive ecological impact in the Great Lakes Basin. Substantial reductions of algae were reported in Lakes Huron and Ontario following the bans, as well as water quality improvements in Saginaw Bay. It was hypothesized that Lake Erie would also show improvements after several years.

Critics of this study have pointed out that many sewage treatment plants initiated phosphorus removal during this same time period so that any improvements cannot be attributed solely to the ban.

d. Wisconsin

D. H. Schuettpetz, et al. Report on the Water Quality Effects of Restricting the Use of Phosphates in Laundry Detergents. Wisconsin Department of Natural Resources, 1982.

This study looked at 13 stream sites and 3 lakes. There was no direct evidence of water quality improvement in the waters investigated within the time period permitted. The authors cautioned that it usually is not possible to measure water quality changes caused by reductions in phosphorus within a short time period.

It is clear from the above studies that discerning water quality improvements resulting from a ban, or any other nutrient control strategy, is no easy task. Factors complicating these types of studies include:

(i) Year-to-year and season-to-season natural variations in water quality may mask improvements especially in the short term.

(ii) Following the reduction in nutrient inputs to a water body from point or nonpoint source controls, nutrient sinks (such as phosphorus laden bottom sediments) may begin releasing nutrients into the water column. Thus, expected water quality improvements may not be realized for many years.

(iii) All of the states with bans also have instituted phosphorus removal requirements at major treatment plants. Depending on the numbers of plants removing phosphorus, the reductions resulting from a ban would either be entirely or partially masked, thus making any conclusions about the ban effects questionable.

Large reductions in phosphorus loadings, such as the 80-90 percent associated with treatment plant upgrades, have shown resulting water quality improvements. In Virginia, the Occoquan Reservoir, which has seen a large reduction in phosphorus loadings due to the high level of treatment provided by the Upper Occoquan Sanitation Authority advanced wastewater treatment facility, is a prime example. With modest reductions, such as the 20-30 percent associated with the bans, it is more difficult to document any associated water quality improvements, especially in the short term.

In most cases, the bans were adopted as part of the initial efforts to reduce phosphorus loadings to the Great Lakes. Each of these states then proceeded to adopt effluent limits for phosphorus requiring the installation of phosphorus removal facilities at many major sewage treatment plants. Thus, a ban could be viewed as an interim measure, holding the line on phosphorus loadings during the time the capital intensive upgrade programs were underway.

Although viewed as an interim measure, the bans have not been repealed in these states. The reasons behind the decisions to stay with the bans are as follows:

(i) Cost savings at treatment plants required to remove phosphorus due to lower concentrations of phosphorus in the plant influent. Savings in chemicals and lower sludge production are realized.

(ii) Not every sewage discharge in these states is required to remove phosphorus. A ban results in lower phosphorus loadings from these discharges.

(iii) Once a ban has been in place, there apparently has not been any consumer efforts to rescind the bans in these states.

In conclusion, phosphate detergent bans would not be expected to show significant improvements in water quality especially in the short term or when used without other nutrient control strategies. However, a ban is a viable method to hold the line, to keep phosphorus loadings from increasing beyond existing levels for some interim period, and thus prevent further water quality degradation.

3. <u>On Consumers</u>

The effect on consumers is a major, disputed issue in the whole detergent ban debate. Much of the data in this area is generated by SDA, Procter and Gamble, washing machine manufacturers or university studies sponsored by the above. The Task Force has reviewed numerous consumer surveys and laboratory studies, and discussed this issue with both professionals and non-professionals familiar with what has occurred in the ban states and municipalities.

In this section of the report the major consumer related issues will be presented. Those studies and surveys most commonly referenced will be presented followed by the Task Force's evaluation. The section will conclude with a summary of comments received from professionals and non-professionals. The discussion regarding the impact of a ban on consumers can be divided into two distinct areas:

(i) The effect of non-phosphate detergents on consumer laundry habits; and

(ii) Deposition that may result on clothes and in washing machines when a commonly used phosphate substitute (sodium carbonate) is used as the detergent builder.

a. Laundry Habits

The major study currently referenced by industry and consumer professionals appeared in the Journal of Consumer Studies and Home Economics in 1982, "The Cost of Washing Clothes: Sources of Variation"*. This paper develops the national average cost of washing clothes by examining consumer research data on the frequencies of using various water temperature settings and laundry additives, and by utilizing national surveys of laundry product prices. A national telephone survey conducted in 1977-78 by Data Group, Inc., an independent market research firm, provided the data regarding laundry habits.

Table IV-2 shows the overall average U.S. laundry habits and practices at the time of the study. In order to evaluate the effect of a detergent ban, this data base was divided into two groupings: Phosphate detergent available (2250 panelists) and phosphate detergent not available (502 panelists). Figure IV-2 shows the difference in habits of the two groups according to the survey. The percentage differences in the various categories in areas where phosphate detergents were not available follows:

		National Average	Soft Water Areas
Washwater temperature selected		(Percent of Loads)	
	Hot	+5%	+3%
	Warm	+2%	-2%
	Cold	-7%	-1%
Rinse Water Temperature selected			
	Hot/Warm	+6%	+2%
	Cold/Cool	-6%	-2%
Use of Bleach		+7%	+4%
Use of Fabric Softener		+5%	-1%
Item Pretreated		+9.6%	-

The above data indicates that in soft water areas the behavior differences measured by the survey are very small and in one instance (use of fabric softeners) essentially no difference exists. These results are expected since all types of detergents perform better in soft water. This is directly relevant to Virginia since a majority of our citizens use soft water.

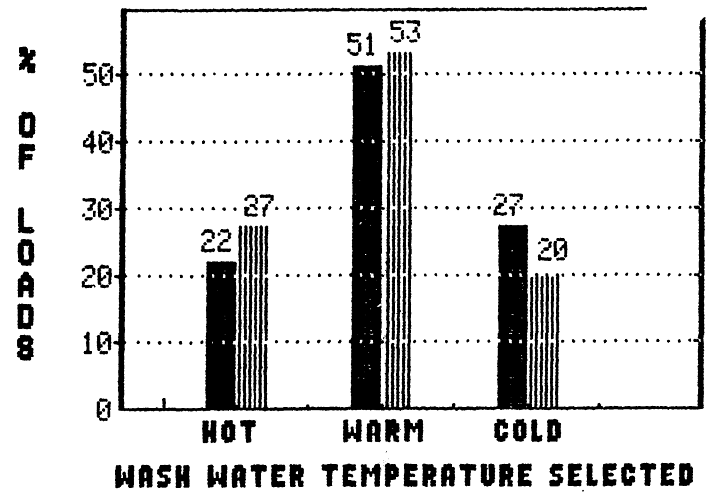
*Mary E. Purchase, Cornell University and Carol K. Berning and Anne L. Lyng, Procter and Gamble.

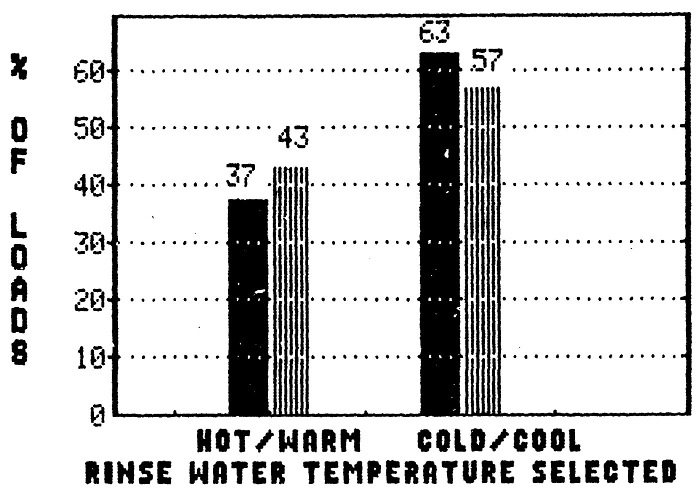
Table IV-2. (83) U.S. laundry habits and practices (1977–78)

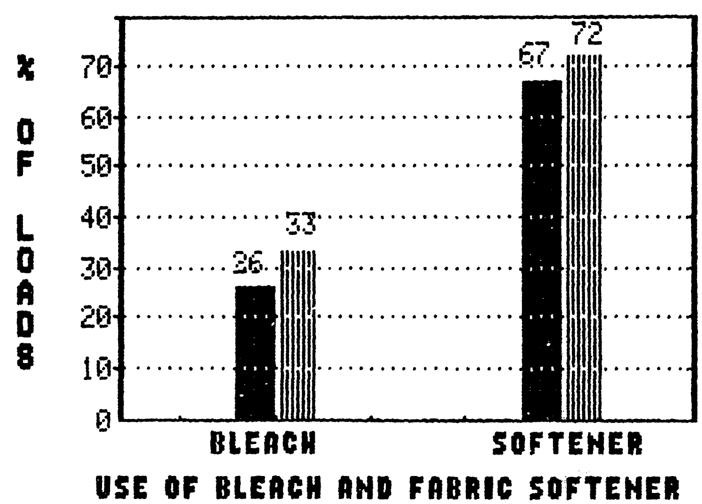
	Overall	At home	At coin-operated laundries
Data base (number of panellists)*	2,752	2,518	274
Size of family wash (number of loads per family per week)†	8·1	8·4	4·4
Loads washed per week (% of families)			
1–3 loads	21	20	46
4–6 loads	30	29	39
7–10 loads	26	27	12
11–20 loads	17	18	3
Over 20 loads	5	5	0
Wash water temperature selected (% of loads)			
Hot	23	22	36
Warm	51	51	49
Cold	26	27	15
Rinse water temperature selected (% of loads)‡			
Hot/warm	–	38	–
Cold/cool	–	62	–
Use of bleach (% of loads)§	28	–	–
Liquid bleach	20	–	–
Dry bleach	8	–	–
Use of fabric softener (% of loads)§	69	–	–
Washer added	35	–	–
Dryer added	35	–	–
Items pretreated (average number per week)§	3·21	–	–

*Some panellists washed loads both at home and at a coin-operated laundry.
†An average load contains 16·7 items (Procter & Gamble, Study II).
‡Question asked only about loads done at home.
§Questions did not distinguish between loads done at home versus at coin-operated laundries.

FIGURE IV-2 EFFECT OF PHOSPHATE DETERGENT AVAILABILITY ON CONSUMER HABITS







The Cornell article references three other surveys done for Procter and Gamble which report the data in terms of the percentage of panelists instead of percentage of loads (See Table IV-3). These studies show that the differences in behavior between phosphate and non-phosphate areas are also less than 10 percent. In addition, these data point out that for large segments of the population laundry habits do not differ between the areas.

Although one industry sponsored study described these overall results as "minor shifts in behavior", a cost can be assigned to help in a cost/benefit comparison. Table IV-4 presents the costs associated with these behavior differences, based on 1980 dollars. The difference of $11.30 per year amounts to an approximate 7.8 percent increase in laundering cost per household. This article is the basis for the consumer costs presented to the Task Force by Procter and Gamble.

Another consumer telephone survey was conducted by the Agricultural Extension Service at the University of Minnesota of 200 metropolitan area households (57). Follow-up surveys were conducted in 1978 and again in 1979 with subsets (10 percent) of the original population. Results of the surveys are shown in Table IV-5. In 1977, six months after the change over to phosphate-free products, about 85 percent of those surveyed rated their level of laundry satisfaction at good or excellent. This percentage did not change in the 1978 and 1979 surveys. However, respondents reporting laundry problems increased from 24 percent in 1977 to 40 percent in 1978; then decreased in 1979 to 30 percent. The use of bleach and pre-soak products seemed to increase following the phosphate ban. However, the use of hot water decreased during the period when only non-phosphate detergents were available.

Task Force Evaluation of Laundry Habits Issue

The Task Force conducted an in depth review of the Cornell study because it is the primary source of quantifiable data on consumer behavior and cost impacts. The cost estimates appeared to be developed in a sound fashion so the review focused on the national survey of laundry habits. Several concerns developed:

(i) The ban states are grouped primarily in the Great Lakes area. Questions arose whether habits in the use of hot water or laundry additives might vary among different regions of the country due to factors other than the detergent. The Task Force was able to analyze only a smattering of the survey data broken down by region. (Procter and Gamble did not provide state by state results because of the competitive nature of their business.) This review indicated that differences in laundry habits do exist between various regions of the country regardless of the availability of phosphate detergents.

Table IV-3

Additional data concerning the effect of phosphate detergent availability on laundry habits (83)

	Study II (1978–79)		Study III (1980)	
	Phosphate area	Non-phosphate area	Phosphate area	Non-phosphate area
	(percent of panellists)			
Wash water temperature selected*				
Hot	51	53	46	55
Warm	82	85	76	85
Cold	35	35	45	44
Laundry additives used				
Liquid bleach	47	52	53	60
Dry bleach	17	19	21	26

	Study IV (1980)	
	Phosphate area	Non-phosphate area
	(percent of panellists)	
Extra steps necessary to get clothes 'really clean'		
Use bleach	33	41
Pretreat spots	34	44
Presoak	29	39

*Percentages total more than 100% since many panellists used more than one water temperature setting during the surveyed period.

Table IV-4

Cost of washing clothes in phosphate versus non-phosphate areas (83)

	Cost/Load		Cost/Year*		Difference non-phosphate versus phosphate areas (dollars per year)
	Phosphate areas	Non-phosphate areas	Phosphate areas	Non-phosphate areas	
	(cents per load)		(dollars per year)		
Detergent	15·6	15·6	65·68	65·68	–
Energy†	11·4	12·9	47·99	54·31	6·32
Bleach	2·0	2·6	8·42	10·95	2·53
Fabric softener					
Liquid	2·64	3·12	11·11	13·14	2·03
Dry	1·94	1·94	8·17	8·17	–
Pretreat products	0·8	0·9	3·37	3·79	0·42
Total	34·4	37·10	144·74	156·04	11·30

*Based on an average of 421 loads per year.
†Energy cost based on weighted average of gas and electric water heaters.

Table IV-5
Minnesota Consumer Survey

Overall Satisfaction with Laundry as Reported by Respondents

	Entire Population (194)	Subset Number 1 (20)		Subset Number 2 (20)	
	1977	1977	1978	1977	1978
Excellent	49 (25%)	7 (35%)	4 (20%)	8 (40%)	4 (20%)
Good	115 (59%)	11 (55%)	13 (65%)	8 (40%)	13 (65%)
Fair	26 (13%)	2 (10%)	3 (15%)	2 (10%)	2 (10%)
Poor	1 (1%)			1 (5%)	
Terrible	3 (2%)			1 (5%)	1 (5%)

Number of Respondents Reporting Laundry Problems

Entire Population (200)	Subset Number 1 (20)		Subset Number 2 (20)	
1977	1977	1978	1977	1979
47 (24%)	5 (25%)	8 (40%)	4 (20%)	6 (30%)

Number of Respondents Using Bleach and Pre Soak Products

	Entire Population (200)		Subset Number 1 (20)		Subset Number 2 (20)	
	1976 (by recall)	1977	1977	1978	1977	1979
Bleach	128 (64%)	147 (74%)	14 (70%)	17 (85%)	12 (60%)	13 (65%)
Pre Soak	40 (20%)	55 (28%)	7 (35%)	11 (55%)	7 (35%)	7 (35%)

Percentage of Respondents Using for One Load or More

	1976	1977	1978
Hot	80	70	60
Warm	92	84	95
Cold	46	40	40

The Task Force believes that consumer behavior can be affected by phosphate detergent availability, but questions whether the magnitude of the difference shown in the survey can be attributed <u>entirely</u> to the detergents.

(ii) The minor differences in behavior using the national data are reduced to even lower levels when soft water areas are compared.

(iii) Data on the habits of consumers in the ban states prior to the dates the bans went into effect are not available to compare to the Cornell study results.

(iv) The survey data is from 1977-78. The Task Force assumes that the detergent industry is continually improving the non-phosphate products. For example, a major manufacturer has informed the Task Force that it has developed a liquid, non-phosphate product that is comparable to phosphate granular detergents. Therefore, this data may not accurately predict the laundry habits of consumers using these newer non-phosphate products.

Although the Task Force has identified these concerns with the available data, the consumer costs presented by Procter and Gamble appear to be the only technically based figures available. They appear reasonable, especially in softwater areas ($5-6 per household per year in 1983 dollars). Furthermore, the EPA Chesapeake Bay Program agreed to similar consumer cost impacts in their analysis of a phosphate detergent ban. Therefore, the Task Force agreed to use the Procter and Gamble cost figures on laundry habits.

b. Carbonate Deposition

Sodium carbonate is the most widely used alternative for phosphate in granular detergents. Sodium carbonate performs the primary builder function (binding mineral hardness ions principally calcium and magnesium) in a manner different from phosphate. It combines with mineral hardness ions to form insoluable precipitates; whereas phosphate binds with mineral hardness ions and holds them in solution. The magnitude of the precipitation is primarily dependent on the level of sodium carbonate used in the product and the mineral hardness of the wash water. The concern for the consumer regarding deposition would be in two areas:

(i) Garment appearance and reduced lifetime, and
(ii) Increase in washing machine service calls and need for replacement parts.

Procter and Gamble has provided information from laboratory studies, manufacturer's literature, as well as testimony by consumer professionals pointing out the problem of calcium carbonate (limestone) deposits, especially in hard water.

No consumer surveys have been performed to quantify any of these effects with respect to reduced fabric lifetime. However, several industry sponsored laboratory studies have shown how carbonate build-up can cause fabric abrasion. In a study (5) conducted by General Electric (prior to 1975) with a high carbonate detergent (70 percent carbonate) in hard water, GE chemists estimated a 15-20 percent reduction in service life of garments depending upon wash conditions and fabric type. Another study by Morris and Prato (68) using a high carbonate detergent (55 percent carbonate) looked at edge abrasion on cotton fabrics in both soft and very hard water. A significantly greater amount of edge abrasion was found on cotton samples laundered (after 20, 30 and 40 cycles) in hard water than on those laundered in soft water regardless of detergent type. The greatest amount of abrasion was on samples laundered in hard water with carbonate detergent. When soft water was used for laundering, neither carbonate nor phosphate detergents caused deleterious effects to fabrics.

With respect to machine repair costs, 1978 testimony by a representative of a washing machine manufacturer indicated that an approximately 15-20 percent increase in service calls and replacement of certain washing machine parts occurred after bans went into effect. Speed Queen (102) conducted a telephone survey of an independent service company in each of four ban areas to secure this information. Also, tests performed in hard water by General Electric (5) indicated that with the rate of build-up of limestone deposits, serious plumbing problems could be anticipated in from 5 to 10 years after commencing regular use of carbonate detergents.

Procter and Gamble has provided a cost analysis which estimates the costs experienced by consumers due to carbonate deposition. Because of the importance of water hardness in the extent of deposition, their costs are projected to be lower for soft water and increase as hardness increases.

Task Force Evaluation Of The Carbonate Deposition Issue

Regarding the projected fabric abrasion costs, the Task Force does not believe that the studies and other information submitted supports assigning any consumer costs in soft water areas. The Morris and Prato study concluded that when soft water was used for laundering, neither carbonate nor phosphate detergent caused deleterious effects to the fabrics. In addition, the Cornell study of consumer habits indicated that there was no difference in the use of fabric softener in soft water areas whether phosphate or non-phosphate detergents were available. Supposedly, fabric damage is caused by the build-up of carbonate deposits which give the fabric a harsh and stiff feel. Consumers would be expected to use more fabric softener to counter this problem. Since there is no difference in use of fabric softener in soft water areas, it is reasonable to expect that consumers would not encounter noticeable build-up in these areas (and perhaps fabric wear).

In the harder water areas, Procter and Gamble projects the following reduction in garment life:

Medium Hard	Hard	Very Hard
3.6%	6%	8.4%

A cost is estimated by multiplying these percentages by the annual household expenditure for washable clothing and other household items ($750 in 1983). The Task Force estimates are different from these costs because:

(i) The lab studies showed abrasion with cottons and blends (cotton portion only). Synthetic fabrics (such as nylon) did not show abrasive damage. A typical family washload is composed of about 25 percent synthetics.

(ii) There are factors other than fabric wear (i.e. fashion shifts, children outgrowing clothes, consumer desire for new or different clothes, etc.) which significantly impact consumer purchase of new garments.

In the absence of any other data, the Task Force believes that a more reasonable approach to allow for these factors is to use one-half of the annual expenditure for washable items in the cost calculations.

With respect to the problems of increased service calls and shorter life for washer parts, the Task Force believes that the data does not support assigning any costs in soft water areas. Literature published by washing machine manufacturers does caution consumers of carbonate deposition problems, but they focus their discussion to washing in hard water. Procter and Gamble extrapolates the results of lab tests performed in hard and very hard water down to soft water areas by a linear relationship. Their data does support a linear relationship between hard and very hard water. However, the Task Force concludes that in soft water areas the data does not support the assumption that machine damage would occur.

In harder water areas, the Task Force estimates differ from Procter and Gamble's costs for two reasons:

(i) Data in the Cornell article indicates that on the average there are two service calls during the life of a washing machine (10.8 years). The Task Force has used this in its calculations and does not agree with a service call rate of every other year used by Procter and Gamble.

(ii) The manufacturer's estimates of a reduced part life of 15-20 percent was used by the Task Force. Procter and Gamble assumed that the parts in all machines would be replaced once during the life of the machine.

In summary, the Task Force considers calcium carbonate deposition to be a potential problem primarily in hard water areas. Several of the references used in the Procter and Gamble cost analysis were reviewed and critiqued during the study done by the Wisconsin Center for Public Policy. (See Appendix E). One economist concluded (58) that the washing machine repair costs were not based on scientific evidence, the results speculative. A professor with the University of Rhode Island's Department of Textiles, Merchandising and Design (59) concluded that the wear history of a garment could make as much impact on the durability of a garment so consumers in real life may not notice loss of wear due only to the detergent used.

In the Chesapeake Bay Program report, EPA's analysis did not project <u>any</u> consumer costs due to carbonate deposition primarily because they considered the Bay watershed to be generally a soft water area. The Task Force concludes that 36 percent of the population in Virginia live in areas with water of varying degrees of hardness from medium to very hard. Carbonate deposition is a potential problem for consumers living in these areas. The Task Force believes there should be a better data base developed for evaluating impacts on consumers from carbonate deposition, especially in soft and medium water hardness areas.

c. Comments Received From Ban Areas

All of the water pollution control agencies in the ban areas reported that they were not aware of any problems to the consumers resulting from the ban (74). They pointed out that during the debate on the ban, the opposition described many problems which would occur in getting clothes clean and in damage to washing machines and clothes. None of these predictions, in their opinion, occurred. The ban had ceased to be an "issue" after it became effective.

Since consumers would tend not to complain to pollution control agencies but rather to home economists and extension specialists, these individuals were also contacted. The responses from these individuals follows:

(i) Mary E. Purchase, Cornell University, New York (55). The number of questions received by Cooperative Extension about laundering increased. However, the number of questions did not increase as much as expected when the ban first went into effect. She believes the consumer makes changes in laundry practice and only those still not satisfied eventually contact them.

(ii) Wanda Olson, University of Minnesota (57). She reported that the president of the state association of appliance repair dealers has stated that consumers complain about performance of washing machines when in reality there is nothing wrong with the machine. He felt that the number of these calls increased when phosphate detergents were no longer available.

(iii) Nadine Hackler, Florida Cooperative Extension Service (56). She disagrees with statements that consumers are not complaining or having problems. In her opinion, the most frequent question that comes into the Dade County offices on clothing has to do with stains and care of clothing. She believes most people do not realize how this is directly related to the phosphate ban.

The Task Force received information from Procter and Gamble regarding consumer feedback on their products. Procter and Gamble concludes that these results clearly demonstrate that consumers prefer phosphate granular detergents and are able to discern the large difference in performance.

4. <u>On Industry</u>

The main concern expressed by detergent industry representatives about a phosphate detergent ban is their inability to offer the consumer the best products available. They also indicate that resulting consumer complaints are directed to the industry and not towards the governmental entity imposing the ban.

When a ban is imposed, the leading brand names continue to be marketed, but with a non-phosphate formulation. The manufacturer would not necessarily have to change the price for the non-phosphate brand. Therefore, a direct cost impact has not been raised as an issue. However, a 1980 study done for SDA by Glassman-Oliver (23) describes detergent industry costs associated with a ban. These costs are for the following:

(i) Testing and research of phosphate substitutes

(ii) New product introduction and marketing

(iii) Producing and carrying a greater line of brands or the same brands with varying levels of phosphorus content.

Bans can also have impacts on the industry supplying the ingredients for the detergents. Only 2 percent of the phosphates processed annually are used in detergents. The main phosphate form used in detergents is sodium tripoly-phosphate (STPP).

About 90 percent of all STPP produced is used in laundry detergents. STPP production has declined steadily from about 950,000 tons in 1973 to 650,000 tons in 1983. Since STPP production is subject to high fixed costs and there are substantial economics in large scale production, a number of plants have shut down due to this reduced demand for STPP. New phosphate detergent bans would aggravate this industry problem.

CHAPTER V

VIRGINIA PHOSPHATE DETERGENT BAN

A. Benefits

1. A BAN WOULD REDUCE CURRENT PHOSPHORUS LOADINGS FROM MUNICIPAL POINT SOURCES BY APPROXIMATELY 25 PERCENT.

Figure V-1 shows the 1983 municipal point source loadings before and after a ban in four major river basins. If a treatment plant removes phosphorus then no reduction in loading is realized from a ban. Since several of the major plants in the Potomac basin remove phosphorus, the ban would result in a smaller reduction for the Potomac basin. A statewide ban would also reduce phosphorus loadings in other nutrient sensitive waters such as the Chowan.

2. A BAN WOULD RESULT IN THE FOLLOWING CHANGES IN 1983 TOTAL PHOSPHORUS LOADS IN COMPARISON TO THE 1980 LOADS FOR BOTH POINT AND NONPOINT SOURCES:

	1983 LOADS IN RELATION TO 1980 LOADS	
	WITHOUT BAN	WITH BAN
POTOMAC	-26.7%	-27.6%
RAPPAHANNOCK	+ 3.6%	- 3.6%
YORK	+40.9%	+27.0%
JAMES	+ 6.3%	-12.1%

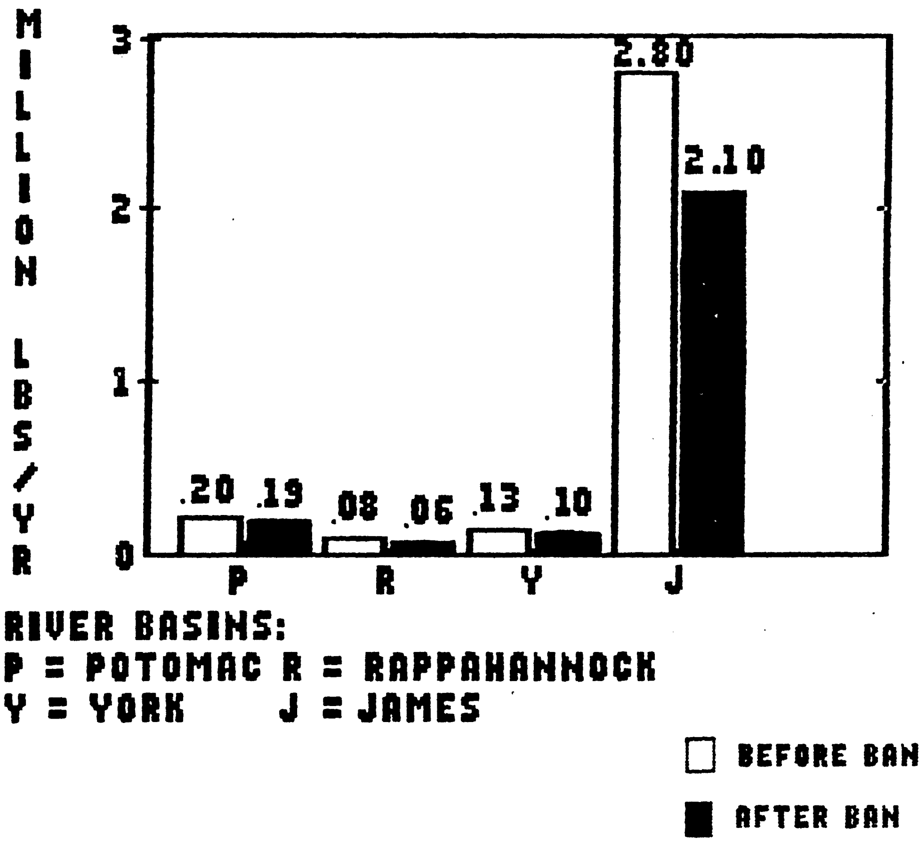
Phosphorus loadings in the Rappahannock and James River Basins have increased slightly between 1980 and 1983. A ban would reduce loadings back under 1980 levels to the levels shown. In the York Basin, phosphorus loads increased substantially due to the start-up of a new, major treatment plant. A ban would cut back on this increase.

Between 1980 and 1983 there was a substantial reduction in phosphorus loads to the Potomac Basin. A ban would result in a slightly greater reduction.

In relation to the working goal of 20 percent reduction from the 1980 phosphorus loads, a ban by itself would not achieve this level of reduction in the Rappahannock, York and James Basins (although in the James over half the necessary reduction is achieved). In the Potomac the 20 percent reduction has been achieved through phosphorus removal at the treatment plants and a ban increases this reduction slightly.

FIGURE V-1

PHOSPHORUS DISCHARGES BY MUNICIPAL POINT SOURCES BEFORE AND AFTER A BAN ON PHOSPHATE DETERGENTS



3. <u>A BAN GOING INTO EFFECT IN 1985 WOULD INSURE THAT PHOSPHORUS LOADINGS IN THESE VIRGINIA RIVER BASINS WOULD NOT RETURN TO CURRENT LEVELS IN SPITE OF POPULATION INCREASES UNTIL</u>:

POTOMAC	-	1987
RAPPAHANNOCK	-	1995
YORK	-	1987
JAMES	-	1997

4. <u>A BAN IS AN EFFECTIVE INTERIM STRATEGY SINCE</u>:

   a. IT CAN BE IMPLEMENTED IN A MATTER OF MONTHS;
   b. IT REQUIRES NO CAPITAL EXPENDITURES; AND,
   c. IT IS REVERSIBLE.

   <u>HOWEVER, AS WITH MOST INTERIM STRATEGIES, A BAN ALONE WILL NOT SOLVE THE NUTRIENT ENRICHMENT PROBLEM</u>.

5. <u>THE NUTRIENT ENRICHMENT PROBLEM IN THE BAY AND ITS TRIBUTARIES (OR ANY OF VIRGINIA'S OTHER WATERS) REQUIRES AN OVERALL PROGRAM COMBINING MANY DIFFERENT STRATEGIES</u>.

   <u>A BAN CAN BE ONE ELEMENT IN THE OVERALL PROGRAM OF NUTRIENT CONTROL STRATEGIES (SEE CHAPTER VI FOR FURTHER DISCUSSION)</u>.

6. <u>A BAN RESULTS IN COST SAVINGS AT MUNICIPAL TREATMENT PLANTS WHICH ARE REQUIRED TO REMOVE PHOSPHORUS PRIOR TO DISCHARGE. THESE COST SAVINGS ARE DUE TO REDUCED CHEMICAL USAGE AND TO REDUCED PRODUCTION OF SLUDGE REQUIRING FINAL DISPOSAL</u>.

   Virginia currently has seven major municipal treatment plants operating phosphorus removal facilities. Reported cost savings and reductions in sludge production for these facilities are shown in Table V-1.

TABLE V-1

COST SAVINGS AT VIRGINIA TREATMENT PLANTS
DUE TO A PHOSPHATE DETERGENT BAN

Treatment Plant	Population Served	Annual Cost Savings $	Annual Cost Savings $/Capita	Reduction in Sludge Tons/Year
Arlington County	223,104	$128,000	0.57	380
[a]Alexandria Sanitation Authority	-	0	0	0
Fairfax County - Lower Potomac	330,000	$167,000	0.51	2,785
Prince William County	77,750	$ 24,000	0.31	180
City of Roanoke	185,000	$ 79,000	0.42	15
[b]Stafford County - Aquia	-	0	0	0
[b]Upper Occoquan Sanitation Authority	-	0	0	0
TOTALS	815,854	$398,000	0.49	3,360

[a]The Alexandria advanced wastewater treatment facilities are not yet fully operational. Under current conditions cost savings would be minimal.

[b]The Aquia and UOSA plants remove phosphorus by the addition of lime. This process does not depend on the influent phosphorus concentration.

NOTE: These plants are designed to meet very stringent effluent phosphorus concentrations of 0.1-0.2 mg/l.

B. Costs and Effects

1. A BAN WOULD REMOVE FROM THE MARKETPLACE LAUNDRY PHOSPHATE DETERGENT PRODUCTS CURRENTLY PURCHASED AND USED BY MANY VIRGINIA CONSUMERS. BRAND NAMES COULD STILL BE MARKETED, BUT WOULD REQUIRE DIFFERENT CHEMICAL FORMULATIONS.

2. SOME CONSUMERS MAY CHOOSE TO MAKE ADJUSTMENTS IN THEIR LAUNDRY HABITS.

   Adjustments may include one or more of the following:

   - Change in detergent brand or type
   - Change in amount of detergent used per load
   - Change in water temperature settings
   - Use of additional laundry additives and pre-soaks

3. WHEN USED IN HARD WATER GRANULAR NON-PHOSPHATE DETERGENTS COULD CAUSE CALCIUM CARBONATE DEPOSITION PROBLEMS FOR CLOTHES AND WASHING MACHINES.

4. PROJECTED CONSUMER COSTS RESULTING FROM A STATEWIDE BAN ARE PRESENTED IN TABLES V-2 and V-3.

   Table V-2 summarizes for each water hardness category the projected consumer costs as presented by Procter and Gamble and by the Task Force.

   Table V-3 presents the average annual statewide consumer costs per household. Three cost projections are presented. Costs from the EPA Chesapeake Bay Program, updated to 1983, are shown in addition to the Procter and Gamble and Task Force cost projections. Refer to the section on Implementation Issues for costs of regional bans.

TABLE V-2

CONSUMER COSTS FOR A
PHOSPHATE DETERGENT BAN
BY WATER HARDNESS CATEGORY

$/Household/Year
(January 1983 Dollars)

Water Hardness Category:		Soft	Medium	Hard	Very Hard
Percent of VA Population		64.4	23.0	8.0	4.6
Laundry Habit Adjustments	Procter and Gamble and Task Force	5.59	13.52	13.52	13.52
Increased Fabric Wear	Procter and Gamble	5.05	15.16	25.28	35.39
	Task Force	0	7.56	12.60	17.64
Washing Machine Repair and Replacement	Procter and Gamble	4.37	13.11	21.86	30.60
	Task Force	0	2.74	4.57	6.40
TOTALS	Procter and Gamble	15.02	41.79	60.66	79.51
	Task Force	5.59	23.82	30.69	37.56

TABLE V-3

CONSUMER COSTS
FOR A PHOSPHATE DETERGENT BAN
STATEWIDE AVERAGE

Cost Projection By	$/Household/Year (January 1983 Dollars)			
		Carbonate Deposition		
	Laundry Habits	Fabric Wear	Machine Repair/Part	Total
EPA	10.43	0	0	10.43
Procter and Gamble	8.41	10.40	8.99	27.80
Task Force	8.41	3.56	1.29	13.26

C. Implementation Issues

1. Type of Ban

A Virginia phosphate detergent ban does not necessarily have to cover the entire state. As shown in Chapter IV, individual cities and counties have successfully adopted and implemented detergent bans. Also, it is clear from the data presented in the Benefits section, certain regions of the state derive greater benefit from a ban than do other areas. Therefore, the Task Force has developed several alternatives under a regional ban concept as shown in Table V-4. The Task Force used the water hardness data presented in the paper, "Water Hardness in Virginia" (Lung, 1983) to determine the relative hardness characteristics of water supplies for people in the Chesapeake Bay tributary watersheds. This evaluation was then used to calculate consumer costs for several alternative regional ban concepts.

In order to allow for a direct comparison between the regional ban alternatives, costs per pound of phosphorus removed are presented. Under this analysis a ban in the James River Basin east of the fall line appears to be the most cost effective.

It should be pointed out that the distribution network for laundry detergents does not follow river basin or political jurisdictional boundaries. Thus, any regional ban could cover a somewhat larger area and population than described in the table. However, in the local jurisdictions in other states currently with bans the distribution systems for the non-phosphate detergents have been successfully set-up to meet the local circumstances.

2. Exemptions

The ban states have focused their attention primarily on phosphorus in household laundry detergents. Thus, the ban legislation in each of these states exempts certain products from the effects of the ban. The exemptions can generally be broken down into two categories:

(i) No alternative to phosphate product
Machine dishwasher detergent is the prime example.

(ii) Outside realm of household products
There are a number of products exempted under this category such as: industrial cleaners, commercial laundries, food processing and dairy equipment, and hospitals.

Consideration would have to be given to product exemptions in any Virginia ban.

TABLE V-4

REGIONAL PHOSPHATE DETERGENT BAN ALTERNATIVES

Regional Ban	Population (1980)	Average Consumer Cost (Task Force Estimate) ($/Household/Year)	Phosphorus Loading Reduction to Virginia Bay Tributaries (lbs/yr)	Reduction in Total Current Phosphorus Loading to Virginia Bay Tributaries* (Percent)	Cost Per Pound of Phosphorus Removed by Ban ($/lb)	Comments
A. Statewide	5,346,000	$13.26	760,000	13.9	No calculation. Total phosphorus loading reduction statewide not known.	Also results in phosphorus reduction to other nutrient sensitive waters, such as the Chowan River.
B. Entire Chesapeake Bay Watershed	3,788,000	$13.54	760,000	13.9	$24.45	Same reduction to Bay tributaries as in A with fewer people impacted.
C. Chesapeake Bay Watershed East of Fall Line	2,842,000	$11.64	650,000	11.9 (18.5% of loads east of Fall Line)	$18.44	Major plants in Potomac Basin east of Fall Line remove phosphorus so some cost savings realized as compared to D and E.
D. Rappahannock/York/James Basins East of Fall Line	1,720,000	$11.92	650,000	10.9 (20.5% of loads to these tributaries)	$11.43	Same reduction to Bay tributaries as in C with fewer people impacted.
E. James River Basin East of Fall Line	1,507,000	$11.13	600,000	10.9 (21.3% of loads to James River below Fall Line)	$10.13	Lowest cost. Fewest people impacted.

*Total phosphorus loading from Virginia tributaries is 5,480,000 lbs/year.

3. Enforcement

The Virginia Department of Agriculture and Consumer Services (VDACS) currently inspects various products in retail grocery stores. Based on correspondence received from VDACS, enforcement of a Virginia ban could be incorporated into the current VDACS programs.

D. Summary of Other PRO's and CON's

PRO's

- MAY INCREASE CITIZENS AWARENESS OF THE ULTIMATE IMPACT THEIR INDIVIDUAL ACTIVITIES HAVE ON THE BAY.
- SLUDGE DISPOSAL IS AN INCREASING PROBLEM STATEWIDE. A BAN COULD DECREASE THE AMOUNT OF SLUDGE GENERATED AT PLANTS REMOVING PHOSPHORUS AND DECREASE PRESSURE ON DISPOSAL SITES.

CON'S

- MAY DIVERT ATTENTION AWAY FROM TAKING ACTION ON OTHER NECESSARY STEPS, SUCH AS POINT SOURCE CONTROL.
- IN AREAS WHERE SEPTIC TANKS ARE COMMON LITTLE, IF ANY, REDUCTION IN NUTRIENT LOADING TO SURFACE WATERS WOULD RESULT (ALTHOUGH WITH FAILING SEPTIC TANK/DRAINFIELD SYSTEMS, SURFACE WATER POLLUTION MAY OCCUR. HOWEVER, THESE CONSUMERS WOULD STILL HAVE TO BEAR THE EFFECTS OF A BAN.

CHAPTER VI

USEFULNESS OF BAN IN CONJUNCTION WITH OTHER PHOSPHORUS CONTROL STRATEGIES

General

As shown in Chapter V, a Phosphate Detergent Ban, by itself, will not achieve the working goal of 20 percent reduction in phosphorus loads from the Virginia tributaries to the Bay. Therefore, it is clear that other control strategies must be implemented if this goal is to be reached. The two major strategy areas are nonpoint source controls and point source controls. How could a ban fit in with these strategies?

Nonpoint Source Controls

Nonpoint source control strategies involved methods of reducing runoff from agricultural and urban areas. There are numerous agricultural practices that can be implemented to reduce runoff including: timing of fertilizer application and land disturbance; use of crop residues for cover; conservation tillage; contour and strip cropping, use of buffer strips; and animal waste collection, handling, storage and disposal practices. Urban runoff control methods include: source controls such as street sweeping and vegetative cover; volume or discharge controls such as porous pavement and grassed swales; and sewer system storage and flow regulators. Some or all of these methods could be implemented in conjunction with a phosphate detergent ban and could provide the benefit c additional reduction in phosphorus loading to the Bay tributaries. At this time it is difficult to specifically quantify the costs of or benefits derived from these methods. However it is clear that nonpint source controls involve costs and provide benefits which are strictly additive to those associated with a ban.

Point Source Controls

Evaluating point source control options is a more complex task. Point source control strategies involve basically two methods: (1) a phosphate detergent ban and (2) phosphorus removal at wastewater treatment plants. A phosphate detergent ban results in the reduction of phosphorus entering wastewater treatment plants. Therefore, without additional treatment, these plants discharge a reduced amount of phosphorus. Phosphorus removal at sewage treatment plants involves additional treatment which results in a significant reduction in the amount of phosphorus discharged. In this latter method, the amount of phosphorus entering the plant does not impact the amount discharged. However, it does impact the cost of treatment. Therefore, in evaluating the usefulness of a ban in conjunction with phosphorus removal at treatment plants it becomes necessary to separate the environmental benefits (reduced phosphorus discharged) from the economic benefits (reduced cost of treatment). A compounding factor involved in this evaluation stems from the fact that implementation of these two methods could be carried out over significantly different time frames.

The remainder of this chapter will provide the following information:

(i) A comparison of the amount of phosphorus reduction which can be achieved at sewage treatment plants by these two methods;

(ii) An analysis of the capital costs associated with providing phosphorus removal at sewage treatment plants by these two methods;

(iii) A comparison of cost savings realized at sewage treatment plants as result of a ban versus the consumer costs associated with a ban; and,

(iv) A summary of how these factors come together in determining the mix of control strategies which could be implemented over a projected time frame.

1. Under a phosphorus removal program, the treatment plants would be required to meet certain limits for phosphorus (P) in their effluents. The following data illustrates several effluent values which could be used in a phosphorus removal program and compare these to no P control and ban strategies:

Strategy	Phosphorus Concentration in Plant Effluent (mg/l)	% Removal in Relation to No P Control
No P Control (Assume Secondary Effluent)	6.4	--
Phosphate Detergent Ban	4.8	25
Levels of Phosphorus Removal	2.0 or	69
	1.0 or	84
	0.2	97

Phosphorus removal at sewage treatment plants removes a much greater percentage of P than does a ban. However, unlike the relationship between a ban and nonpoint source control, phosphorus removal at treatment plants is not additive to the reduction in phosphorus achieved by a ban. If a ban is in effect in the service area of a treatment plant removing phosphorus, there will be no environmental benefit (i.e. reduction in P discharged to State waters) associated with the ban. Since the ban would reduce the phosphorus level in the wastewater influent to the treatment plant, there could be an economic benefit since the cost of phosphorus treatment would decrease.

2. In order to fully appreciate how a ban could be used in conjunction with phosphorus removal at sewage treatment plants, the Task Force has developed cost estimates for providing

phosphorus removal at Virginia's major sewage treatment plants tributary to the Chesapeake Bay. Table VI-1 presents estimates for the capital costs to provide phosphorus removal facilities at these plants. Also presented are the annual operation and maintenance costs, the equivalent annual cost and the total annual per capita cost.

The Task Force believes the most important aspect of this cost information is the magnitude of the capital cost involved. Clearly, such a large scale capital improvements program will require a lengthy time period (on the order of a decade) to complete. Design and financing considerations plus the construction of the number of plants involved each contribute in making this a long-term program.

As stated in Chapter V, a ban can be implemented in a matter of a few months. Thus, a ban can be used during the time the treatment plants are being upgraded to hold the line on phosphorus loads until phosphorus removal can begin.

The Task Force has purposely not shown a direct comparison between the costs of phosphorus removal and the consumer costs associated with a ban because these two strategies should not be viewed as "either/or" options. A ban's primary benefit is to be used in a nutrient control program as the initial step while the major step, phosphorus removal, is being put in place.

3. If a ban is adopted and phosphorus removal at the treatment plant is either in operation or subsequently begins operation, then the primary environmental benefit of the ban is not achieved. However, the ban does provide some economic benefit due to cost savings in the operation of the treatment plants.

   The Task Force received estimates of these cost savings from several different sources. Because of the wide variation in these projected costs each will be presented to demonstrate the range of costs involved. The Soap and Detergent Association estimates an annual savings of \$0.31 to \$0.64 per capita whereas the Washington Suburban Sanitary Commission estimates a ban in their service area would result in savings about three times the SDA estimate (44). The EPA Chesapeake Bay Report estimated that a ban would save about 15 percent on annual phosphorus O&M costs. After reviewing the data, the Task Force concluded that expected savings would be somewhere in the middle of the range of costs presented. The Task Force will use 10 percent cost savings at plants meeting 1 mg/l, but allow only 3 percent savings at plants meeting 0.2 mg/l. Table VI-2 presents the estimated savings. These savings range from about 4 to 15 percent of the annual O&M costs for the phosphorus removal facilities.

   When both phosphorus removal and a ban are in place, the pros and cons for and against a ban are <u>primarily</u> economic. The ban might save \$2.94/household/year in sewage treatment costs, but cost \$13.26/household/year in added laundry costs (Task Force

TABLE VI-1

COSTS OF PHOSPHORUS REMOVAL AT MAJOR
VIRGINIA (>1 MGD) SEWAGE TRATMENT PLANTS[a]
(January 1983 Dollars)

Basin	# of Major Plants	Total Current Design Flow (MGD)	Capital Costs * (Million $)	O&M Costs (Million $/Year)	Equivalent Annual Cost[d] (Million $/Year)	Total Annual Per Capita Cost[e] ($/Capita/Year)
Potomac	16[b]	190[b]	14.1	16.1[c]	17.5	13.4
Rappahannock	5	12	6.4	1.2	1.8	21.7
York	3	19	7.7	1.9	2.7	20.6
James	18	295	104.0	28.0	38.5	18.9
TOTALS	42	516	132.2	47.2	60.5	17.0

[a]Source: EPA-Chesapeake Bay Program Report for Costs for Upgrading the Operating Plants

[b]Seven of these plants (27 mgd) need to be upgraded with phosphorus removal.

[c]Includes O&M costs for plants still to be upgraded as well as O&M costs for plants currently with phosphorus removal.

[d]Sum of annual O&M costs and capital costs expressed as a uniform annual amount over 20-year period using a discount rate of 7.875 percent.

[e]Used 145 gallons/capita/day to develop estimate of population served.

*Note: For this analysis capital costs are based on upgrading 33 major STPs throughout these basins at their current design flow and are expressed in terms of 1983 dollars. A cost estimate of $200 million has previously been presented to the General Assembly. That estimate was based on providing phosphorus removal at 32 STPs (18 majors and 14 minors) primarily east of the fall line at their projected year 2000 design flow . Costs were expressed in total cumulative dollars (including inflation) spent over a ten year upgraded program (therefore, approximately a year 1990 dollar figure).

TABLE VI-2

TOTAL ESTIMATED O & M COST SAVINGS RESULTING FROM A BAN AT MAJOR TREATMENT PLANTS WITH PHOSPHORUS REMOVAL (Millions of Dollars/Year)

Basins	SDA [a]	WSSC [b]	EPA Criteria/ Virginia O&M Costs [c]	Task Force [d]
Potomac	0.66	1.98	2.42	0.68
Rappahannock	0.04	0.12	0.18	0.12
York	0.07	0.21	0.29	0.19
James	1.02	3.06	4.20	2.80
TOTALS	1.79	5.37	7.09	3.79

AVERAGE COST SAVINGS PER HOUSEHOLD ($/Household/Year)

TOTALS	1.38	4.16	5.49	2.94

a. Using SDA's savings estimate of $0.50 capita/year
b. Using the Washington Suburban Sanitary Commission's savings estimate of three times SDA estimate - use $1.50 capita/year.
c. The EPA Chesapeake Bay Program used a cost savings estimate of 15% of annual O & M costs. Use that percentage with the estimated annual O & M costs from Table VI-1.
d. The Task Force used cost savings estimates of 10% of annual O & M costs for plants meeting 1 mg/l, but only 3% for plants meeting 0.2 mg/l.

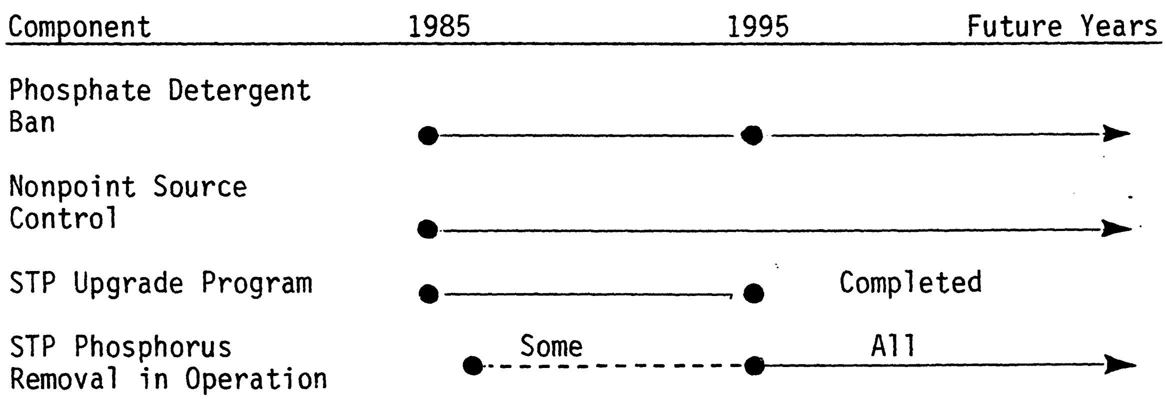
Assumptions:

All major sewage treatment plants have phosphorus removal.

estimates). It should be pointed out that most likely not all treatment plants will end up with phosphorus removal facilities so there would still be some phosphorus loading reductions from these other plants. Also, the sludge disposal problem in Virginia is becoming increasingly more complex. Some of the cost savings at the plant due to a ban are a result of some reduction in sludge needing final disposal. A ban does help alleviate some of the pressure on sludge disposal areas.

Summary

The Task Force concludes that the usefulness of a phosphate detergent ban in conjunction with other nutrient control strategies can best be illustrated by this time line:



A ban can be implemented in 1985, with immediate reduction in phosphorus loads achieved.

Nonpoint source control is an on-going program that should continue over the long term.

Phosphorus removal at sewage treatment plants requires large scale capital improvements which may take 10 years to complete.

Phosphorus removal at sewage treatment plants could begin as each plant is upgraded. Full operation of phosphorus removal could begin in 1995. At that time a decision can be made whether to continue or terminate a state or regional ban.

CHAPTER VII

A REVENUE SOURCE FOR UPGRADING TREATMENT PLANTS:

PHOSPHATE DETERGENT USER FEE

As discussed in Chapter VI, in order to achieve a substantial reduction in phosphorus loads to the Bay tributaries, sewage treatment plants would need to provide phosphorus removal. During the discussions last year on the Chesapeake Bay Initiatives a sewage treatment plant improvement program was projected for funding in future bienniums (1986-94). At that time it was estimated that approximately $110 million in State funds would be needed to upgrade the treatment plants.

During the Task Force's evaluation of a phosphate detergent ban, an alternative approach to the phosphorus loading problem as it relates to detergents was suggested. The alternative is to place a user fee or excise tax on the wholesale distributor of phosphorus detergents. The revenues collected by the State could help pay for the costs of upgrading and/or operating phosphorus removal facilities at the sewage plants.

The Task Force was first made aware of this concept through the Wisconsin "Information Verification Project on the Phosphate Ban Controversy". (See Appendix F - Recommendation number 5).

The Soap and Detergent Association has stated publicly that: (1) nutrient enrichment is a problem in the Bay and its tributaries as outlined in the EPA Chesapeake Bay Program study; (2) the problem can be most effectively dealt with at the sewage treatment plants, not through a ban; and (3) up to 25 percent of the phosphorus which goes into the sewage treatment plant comes from detergents. Through the use of a tax to pay for part of the capital and/or operating and maintenance costs, the detergent industry would pay for the part of the problem that their products are causing. With the tax alternative there would be no ban on the sale of phosphate detergents in Virginia stores.

It would appear most appropriate to impose such a tax on the wholesale distributor of the commodity. Administrative costs to collect the tax would be deducted from the revenues collected. Such a tax could be modeled on the State Litter Tax, the Cigarette Tax or some other option.

The Task Force has performed a preliminary cost analysis in order to estimate the amount of revenues that could be generated by such a tax. The size of the tax should relate directly to the share of the problem contributed by the detergent phosphate. There appears to be two options:

(i) Use 25 percent of the cost of phosphorus removal at the treatment plant since that is the percentage of the plant influent phosphorus originating from detergents, or

(ii) Use the actual cost of removal of the detergent phosphorus (this is less than 25 percent due to the nature of the chemical reactions involved and the sizing of treatment plant units).

Table VII-1 contains a preliminary analysis depicting the amount of tax per household and expected revenues. There is a wide range in the cost estimates for treating detergent phosphorus, so four different estimates are presented. The fifth estimate reflects 25 percent of the cost of phosphorus removal. Using the Task Force estimate a phosphate detergent tax could generate about $5.8 million per year.

Table VII-2 suggests a Virginia treatment plant upgrade program which incorporates the revenues derived from a phosphate detergent tax.

TABLE VII-1

PHOSPHATE DETERGENT USER FEE

Tax on Phosphate Detergent which would Recover Costs of Treating Detergent Phosphorus at Sewage Treatment Plants

Various Estimates	Annual Cost To Treat Detergent Phosphorus ($/Household) [a]	Tax on Phosphate Households ($/Year)[b]	Tax ($)			Phosphate Revenues Generated ($ Million) [e]
			Pound [c]	20 Oz Box [d]	5 lb,4 oz Box [d]	
SDA	1.38	2.06	0.02	0.03	0.10	2.7
Task Force	2.93	4.39	0.05	0.06	0.26	5.8
WSSC	4.17	6.21	0.07	0.09	0.37	8.0
EPA Criteria/Virginia O&M Costs	5.49	8.19	0.09	0.11	0.47	10.6
25% Total Cost[e]	11.73	17.51	0.20	0.25	1.05	22.7

[a] For the first four estimates see Table VI-2 for O & M costs of treating detergent phosphorus at Virginia treatment plants. The fifth estimate is based on using 25% (which is the percentage of the detergent phosphorus component in raw sewage) of the total annual cost to remove phosphorus (from Table VI-1: $17/capita/year). Thus, $17 x 2.76 persons/household x 0.25 = $11.73/household.

[b] Approximately two-thirds of Virginia households currently use phosphate detergent. Thus, these households would pay, through a tax on the phosphate detergent, the cost of removing the detergent phosphorus at the treatment plant. For the Task Force estimate,$2.94/household ÷ 2/3 = $4.39/household.

[c] Consumers do 8.1 washloads/week (P & G data) and assuming detergent usage of 3 1/3 oz./load. the annual amount of detergent used per household is: 8.1 loads/week x 52 weeks/year x 3.33 oz/load x 1 lb/16 oz. = 88 lbs. of detergent/household/year. Thus, the tax per pound would be (using the Task Force estimate): $4.39/household/year ÷ 88 lbs./household/year = $0.05/lb.

[d] A 20 oz. box of phosphate detergent retails for about $1.00 and a 5 lb. 4 oz. box for about $3.50.

[e] This analysis assumes a statewide tax. Regional options could be investigated.

TABLE VII-2

FUNDING SOURCES FOR TREATMENT PLANT UPGRADE PROGRAM

Revenue generated by a detergent tax, even with the lower estimates of $3 to $6 million, provides a substantial percentage of the funds needed to implement point source phosphorus controls at major sewage treatment plants located in the Chesapeake Bay tributaries.

Total Capital Cost to Upgrade Treatment Plants *	-	$200 million
Years to Complete Upgrade Program	-	10
Cost to State per Year	-	$15 million
State - 75 percent		
Local - 25 percent		
Source of Funds		
Detergent Tax	-	$3-6 million
Supplemental General Fund Appropriation	-	$9-12 million

* See note on Table VI-1.

APPENDICES

APPENDIX A

SENATE JOINT RESOLUTION NO. 54

SENATE JOINT RESOLUTION NO. 54

Requesting the State Water Control Board, the Chesapeake Bay Commission and the Virginia Cooperative Extension Service to study the costs and benefits of imposing a ban on phosphate detergents.

Agreed to by the Senate, March 8, 1984
Agreed to by the House of Delegates, March 6, 1984

WHEREAS, the U.S. Environmental Protection Agency has determined that much of the Chesapeake Bay and its tributaries are over-enriched with nutrients, including phosphorus; and

WHEREAS, the elimination of the use of phosphate detergent and phosphorus-containing cleaning agents would result in an immediate reduction of the levels of phosphorus being discharged into the Chesapeake Bay; and

WHEREAS, participants in the 1983 Chesapeake Bay Conference were informed that phosphorus discharges to the Bay and its tributaries would be reduced by twenty percent should a phosphate detergent ban be imposed; and

WHEREAS, considerable controversy concerning the costs and benefits of banning phosphate detergents and other phosphorus-containing cleaning agents exists; and

WHEREAS, other means of reducing phosphorus levels are available, such as the imposition of a phorosphorus discharge standard on sewage and industrial effluents, and the implementation of Best Management Practices for the control of non-point sources of run-off; and

WHEREAS, the State Water Control Board, the Chesapeake Bay Commission and the Virginia Cooperative Extension Service are currently examining the efficacy of a phosphate detergent ban; now, therefore, be it

RESOLVED by the Senate of Virginia, the House of Delegates concurring, That the State Water Control Board, the Chesapeake Bay Commission and the Virginia Cooperative Extension Service are requested to report to the Governor and the General Assembly by December 1, 1984, on the cost and benefits of imposing a ban on phosphate detergents and phosphorus-containing cleaning agents; and, be it

RESOLVED FURTHER, That the study report should include an analysis of the usefulness of a phosphate detergent ban in conjunction with other means of achieving goals for the reduction in phosphorus discharges in various segments of the Chesapeake Bay and its tributaries.

NOTE: The third paragraph in Senate Joint Resolution No. 54 should read:

WHEREAS, participants in the 1983 Chesapeake Bay Conference were informed that phosphorus discharges to the Bay and its tributaries would be reduced by eleven percent should a phosphate detergent ban be imposed;

APPENDIX B

TASK FORCE MEMBERSHIP

VIRGINIA TASK FORCE

TO REPORT ON A PHOSPHATE DETERGENT BAN

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APPENDIX C

PUBLIC FACT-FINDING MEETING

SUMMARY
PUBLIC FACT FINDING MEETING
PHOSPHATE DETERGENT BAN STUDY
AUGUST 21, 1984

A public fact finding meeting was held at 1:00 p.m. on August 21st at the Henrico County Board of Supervisors Meeting Room for the purpose of receiving comments from all interested parties on the costs and benefits of imposing a ban on phosphate detergents.

Mr. Larry G. Lawson, Director of the State Water Control Board's Office of Water Resources Management, opened the meeting by introducing the members of the Phosphate Detergent Ban Task Force. He then went over the procedures for the meeting. Alan Pollock, a State Water Control Board staff member, then made a brief presentation. This presentation covered the following areas:

- Findings of the Chesapeake Bay Report
- Reasons for consideration of a phosphate detergent ban
- Virginia's Chesapeake Bay Initiatives
- Senate Joint Resolution #54
- Task Force activities.

Mr. Lawson then proceeded to call speakers according to the order in which they registered. The speakers and a brief summary of their comments are given below.

Mrs. Maxine P. Yoffe - President: D.C., Maryland, Virginia Coin Laundry Association

- The Association supports sensible programs to clean up the Chesapeake Bay by upgrading sewage treatment plants (STPs).

- The Association does not support a detergent phosphate ban because it would be a financial hardship for coin laundromat owners and their customers.

- A phosphate ban would cause machine repair bills to increase as non-phosphate detergents leave a cement-like residue that clogs the tub and filters. Also, because non-phosphate detergents do not clean very well, customers use more hot water and more water in general, increasing utility bills.

- A ban would increase costs to customers and laundromat customers tend to be in the lower income groups.

Mr. Keith Booman - Technical Director: Soap and Detergent Association

- Consumer costs of a ban are already in the Task Force file. He stressed that the adverse impact due to the widespread presence of iron in well water had not been quantified.

- 20-25 percent of the phosphorus in raw sewage comes from detergents. A ban would reduce the phosphorus loading from sewage treatment plants by similar percentages. If phosphorus removal is instituted at these STPs, a ban will not effect effluent discharges at all.

- Chesapeake Bay Program data shows a ban alone is not an effective tool for nutrient control. Further, it is not generally cost-effective when compared to alternative approaches such as nonpoint source control and phosphorus removal at STPs.

- A detergent phosphate ban would contribute negligible environmental benefits to the State of Virginia.

Dr. Wu Seng Lung - Dept. of Civil Engineering, University of Virginia

- There has been an appreciable decrease in phosphorus loading from STPs from 1980 to 1983.

- Nonpoint sources (NPS) dominate total loading of phosphorus. This dominance is even greater in wet years when runoff is very high and point source loading remains fairly constant. The increase in NPS loading during wet years more than offsets any reductions which may result from point source controls. He was not suggesting that point source controls may not be needed as everything chips in to clean up the Bay. James River contributes significantly to the total loading to the Bay. However, flow from the James flushes out rapidly to the ocean as opposed to staying within the Bay area. Data from the 1983 water quality monitoring work indicates that in the estuary, phytoplankton growth is light limited due to the high turbulance of the water. A tremendous reduction in phosphorus loading would be necessary in order to reach a level where the system is phosphorus limited. The reduction that would result from a phosphate detergent ban does not even approach that level.

Thomas N. Lash - Associate: Rummel, Klepper and Kahl (for SDA)

- His firm has developed cost estimates for upgrading several Virginia sewage treatment plants to achieve phosphorus removal. They had previously done work estimating the cost for phosphorus removal in Maryland. The costs are based on the addition of chemical feed and sludge drying facilities and are as follows:

Plant	Flow	Capital Cost	Cost/Capita/Year
Hopewell	50 MGD	\$4.7 million	\$1.30
Richmond	70 MGD	\$8.2 million	\$1.60
Lamberts Points	35 MGD	\$1.3-2.0 million	\$0.50-0.80

John P. Kidd - Executive Director: Richmond Planning District Commission

- In January, 1984, the RRPDC adopted a resolution and sent it to the General Assembly. The resolution recognized that phosphorus is the key nutrient adversely affecting the James River and Chesapeake Bay and that removal of large amounts of phosphorus prior to its introduction into wastewater systems appeared to be the most cost effective control means. The Commission recommended that phosphorus limits not be imposed in NPDES permits unless the General Assembly first considered a phosphate laundry detergent ban.

- The Commission considers James and Upper James Estuary as important as the Bay itself. They think that a phosphate detergent ban is advisable for Upper James Estuary.

- The James River Monitoring Study has been the most extensive of any monitoring work in the State. Scientists have indicated that during summer low flow, high temperature conditions, the Upper James River Estuary is phosphorus limited.

- Nonpoint sources are significant, but politically difficult to control in Virginia.

- Capital costs of phosphorus removal are $23 million for Chesterfield County (2025 flows) with annual O & M costs of $1.5 million. After 1990, phosphorus removal for the City of Richmond would be approximately $68 per household per year.

- Sludge generated by STPs in Richmond area is a very controversial land use issue with costs associated from a political and social aspects as well as economic. A 1.0 mg/l phosphorus limit on all Richmond area STPs would roughly double the tonnage of sludge generated.

<u>Dr. Bruce Neilson - Virginia Institute of Marine Science</u>

- Nobody really knows what amount of phosphorus that enters the James River leaves and goes into the Chesapeake Bay. Concern should focus on the tributaries to the Bay as well as the Bay itself.

- Maximum turbidity in the James is in the area of Jamestown Island. Most algal blooms occur above this area because turbidity is not as high.

- In talking to civic groups, many individuals want to know what they can do to clean up the Bay. A phosphate detergent ban is one way individuals become involved.

- Many lakes in Virginia as well as the Chowan River experience eutrophication problems as well.

<u>W. Thomas Hudson - Virginia Manufacturers Association</u>

- VMA would oppose any legislation or regulation banning phosphate detergent.

- Consumers prefer phosphate detergents by a 4:1 margin. Phosphate detergents have been found to be more effective by consumers and by various studies.

- Phosphate detergents cause less wear and tear on clothing as well as machines and equipment.

- A phosphate detergent ban would result in a very small change in phosphorus loading and would provide no significant water quality improvement. Non-point sources play a much larger role in phosphorus loading to the Bay (75% in the James River during wet years).

- A phosphate detergent ban may have some allure as it would not cost government anything. However, consumers (taxpayers) would still have to pay the cost. Alternative methods of phosphorus control are more cost effective.

Jolene Chinchilli - Senior Scientist: Chesapeake Bay Foundation

- Cleaning agents such as laundry detergents are a significant source of phosphorus entering the Bay from point sources. The CBF supports the implementation of a phosphate detergent ban statewide or basinwide as part of a more comprehensive strategy for reducing the amount of phosphorus entering Virginia's receiving waters. CBF does not support a phosphate ban as a substitute for moving aggressively towards the implementation of phosphorus removal at sewage treatment plants.

- A phosphate detergent ban can be implemented relatively soon and it can effect an almost immediate reduction in the amount of phosphorus in treatment plant effluents. It would serve to keep future increases in phosphorus loadings from STPs to a minimum and would also reduce costs associated with phosphorus removal.

- A ban would likely make citizens more aware of the ultimate impact their individual activities have on the Bay.

Patti Jackson - Executive Director: Lower James River Association

- LJRA recommends initiation of planning for phosphorus controls at major STPs and implementation of a ban on detergents exceeding 0.5 percent phosphates in the James River Basin.

- A phosphate ban would produce an immediate phosphorus reduction of approximately 18 percent in the James River. This would reduce phosphorus loads by 682,000 pounds now with a projected reduction of over 1,000,000 pounds by the year 2000.

- A phosphate detergent ban represents a more economical means of phosphorus removal than of pipe treatment. The cost per pound of phosphorus removed by a phosphate ban is \$2.82 compared to \$3.80-\$4.13 per pound removed at a sewage treatment plant.

With the exception of Mr. Hudson and Dr. Neilson, all of the speakers provided written copies of their presentations/reports. In addition, a number of written comments were received for the meeting record. Listed below are the persons presenting written comments with a brief description of the comments.

D. R. Wheeler - Director of Water Quality: Hampton Roads Sanitation District

- Mr. Wheeler presented a copy of "A Report on Potential New Facilities for Nitrogen and Phosphorus Removal at Hampton Roads Sanitation District Wastewater Treatment Plants" which projects costs for upgrading and maintaining phosphorus control facilities. This report projects the cost to upgrade the Lamberts Point STP for phosphorus removal to be $16.7 million.

Dr. Theo A. Dillaha - Water Quality Engineer: Virginia Tech

- Dr. Dillaha endorses a phosphate detergent ban as an important first step to improve the water quality of the Chesapeake Bay.

Todd G. Schwendeman - Bowie, Maryland

- Mr. Schwendeman supports the Phosphate Ban Bill in Maryland and also supports any similar measure in Virginia.

Patrick J. Brady - Director: Henrico County Department of Utilities

- If phosphorus removal is required at the Henrico Regional STP, a phosphate detergent ban could translate to an annual savings in chemical costs approaching $470,000. If a ban is imposed, the State should provide sufficient monitoring to determine its effects on the water quality of the Chesapeake Bay.

W. Lee Fleming, Jr. - Chief of Water Quality Section: North Carolina Department of Natural Resources and Community Development

- The North Carolina Water Quality Section has conducted an extensive literature review, discussed the issues with industry and university scientists, and visited states where bans have been implemented. Based on available information, the WQS supports a ban as a cost effective first step in addressing the water quality problem of phosphorus over-enrichment. A phosphate detergent ban in the Virginia portion of the Chowan River Basin would help achieve the phosphorus reductions needed to improve water quality in the lower Chowan River.

David H. Welchons - Director of Utilities: Chesterfield County

- If it has been determined that there is a need to reduce the phosphate loading to the Chesapeake Bay and its tributaries, then the first step should be banning the continued use of phosphate detergents. If it is determined that additional phosphate removal is needed at STPs, the ban of phosphate removal is needed at STPs, the ban of phosphate detergents should still be required since it will reduce the costs associated as well as the sludge generated.

Bonnie M. Hudgins - Homemaker

- She does not buy any detergent containing phosphates and believes that private individuals do make a difference to the Bay. She supports a ban.

Dr. G. K. Williams - The Procter and Gamble Company

- Dr. Williams presented information providing details on the impact a detergent phosphate ban would have on Virginia consumers. They estimate a ban would result in an additional cost to consumers in Virginia of $54,000,000 per year or $27.80 annually per household.

Alan F. Cassel - Chief of Water Pollution Control Division: Arlington County

- They do not believe a phosphate ban would significantly reduce phosphorus in their effluent. (They currently operate phosphorus removal facilities.) Operational cost savings from a ban would be minimal; estimated to be an average of $0.45 per resident per year. They see little benefit of a phosphate ban for Arlington County.

Rebecca P. Lovingood - Associate Professor: Virginia Tech

- Powdered, built, non-phosphate laundry detergents contain sodium carbonate which forms an insoluble precipitate when combined with hard water. This results in problems such as "tattle-tale" grey, lint deposits, and a build-up of a hard, calcium carbonate scale on washer tubs and components. The liquid, built laundry detergents contains sodium citrate, which does not form a precipitate but soil removal per unit cost is less effective.

- She is not convinced that a statewide ban on phosphates in laundry detergents would solve the problems of the Chesapeake Bay. In addition, such action seems discriminatory to residents in watersheds that do not drain into the Bay.

Dr. Glenn Kinser - Supervisor of Annapolis Field Office: U.S. Fish and Wildlife Service

- Based on the findings of the Chesapeake Bay Report, they believe that a ban on phosphate detergents is a logical first step in an effective nutrient control program.

Appendix D

Bibliography

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APPENDIX E

INFORMATION VERIFICATION PROJECT

ON THE PHOSPHATE BAN

INFORMATION VERIFICATION PROJECT
ON THE PHOSPHATE BAN CONTROVERSY

SUMMARY REPORT

July 31, 1984

WISCONSIN CENTER FOR PUBLIC POLICY
1605 Monroe Street, Madison, Wisconsin 53711 Telephone (608) 257-4414

FINDINGS

1. A very large proportion of Wisconsin's sewage, including household wastewater, is being treated in about 600 treatment plants at relatively low cost. Fifty-five of these plants, generally in larger muncipalities, include phosphorus removal capability.

   The contribution of household detergents to the total phosphates in point-source wastewater is relatively small, perhaps about 20 percent. Eighty to ninety percent of this phosphorus can be removed by effectively operated, advanced treatment plants. The cost attributable to the treatment of detergent phosphorus appears to be about $1 per capita per year.

   Purification standards are 1 milligram of phosphorus per liter of discharge. In Wisconsin still more rigorous standards seem reasonable without greatly increased costs. In 1980 the average effluent phosphorus concentration for plants removing phosphorus was 0.66 mg/liter.

2. Studies of the effects of bans in other areas have only limited application to the Wisconsin situation. Early studies measured the effects when the detergent phosphorus content was 12 percent, considerably higher than is now the case. Many bans were initiated simultaneously with improvements in wastewater treatment so the effects of the ban alone could not be isolated. Furthermore, lake loadings and ecologies vary widely, making generalizations from one lake to another very uncertain.

3. The laundry detergent ban in effect in Wisconsin from 1979 to 1982 reduced phosphorus loading to treatment plants by 6 to 32 percent. However, studies failed to prove that the ban measurably improved the water quality of the state's lakes and streams. Failure may be attributable to the small magnitude of the detergent contribution to total phosphorus in wastewater effluent before the ban; to lack of adequate time for measuring water response; to a lack of pre-ban data; to a lack of research money to carry out the necessary studies; or to other factors.

4. A ban, of course, makes a difference where there is untreated or inadequately treated water such as combined sewer overflows, infiltration, septic systems which are failing or defective, treatment plants without phosphorus removal capability, etc. This difference has not been measured, and is very difficult to estimate.

5. Reduced phosphorus loadings attributable to detergent controls result in modest reductions in chemical costs of treatment. Reductions in sludge handling costs may also result in a savings, but the actual amount has not been determined.

6. Phosphorus as used in detergents is an effective, even superior, laundering agent, especially when hard water must be used. Alternative ingredients are available and in growing use. While only 22 percent of United States households are located in ban areas, 40 percent of households report using non-phosphate detergents.

When a ban on phosphate detergents is imposed, some consumers change their laundering tactics in such a way as to increase their cost for additives, hot water, etc. Estimates suggest a minimum of 3.6¢ per load in additional costs. In addition, there may be increased costs to the consumer for fabric wear and machine wear, but such have not been adequately quantified. In areas where water supplies are considered hard (10 grains), many households and commercial laundries use water softeners or water softening agents. This greatly reduces the deposit of carbonate materials which occur when carbonate based detergents are used. The total amount of such additional costs is disputed but they would seem to be at least several times the cost per household of removing detergent phosphorus at treatment plants.

7. The relative "biological availability" of phosphorus from various sources may be a relevant factor. Experts disagree on how much phosphorus is actually available for phytoplankton growth since some is chemically bound, and therefore either unavailable or only slowly available for biological assimilation. While some report that point sources are more bio-available, others suggest that non-point source phosphorus may reappear in an available form after some years; for example, from bottom sediments. Bio-availability depends on complex interactions of type of source, time of year, flow of water, soil, etc.

CONCLUSIONS

The Great Lakes area in general, and Wisconsin in particular, have a special responsibility for ensuring high quality water in our lakes and streams. The economic and recreational benefits of our fresh water supplies are incalculable and there are important aesthetic and social benefits.

At best "the ban" can produce only limited results in decreasing the amount of phosphorus entering Wisconsin waterways. At worse, the increased household laundry costs to the consumer resulting from "the ban" are irritating and discriminatory. Neither effect seems significant enough in relation to the overall question of water quality to warrant the attention it has received and the acrimony it has generated.

Water quality management is gradually shifting from pollution control to resource management. But until sewage treatment facilities are sufficiently upgraded and widespread to ensure adequate phosphorus removal and until non-point pollution controls are widely in place, a ban can contribute somewhat to a reduction in phosphorus entering the state's waterways.

On the other hand, consumers have a right to question why some are asked to bear the increased costs resulting from the ban when others are not. A ban on the use of phosphates in household laundry detergents appears to cost more, in narrow economic terms, than removal of the phosphates at treatment plants. A nationwide phosphate limit or tax would spread the burden. Increased taxes for pollution abatement would lessen the time period during which a ban is needed. Increased detergent prices to cover research into more effective substitutes would likewise spread the costs. Better consumer education on ways to launder successfully with less phosphorus also would help.

In summary, the spotlight on detergent phosphorus may have deflected attention from the total complex of cause-effect relationships. This does not mean that "the ban" has been useless; it has just not been useful enough. Nor does it mean that extra household laundry costs are not justified; they are part of the pollution abatement costs.

RECOMMENDATIONS

Based on the information presented at the Information Verification Hearing and on the documents submitted in testimony, the panel has developed a set of recommendations regarding the phosphate controversy. These recommendations reflect the panel's thinking about current and future aspects of the problems discussed at the hearing. However, because our information was limited solely to the evidence and arguments raised as part of the process, we wish to stress that these recommendations are limited to the scope of the information we were directed to consider.

Panel Recommendations

1. An effective strategy of phosphorus control must be based on a comprehensive analysis which takes account of all major sources of phosphorus loading, both "point" and "non-point".

2. For further control of "point" sources we should:

    a. Complete the improvement of existing water treatment facilities to meet present standards of phosphate removal;

    b. Consider the construction of treatment plants or use of phosphorus removal techniques at smaller communities;

    c. Consider raising the minimum standards for removal.

3. As chemical treatment from "point" sources becomes more effective and widely applied, pollution from "non-point" sources will become the major control target. We should:

a. Increase state and federal resources for assessment of priority watersheds, and for development improved methods of "non-point" control;

b. Develop more educational and demonstration projects for control of agricultural and urban runoff, particularly where owner benefits can be demonstrated;

c. Consider low-cost loans, tax incentives and compulsory requirements where owner benefits are less apparent to control diverse pollution sources.

4. Increase funding for studies of Wisconsin lake and stream ecology to better determine which waterways are at risk from what sources.

5. Consider alternatives to the banning strategy, including:

   a. Setting a limit on the amount of phosphorus in detergents, including dishwasher detergents; and/or

   b. Taxing phosphorus products to deter their use and to help pay for control.

6. If a ban is to be continued, or strict limits imposed, any exemptions should be critically examined to insure that they are technically, not merely politically, justified.

8. Research on the question of "bio-availability" should be strengthened.

9. The problem of phosphate pollution cannot be solved finally on a state-by-state basis. Lakes and streams are not confined by state boundaries, nor is the commerce in phosphate products. The Federal government should substantially increase attention and action on this problem.

Appendix F

Glossary

ALGAE - Simplest green plants having neither roots, stems, nor leaves; those in fresh water are usually microscopic in size.

ALGAE BLOOM OR ALGAL BLOOM - Very rapid growth of algae with formation of large concentrations which sometimes form floating mats or dinstinct coloration of the water.

BEST MANAGEMENT PRACTICES (BMPs) - A practice, or combination of practices, that is determined by the State after problem assessment, examination of alternatives, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals.

CHLOROPHYLL - A green pigment present in algae and higher plants which absorbs light energy used in photosynthesis.

D.O. - Dissolved oxygen required for the maintenance of aerobic aquatic organisms.

EUTROPHIC - Waters with high rate of nutrient supply and resulting high levels of organic production.

EUTROPHICATION - A process in which nutrient levels and productivity of a water body increase, often resulting in depletion of dissolved oxygen, and reduced species diversity; an overenriched condition.

MGD - million gallons per day

mg/l - milligram/liter

NITROGEN - An essential nutrient that is often present in wastewater as ammonia, nitrate, nitrite, and organic nitrogen.

NONPOINT SOURCE - Causes of water pollution that are not associated with point sources, such as agricultural fertilizer runoff, sediment from construction sites, or runoff from streets and parking lots.

NUTRIENT - A chemical element or compound which promotes the growth and development of organisms.

PHOSPHORUS - An essential food element that can contribute to the eutrophication of water bodies.

POINT SOURCE - Any discernable, confined, or discrete conveyance from which pollutants are or may be discharged, such as at a sewage treatment plant.

SEWAGE TREATMENT PLANT (STP) - The central facility of wastewater treatment facilities which contains all treatment processes exclusive of the collector facilities.