

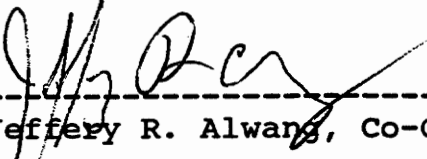
**An Analysis of the Ability of Virginia's Water Systems
to Finance System Improvements**

by
Janet R. Hunter

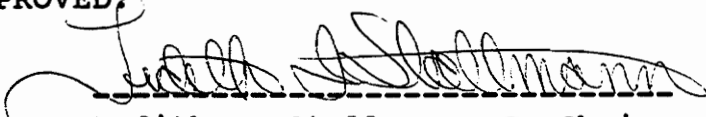
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AN ANALYSIS OF THE ABILITY OF VIRGINIA'S WATER SYSTEMS TO
FINANCE SYSTEM IMPROVEMENTS

by

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(ABSTRACT)

The Safe Drinking Water Act and its 1986 Amendments are expected to result in increasing costs for water systems. The ability of systems to finance the required improvements is examined. The financial needs of water systems are examined to determine if needs vary by system ownership or system size.

Increased water rates are expected as a result of financing system improvements. The increase in rates is predicted, and the effect of increased rates on low-income households is examined.

The study concluded that the problem facing Virginia's water systems is not an inability to finance system improvements. The increased rates expected as a result may, however, impose hardships on low-income households.

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CHAPTER 1

INTRODUCTION

More than 200,000 Virginians relied on unsanitary water sources in 1985 (Weigmann and Kroehler, 1988). The majority of these citizens lived in rural areas served by individual wells, and in small communities served by privately owned or local government-provided systems. Small rural systems often use inadequate and/or outdated equipment. Many of Virginia's citizens still face the same problems today.

THE SAFE DRINKING WATER ACT

The Safe Drinking Water Act (SDWA) (PL. 93-523), 1974, requires public water systems to meet standards that are designed to protect the public health by ensuring access to safe drinking water.¹ In Virginia, the costs of improving

1

A public water system is defined by the SDWA (sec.300f(4)) to be a system that serves the public, having at least fifteen connections, or serving an average of twenty-five individuals for at least sixty days out of the year. See Appendix 1.1 for definitions of types of water systems.

existing systems to meet the SDWA regulations are high; estimates range up to \$143 million annually (Virginia Water Commission, 1990). Some funds are available to publicly-owned systems for the purpose of improving infrastructure.² Small privately-owned and individually-owned systems are not eligible for many of these public funds. (Table 1.1 provides examples of system types and ownership.)

Small systems, both publicly- and privately-owned, lack the scale of operation that helps to keep costs per household low in more densely-populated areas.³ Water systems are presumed to be characterized by economies of scale, so that as size of operation increases, average production costs continually decrease. Thus, large water systems are expected to have lower costs per unit (gallons of water) than smaller systems. Additionally, rural systems generally experience diseconomies of transporting water because the long lines with few connections result in high costs per connection.

2

Public systems can be either publicly-owned (by the locality) or privately-owned. The term "locality" refers to local governments, i.e., cities, towns and counties. The majority of the privately-owned systems in Virginia are housing developments or trailer parks. Public water systems are termed "waterworks" in Virginia.

3

Sixty percent of Virginia's water systems serve fewer than 200 people (Task Force, 1990).

Table 1.1

Waterworks Owners by Government Ownership Form and Type

Category of System Owner	Community	Nontransient Noncommunity
Local governments	Cities Towns Counties Authorities Jails	Public Schools Municipal Offices
State government	Correction Centers Hospitals Colleges	Highway Shops State Police HQs Community
Colleges	State Parks	State Parks
Federal government	Defense Installations NASA	Federal Reserve Facilities National Parks Army Corps of Engineers
Investor	Subdivisions Trailer/Mobile Home Parks Private Water Cos. Boarding Schools Nursing Homes	Factories Mines Resort Hotels Day Care Centers Private Schools

Private/Individual	Private home systems	

Source: Virginia Department of Health, 1990a.

The 1986 Amendments to the SDWA

The Safe Drinking Water Act of 1974 defined 23 contaminants to be covered by regulations. The 1986 Amendments have resulted in a total of 83 new regulated contaminants starting in 1988, with 25 being added every three years, beginning in 1991. The 1986 Amendments also require the EPA to specify criteria for the filtration of all surface water supplies and criteria for disinfection of all water supplies. The 1986 Amendments add considerable cost to water systems. The EPA estimates that nationally over 6,000 water systems will have to install additional water treatment facilities to meet the 1986 standards for organic and inorganic substances, 11,000 will be affected by filtration requirements, 43,000 will need corrosion control alternatives, and 10,000 will be required to develop public-education programs on the health impacts of lead (Hurd, 1989).

Virginia waterworks owners testified to the Virginia Water Commission (1990) that they would require \$51 to \$143 million annually in order to comply with the new amendments. These costs would be passed on to the consumers at additional annual costs of \$5, for customers of large systems which are already in full compliance with SDWA regulations, to as much as \$1284 per household in smaller

systems affected by the new regulations.⁴ (Nationally, the "typical" residential water bill is \$220.50 per year for an average annual use of 100,400 gallons, with the "typical" household spending less than one percent of annual income for water, wastewater and waste disposal (Capsules, 1991).

PROBLEM STATEMENT

Recent reductions in federal funding for water projects, at a time of increased standards has resulted in financial problems for many small rural water systems. Ryan (1987) reports that, nationally, funding needs are greatest in communities of less than 2500, and in unincorporated communities.

Since 1977, the share of construction and infrastructure improvement costs borne by local governments has increased dramatically (Ryan, 1987). Before 1990, the Environmental Protection Agency (EPA) provided 75 percent of the costs associated with water treatment construction and upgrading as a part of its Construction Grants Program. This program is scheduled to be completely phased out by 1995. The federal government has provided \$8.4 billion

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This estimate is a little higher than that of Dyksen and Westerhoff (1987), who estimate costs (nationally) to increase \$91 per household per year for systems serving 25-500 people, to \$3 pe household per year for systems serving over 50,000.

which is to be used to set up state revolving loan funds (Ryan, 1988). By 1995, state and local governments are to assume complete responsibility for financing construction and improvement of waterworks (Ryan, 1988). These major changes in funding patterns mean that state and local governments will have to find alternative sources of revenue. The 1990 Virginia General Assembly recommended the provision of additional revenue in a loan fund or as grants to help local governments with limited revenue sources in order to reduce the burden on these communities.

Some funds are still available from the federal government for publicly-owned systems. The Federal Farmers Home Administration provides loans and grants to communities of less than 10,000. Funding may also be obtained from the Department of Housing and Urban Development Community Improvement Grants, or Economic Development Administration Grants and Loans.

Virginia provides funds for water system improvements through the Virginia Resources Authority, the State Water Control Board, and the Virginia Health of Department. The Virginia Water Project, Inc., a private organization, also provides funds. Some of the Virginia programs provide grants to low-income families.

Funds available from federal and state sources are not sufficient to cover all costs expected to be incurred in

meeting the requirements of the SDWA Amendments. As a result, waterworks owned by local governments may need to recover costs of meeting the SDWA regulations from such sources as taxes or other assessments, General Assembly appropriations or increased water rates (user fees).

Many waterworks owners are individuals or businesses that provide water as a part of doing business. For example, developers may be required to provide water services to homeowners in their communities. Private systems serving groups such as developments, trailer parks and apartments are funded through increased rents and lot fees. These privately-owned systems are not eligible for government grants, although the Task Force on the Proposed Drinking Water Protection Fund (1990) proposed that they be eligible to receive loans. Alternatives for funding water system improvements are limited for privately-owned systems.

Problem Summary

Amendments to the Safe Drinking Water Act have greatly increased the number of regulated contaminants. In Virginia, the costs of improving existing systems to meet the SDWA requirements are estimated to be high, particularly for small systems, which lack the scale of operation that helps to keep costs per household low in more densely populated areas.

Government loans and grants have declined as a source of funding water system improvements in recent years. This decline has resulted in concerns that systems will have difficulty raising the initial funds needed to pay for the required system improvements.

A second area of concern is the effect that payment of interest and principal on loans or bonds will have on water rates. Economic efficiency requires that users pay the costs of production and improvement of water systems, but equity concerns require consideration of the effect this would have on low-income households.

OBJECTIVES

1. To compare the cost of physical needs for water system improvements to ability of localities to pay.

1a. To summarize and describe the distribution of estimates of financial needs to meet SDWA requirements.

1b. To examine the ability of local systems to pay for water system improvements.

(i) To describe factors that impact a locality's ability to pay: fiscal stress level, current debt level, and ability to obtain loan or grant funds or issue bonds.

(ii) To describe factors that affect water system costs: debt servicing costs, operation and

maintenance costs.

2.To consider the impact of increased water rates on individual households.

2a. To determine the effect of costs of system improvements on water rates.

(i) To predict rates required to pay for water system improvements.

(ii) To compare current rates with predicted rates.

2b. To summarize the effect of increased rates on households at different income levels.

2c. To discuss any equity effects that may result from increased rates.

Summary

Statistical analyses will be used to provide a clearer and more objective understanding of what the actual impact of the 1986 Amendments to the Safe Drinking Water Act will be on public water systems in Virginia. Estimates of the impact on water rates will be made to determine any significant changes in the cost of water, particularly in relation to low-income consumers.

CHAPTER OUTLINE

Chapter 2 describes the institutional environment. The

types of systems authorized to provide water services in Virginia will be described, and legal constraints on funding sources will be noted. This chapter includes a review of the various sources of funding available to different types of systems, including intergovernmental loans and grants.

Chapter 3 provides a review of economic theory related to the cost structure of water systems. The review of economic theory provides a basis for the analysis and discussion provided in Chapter 4.

Chapter 4 provides an analysis of the data. The expected costs of meeting the requirements of the 1986 Amendments for various systems is compared to their ability to pay. Rates required to cover the costs of meeting the requirements are predicted. The effect of predicted rate increases on households at different income levels are considered. Any significant effects on low-income households are discussed.

Chapter 5 summarizes the results of this study.

CHAPTER 2

THE INSTITUTIONAL ENVIRONMENT

The purpose of this chapter is to describe the different types of water systems authorized to serve the public in Virginia, the provisions governing and regulating each, and the sources of financing available to each. The identification of the possible financing sources and limits for each type of system will help determine which type of system faces the greatest difficulty in meeting the requirements of the Safe Drinking Water Act (SDWA). First, types of publicly-owned systems are described, including regulations they face regarding authority to tax and issue bonds. Second, the special regulations covering privately-owned systems are discussed. Third, various sources of funding available to water systems are described.

There are several authorized institutional arrangements for the provision of public water in Virginia. These are local governments (city, town and county), sanitary districts, public facility districts, service districts, water authorities, and privately-owned water companies. Table 2.1 provides a break-down of the number of different

Table 2.1
Community Waterworks by Size and Owner

<u>Owner Category</u>	<u>Number of Waterworks by Size</u>			
	<u>Small</u>	<u>Medium</u>	<u>Large</u>	<u>Total</u>
Local Government				
Authority	175	9	16	200
City	18	10	28	56
Town	112	34	9	154
County	88	7	8	104
	----	---	---	----
Total local government	393	60	61	514
State government	29	1	0	30
Federal Government	20	7	5	32
Investor	937	2	3	942
Other	69	0	0	69
	----	---	---	----
Total Systems	1,448	70	69	1,587

Source: Virginia Department of Health, 1990c.

types of water systems operating in Virginia as of 1990.

PUBLICLY-OWNED WATER SYSTEMS

Publicly-owned systems are eligible for several federal and state funding programs. A detailed description of loan and grant programs is provided.

Publicly-owned water systems are governed and given authority by the Virginia Constitution and/or the Code of Virginia. These documents provide for the generation of funds by bond issue and taxing. Public systems face different limits on the use of debt and the type of bond that can be utilized. Public systems also differ in the authority to tax. The limits of debt and the authority to tax are described below.

In order to raise funds, cities, towns and counties may issue bonds in the market for municipal securities. The term "municipal securities" refers to all publicly-offered state and local debt. Each bond issue is given a rating, indicating the relative credit quality of that issue.

(Small issues can often be marketed on a non-rated basis.) General obligation bonds (defined below) generally carry a higher credit rating because they are backed by a pledge of "full faith and general credit." Earnings on municipal bonds are exempt from federal taxes, and also from many state taxes. As a result, investors are willing to accept

lower yields on municipal bonds.

The Constitution and Code of Virginia place limitations on the issuance of bonds by publicly-owned water systems. The Code of Virginia distinguishes two types of bonds: general obligation bonds, and revenue bonds. General obligation bonds are defined as bonds that are paid by ad valorem taxes (e.g., sales taxes, payroll taxes). General obligation bonds may be additionally secured by a "pledge of revenues, special assessments or funds derived from any other source (Sec. 15.1-172)." For example, special property taxes may be imposed for the payment of principal and interest on general obligation bonds.

Revenue bonds are bonds for which only the revenues of a project financed or refinanced by such bonds are pledged to pay principal or interest. A portion of the bond may be used for operational expenses. It may be stipulated by the bondholder as a part of the bond issue that rates, fees and charges for services be maintained at a level sufficient to produce revenue ⁵to pay operation and administrative costs, insurance, and interest and principal on the bond.

5

The term "localities" refers to local governments, i.e., cities, towns and counties, unless otherwise specified. When the Constitution or Code of Virginia refers only to specific types of localities, the specific type of locality will be indicated.

Local governments

The Constitution of Virginia (Article VII, Sec. 10) provides for three forms of local government. These three forms are cities, towns and counties. Local governments (localities) are authorized to provide various types of public services, such as the provision of water supply, sewer services, fire protection, and police protection.

Localities are eligible to exercise only those powers explicitly granted them by the State Constitution, State statutes and individual city or town charters. Counties do not have charters. Instead, the Constitution of Virginia provides for county government and gives the General Assembly wide powers over them. Cities, towns and counties differ in powers of taxation and authority to issue bonds. Taxes may be used to pay any debts or expenses incurred in conducting necessary government functions, including the provision of these services. Cities, towns and counties may use the following types of tax: real estate taxes, taxes on tangible personal property, business and automobile license taxes, amusement admissions taxes and excise taxes. Both general obligation and revenue bonds as described above may be utilized to generate the funds necessary for the provision of authorized services.

Cities and Towns

Virginia has a separation of cities from counties that differs from most other states. Cities and counties are separate entities with no overlapping jurisdictional boundaries. They are considered equal levels of government (Jennings, 1975). Cities have certain powers specifically granted to them by the Constitution and Code of Virginia regarding taxation and provision of public services.⁶ The Code of Virginia provides for the "production, distribution and transmission of water, including establishment of facilities and equipment" by cities (Sec. 15.1-854). In addition, each city has its own individual charter tailored to the city's particular needs. When the Code of Virginia conflicts with the charter, the charter takes precedence.

ISSUANCE OF BONDS

A city can issue either general obligation or revenue bonds only after a public hearing is held. This hearing must be held prior to the initial resolution or adoption of an ordinance by the governing body of the city regarding the

6

To become incorporated, an unincorporated town or densely populated community must have a population of at least 1000, but less than 10,000. A city must have a population of 10,000 or more.

bonds to be issued.⁷ Total debt may not exceed ten percent of a city's assessed valuation of taxable real estate.⁸ Revenue bonds, described as follows, are specifically excluded from this debt limit.

- (1) revenue bonds or other obligations issued in anticipation of revenues, provided that these mature within one year of the date of issue, are not past due and do not exceed the revenue for each year
- (2) bonds for a water supply or other specific undertaking from which a revenue may be derived
- (3) bonds for which the principle and interest are paid exclusively from the receipts and revenues of a water system or other specific undertaking
- (4) contract obligations for a period of more than one year or a publicly-owned or controlled project authorized by interstate compact, the General Assembly or special act

Thus, for water systems financed by revenue bonds, there is

7

The Public Finance Act of 1971 describes the manner in which cities may issue bonds (Code of Virginia, Sec.15.1-170).

8

A 1980 Amendment to the Constitution lowered the maximum indebtedness for cities and towns from eighteen percent to ten percent (Virginia Constitution, 1991, c.668). The City of Danville is excepted from this ruling in accordance with its charter (Code of Virginia, sec.15.1-227.35).

no debt limit.

The term "towns" refers to incorporated towns. These are towns which have attained a minimum population level and meet requirements as defined in the Constitution of Virginia.⁹ Towns are not considered separate entities, but are part of the surrounding county, and exist primarily to provide local services to more densely populated pockets within counties. Town residents are subject to both county and town taxes. The pattern of each town government is set forth in the town charter (Jennings, 1975). Towns can perform services and enact ordinances as permitted by their charter and by general state law.

Towns are authorized to operate water systems and to issue debt in the same manner as cities, and are subject to the same debt limits.

Counties

Counties are defined and given powers by the Constitution and Code of Virginia. Counties serve a dual role as agent of the state and local governmental body. Like cities and towns, counties are authorized to provide many public services, including water.

9

To become incorporated, an unincorporated town or densely populated community must have a population of at least 1000, but less than 10,000 (Constitution of Virginia, Article VII).

The power of counties to issue bonds differs from that of cities and towns. The Code of Virginia describes regulations regarding bond issues by counties (Sec.15.1-185 through 15.2-191). A county cannot issue bonds for any particular project or issue general obligation bonds, unless approved by referendum.¹⁰ Bonded debt may not exceed eighteen percent of the assessed valuation of taxable property in the county. This limit includes the indebtedness of any town or district in that county empowered to levy taxes on real estate.

Counties may elect, upon approval of voters of the county, to be treated as a city for bond purposes. When treated as a city, the county is subject to Code of Virginia provisions related to bond indebtedness applicable to cities, and is thus subject to the ten percent limit (Code of Virginia, Sec. 15.1-227.40). When a county is treated as a city for bond purposes, the debt limit includes the indebtedness of any town empowered to levy taxes on real estate within the county.

Sanitary Districts

A sanitary district is a special district within a city

10

This restriction on bond issues does not apply to bonds issued for capital projects for school purposes and sold to the Literary Fund or other state agency.

or county created to provide special services for particular areas within that city or county. These services may include garbage removal and disposal, street lighting, water services, and sewer services.¹¹ Regulations concerning sanitary districts are described in Code of Virginia.¹²

A sanitary district is created by order of the Circuit Court of the county or city after petition of fifty qualified voters (or fifty percent of voters if there are fewer than 100 in the district) and after public hearing. Property may be excluded from the district if the court is of the opinion that it will not benefit from inclusion. A town within the county may be included in the sanitary district upon approval of the county board of supervisors and the town council.¹³ County or city officials have jurisdiction over sanitary districts, and set rates, fees, and other charges for public services within the sanitary district.¹⁴ The Virginia Code states that the county or

11

Enabling legislation may be passed to allow for the provision of other services.

12

Sec.21-112.22 through 21-1203.

13

Title 21 also makes provisions for the enlargement and merger of sanitary districts.

14

The use of sanitary district funds is authorized for certain other purposes, such as police provision, to highly populated

city is obligated to set rates and other charges at a level sufficient to cover the expenses incurred by the provision of the service. However, if revenues derived from the system are insufficient for operation and maintenance expenses or payment of interest and principal on outstanding bonds, the sanitary district may levy an annual tax on all property within the district that is subject to local taxation. In general, the County Board of Supervisors or City Council, as the governing body of the sanitary district, may issue revenue bonds. The amount of the bonds issued may not exceed eighteen percent of the assessed value of taxable real estate in the district. Generally, a referendum must be held and passed by a majority of the voters in the district. A referendum is not required for the issuance of special purpose bonds designated for improvements of water and sewer systems mandated by the State Water Control Board. Principal and interest on bonds must be paid from revenues generated by the system to be improved.

Public Facility Districts

Public facility districts may be created to provide various services including water supply, sewer, garbage

areas meeting certain restrictions (Code of Virginia, sec.21-118.2).

collection, fire protection, police protection, parks, light systems and streets (Virginia Acts of Assembly, Ch.93, 1946). Enabling legislation for public facility districts applies only to certain highly urbanized counties and cities as provided for in the Code of Virginia.¹⁵

Public facility districts are created in the same manner as are sanitary districts. Local government officials have jurisdiction over the public facility district. The governing body of the public facility district may set rates and collect charges for the provision of services. An annual tax, based on all real property in the district, may also be collected to pay all or part of the expense incurred in the establishment, maintenance or operation of the facility.

Public facility districts may issue bonds in the same manner, and according to the same limits as sanitary districts described above.

Service Districts

15

These are counties with a population between 500 and 1000 people per square mile and a land area of between thirty and seventy square miles, or any county having a land area of between thirty and eighty-five square miles. Also eligible are cities having a population of greater than 50,000 but less than 61,000 and a land area of less than seventy square miles but greater than fifty square miles (Code of Virginia, Sec.21-427,427.1).

Service districts are authorized under the Virginia Area Development Act (1968) and are special districts within planning districts.¹⁶ A service district is created by request of the governing bodies of at least two of the localities within the planning district. The creation of a service district requires that a plan be developed which includes boundaries, services to be performed and other details. The Code of Virginia states that the plan must include "two or more political subdivisions embracing the majority of the population within the planning district." "Political subdivisions" are defined as "governmental subdivisions, sanitary, sanitation and transportation districts, authorities and other such public bodies" (Code of Virginia, Sec. 15.1-1402(d)). The plan must be approved by governing bodies of the subdivisions involved and the majority of the voters in each participating subdivision must approve the plan by referendum. After approval, a service district commission is formed, composed of "elected" members (elected from each participating subdivision) and "official" members (representatives of the participating local governments).¹⁷

16

There are twenty-two planning districts in Virginia.

17

The district is exempt from taxation on any property or income derived from provision of the service.

The service district is authorized to charge and collect fees and other charges for services provided. The service district can also annually assess each governmental unit within the district for the purpose of financing its operations up to the limits defined by the district plan. This is done on the basis of taxable real estate in each unit. The locality may pay part or all of this assessment through a separate tax on real estate.

A service district may issue revenue bonds for the purchase, construction, extension and improvement of the system. These bonds may be additionally secured by pledge of assessments made against the localities within the district. Interest on these bonds is limited to a maximum of six percent per year. Service districts are not authorized to issue general obligation bonds.

The Code of Virginia specifically entitles a service districts to receive state financial support (based on population) to assist in carrying out its functions.¹⁸ This

18

"State aid shall be in the amount provided in the General Appropriations Act. In order to be allocated such aid, an annual budget must be submitted to the Governor, showing estimated receipts and expenditures during the next fiscal year. The Governor with the assistance of the Department of Housing and Community Development shall allocate funds, subject to availability, as judged to be sufficient" (Code of Virginia, Sec. 15.1-1412, 1433).

sources.

Water Authorities

An authority is an independent public agency created to provide certain services. These services may include water supply, sewage disposal, garbage or refuse collection and disposal, or any combination of these services.¹⁹ An authority is created by the action of the governing body of any individual locality or any two or more localities by ordinance or resolution.²⁰ A public hearing must be held on this and voter approval by referendum is required.

The authority constitutes an independent agency existing as a corporation.²¹ The authority is governed by a board consisting of at least five members, including at least one member from each participating locality. Selection of board members is specified in the ordinance or resolution creating the Authority.

The Code of Virginia specifically provides for the

19

Provisions for this are made under the Virginia Water and Sewer Authorities Act of 1981.

20

Provision is also made for citizens to initiate proceedings (Code of Virginia, Sec. 15.1-1241).

21

An Authority is not required to pay taxes or assessments upon properties or income (Code of Virginia, Sec. 15.1-1258).

Authority to obtain facilities or funds from other governmental units. A county, city or town or other public body may convey or lease to an authority, with or without consideration, any water system or facilities.²² Any locality which is a member of an authority may also lend, advance or give money to the authority.

The authority sets and collects service fees or charges. Revenues generated from the service are used to provide the service. A connection fee may be made for hook up to the system subject to the approval of the State Corporation Commission. Rates are to be set and revised to provide funds for cost of maintaining, repairing and operating the system, payment of principal and interest on bonds outstanding, and to provide a margin of safety for making such payments. Public hearings must be held concerning proposed rates and charges before these can be adopted.

The authority may contract for the use of facilities or services of other water systems not owned by the authority. These other water systems may be authorized to act as the billing and collecting agents for the authority. If the

22

Other public bodies may be any so designated in the Code of Virginia or Constitution, including such divisions as sanitary districts, public facility districts and service districts. (Code of Virginia, Sec.15.1-1250).

authority and water system cannot agree as to rates and conditions, the State Corporation Commission may be petitioned to make the determination.

An authority may issue revenue bonds. Proceeds of bonds must be used solely to pay system costs for which the bonds were issued. If bond proceeds are less than actual costs, additional bonds may be issued. If there is a surplus of bond proceeds over cost, the surplus must be deposited to a sinking fund for the bonds. The authority may also borrow by note or other obligation. The authority is not authorized to issue general obligation bonds.

PRIVATELY-OWNED WATER COMPANIES

Privately-owned systems serving at least fifteen units or twenty-five persons must register with the Virginia Department of Health, and are subject to the requirements of the Safe Drinking Water Act. As of November 1990, there were a total of 942 privately-owned water systems in Virginia (Virginia Department of Health, 1990c). All but five were classified by the Virginia Department of Health as small systems serving 3000 or fewer customers. Privately-owned water companies serving fifty or more customers are subject to regulation by the State Corporation Commission.²³

23

Regulations covering small water systems are stipulated under

Those who serve fewer than fifty customers need not register with the SCC (Stevens, 1992).

The SCC is responsible for ensuring that rates charged are reasonable and will provide for the financial stability of the system, including providing a fair rate of return.²⁴ The SCC judges rates based on cost of services. Cost of service includes all costs incurred in producing and delivering the service, including a return on capital.²⁵ In determining the revenue required to cover costs and return, the data are adjusted to reflect current costs and anticipated future costs (Appalachian Power Company, 1988).

The SCC currently (1992) regulates seventy-three privately- owned water companies. Of these, fifty-five companies provide only water services, six provide sewer only and twelve provide both water and sewer. All but two of the sixty-seven that supply water are classified as

the Small Water and Sewer Public Utility Act (Virginia Code Sec. 56-265.14:7).

24

The SCC can also intervene in matters concerning water quality after customer complaints. Water classified as potable by the Virginia Department of Health is often unacceptable to consumers due to quantities of some substance in the water. Iron, for example, turns laundry red and often results in complaints (Stevens, 1992).

25

The rate base is comprised of the original cost of plant and other facilities, plus working capital, less accumulated depreciation (Appalachian Power Company, 1988).

small companies by the SCC. Small companies are defined as those that have less than one million in revenue per year.²⁶

Private water companies are subject to SCC regulation if they provide water from their own water source, or if they act only as a water distributor. For example, assume a trailer park owner receives water from a Water Authority line. If the trailer park owner has a main water meter and distributes the incoming water to individual trailers through meters, charging the customers individually for the water, he or she is subject to regulation by the SCC (Stevens, 1992).

If water is provided as a part of the rent, rather than as a separate fee, the trailer park owner is not defined as a private water company under the Small Water and Sewer Public Utility Act, and is not regulated by the SCC. (These private companies are, however, regulated by the Virginia Department of Health if they meet the definition of a water supplier under the SDWA as noted above.) This is the case with a large portion of the private companies supplying water. Many are run by developers who wish to hold down water rates in order to make their properties more attractive. Rather than being a self-supporting system,

26

These classifications and regulations are stipulated under the Small Water and Sewer Public Utility Act (Code of Virginia, Sec.56-265.13:7).

costs are subsidized with funds from the construction business (Stevens, 1992; Gray, 1992).

When faced with the necessity of making costly improvements, many private water companies have given or sold their systems to adjoining publicly-owned water systems. However, the publicly-owned system is not required take over these systems. The publicly-owned system may require that improvements be made before taking over the privately-owned system (Stevens, 1992).

Privately-owned water companies may also try to abandon a system. However, the "Abandonment Law" prevents any system that serves more than ten customers from abandoning the system. The SCC is charged with preventing abandonment in these situations.

The major sources of funds for privately-owned water companies are investors and bank loans. Bank loans are constrained by the revenues available to repay them.

A for-profit water system may be able to attract money from investors. Most of the private water companies in Virginia do not generate profit independently, existing only as a part of another venture such as a housing development, where the developer provides a water system in order to more easily sell the houses. If the developer chooses to provide a water system, he is then responsible for operation of the system until it can be sold or taken over by a homeowners

association or otherwise transferred. Some privately-owned systems do generate a profit. These are few in number, however, and are large systems.²⁷

The Farmers Home Administration provides limited assistance through the Business and Industry Guaranteed Loan Program to privately-owned systems in rural areas. The business locates a private lender, and FmHA guarantees the loan.²⁸ The Economic Development Administration also provides help to industrial users in low-income areas as described below.

PUBLIC LOAN AND GRANT SOURCES

Several governmental (public) sources of loans and grants are available to local governments for water system construction and improvements. The federal government offers loans and grants through the Farmer's Home Administration (an agency of the Department of Agriculture), the Economic Development Administration (an agency of the Department of Commerce), and the Department of Housing and

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For example, Virginia American, which serves the city of Alexandria, is part of a national company and does generate a profit (Stevens, 1992; Gray, 1992).

28

Robert Boyd of the State office of the Farmers Home Administration indicates that this program is not often used (Boyd, 1992).

Urban Development. The Environmental Protection Agency (EPA) provides a loan guarantee program for small public water systems. The Appalachia Regional Commission, a federal-state agency, provides funds to several counties and cities in Virginia. Virginia state government sources are the Virginia Department of Housing and Community Development, the Virginia Resources Authority and the Virginia Water Supply Revolving Fund.

Farmers Home Administration

The Farmers Home Administration (FmHA), created by the Housing Act of 1949, offers grants and loans for the construction of rural water systems. Any publicly-owned system meeting the rural requirement (indicated below) is eligible for these funds.²⁹ Eligible programs include facilities for the development, storage, treatment, purification and distribution of water. Funds may also be used for purchase or rent of necessary equipment, acquisition of land and legal or planning service fees (Cox

29

Eligible recipients are municipalities, counties, special purpose districts, Indian tribes and corporations not operated for profit (Farmers Home Administration, 1990). This program also provides Rural Housing Loans 502 and 504, which are loans and grants to eligible individuals in rural areas of less than 10,000 population.

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and Patrizi, 1984). Grants and loans cannot be made for operation and maintenance expenses, purchase of already existing systems, or refinancing of existing debt.

FmHA provides Water and Wastewater Disposal Loans and Grants to rural communities of less than 10,000.³⁰ Preference is given to localities with populations of less than 5500 (Farmers Home Administration, 1990). First priority is given to projects needed to comply with SDWA requirements (Cox and Patrizi, 1984). Additionally, FmHA Community Facility Loans provide funds for a variety of public service needs, including health care, fire services and water service. For fiscal year 1992, the Water Loan Program in Virginia received \$14.7 million, the Grant Program, \$8.4 million, and the Community Facility Loan Program, \$2.5 million (Boyd, 1992). The demand for these funds greatly exceeds the funds allocated.³¹ For example, applications for the grant program have exceeded available funds by \$10 million.

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A rural area is defined as any town, city, village or place not associated with an urbanized area. It must have a population of less than 10,000 and be rural in character. The limit can be extended to 20,000 if the area is not within a Standard Metropolitan Statistical Area and has a serious lack of mortgage credit (U.S. Code, Sec.1474).

31

Robert Boyd (1992) indicates that additional funds can be requested, and requests are generally approved.

FmHA loans are made at, or slightly below, current market interest rates, generally for periods of fifteen to twenty years. The maximum loan term is forty years. There is no limit to the amount that can be loaned to a system. Interest rates are based on the area's median household income. If the median income is below the federal poverty level, rates are set by statute at five percent. If the median income is at or above the median non-metropolitan household income for Virginia, the rate charged is the current market rate.³² If the median income is between these two income levels, the rate is set halfway between the above rates (Boyd, 1992). For FmHA loans, the loan contract takes the form of a bond rather than a note, and may be backed by either general obligation or revenue bonds (Boyd, 1992). A mortgage may also be taken on the facility (Farmers Home Administration, 1990).

The grant program is intended to provide an increased level of assistance to the most financially needy communities. Grants are based on median household income and are only provided in conjunction with loans. An area is eligible for a grant if the area's median household income

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The market rate used is the 11-bond index of AA rated general obligation bonds (of states and other public bodies). Rates are adjusted quarterly. As of April 1992, the current poverty level was \$13,950, the Virginia median non-household income was \$14,225, and the market interest rate was 6.625.

is below the non-metropolitan household income for the state. Up to seventy-five percent of the total project cost can be provided as a grant if the area's median household income is below the federal poverty level and fifty-five percent can be provided if the median household income is between the federal poverty level and the median non-metropolitan household income (Boyd, 1992). Grant funds are distributed according to a rating process which considers need, median income and severity of condition. Available funds are then distributed according to rank.

Economic Development Administration

The federal Economic Development Administration (EDA), created by the Public Works and Economic Development Act of 1965, provides assistance in the form of grants to urban and rural areas with substantial unemployment and underemployment through the financing of public works and economic development activities. Areas must have one of the following conditions: (1) a large concentration of low-income persons, (2) a substantial out-migration from rural areas, (3) substantial unemployment or (4) an actual or theoretical rise of unemployment because of closing or curtailment of a major source of employment (Cox and Patrizi, 1984).

The facilities funded must provide for more employment

Patrizi, 1984).

The facilities funded must provide for more employment opportunities in the area of concern. The only type of water supply system eligible for these grants is that for which industrial users are the primary beneficiaries. This includes water supply development for individual industries and industrial parks only (Cox and Patrizi, 1984).

Projects are almost always jointly funded, typically with the FmHA; joint funding arranged with the Appalachian Regional Commission, Community Development Block Grant Program, and the Virginia Water Supply Revolving Fund has also been used.

Historically, there have been four to seven projects funded by EDA in Virginia per year. Total funding has ranged from \$3.3 million to \$3.7 million per year. For a project to be acceptable to the EDA, the federal cost per job (funds provided by the EDA) for the project should not exceed about \$5000 per job (Noyes, 1992). The EDA office in Richmond recommends potential projects to the regional office in Philadelphia.³³ Funds requested are generally received (Noyes, 1992). Five projects in Virginia were funded for 1992. Two of these fund water systems, and were

33

There are three regional offices. Virginia is in Region III, which includes thirteen states, the District of Columbia, Puerto Rico and the Virgin Islands.

allocated \$700,000 each (Noyes, 1992).

The EDA also provides a Technical Assistance Program which provides funding for such needs as site selection, engineering studies and environmental audits.

Privately-owned systems for the benefit of industrial users are eligible for EDA loan guarantees only (Noyes, 1992). Under this program, a commercial bank loans funds contingent upon receiving a guarantee from the EDA. The EDA will not guarantee more than fifty percent of the total project funds. The loan guarantee program has been deemphasized by Congress in the past few years. Nationally, the authorization to guarantee loans has declined from a total of \$150 million ten years ago to \$5 million (Noyes, 1992).

The Environmental Protection Agency

Under the SDWA, the EPA is authorized to guarantee private market loans made to small public water systems.³⁴ These loans must be used for purposes of complying with drinking water regulations. The total federal guaranteed debt to a recipient cannot exceed \$50,000 (Cox and Patrizi, 1984). This program is not very important for two reasons.

34

The term "small public water systems" is not defined by the SDWA.

First, many of the needed improvements cost more than \$50,000. Second many small systems are not able to meet private market interest rates and loan repayment periods (Cox and Patrizi, 1984).

In response to cutbacks in federal funding programs, the Environmental Protection Agency provided \$33,917,256 in contributions under the Capitalization Grants for State Revolving Fund federal assistance program (Virginia Resources Authority, 1992). Of the total contributions made by the EPA, the Virginia Resources Authority received state appropriations for the fund of \$300,000 per year through fiscal 1991 (Virginia Resources Authority, 1992).

Community Development Block Grant

The Department of Housing and Urban Development (HUD) sponsors the Community Development Block Grant Program, established under the Housing and Community Development Act of 1974. This Act was created to promote community development and to improve the living environment of low and moderate income people. Funds may be used for a wide variety of community development needs, including public water systems (Cox and Patrizi, 1984). All publicly-owned systems are eligible to receive funds. Awards may also be made jointly to localities for regional projects (Virginia Department of Housing and Community Development, 1989).

Administration of the Grant Program is divided between the federal government and state governments. Funds are available for the acquisition, upgrading and expansion of water supply facilities and replacement (or expansion) of distribution lines. The federal program, administered by HUD, is available to metropolitan cities of 50,000 or more, and counties of 200,000 or more in population (Virginia Department of Housing and Community Development, 1989). This excludes most areas of Virginia.

The Virginia state program, administered by the Virginia Department of Housing and Community Development is available to political subdivisions not meeting the requirements of the federal program.³⁵ The goal of the Virginia program is to improve the economic and physical environment in Virginia communities for the primary benefit of low and moderate income citizens (Virginia Department of Housing and Community Development, 1989). Objectives include improvements in economic development, housing and community facilities (including water).

The Virginia program provides two types of grants, community development planning assistance grants and

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The term "political subdivision is defined by the Code of Virginia to include "local governments, authorities, sanitary, service districts or any other governmental subdivision so authorized by the Code" (Sec. 21-1402).

community improvement grants. The planning assistance grants are limited to \$25,000 and are designed to assist small localities in developing plans to compete effectively for additional grants.³⁶ Community improvement grants of up to \$700,000 per year are provided on a competitive basis. The ranking criteria are: (1) a community's relative need for assistance and (2) the impact of the proposed project on community development needs and program objectives. Relative need is based on a weighted index of income, population change, unemployment and tax effort/ability. Indicators of grant impact are relationship to state and regional priorities, and impact on community needs and objectives (Virginia Department of Housing and Community Development, 1989). (Appendix 2.1 illustrates the weighting system used.)

In 1990, sixty-eight applicants requested \$141,079,363. The average request was \$604,108. Twenty-eight of these applications were community facilities applications, which include water and sewer projects. A total of \$16,252,636 was available, and twenty-seven localities received grant offers. Three of these had water system improvements as the main project focus. Funding received for these three

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Local governments are designated as the only legal recipients of the grants, but non-profit organizations may be designated to undertake project activities (Cox and Patrizi, 1984).

projects averaged \$605,900 (Virginia Department of Housing and Community Development, 1992).

Appalachian Regional Commission

The Appalachian Regional Commission (ARC), created by the Appalachian Regional Development Act of 1965, is a regional federal-state agency created to assist the mountain regions of several states considered part of Appalachia. The main focus of ARC efforts are in the construction of the Appalachian Development Highway System, creating and retaining jobs, job training and education, and assisting in construction of basic facilities in the region's poorest counties.³⁷ Eligible projects range from airport safety improvement to health care projects. Five cities and twenty-one counties in Virginia are included in Appalachia. Table 2.2 lists these areas.

The Appalachian Regional Commission provides grants only. All publicly-owned systems are eligible to receive funds. Funding for the program are appropriated through congress, and have been declining throughout the 1980's (Rungren, 1992).

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The indicators used to determine which counties are the poorest are the region's per capita income, poverty rate, and the latest three-year average unemployment rate (Appalachian Regional Commission, 1990).

Table 2.2

Counties and Cities in Virginia which are considered part
of Appalachia

Alleghany	Pulaski
Bath	Russell
Bland	Scott
Botetourt	Smyth
Buchanan	Tazewell
Carroll	Washington
Craig	Wise
Dickenson	Wythe
Floyd	Bristol City
Giles	Clifton Forge City
Grayson	Covington City
Highland	Galax City
Lee	Norton City

Source: Appalachian Regional Commission, 1990.

The Appalachian Regional Commission is called a federal-state agency because each state must develop its own rules and regulations along with a plan for spending the funds (Rungren, 1992). Virginia has received about \$1,200,000 in federal allocations for fiscal year 1992 (Rungren, 1992). A wide variety of projects are eligible, but only those projects approved by another federal agency are eligible for ARC funds. Most projects are approved through FmHA, and ARC funds are channeled to the recipient through FmHA. Generally ARC funds are issued on a one to one matching basis with state funds (Rungren, 1992). A supplemental grant program, however, provides for the federal share of the grant to be raised up to eighty percent for communities who have difficulty raising the matching share (Appalachian Regional Commission, 1992).

Historically, about twenty-six percent of total ARC funds have been allocated for water system projects, with an average allocation of \$235,900 per project. Thirty to forty projects per year are funded for the entire ARC area, including Virginia (Appalachian Regional Commission, 1990). For the period 1976-1988, ARC provided funding of \$21,777,213 to Virginia for water and wastewater improvements (Deaton, 1990).

Virginia Resources Authority

The Virginia Resources Authority (VRA) was created in 1984 by the General Assembly.³⁸ The Virginia Resources Authority maintains available funds through the Pooled Loan Program, which provides localities access to the national tax-exempt bond market to provide loans for drinking water, wastewater and solid waste financing needs (Virginia Resources Authority, 1990). This program provides for localities to receive a bond rating of AA from Moody's and Standard and Poor's. All publicly-owned systems are eligible. Eligible projects include water supply, intake, treatment, filtration, storage and distribution facilities; drainage facilities and drainfield management, office administration, maintenance and laboratory facilities. Loans have ranged from \$400,000 to \$31 million. The VRA has a bonding cap of \$400 million, with \$120 million available in 1992 (Massey, 1992).

The average bond issue is two to three million, with about seven to eight being issued per year (Massey, 1992). There is no limit to the amount a system may issue. Loans terms may be ten to twenty-eight years, with fixed or variable interest rates. Terms are flexible to the needs of

38

Virginia Resources Authority Act, Code of Virginia, Sec. 62.1-197 through 62.1-223.

the local government, but completion time of proposed projects must be within three years of the date the loan is made (Virginia Resources Authority, 1990). There are no limits on how much a locality can receive, subject to the VRA's overall limit of \$400 million (Crumbley, 1992). Most of the VRA funds are for wastewater or a combination water/sewer project, a few are for solid waste projects (Massey, 1992).

Virginia Water Supply Revolving Fund

The Virginia Water Supply Revolving Fund was established in 1987 by the General Assembly for the construction, expansion or improvement of water supply facilities. Eligible recipients include all publicly-owned water systems.

Eligibility for loans is determined by the Virginia Department of Health and loans are administered by the Virginia Resources Authority (Virginia Resources Authority, 1990). Priority is given to problems which pose a serious health risk. Four hundred thousand dollars are currently available in the fund (Jones, 1992). Loans are available at low to zero interest rates, with no closing costs.³⁹ The

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Factors considered are existing rates, other existing debt

loan must be fully amortized within twenty years of the completion of the water facility project. Median household income and the impact the loan will have on user rates is considered in determining loan terms and interest rates. Table 2.3 provides the current income levels and appropriate percentage of income to pay for water used by the VRA in the determination of loan terms.

Only one to two loans, averaging \$100,000 to \$150,000 have been made per year. The loans are considered by the VRA to be bonded indebtedness, and a pledge of revenue bonds, general obligation bonds, or a combination of these two is required. For 1991, only one loan was made for water system improvements. This loan, for \$150,000 was made to the Town of Clarksville.

PRIVATE LOAN AND GRANT SOURCES

Publicly-owned systems have available to them a limited number of funding alternatives from private sources. These include the Virginia Water Project, Inc. and municipal bond issues.

Virginia Water Project, Inc.

The Virginia Water Project, Inc. (VWP) is a non-profit organization that provides financial assistance in the form of grants and loans to low-income rural communities and

Table 2.3

Appropriate percent of income spent on water
for various income categories
as used by the Virginia Resources Authority

Income category	income*	percent income
low	below \$19,000	0.5 percent
low medium	\$19,000-\$25,000	1.0 percent
upper medium	\$25,000-\$29,000	1.25 percent
upper	over \$29,000	1.5 percent

*median household income in locality

Source: Massey, 1992.

individuals for water and sewer facility needs. Rural communities are defined as those having a population of under 10,000. Funds are available to any publicly-owned system in these communities. Generally funds from VWP are used in conjunction with funds from other sources, such as FmHA or Community Development Block Grants (Hill, 1992). Funding for the grant program is provided through General Assembly appropriations. For 1992, \$237,000 has been funded by the Virginia General Assembly (Hill, 1992). Grants are available for individuals only and project funds may be specifically granted for hook-up of lines and meters to low-income families. Grants are allocated based on the poverty level. The VWP uses a rate of 125 percent of the poverty level as a cutoff point. For example, in 1992, the poverty level (U.S. Poverty Guidelines) was \$6,810 per year for a family of one. The Virginia Water Project multiplies this figure by 1.25 for an cutoff income level of \$8513. Individuals in a family of one were eligible for grants if their income was \$8513 or less (Hill, 1992).

The loan program provides funds to rural communities of less than 10,000, with preference given to communities of less than 2500. Funds for the loan program have been made available through a one million dollar loan made to the VWP by the Ford Foundation. This loan is payable to the Foundation in February 1996, and as a result all loans being

made by the VWP have a balloon payment due in 1996 (Hill, 1992).

In 1992, \$400,000 in loan funds were available. The maximum loan amount is \$100,000 per project. The average loan amount is \$60,000. The maximum interest rate charged is seven percent, with most loans made at three to seven percent (Jones, 1992). Interest rates are set based on the locality's ability to pay and the number of low-income people in the project area.

SUMMARY

Publicly-owned water systems have a number of sources of funding available to them. All publicly-owned systems can offer revenue bonds. Systems owned by localities can also use general obligation bonds. The option of raising funds through taxes is available only to localities and service districts.

There are a number of outside funding sources available to publicly-owned systems in the form of loans and grants. Many of these are available only to low-income or rural areas. Funding for these sources has been decreasing in recent years due to state and federal government cutbacks.

Privately-owned systems have very few funding sources available to them.

CHAPTER 3

ECONOMIC THEORY

Economic theory provides a framework within which the cost structure of an industry or individual firms within an industry may be analyzed. In Chapter 3, economic theory is used to show the effects of the requirements of the SDWA Amendments on a firm's costs, and the effect of rising costs on prices (water rates).

In Chapter 4 the increased water rates expected to result from water system improvements are predicted. Increased water rates impact households at different levels of income differently. Economic theory addresses the impact of increasing prices (water rates) on households at different levels of income.

PRODUCTION COSTS

Short run Costs

In the short run, the total costs encountered in the production of the output of any firm is the sum of total variable costs and total fixed costs. The revenue per unit that must be received in order to cover total costs is the average total cost per unit. (See Figure 3.1.) To continue

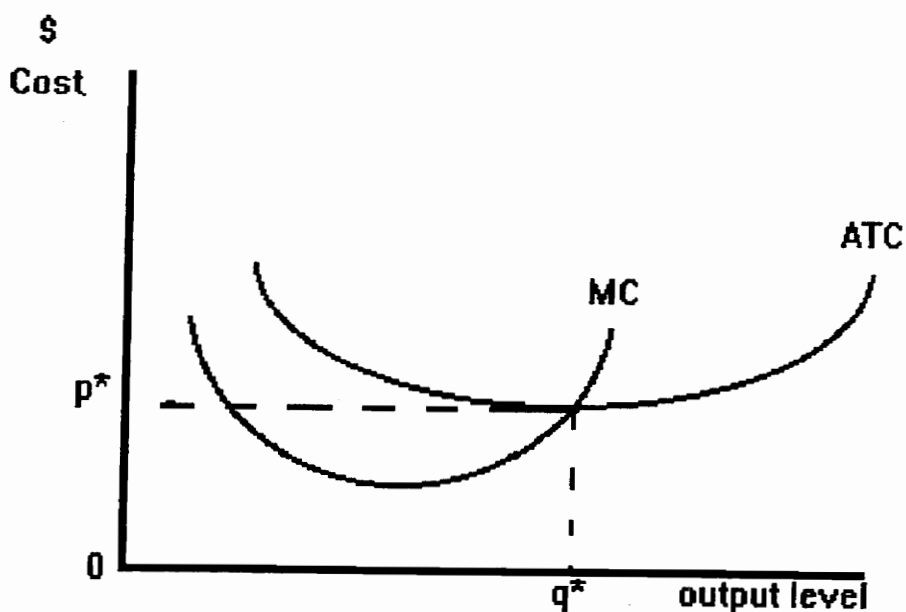


Figure 3.1

Short-run Cost Structure of a Firm

Decreasing marginal productivity results in increasing marginal costs, which increase average variable costs. As a result average total costs increase. Total costs are covered when price equals average total cost for a given level of production.

in operation in the short run, a firm must be able to cover at least its average variable costs. If revenue drops below average variable costs, required at output level q^* . the firm will shut-down.

Economic theory indicates that as output increases, average total costs decrease, then begin to increase beyond some point. This cost pattern occurs as the result of the diminishing marginal productivity which occurs when additional units of variable factors of production are added to a fixed factor. The point at which average total costs begin to increase may not be apparent over the relevant range of production, with the cost curve displaying an L-shape. When the average total cost curve displays an L-shape, the production function is said to exhibit economies of scale. When the minimum average total cost of production occurs at a rate of output more than sufficient to supply the entire market at a price covering full cost, the firm is called a natural monopoly. This situation is common for firms providing water, electric and gas service. (See Figure 3.2.)

Total costs incurred in the operation of a drinking water treatment system include the costs of building and maintaining the physical facilities, labor and treatment costs. Cox, Sherrard and Gaw (1991) developed cost data for a variety of treatment processes which are used by systems

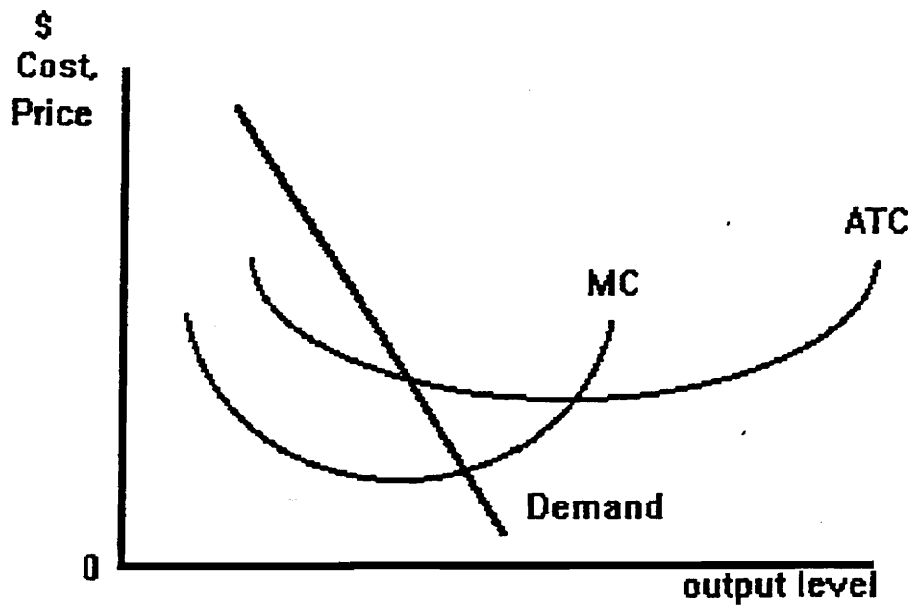


Figure 3.2

Graphical Representation of a Natural Monopoly

A natural monopoly exists when market demand intersects average cost in the downward-sloping portion of the average cost curve.

of various sizes. Cox, Sherrard and Gaw divide total costs into three categories: construction costs, operation and maintenance costs, and chemical costs. Construction costs include sitework and excavation, manufactured equipment, concrete, steel, pipes and valves, housing and electrical equipment. These are classified as fixed economic inputs. The other two categories of costs specified by Cox, Sherrard and Gaw are operation and maintenance costs, and chemical costs.

Operation and maintenance costs, and chemical costs are variable economic inputs, typically resulting in costs which increase as output levels increase. Operation and maintenance costs include process energy costs, labor, maintenance materials and building energy costs. The level of normal operating and maintenance costs is dependent on the size of the system, source of water and population density. A variety of chemicals are used for water treatment. Chemical costs increase directly with output levels. (Meeting the SDWA requirements may require both additional fixed equipment, and additional chemical requirements.) According to Cox, Sherrard and Gaw, the importance of each category in total cost varies by system size and treatment system used. However, in most cases, labor costs represent the largest portion of annual operating costs.

Long run Costs

In the long run, all costs are variable. In the long run, average cost must be covered by revenue (or government subsidies) if the firm is to remain in operation. The long situation facing a firm in a monopolistic market is shown in Figure 3.3. To maximize profit, a monopoly will produce an output level where marginal revenue equals marginal cost. The price (rate) charged is then determined by the demand curve. For a profit-maximizing monopolist, the price will be R^* . The resulting profit per unit is R^* minus C^* , the average cost per unit at that output level.⁴⁰ In the case of water systems, the monopoly may choose not to maximize profits, or the prices may be regulated, so that the system charges a price less than R^* . Presumably the price charged will be sufficient to cover long run average cost.

Natural Monopoly

Water systems are typically natural monopolies, exhibiting economies of scale. As the size of the operation (generally measured in gallons per day) increases, average production costs per gallon continually decrease. Large water systems thus experience lower costs per unit than smaller

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Note that this output level is not considered to be economically efficient as the firm is not producing at minimum average cost.

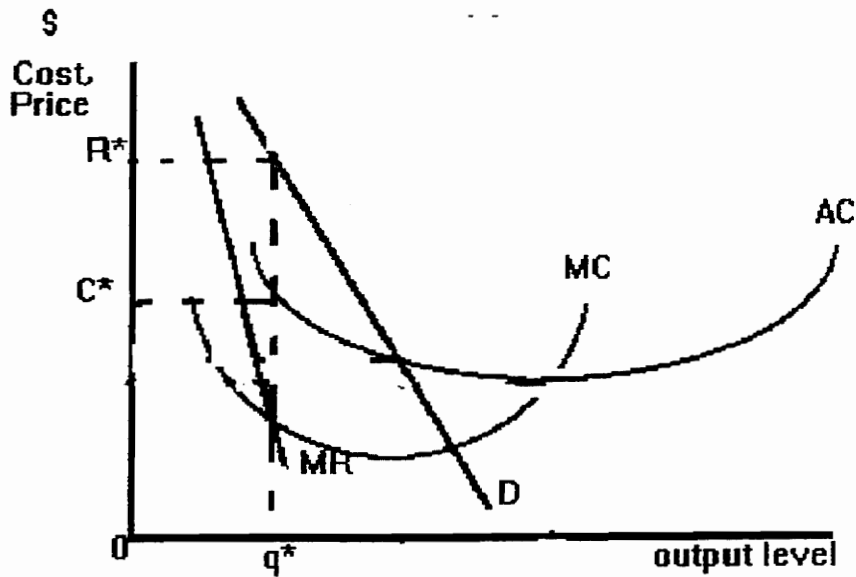


Figure 3.3

Typical Long Run Situation for a Monopolist

The monopolist will produce an output level where marginal revenue equals marginal cost, at q^* . The price charged is then determined by the demand curve. A profit maximizing monopolist will charge R^* . The resulting profit per unit is R^* minus C^* .

systems, and require lower rates to cover average total cost in the short run. As a result, they are able to charge lower prices.⁴¹ Economies of scale in water production have been studied by Andrews (1971), Daugherty and Jansma (1973), and Cox, Sherrard and Gaw (1991).

In Virginia, many systems are located in rural areas. Rural areas may experience diseconomies of transporting water (distribution). Rural systems generally have long lines with few connections, resulting in high costs per connection. Trade-offs between economies in production and diseconomies of transport have been studied by Clark (1971) and Clark and Stevie (1981).

Effect of SDWA Amendments on Water System Costs

The result of the expected increase in costs due to the 1986 Amendments to the SDWA is an upward shift in the cost curves.

Fixed Costs

Many systems will be required to install additional

41

As noted in Chapter 2, in Virginia, privately-owned water systems serving over 50 people are regulated. Systems owned by authorities, cities, counties and towns are constrained by the voters in each locality as to the rates they can charge. If voters are not satisfied, they will vote in new officials during the next election.

equipment of build additional treatment facilities (fixed costs). The cost of these improvements may be paid through external financing (loans or bonds), internal financing (charges or fees) imposed on system users, or retained earnings), or through increased taxes (where permitted by law). Financing through loans or the issuance of bonds will require raising the price per unit (water rates) in order to cover interest and principal payments. One-time charges or fees may be imposed to cover the cost of additional equipment. The additional fixed costs may also be covered by using tax revenues. However, those who pay higher taxes may not be those who use more water, thus the benefit principle of equity would be violated.⁴²

Variable Costs

Variable costs may increase due to additional chemical treatments required by the 1986 Amendments. Additional labor costs may also be incurred for additional testing of the water for contaminants.

42

According to the benefit principle, the user (who benefits) should pay the costs of additional treatment. (The ability to pay principle of equity focuses on the ability of low-income households to pay for increasing water costs.)

A Model

Water rates are expected to be related to the following variables:

1. Type of ownership
2. Size of system .
3. Population density
4. Source of water

Type of ownership (public or investor) may be relevant if publicly-owned systems are subsidized by the government. Size of system and population density influence economies of scale, with increases in either expected to result in lower costs per gallon, all other things equal. Size of system can be measured by gallons of water throughput per day, size of population served, or number of connections. Throughput (gallons per day) may be the most appropriate measure as industrial customers can have a large effect on throughput, for systems of the same number of connections or population.

Costs may also differ depending on the source of water. Surface water is generally more costly to bring up to standards due to higher levels of contaminants.

The major factors affecting costs can be summarized using the following equation.

$$C = B_0 + B_1S + B_2P + B_3W + B_4O + E$$

where,

C = average total cost
 B_0 = fixed costs (the intercept)
 S = size of system (gallons per day)
 P = population density
 W = source of water, identified by dummy variables
 1 = surface
 2 = ground
 3 = ground and surface
 O = ownership, identified by dummy variables
 1 = investor
 2 = public
 E = the error term

The B_n terms are the response of C to a change in the independent variable. For example, B_1 represents the marginal change in C with respect to a one unit change in size of system, (marginal cost). This equation is not estimated in the analysis, but is used to more clearly identify the various variables influencing the level of costs experienced by a water system.

The level of normal operating and maintenance costs are determined by S , P , and W . Meeting the SDWA requirements results in additional production costs. The added costs increase both fixed costs (because of additional fixed equipment needed to improve water quality), increasing both average total cost in the short-run, and long-run average cost. Marginal costs may also increase due to additional chemical requirements. The increased costs are expected to

result in increased rates. (See Figure 3.4.)

Economic Efficiency

Economic efficiency requires that rates charged be based on the costs of production. To achieve efficiency in production, the firm should be operating at the minimum average cost of production. To achieve efficiency in allocation of resources, the marginal cost of the resource should be equal to the marginal benefit (the value to the consumer, indicated by the demand curve) or price. In a perfectly competitive market efficiency will be achieved in the long run. Figure 3.5 provides a graphical representation of a single firm and the market in a perfectly competitive market in the long run. In a monopolistic market, the same result will not typically occur.

The economically efficient rate (price of water) occurs at the point where marginal cost equals marginal revenue. If a monopolist prices its output based on marginal cost (because of a regulatory agency, for example), the result is that the monopolist may not be able to cover all costs. The possible loss occurs because marginal cost is less than average cost at the profit maximizing level of output. (See Figure 3.6.)

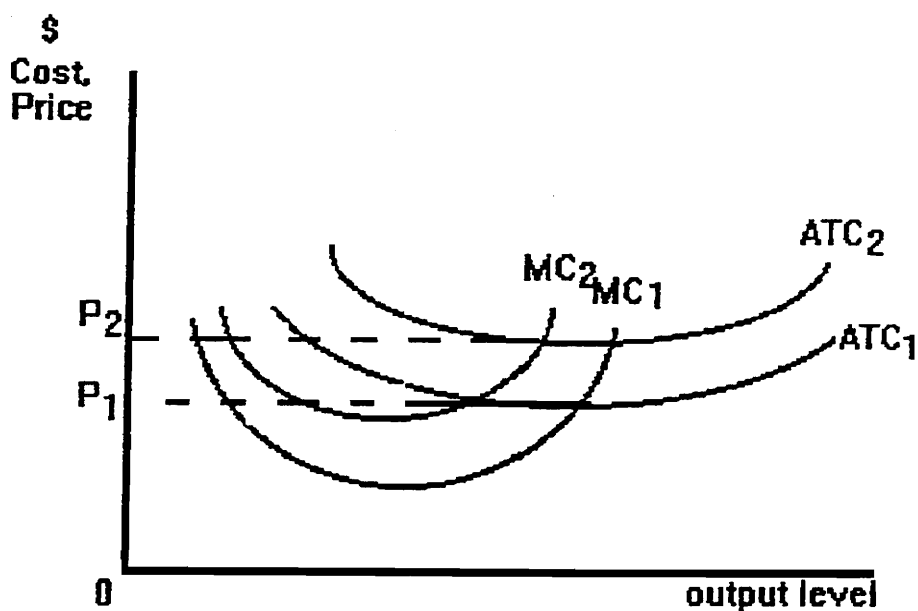


Figure 3.4

Effect of Increased Fixed and Variable Costs
on Average Total Cost

The requirements of the SDWA and the 1986 Amendments will increase both fixed and variable costs for many water systems. The increased costs shift up the average total cost curve from ATC_1 to ATC_2 . As a result, water systems are expected to increase rates to cover the increased costs.

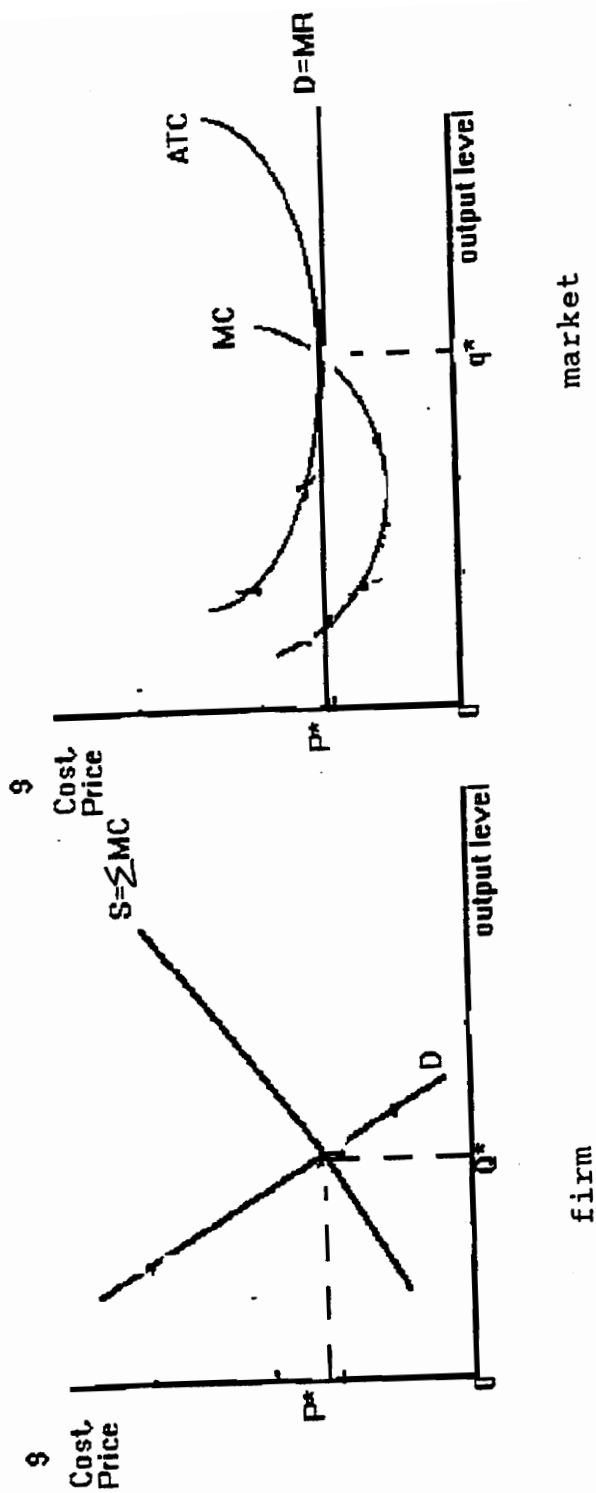


Figure 3.5

Graphical Representation of a Perfectly Competitive Market

The perfectly competitive firm produces an output level of q^* , where marginal cost equals marginal revenue. The firm is operating at minimum average total cost, achieving productive efficiency.

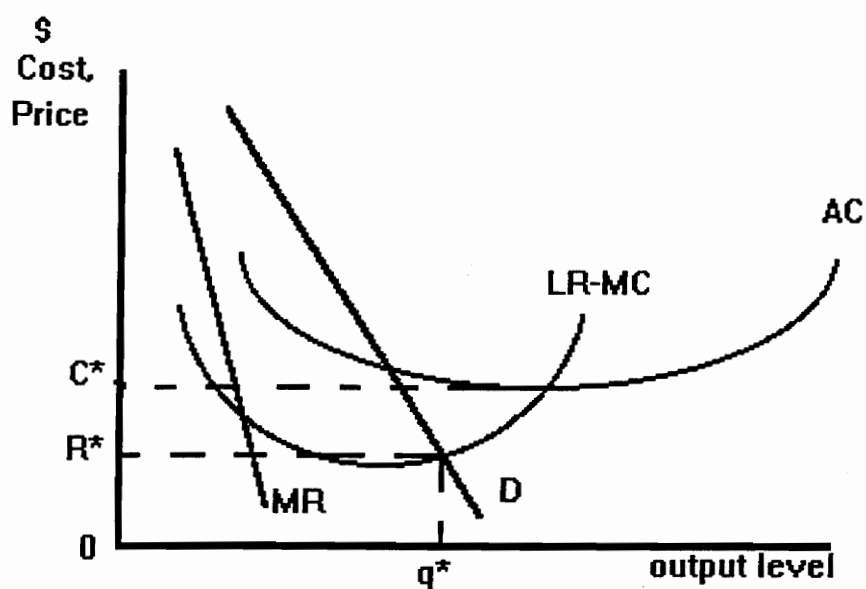


Figure 3.6

Result of Marginal Cost Pricing on a Natural Monopoly

When marginal cost pricing is used, an output level of q^* is produced. At the rate R^* , the firm cannot cover average total cost per unit. The result is a loss per unit of C^* minus R^* .

Several methods can be used to compensate the water provider and alleviate the deficit problem caused by marginal pricing. Price discrimination can allow the producer to cover all costs. One method of price discrimination is to charge an entry fee or higher rate on the first units produced to cover average cost. All purchases produced at the margin would be priced at marginal cost (a declining block tariff). The fee or higher price on the first units are designed to make up the monopolist's losses so that long run economic profits are zero.

A second method is the use of a two-part tariff. This calls for a low flat rate for basic services with higher rates (above marginal cost) for larger quantities. This method helps to minimize the cost to low-income users.⁴³ A variation on this is to charge a single price per unit, but pay a lump-sum fee to be allowed to buy at all. The lump sum can be differentiated according to the intensity of demand of different consumers (residential or industrial).

A third method is average cost (or rate of return) pricing. This type of pricing scheme allows the firm to

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The amounts of water needed for drinking, cooking and other basic domestic activities (not including car washing and lawn sprinkling) are quite low. Drinking water and cooking account for about 2 gallons per capita daily for a family of four. Dishwashing, toilet, baths and laundry account for about 50 more gallons (Young, 1972).

earn just enough profits to cover the opportunity cost of the fixed inputs. This scheme has been used by regulatory agencies for other industries, e.g., electric utilities.

A solution that is often used to cover the loss is a government subsidy. Although it is not desirable on efficiency grounds, public water systems may be supplemented by tax revenues.

EQUITY ISSUES

Some aspects of water usage are generally considered public goods, for example, urban parks and the recreational value of water on public lands. This type of water usage exhibits both non-rivalry and non-excludability in consumption. Water used by individual households does not exhibit these characteristics, however, and represents a privately-consumed good. According to economic theory, the price paid for privately-consumed goods should reflect the cost of providing that good. However, equity considerations may result in other payment alternatives.

The cost of water services generally represents a larger portion of a poor family's income than a rich family's income. When prices are increased, the burden on the lower income family increases disproportionately. This result may be perceived as inequitable. Defining "equity" involves value judgments. However, there generally is a

consensus among citizens of the United States that in certain cases, such as the provision of water, where the burden of payment may exceed the capacity of some individuals, the "ability to pay criterion" calls for some people to pay more or less than others for the benefits received.

SUMMARY

Economic theory provides the framework for an analysis of the effect of increasing costs on water systems. All systems not currently meeting the requirements of the SDWA Amendments are expected to incur cost increases. The expected increase in rates due to increased costs may impact low-income households more than higher-income households, leading to equity issues. Chapter 4 will address these issues.

CHAPTER 4

DATA DESCRIPTION AND ANALYSIS

The purpose of this chapter is to examine the costs of capital improvements required to meet the SDWA and its 1986 Amendments in relation to the ability of localities and individual households to pay for those improvements. Rates expected as a result of improvement costs are predicted, and the impact increased rates may have on different households is discussed.

ABILITY OF LOCALITIES TO PAY

The ability of localities to pay for water system improvements depends on their ability to secure funds for water system improvements, either through internally-generated funds or through externally-obtained funds. Internally-generated funds are funds generated from sources including retained earnings, water rates or other fees, or from tax revenues (for localities where this is an option). Externally-obtained funds are funds received from sources outside the locality, and include bank loans, loans or grants from government or private agencies, or bond issues.

Model

As discussed in Chapter 1, many water system owners expect to experience difficulty paying for the required water system improvements. Chapter 2 indicates that funding alternatives vary depending on the form of system ownership. The discussion in Chapter 3 indicates that costs per gallon vary, depending largely on system size. Chapter 3 also indicates that water rates are expected to increase as a result of increasing costs.

The preceding chapters suggest the following model.

$$\text{Equation 1: } A_C = f (F,D,N,G)$$

where,

A_C = ability of community to pay for water system improvements

F = fiscal stress level

D = current debt level

N = dollar needs required for system improvements

G = other factors, such as grant funding

$$\text{Equation 2: } N = f (S,O,W)$$

where,

N = dollar needs for required system improvements

S = system size (gallons produced per year)

O = system ownership

W = other factors, such as water source, not addressed in this analysis

The analysis below will determine whether the variables listed in Equation 1 are, in fact, indicators of a system's ability to finance water system improvements. The analysis below will also determine whether differences in system size or system ownership, as indicated in Equation 2, influence system needs.

Variables

Ability to Pay

Ability to pay is defined as the relative ease or difficulty a system faces in paying for water system improvements. It indicates the ability of a system to generate funds internally or to obtain funds from external sources.

Variables that may affect a system's ability to pay for water system improvements (ability to pay) with internally-generated funds include the fiscal stress level, needs per 1000 gallons (needs). Components of the fiscal stress index, i.e., tax effort, revenue capacity, adjusted gross income, and poverty rate may be individual indicators and are also considered.

A locality's ability to pay is also influenced by its

ability to secure externally-obtained funds. Factors affecting ability to obtain externally-obtained funds are current debt level and availability of grant funds.

Each of the components of the model are now described.

Fiscal Stress Level

Fiscal stress is a measure of the ability of a governmental unit to generate the revenues that are needed to provide public services. A number of factors may cause fiscal stress. These include citizen demands for increased levels of services, escalating costs of providing services, and new and expanding regulations such as the 1986 SDWA Amendments. Rural localities may experience fiscal stress due to high levels of poverty and low revenue capacities. Urbanizing localities may be stressed by high growth, revenue generation that lags behind infrastructure needs, and the need to expand capital facilities (Hite and Ulbrich, 1986). Fiscal stress is expected to be inversely related to ability to pay.

In this analysis the relative fiscal stress of a locality at a point in time as indicated by the Fiscal Stress Index (FSI) will be used as a measure of fiscal stress. The Virginia Department of Health (VDH) uses the FSI as an indicator of the ability of local governments to pay for water system improvements.

The FSI was developed by the Virginia Joint Legislative Audit and Review Commission (JLARC) and is designed to assess local financial resources, and to measure the ability of local governments to pay for various public projects. The Joint Legislative Audit and Review Commission (1986) defined five key indicators of fiscal stress. These are low revenue capacity or tax base, low growth in tax base, high tax effort, high increase in tax effort, and low resident income. The localities considered to have the least ability to generate funds are those with low revenue capacities along with low growth in revenue capacity or high tax effort.

The Fiscal Stress Index is a composite stress index. It is a relative measure, with approximately half of all localities having an above-average position, and approximately half having a below-average position. The FSI measures fiscal stress as a relative level calculated at a point in time. Appendices 4.1-4.4 provide descriptions and sample computations of the FSI and its components.

Availability of grant funds

One factor affecting ability to pay using externally-obtained funds is the availability of grant funds. Grant availability is expected to be inversely related to ability to pay. As discussed in Chapter 2, all publicly-owned

systems are eligible for a variety of grants. Grant funding is generally limited, however, so that grants could not be expected to cover all needed improvements. Privately-owned systems are ineligible for most grants. For the analysis described below, it is assumed that grants are not available.

Current Debt Level

A second variable influencing a community's ability to obtain external funds is the locality's current debt level. High current debt level is expected to result in low ability to pay (an inverse relationship). As discussed in Chapter 2, all political subdivisions may issue revenue bonds. There is no legal limit to revenue bond debt. Cities, towns and counties may issue general obligation bonds. Localities are limited as to maximum bond debt that may be financed by general obligation bonds. The maximum general obligation bond debt is based on taxable real estate values. (See Chapter 2 for regulations regarding bonds.)

Local government bonds are seldom issued with a maturity that exceeds the estimated life of the capital improvement. Capital improvements are generally assumed to have lives of twenty years. Local government bonds are almost always issued on a serial basis, i.e., the bonds mature in installments over the scheduled life of the loan.

Each issue will typically have its own rate of interest, with the shorter maturities generally having the lowest interest rates. Occasionally, sinking fund bonds are issued. These require the issuer to set aside a certain sum for the retirement of the bonds on the maturity date. Sinking fund payments are generally made to a trustee.

Needs

Dollar needs per 1000 gallons (needs) is used as a measure of the cost to a system of meeting the requirements of the SDWA and its Amendments. Needs are expected to be inversely related to ability to pay. The total dollar cost to a system used in this analysis is that compiled by the Virginia Department of Health (1990b). The Virginia Department of Health defines needs as the cost of those capital improvements needed to solve either a documented public health hazard, a drinking water quality problem, or to correct or prevent deterioration of present structures. Dollar needs are determined by system size, ownership and other factors not considered in this analysis. Needs are expected to be inversely related to system size and to be higher for authorities than for counties, cities, and towns. These relationships are examined below.

System Ownership

As discussed in Chapter 2, there are several legal forms that publicly-owned systems may take. Some forms have more financing options than others due to restrictions and regulations governing each form. Due to limited ability to generate funds, systems of certain ownership forms may be in worse condition, due to lack of maintenance, for example, and thus have higher needs per gallon to meet SDWA requirements. Authorities have fewer options and are expected to have higher needs, and lower ability to pay than towns, cities and counties. Some systems may simply be better managed, and more efficient in operation, resulting in lower needs. For example, larger systems are more likely to have professional managers.

System Size

It has been suggested (see Chapter 3) that small systems may experience greater difficulty in paying for water systems due to the lack of economies of scale available to them. Needs per gallon are expected to be greater for smaller systems than for larger systems.

Data Sources

Some data are available at the system level while others are available only at the county or city level.

Table 4.1 provides a break-down of the level at which data are available. Systems within each county are assumed to have the same descriptive statistics as the county.

Current Debt Level

Maximum legal bond debt is based on taxable real estate value. Taxable real estate values were obtained from the Virginia Department of Taxation (1991). Current general obligation bond debt outstanding in Virginia's cities and counties is available from the Virginia Auditor of Public Accounts (1991). Both sources compile data yearly at the county and city levels of government. Data for the year 1990 are used in this analysis.

Specific Water System Data

Printouts obtained from the Virginia Department of Health (1990d) provide data on population served, number of gallons produced per day, and system ownership for public water systems in Virginia. Data for the year 1990 are used in this analysis.

Fiscal Stress Index Scores

Fiscal Stress Index scores, tax base and revenue capacity at the county and city level are published by the Commission on Local Government (1989). The most recent

Table 4.1

Level at which Data are Available

Data	County or City	System
Current bond debt	X	
Taxable real estate values	X	
Fiscal Stress Index	X	
Percentage of households at or below poverty level	X	
Household income	X	
Population served		X
Total dollar needs		X
Gallons produced per year		X
Monthly water rates		X
System size		X
System ownership		X

data available are for the years 1986/1987, and are used in this analysis.

Needs

Data obtained from the Virginia Department of Health (1990b) are used as the best estimate of the cost of water system improvements necessary to meet the requirements of the SDWA and its Amendments. The Virginia Department of Health developed a survey that asked water system owners to provide their best estimate of projected costs required to cover system "needs" and system "wants". See Table 4.2 for definitions used in the Virginia Department of Health survey. The dollar amounts are the "best estimates" of the system operators who responded to the survey. These estimates may understate actual needs because the operators lack complete information about the future costs of removing contaminants. Alternatively, some estimates might be expected to overstate actual needs because operators believe high estimates may influence policymakers to increase funding to water systems. Overall, while there is reason to believe that the stated needs overstate real needs, the issue of survey bias needs to be resolved through more research.

The Virginia Department of Health mailed 1460 survey forms. Responses were received from 270 publicly-owned

Table 4.2

Definitions of Water System "Needs" and "Wants" as Used in
Virginia Department of Health Survey

System needs are capital improvements required to solve at least one of the following three conditions:

(a) a documented public health hazard

A public health hazard, for example, would occur where a boil water notice is in effect because "the waterworks cannot deliver a good quality of water, where nearby residences need water service because failing septic tanks or other problems cause their wells to be polluted, etc."

(b) drinking water quality problem

"A water quality problem is where source water is contributing to system problems, i.e., turbidity levels are fluctuating and filtration/disinfection is required, iron levels are causing red water problems and treatment is needed, etc."

(c) to correct or prevent deterioration of present structures.

"Deterioration or deficiency of present facilities is where pipelines are old and no longer carry adequate flows to adequate pressure and continually break or leak, where the storage tank is leaking or needs repair, etc."

System "wants" are capital improvements that would allow system expansion and growth to the year 2000.

System needs related to source and treatment were the largest category of needs in almost all systems responding to the survey.

Source: Virginia Department of Health, 1990b.

systems and 245 privately-owned systems. (Thirty-five of the systems are not used in the analysis below because data on population or gallons produced are not available.) Table 4.3 provides a summary of survey results. Additional data is provided in Appendix 4.5.

The "needs" estimates are used in this analysis as the dollar cost of improvements (needs) needed to meet the requirements of the SDWA and its Amendments. Needs are measured as needs per 1000 gallons produced.

ANALYSIS

This analysis will determine whether there are significant differences among systems of different size and ownership categories regarding dollar needs for system improvements. Chapter 3 suggests that smaller systems are expected to have more difficulty funding system improvements because the dollar needs per gallon will be greater for these systems. Chapter 2 suggests that systems of certain ownership may experience greater difficulty due to the types of financing legally available to them. For example, authorities do not have the ability to tax residents in order to pay for system improvements, and therefore may have more difficulty generating funds than cities, counties and towns.

The relationship between these variables and recorded

Table 4.3

Summary of Virginia Department of Health Survey of Virginia
Water System "Needs" to Meet SDWA Requirements

<u>Population</u> <u>Served</u> <u>by System</u>	<u>Number</u> <u>Responses</u>	<u>Needs</u> <u>(\$million)</u>	<u>Average</u> <u>Number</u> <u>Customers</u>	<u>Average cost</u> <u>Per Customer</u>
0-3300	458	\$ 63.9	84	\$1661
3301-10,000	26	8.2	1,620	195
>10,000	31	325.4	14,720	713
Total	515	\$397.5	-----	-----

Source: Virginia Department of Health Survey (1990) cited
in Raflo, 1991.

financial needs are examined using correlation analysis below. The current debt level and FSI are also examined to see if they are related to needs.

Fiscal Stress Level

A locality's Fiscal Stress Index (FSI) may indicate that a water system will have difficulty funding water system improvements. A correlation analysis was performed on needs, FSI, and the components of the FSI to determine if there is any correlation between the FSI and system-declared needs. A system is expected to have difficulty funding system improvements if the system is located in an area with a high FSI score. Table 4.4 provides results of the correlation analysis.

To test the hypothesis that the variables are not related ($P=0$), a t-test was used. At the $\alpha=.05$ level of significance, the r values shown in Table 4.4 indicate that neither needs per gallon, rates, or system size are significantly related to the FSI. The FSI is therefore not an adequate indicator of system needs.

The analysis of relationships between FSI, its components and needs suggests that as an indicator of ability to pay, the Fiscal Stress Index is not an adequate measure.

Table 4.4

Results of Correlation Analysis

	fsi	reveff	revcap	agi	povr	own	galda	need
reveff	1.000							
revcap	1.000	1.000						
agi	1.000	1.000	1.000					
povr	1.000	1.000	1.000	1.000				
own	1.000	1.000	1.000	1.000	1.000			
galda	1.000	1.000	1.000	1.000	1.000	1.000		
need	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
pop	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ned/gal	0.439	0.439	0.439	0.439	0.439	0.439	0.439	0.439
rate	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
siz	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102
	pop	ned/gal	rate					
ned/gal	0.439							
rate	1.000	0.439						
siz	0.102	0.066	0.102					

r values of .232 and above are significant in a test of

$H_0: \rho = 0$, for $\alpha = .05$. (The critical value of t is 2.00.)

Current Debt Level

The amount of currently-outstanding debt as a percentage of maximum legal debt is calculated to determine if localities have the legal capacity to pay for water system improvements by issuing general obligation bonds.

The current general obligation bond debt outstanding at the county and city level is compared to maximum legal bond debt. The maximum legal bond debt based on taxable real estate values (eighteen percent for counties and ten percent for cities), is calculated. Currently outstanding bond debt is then compared to the legal maximum bond debt limit. Table 4.5 provides a summary of the percentage of legal maximum bond debt outstanding in Virginia's cities and counties.

The results indicate that most cities and counties in Virginia are substantially below legal debt limits. Counties average only 3.9 percent of maximum possible debt. Cities are higher, with an average debt of 23.7 percent of the maximum possible. Only the relatively small city of Covington, with a current debt of 78.6 percent of maximum possible is nearing its debt limit. If the City of Covington is deleted, the average debt among cities is 22.4 percent of the maximum possible debt. Thus cities and counties have the capacity to fund water system improvements by issuing general obligation bonds.

Table 4.5

Summary of Percentage of Maximum Legal Bond Debt Outstanding in
Virginia's Cities and Counties*

	cities	counties	combined
Average bond debt outstanding**	23.7%	3.9%	9.9 %
Standard deviation	16.6	4.0	13.2
Maximum***	78.6	18.6	78.6
Minimum	0.0	0.0	0.0

*Bond debt outstanding is the percentage of maximum legal debt that the locality currently has borrowed.

**1990 data, general obligation bonds

***Among cities, the City of Covington ranked the highest; the city with the second highest bond debt was Manassas Park, with 44 percent of maximum possible. When Covington is deleted, the average debt outstanding among cities is 22.4 percent of maximum bond debt. One of the cities included above, South Boston, has since 1990 reverted to town status. South Boston had outstanding, in 1990, 33.9 percent of its maximum possible debt. Among counties, the County of Chesterfield ranked the highest; the county with the second highest bond debt was Gloucester, with 14.9 percent of maximum possible.

Note: Wythe and Prince George counties have elected to act as cities for the purpose of issuing bonds.

Source: Virginia Auditor of Public Accounts, 1991;
Virginia Department of Taxation, 1991.

Although debt may be used to fund system improvements, the resultant increase in taxes (or other fees) required to pay the bond interest and principal could place additional stress on the locality (and households within it). The effect of debt servicing will be addressed below.

System Ownership

The form of system ownership results in legal restrictions regarding types of financing which may be used to fund system improvements. (Ownership categories are those defined by the Code of Virginia. See Chapter 2.) Form of ownership may therefore affect the ease or difficulty a system has in financing system improvements. For example, authorities have fewer options than cities or counties, and are expected to experience greater difficulty. Table 4.6 provides a summary of the distribution of dollar needs per 1000 gallons by system ownership.

F-tests are used to determine if there is a significant difference among the mean needs of the various ownership categories. The first hypothesis tested is that mean needs per 1000 gallons are the same for privately-owned and publicly-owned systems. This hypothesis is rejected. Mean needs of publicly-owned systems are significantly higher than those of privately-owned systems. Table 4.7 provides the results of the F-test.

Although debt may be used to fund system improvements, the resultant increase in taxes (or other fees) required to pay the bond interest and principal could place additional stress on the locality (and households within it). The effect of debt servicing will be addressed below.

System Ownership

The form of system ownership results in legal restrictions regarding types of financing which may be used to fund system improvements. (Ownership categories are those defined by the Code of Virginia. See Chapter 2.) Form of ownership may therefore affect the ease or difficulty a system has in financing system improvements. For example, authorities have fewer options than cities or counties, and are expected to experience greater difficulty. Table 4.6 provides a summary of the distribution of dollar needs per 1000 gallons by system ownership.

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Table 4.7

Summary of Results of F-Test
Mean Needs by System Ownership
Hypothesis 1

Hypothesis 1: $H_0: U_{\text{privately-owned}} = U_{\text{publicly-owned}}$

Source	Sum of squares	degrees of freedom	variance estimate	F
Between	9778.9	1	9778.9	5.78
Within	808053	478	1690.4	
Total	817831.7			

Critical value F at $\alpha=.05$ level of confidence, 3.86

Conclusion: Reject H_0 . The mean needs of publicly-owned and privately-owned systems differ significantly.

The second hypothesis tested is that the mean average needs per 1000 gallons are the same for authorities, cities, towns, and counties (publicly-owned systems). The hypothesis is rejected. The conclusion is that the mean needs of publicly-owned systems differ significantly. This result suggests that certain public ownership categories experience higher needs and may have greater difficulty financing system improvements. Results of the F-test are provided in Table 4.8.

A review of the statistics on water system needs by ownership category suggests that rejection of the second hypothesis might be the result of the influence of outliers, those systems lying more than three standard deviations from the mean. It appears from the data that privately-owned systems, and those owned by cities, counties or towns all had approximately the same mean, while the mean for authority-owned systems appears to be much higher, possibly due to the influence of outliers. To determine if this is the case, outliers were deleted from all publicly-owned system categories. Table 4.9 provides a summary of the distribution of needs per gallon with outliers deleted from each category.

The third hypothesis tested is that the mean average needs per 1000 gallons is the same for systems owned by authorities, cities, counties and towns, with outliers

Table 4.8
Summary of Results of F-Test
Mean Needs by System Ownership
Hypothesis 2

Hypothesis 2: $H_0 : U_{\text{authority}} = U_{\text{county}} = U_{\text{town}} = U_{\text{city}}$

Source	sum of squares	degrees of freedom	variance estimate	F
Between	49456	3	16485	6.24
Within	675710	256	2639.4	
Total	725168			

Critical value F at $\alpha=.05$, 2.62

Conclusion: Reject H_0 . The mean needs of publicly-owned systems differ significantly.

Table 4.9

Distribution of Needs by System Ownership

Publicly-owned Systems, Outliers Deleted*

	<u>Authority</u>	<u>County</u>	<u>Town</u>	<u>City</u>
Total systems	87	54	96	16
Average needs per 1000 gallons	\$12.61	\$4.17	\$6.65	\$2.16
Standard Deviation	29.13	14.22	12.34	2.81
Minimum	0	0	0	0
Maximum'	178.7	74.9	56.6	9.2
*Number systems Deleted	4	1	1	1

deleted from each category. The hypothesis is rejected. The conclusion is that mean needs differ among various ownership categories, with authorities having significantly higher mean needs. See Table 4.10 for results of the F-test.

Water authorities are independent public agencies created to provide water services, and may cover more than one locality. Authorities are likely to be located in rural areas, serving several small communities.

As discussed in Chapter 3, the long water lines associated with rural systems tend to lead to higher costs per gallon, so that mean needs are expected to be higher than for systems serving more densely populated areas. Additionally, authorities have fewer financing options available to them, and thus may not have maintained the equipment adequately, incurring additional treatment costs.

System Size

The Virginia Department of Health (VDH) classifies systems into three categories based on population served. These categories are: small systems (populations of 3000 or less), medium systems (3001 to 10,000), and large systems (over 10,000). Table 4.11 provides a summary of the distribution of dollar needs per 1000 gallons by VDH size categories. As discussed in Chapter 3, larger systems are

Table 4.10
Summary of Results of F-Test
Mean Needs by System Ownership
Hypothesis 3

Hypothesis 3: $U_{\text{city}} = U_{\text{town}} = U_{\text{authority}} = U_{\text{county}}$, outliers deleted

Source	Sum of squares	Degree of freedom	Variance estimate	F
Between	3360.7	3	1120.1	2.8
Within	99554.4	249	399.8	
Total	102914.6			

Critical value of F at $\alpha=.05$ level of confidence, 2.65

Conclusion: Reject H_0 . The mean needs of publicly-owned systems, with outliers deleted, do differ significantly.

Table 4.11

Distribution of Needs Based on VDH categories of System Size

Size of system*	Small	Medium	Large
number of systems	434	14	32
average needs per 1000 gal	\$11.34	\$5.52	\$5.80
standard deviation**	43	11	17.9
maximum	483	43	100
minimum	0	0	0
median	0	.4	.49

*The Virginia Department of Health categorizes systems by size based on the following criteria:

small systems serve fewer than 3300 customers
medium systems serve 3301 to 10,000 customers
large systems serve over 10,000 customers

**In the small category there were nine outliers ranging in needs per 1000 gallons from \$131 to \$483. In the medium size category, the only outlier had needs of \$43, and in the large category, the only outlier had needs of \$100.

expected to be able to take advantage of economies of scale and thus have lower costs per gallon.

An F-test is used to determine if there is any significant difference among the means of the various VDH size categories. The hypothesis of no difference is not rejected, indicating no significant difference among size categories. Small, medium and large systems experience comparable dollar needs per 1000 gallons. Table 4.12 provides the results of the F-test.

Because of the unequal number of systems in each size category based on VDH classifications, a second method is also used to test for differences among means of various size systems. This second method bases size categories on gallons produced per year. Systems are divided into three categories containing an equal number of systems based on gallons produced. This is done to more appropriately test for any differences in means among systems of different sizes. The unequal number of systems represented in the VDH size categories may distort the results of the F-test. Also, the use of population as a defining variable may not be the most appropriate for cost considerations. Gallons per year may be a more accurate measure of size than population due to factors such as business usage, agricultural usage, or suburban versus city usage of water. See Table 4.13 for a summary of dollar needs based on equal

Table 4.12

Summary of Results of F-test

Mean Needs Based on VDH Categories of System Size

Hypothesis: $H_0 : U_{\text{small}} = U_{\text{medium}} = U_{\text{large}}$

Source	Sum of squares	degrees of freedom	variance	F estimate
Between	1317.75	2	658.8	.38
Within	816516.6	477	1711.7	
Total	817834.4			

Critical F, $\alpha=.05$ level of confidence: 3.02

Conclusion: Do not reject H_0 . The mean needs of small, medium and large systems do not differs significantly.

size categories.

An F-test is used to test the hypothesis that mean needs are equal for all size categories. The hypothesis is rejected. The conclusion is that mean needs do differ among various size systems based on gallons produced. Smaller systems have significantly larger mean needs per 1000 gallons than do mid-size and larger systems. This result is suggested by the discussion of economies of scale in Chapter 3. (Smaller systems are expected to have higher costs per gallon.) See Table 4.14 for results of the F-test.

SUMMARY

Results of the above analysis suggest that, in general, localities have the ability to pay for water system improvements. Needs do not appear to be the problem as many anticipated (see Chapter 1). The median needs are zero, indicating that half of the systems surveyed anticipate no improvement costs associated with meeting the SDWA requirements. It has also been noted that needs estimates may be biased. The systems that do have needs have sufficient debt capacity to finance those needs.

Variations in ability among various size or ownership categories do exist. Water authorities are shown to have higher mean needs than other publicly-owned systems. When based on gallons produced, the smallest third of systems are

Table 4.13
Distribution of Needs
Categories Based on Gallons Produced per Year

<u>Size category</u>	<u>low third</u>	<u>mid third</u>	<u>high third</u>
number systems	160	160	160
average needs per 1000 gallons	\$16.9	\$9.9	\$5.7
standard deviation	55.0	42.5	14.7
maximum*	344.9	483.5	146.7
minimum	0	0	0
median	0	0	0.7

*Outliers in each category have needs as listed below.

low third	mid third	high third
\$256.85	\$483.48	\$54.79
292.23		146.72
294.36		
301.36		
344.90		

Table 4.14

Summary of Results of F-Test

Mean Needs, Categories Based on Gallons Produced per Year

Hypotheses: $H_0: U_{\text{low third}} = U_{\text{mid third}} = U_{\text{high third}}$

Source	Sum of squares	degrees freedom	variance estimate	F
Between	10896	2	5448	3.2
Within	806823	476	1695	
Total	817719			

Critical F, $\alpha=.05$ level of confidence: 3.02

Conclusion: Reject H_0

shown to have significantly higher mean needs. These results suggest that authority-owned and smaller systems may have the greatest difficulty paying for water system improvements. The implications of this are discussed in Chapter 5.

ABILITY OF HOUSEHOLDS TO PAY

The costs of water system improvements may have a significant impact on individual households due to the increased rates needed to pay for system improvements. To determine the impact on households, increases in water rates needed to cover the cost of improvements are estimated. The percentage of household income spent on water is then calculated.

Operation and maintenance costs, including labor, treatment chemicals and testing are also expected to increase due to the increased number of substances included under the 1986 Amendments. These costs vary substantially depending on age and size of system, type of water source and treatment devices used, and even knowledge of system operator (Cox, Sherrard, and Gaw, 1989). The effect of increased costs of operation and maintenance are not considered in this analysis.

The source of funds used for water system improvements influences debt servicing costs. Privately-owned systems

are not eligible for most government agency loan and grant programs (see Chapter 2). Large privately-owned systems may be able to issue bonds. For small and medium size privately-owned systems, the only source of external funds may be bank loans. Loan rates for privately-owned systems are unavailable, and will not be considered in this analysis.

There are a variety of government agency loan and grant programs available to publicly-owned systems. As noted in Chapter 2, grant funds are limited. It is assumed, for the purposes of this analysis, that publicly-owned systems obtain external financing by issuing bonds through the Virginia Resources Authority.

Model

$$A_h = f(I, R)$$

where,

A_h = ability of households to pay

I = income

R = water rates

Variables

Ability of Households to Pay

Ability of households to pay is a relative measure. It is based on the percentage of yearly household income that

expenditures on water represent. Households with lower incomes combined with high rates are expected to have the least ability to pay.

Income

Income is the household's yearly income. A household consists of a family of four. Income is expected to be directly related to ability of households to pay. Four levels of household income are considered. These are: incomes at or below the federally defined poverty level of income (\$13,950 or below), low income (\$19,000), middle income (\$25,000) and high income (over \$25,000). Incomes are 1992 current dollar incomes. Low-income households are defined as those with incomes of \$19,000 or below.

Water Rates

Water rates are monthly consumer rates, based on consumption of 5000 gallons. Water rates are expected to be inversely related to ability of households to pay.

Data Sources

Rates

Data on system rates was obtained from surveys performed by Draper Aden Associates, Inc. (1990, 1991,

1992).⁴⁴ The surveys ask system owners to provide data on current rates (based on 5000 gallons per month), date rates were last changed, number of connections, billing cycle, number of residents, average daily flow (gallons), and charges for connection or availability fees, if used. Respondents to the surveys totaled 120 in 1990, 156 in 1991, and 196 in 1992, and include both publicly- and privately-owned systems. The respondents represent approximately eleven percent of all systems in Virginia, and twenty-nine percent of publicly-owned systems. Rate data from those systems which are represented in both the Virginia Department of Health needs survey and the Draper Aden rate survey are used in this analysis to calculate predicted rates needed to pay for system improvements. There are no privately-owned systems for which both rates and needs data are available. Table 4.15 provides a summary of the results of the Draper Aden surveys. Table 4.16 provides a summary of water rates for those systems represented in both surveys by system ownership and Virginia Department of Health system size.

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The annual reports are compiled by Draper Aden Associates, the Virginia Municipal League and the Virginia Association of Counties.

Table 4.15

Summary of Results of the Draper Aden Surveys

Year	1990	1991	1992
Average	\$11.78	\$14.86	\$13.38
Maximum	40.17	47.50	30.86
Minimum	3.58	4.33	2.44
Number systems	120	156	196

Source: Draper Aden Associates, Inc. (1990, 1991, 1992)

Table 4.16
Summary of Monthly Water Rates
By Ownership and System Size*

By Ownership Category

	All systems	Authority	County	Town	City
average**	\$12.14	\$16.73	\$10.62	\$12.04	\$ 8.58
standard deviation	5.99	7.85	3.53	5.63	2.55
minimum	2.50	2.50	2.50	5.00	5.00
maximum	36.00	31.75	14.43	36.00	13.45
number	74	10	4	47	13

By VDH Size Category

	Small	Medium	Large
average	\$13.11	\$11.63	\$9.79
standard deviation	6.67	4.03	3.69
minimum	2.50	7.45	5.75
maximum	36.00	19.75	18.20
number	48	8	18

By Gallons Produced per Year

	low third	mid third	high third
average	\$13.75	\$12.50	\$9.92
standard deviation	6.6	6.3	3.9
minimum	5.00	5.00	2.50
maximum	31.75	36.00	18.20
number	25	24	24

*Monthly rates are based on residential usage of 5000 gallons per month (Draper Aden, 1990, 1991, 1992).

**The highest rate is \$36 (Town of Colonial Beach, Westmoreland County), the next highest rate is \$31.70 (Hiltones-Scott Water Authority, Scott County).

Bond Interest Rates

The bond interest rate used in this analysis is seven percent. Bonds are assumed to be issued through the Virginia Resources Authority (VRA), with a twenty year maturity date, and equal annual payments. The interest rate is based on interest rates for water system bonds issued by the Virginia Resources Authority in 1990, which ranged from 6.8 to 7.3 percent. Seven percent is used as a representative rate. (The Virginia Resources Authority (1990) provides for Aa bond ratings. Maturities are ten to twenty-eight years. See Chapter 2.)

ANALYSIS

This analysis will provide estimates of rates required to pay for improvements for those systems for which both rate data and needs data are available. The predicted rates are calculated as a percentage of income at four levels of household income. This is done to determine the impact of predicted rates on households at those income levels.

Systems for which 1990 rates are available from Draper Aden surveys are matched with needs data from the Virginia Department of Health (1990b) survey. The Draper Aden 1990 rate survey provides fifty-four systems for which needs data

are available. In order to increase the number of systems available for the analysis, the 1991 and 1992 Draper Aden surveys were also reviewed in order to find additional systems for which 1990 rates are available.⁴⁵ This provided an additional nineteen systems, for a total of seventy-three systems. Fifty-four of the seventy-three systems had needs greater than zero.

A number of researchers have studied have average monthly water usage and rates in various areas of the United States. Table 4.17 summarizes the results of these studies. Young and Gray (1972) cite a study published by the American Society of Civil Engineers. This study estimated per capita daily consumption of water for various purposes in a family of four. The monthly water usage based on this estimate is 10,320 gallons. (Table 4.18 provides the results of the Young and Gray study.) The study included use of an automatic dishwasher, automatic washer, garbage disposal, lawn watering and car washing. If it is assumed that households at or below the poverty level of income are unlikely to have these conveniences in the home, or engage in car washing or lawn watering, the average daily

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The respondents the the Draper Aden surveys are asked for the date of the last rate change. Systems whose rates had not changed since July 1990 or before were added to the fifty-four from the 1990 survey.

Table 4.17

Results of Studies of Water Rates and Usage
for Various Areas of the United States

Study Area	Monthly Usage	Monthly Water Bill
Agthe and Billings (1987)		
area studied: Tucson, Arizona		
average monthly usage: 11,000 gallons		
Draper Aden		
area studied: Virginia		
average monthly water bill: \$14.86		
Ernst and Young Co (1991)		
area studied: United States		
average monthly water bill: \$6.78 to 11.16		
average monthly water usage: 3740 to 7480 gallons		
Neiwiadomy (1992)		
area studied: South ¹		
average monthly water bill: \$11.57		
average monthly water usage: 9370 gallons		
Neiwiadomy and Molina (1989)		
area studied: Denton, Texas		
average monthly water usage: 14,000 to 65,000 gallons		
Schefter and David (1985)		
area studied: Wisconsin		
average monthly usage: 4175 gallons		
Virginia Department of Health (1992)		
area studied: Virginia subdivisions with no industry		
average monthly water usage: 9000 gallons		
Weigman (1992)		
area studied: United States		
average water bill: \$100 to \$150 per year (\$8.33 to \$12.50 per month)		
percent of income spent on water: less than one percent		
Young and Gray (1972)		
area studied: United States		
average monthly usage: cited estimate of 86 gallons per day per person in a family of four (total 10320 gal per month per family)		

¹South was defined as the following states: Alabama, Arkansas, Delaware, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Oklahoma, Tennessee, Texas, Virginia and West Virginia

Table 4.18

Estimated Per Capita Daily Consumption of Water
for Various Purposes in a Family of Four*

Purpose	Comments	Volume of Use
Drinking water and cooking		2.00
Dishwashing	Automatic dishwasher	3.75
Toilet	12 flushes	24.00
Baths		20.00
Laundry	Automatic washer	8.00
Car washing		2.50
Lawn watering	200 gallons per hour 2 hrs per day-90 days	25.00
Garbage	Garbage disposal	.75

*Weekly, monthly and seasonal variations are averaged and prorated to a daily basis. The authors note that this is to be taken as an "indication of what may be typical levels of use". They also note that lawn watering is subject to great variation in use.

Source: Young, Robert A. and S. Lee Gray (1972)

consumption per person is cut approximately in half, from eighty-six to forty-six gallons per person per day. The monthly consumption would then be 5520 per month for a family of four. As noted above, the Draper Aden Rate Surveys (1990, 1991, 1992) are based on a monthly usage of 5000 gallons. A monthly average of 5000 gallons is used for this analysis.

Debt Servicing Costs

Yearly principal and interest payments are calculated for each system having greater than zero needs. Debt servicing costs are based on twenty year maturities and seven percent interest rates for AA bonds as described above. The debt servicing costs per year are divided by gallons produced per year, to calculate additional cost per gallon per year. The effect on rates is computed as current rates per 5000 gallons plus cost of additional principal and interest. Predicted rates are calculated as follows:

$$\text{predicted rate} = \text{current rate} + (\text{debt cost per gallon} \times 5000 \text{ gallons})$$

This calculation provides an estimate of rates required to pay for system improvements. Table 4.19 provides a summary of predicted rates.

To determine if predicted rates are significantly different from current rates, an F-test is performed. The

Table 4.19

Summary of Predicted Rates per 5000 Gallons per Month

Predicted Monthly Rates*

average	\$12.53
standard deviation	6.23
minimum	2.68
maximum**	36.37
median	11.65
total number systems***	73

*Predicted rates are based on usage per household of 5000 gallons per month.

**There are two outliers with rates of \$36.37 and \$31.75

***number of systems with needs: 54

results of the F-test indicate that current and predicted rates do not differ significantly. The results of the F-test are provided in Table 4.20.

Predicted Rates compared to National Averages

To determine if predicted water rates in Virginia are equivalent to those in states surrounding Virginia, the predicted rates are compared to national averages compiled by Ernst and Young Company, Inc. (1990). Table 4.21 provides a listing of averages from Virginia and several neighboring states. These are for urban areas, and are used to provide a baseline for comparison. An F-test is used to determine if predicted rates in Virginia differ significantly from national averages. In order to compare the rates in surrounding states to the predicted rates per 5000 gallons for Virginia's systems, rates per 5000 gallons were estimated as follows:

$$\text{Rate per 5000 gallons} = \text{rate per 4000 gallons} + (1/3 \text{ difference*})$$

*difference is rate per 7000 gallons minus rate per 4000 gallons. Estimated rates for surrounding states based on 5000 gallons per month are provided in Table 4.22.

An F-test is performed to determine if predicted rates in Virginia are the same as those in neighboring states. The hypothesis is not rejected. The conclusion is that

Table 4.20

Summary of Results of F-Test
Means of Current and Predicted Rates

$$H_0: U_{\text{current}} = U_{\text{predicted}}$$

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F
Between	7.59	1	7.59	.199
Within	5478.34	144	38.0	
Total	5485.93			

Critical $F_{\alpha=.05}$ 3.91

Conclusion: Do not reject H_0 . The means of current and predicted water rates do not differ significantly.

Table 4.21

Average Monthly Residential Water Rates for Cities in
Virginia

and Surrounding States*

	4000 gallons	7000
gallons		
Virginia		
Norfolk	\$8.02	\$13.90
Tennessee		
Chattanooga	10.02	20.82
Johnson City	11.82	17.58
Knoxville	9.53	17.73
Memphis	3.29	6.58
Nashville	11.65	24.30
North Carolina		
Charlotte	5.30	9.10
Greensboro	3.45	6.90
Raleigh	6.61	
11.81		
Maryland		
Baltimore	3.50	7.00
District of Columbia		
Washington	5.02	10.04
Average rates, non-Virginia cities	\$7.04	\$13.19
Standard deviation, non-Virginia cities	3.27	6.1

*No cities in West Virginia were included in the survey.

Source: Ernst and Young Co., 1990; Raftelis, 1993.

Table 4.22

Summary of Estimated Rates, Cities in States Surrounding
Virginia

Household Consumption of 5000 Gallons per Month

<u>City</u>	<u>Estimated Rate</u>
Chattanooga	\$13.58
Johnson City	13.72
Knoxville	12.24
Memphis	4.38
Nashville	15.82
Charlotte	6.55
Greensboro	4.59
Raleigh	8.33
Baltimore	4.66
Washington	6.68
 <u>Summary</u>	
Average rate	\$9.05
Standard Deviation	4.15
Minimum	4.38
Maximum	15.82

predicted rates in Virginia do not differ significantly from rates in neighboring states. Therefore, Virginia households will, in general, pay approximately the same rates for water as households in neighboring states. The results of the F-test are provided in Table 4.23.

Effect of Predicted Rates on Low-Income Households

Although predicted rates do not differ significantly from rates in neighboring states, predicted rates may cause low-income households to experience lowered ability to pay, and may be considered unequitable. To measure the impact of the predicted rates on low-income households, the percentage of income a typical bill would represent is calculated. Weigmann (1992) indicates that nationally, the average percentage of income spent on water is one percent. This average will be used as a standard to consider the impact of predicted rates on households.

The monthly cost of water for a household is calculated as a percentage of income at four levels of income for comparative purposes. The four income levels used are \$13,950, \$19,000, \$25,000 and \$29,000. These income levels are based on the three levels used by the Virginia Resources Authority (VRA), with the addition of the poverty level income of \$13,950. The VRA income categories are based on median household income in the city or county. (The VRA

Table 4.23
Summary of Results of F-Test
Rates per 5000 Gallons
Virginia and Cities in Surrounding States

Hypothesis: $H_0 : U_{\text{Virginia}} = U_{\text{surrounding states}}$

Source	Sum of squares	degrees of freedom	variance estimate	F
Between	106.8	1	106.8	3.06
Within	2827.5	81	34.9	
Total	2934.3			

Critical F, $\alpha = .05$ level of confidence: 3.96

Conclusion: Do not reject H_0 . The means of water rates for cities in Virginia and cities in surrounding states do not differ significantly.

uses these income levels as guidelines when ranking projects. Table 4.24 summarizes VRA guidelines for appropriate percentages of income spent on water at various income levels.) The greatest impact of increasing water rates is expected to be on poverty level households.

Household size is assumed to be four people. The approximate number of households served by each system is estimated by dividing the population served by each system by four. The number of poverty level households served by each system is approximated as the number of households in each system multiplied by the poverty rate in the city or surrounding county.

Table 4.25 summarizes water costs as a percent of household income based on predicted rates. At income levels of \$19,000 and above, the average water cost represents less than one percent of income. In only two systems are households with yearly incomes of \$19,000 predicted to pay more than two percent of their income on water. In an additional fifteen systems, households with incomes of \$19,000 are expected to pay over one percent of their income on water.

At the poverty level of income, the average household is predicted to spent one percent of income on water. Based on predicted rates, 230 poverty level households served by the seventy-three systems considered in this analysis will

Table 4.24
 Appropriate Percentage of Income Spent on Water
 for Various Income Categories
 as Used by the Virginia Resources Authority

<u>Income category</u>	<u>Dollar income*</u>	<u>Percent of income spent on water</u>
low	below \$19,000	0.5 percent
low medium	19,001-25,000	1.0 percent
upper medium	25,000-29,000	1.25 percent
upper	over 29,000	1.5 percent

*median household income

Source: Massey, 1992.

Table 4.25
Percentage of Income Spent on Water
Based on Predicted Rates*

Income category**	\$13950***	\$19000	\$25000	\$29000
average	.01	.007	.006	.005
standard deviation	.005	.003	.002	.002
minimum	.002	.001	.001	.001
maximum****	.031	.022	.017	.015

*percentage of yearly household income spent on water using predicted rates. For example, a household with \$13,950 income would spend, on average, one percent (\$139) of their annual income on water.

**yearly household income

***1992 poverty rate for family of four based on U.S. Poverty Guidelines (Boyd, 1992).

****There are two outliers in the poverty level income category, .031 and .027. At \$19,000, there are three outliers, .022, .020 and .017. At \$25,000, outliers are .017, .015, .013. At \$29,000, outliers are .015, .014, and .0116.

pay more than two percent of yearly income on water. These 230 households represent just under six percent of total households served by the seventy-three systems. In ten additional systems, 1767 poverty level households are expected to pay between one and one-half and two percent of their income on water. Poverty level households served by another twenty-three systems will spend over one percent of their incomes on water. Because the national average for all income levels is one percent, these results suggest that poverty level households may experience relatively more difficulty paying for water, compared to households at higher income levels. Table 4.26 provides a summary of the percentage of income paid for water by households at the poverty level.

If one percent of income is considered to be the appropriate amount to be spent on water, households at the poverty level or with relatively low incomes are expected to have the lowest ability to pay. The implications of this result regarding equity theory are discussed in Chapter 5.

SUMMARY

The results of this analysis indicate that individual households will generally not face increased water rates beyond their ability to pay. The predicted rates required to cover system improvements will still fall within national

Table 4.26

Summary of Percentage of Income Paid for Water by
Households at the Poverty Level*

Income: \$13,950 (poverty level)

<u>Percentage of Income</u>	<u>no.systems**</u>	<u>Households</u>	
		<u>number</u>	<u>percent***</u>
x>0.02	4	230	0.5%
0.02>x>0.015	10	1,767	4.4
0.015>x>0.01	23	26,256	66.3
0.01>x>0.005	32	9,027	22.8
x>0.005	4	2,309	5.3

*Based on predicted rates

**No. systems is the number of systems for which percentage of income spent on water falls within the given range.

Range is the percentage of income spent on water. For example, there are four systems for which the predicted water rate will represent over two percent of \$13,950.

***Percent is the percentage of total poverty level households served by the systems used in this analysis. Approximately 351,903 households are served by the seventy-three systems. Approximately 39,589 households are at or below the poverty level of income.

averages, and are not significantly different from current rates. Authorities are shown to have higher rates, on average. This may be because of the higher needs associated with authorities.

Households near or at the poverty level may experience a hardship due to increased rates. Methods to deal with this possibility are discussed in Chapter 5.

CHAPTER 5

CONCLUSIONS

This chapter will summarize the conclusions of the analysis presented in Chapter 4. Alternatives suggested to help systems and households with relatively low ability to pay are briefly discussed. A more detailed analysis of alternatives is suggested for future research.

ABILITY OF LOCALITIES TO PAY

The analysis in Chapter 4 indicates that the majority of systems have the ability to pay for system improvements.

Counties, cities and towns are generally well below legal debt limits and thus have the capacity to secure funds through bank loans or bond issues. As is noted in Chapter 4, as of December, 1990, only one city (Covington) was relatively near its debt limit. All other cities, counties and towns had less than half their maximum possible debt outstanding. Thus it is possible for these cities, counties and towns to finance water system improvements by issuing debt.

Among the various ownership forms, water authorities

are shown to have significantly higher mean needs than other forms. As indicated in Chapter 2, authorities have fewer financing options than cities, counties and towns. The combination of higher needs and fewer financing options suggests that water authorities may experience relatively more difficulty paying for system improvements (lower ability to pay).

Among the various size categories, the smallest third of systems (based on gallons produced) have significantly higher mean needs. Smaller systems have fewer customers over which to spread the costs of improvements. This suggests that the smallest systems may experience relatively more difficulty paying for system improvements (lower ability to pay).

Suggested Alternatives

Given the overall (small) dimension of the problem, few systems are expected to face difficulty financing system improvements. For systems where difficulty does exist, several alternatives have been suggested to help systems pay for improvements. The National Council on Public Works (1988), and Hite and Ulbrich (1986), suggest that the federal or state government provide additional funding. Additional funding could be directed to those systems showing the lowest ability to pay. In a time of declining

federal funding and declining state revenues this alternative may not be feasible.

A second alternative suggested to help water systems is simply to improve management efficiency within the system. Costs in small systems may be higher than is necessary due to inefficiency in daily operations. In addition, system operators may lack knowledge of the lowest cost way to upgrade and improve their infrastructure. Raflo (1991) suggests that small waterworks may lack the staff needed to evaluate different financing options and time periods, and thus face relatively higher financing costs for capital improvements. The Report of the Task Force on the Drinking Water Protection Fund (1990) concluded that most small systems lack adequate training and/or management. The report suggested that the Virginia Department of Health provide training for small systems.

A third alternative is to reduce treatment requirements for systems with the lowest ability to pay. The analysis in Chapter 4 has indicated that systems with relatively low ability to pay are small systems and authorities. Costs may be lowered for these systems by instituting limited requirements for those systems.⁴⁶ Costs and benefits of

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The Report of the Task Force on the Drinking Water Protection Fund (1990) indicates that small systems account for the greatest number of violations.

lowered treatment requirements would have to be analyzed to determine if the benefits outweigh the risks (for customers drinking the water).

A fourth alternative is to consolidate systems. One half of Virginia's cities and almost half of its counties have fewer than 20,000 residents. Twenty-seven cities and counties have fewer than 10,000 residents (Virginia Assembly, 1990). Greater economies of scale may be achieved by consolidating infrastructures and management of systems where there are currently small systems serving contiguous areas. This could be done by consolidating systems under the management of the Regional Planning District Commissions. Virginia has authorized these districts to take on service functions. However, the benefits of consolidation will have to be weighed against the costs, including the diseconomies associated with longer lines.

ABILITY OF HOUSEHOLDS TO PAY

The analysis discussed in Chapter 4 indicates that, in general, rate increases required to pay for system improvements will not result in substantially increased rates in the majority of systems. In those systems, however, the predicted rates are expected to result in some households paying more than one percent of their incomes for water. In these cases, equity concerns may arise. When

households at lower income levels pay a higher percentage of their income on water (a "necessity") than do those at higher income levels, it is not considered equitable by many people. Alternatives suggested to minimize the impact of increased water rates on low-income households are briefly discussed below.

Suggested Alternatives

One alternative that has been suggested to help low-income households is to provide water "stamps". The state or federal government could provide "stamps", similar to food stamps, for the payment of water charges (Hite, 1989). Alternatively, grants could be allocated to the household. Grants could be given to the household, or paid directly to the provider of the service. In this way, the ability-to-pay principal could be satisfied.

A second alternative is to offer reduced rates to low-income households. Results of the Earnst and Young survey (1990) indicate that some systems have established reduced rates for low-income households.⁴⁷ This does ease the impact of increased rates on low-income households. However, it does not encourage households to conserve water.

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Of the 150 systems responding to the Earnst and Young survey, twenty-four offer reduced rates to elderly or low-income households.

If rates are decreased, low-income households may simply use more water.

A third method that has been suggested is to provide rebates or special rate reductions (for a limited time) to those households which invest in water saving devices such as low-flow toilets, or water-saving washers, for example. A rebate or rate reduction would provide a means for low-income households to invest in water-saving devices. Reduced water usage would then decrease the households cost per month.

A fourth method of assisting residential customers is to increase the rates paid by commercial customers. Commercial customers often require large amounts of water during peak use periods. Additional charges on heavy users could be used to offset charges to low-income customers.

Policy Implications

Measures of funding ability

The analysis of Chapter 4 has shown that the Fiscal Stress Index, is not an adequate indicator of a water system's ability to finance system improvements. None of the variables shown to be significant in relation to dollar needs is significantly related to the Fiscal Stress Index. Thus, the FSI should not be used to allocate state resources for water system improvements.

One alternative approach to evaluating the ability of a water system to finance improvements is a ranking system. The system should be based on variables which have been shown to be significant, including system ownership, current debt level, and system size (based on gallons). As shown in Chapter 4, system size, based on population served as used by the VDH, is not a significant indicator of needs. Such a ranking system would be a more effective means of targeting systems for state assistance.

Estimating Needs per Gallon

Estimates of needs for system improvements made by system operators may not be sufficiently accurate for the purpose of making state funding decisions. System operators may simply lack the knowledge to be able to make accurate estimates. A more appropriate method of estimating needs for systems is to use a cost equation, such as that described in Chapter 3. The various factors which influence treatment costs, e.g., water source, system size (in gallons), existing treatment technology, etc., can be estimated for each system based on engineering data. The estimates can then be entered into a cost equation in order to estimate the costs for any particular system. Unusual situations could be considered on an individual basis. The funding formula described above could be explained using

these engineering-based needs data.

Suggestions for Future Research

The results of the current analysis have more clearly indicated which systems are expected to have relatively low ability to pay for water system improvements. The analysis also indicated the extent to which low-income household may be affected by increased rates. The results will be useful to groups that allocate funding to water systems. Future research examining alternatives in more depth will provide additional information on the feasibility of each alternative discussed above. Additional research on systems with the lowest ability to pay, small systems and authorities, may be warranted to develop additional alternatives for these systems.

CONCLUSION

The analysis of Chapter 4 indicates that the problem facing Virginia's water systems is not an inability to finance system improvements. The more significant problem may be the effect of increased rates on low-income households. The effects of increasing water rates incurred as a result of financing system improvements may result in hardships on low-income households.

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Appendix 1

Safe Drinking Water Act

Definitions of Types of Water Systems

Public water systems

A system serving the public, having at least fifteen connections, or serving an average of twenty-five individuals for at least sixty days out of the year. This category includes:

1. Community Water System-a waterworks which serves at least fifteen service connections used by year-round residents or regularly serves at least twenty-five year-round residents.
2. Noncommunity Water System-a waterworks that is not a community waterworks, but operates at least sixty days out of the year.
3. Non-transient Noncommunity Water System-a waterworks that is not a community waterworks and that regularly serves at least twenty-five of the same persons over six months out of the year.

Non-public water systems

Those water systems which are not publicly owned, such as investor-owned development systems or individual wells and septic tanks.

Source: Virginia Department of Health, 1990c.

Appendix 2

Weighting System for Community Improvement Grant Selection used by Virginia Department of Housing and Community Development

<u>Criteria</u>	Percent Weight
Indicators of Community Relative Need	
Income (Adjusted Gross Income and transfer payments)	7
Population Change	6
Unemployment	6
Tax Effort/Ability Index	<u>6</u>
Total Community Relative Need	25
<u>Indicators of Community Improvement Grant Impact</u>	
Relationship to State Priorities	8
Relationship to Regional Priorities	8
Impact on Community Needs and Objectives	59
Project Relation to Local Needs and Objectives	5
Appropriate Project Cost/Affordability	14
Level of Commitment	10
Benefit to Low and Moderate Income	20
Impact on Community Economic Development, Housing and/or Community Facility Needs	10
Total Community Improvement Grant Impact	<u>75</u>
TOTAL	100

Source: Virginia Department of Housing and Community
Development, 1989

Appendix 4.1

Components of the Fiscal Stress Index*

Revenue Capacity

Revenue capacity is a measure of each locality's ability to raise revenues to support public services. It indicates potential revenue which could be generated if statewide average tax rates were used. It is computed by multiplying each major component of a local government's tax base by the statewide average tax rate. This concept was developed by the U.S. Advisory Commission on Intergovernmental Relations and is often referred to as the "representative tax system." (Joint Legislative Audit and Review Committee, 1986). Appendix 4.3 shows how revenue capacity is calculated.

Tax Effort

Tax effort is a measure of the amount of the available tax base or revenue capacity which the locality is currently using. Tax effort equals the actual local tax revenues divided by local revenue capacity. It is used to determine each locality's tax levels, and to compare localities to each other (Joint Legislative Audit and Review Committee, 1986). The Joint Legislative Audit and Review Committee suggests that governments with low revenue capacities in conjunction with high tax efforts have the least ability or latitude to generate more funds. Table 4.4 shows how tax effort is calculated.

*Appendix 4.2 shows how the Fiscal Stress Index is calculated.

Note: In the calculation of the FSI, low income households are defined as those below the federally-defined poverty level.

Appendix 4.2

Computation of the Fiscal Stress Index

Local Indicators

1977 revenue Capacity
 1977 tax effort
 change in revenue capacity 1977-1983
 change in tax effort 1977-1983
 poverty index

Each local indicator assigned a value from 1 to 8, depending on position compared to the mean. Value of 8 implies high stress. Value of 1 indicates low stress.

=====

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Example: Accomack
 St. Dev.*Value Weight

1977 capacity	= \$302.47	2/361
1977 effort	= 0.50	2/332
Change in capacity	= 129.18	1/352
Change in effort	= 0.00	2/331
Poverty	= 21.1%>1	7.751

1983 Stress Index = $6 + (2 \times 3) + (2 \times 5) + 2 + 7.75 = 32.75$
 (Above Average Stress)

*St.Dev. = standard deviation below mean

Source: Joint Legislative Audit and Review Commission,
 1986.

Appendix 4.3

An example of the computation of Revenue Capacity

Per Capita Revenue Capacity =

[(Real Property Value x Average Rate)
+ (Number of Motor Vehicles x Average License Fee)
+ (Number of Motor Vehicles x Average Personal Property Tax)
+ Sales Tax Revenue
+ (Public Service Corporation Property x Average Rate)
+ (Adjusted Gross Income x Average "Other" Tax Rate)]

Population

=====

Example: Accomack

[(720,255,386 x .00897)
+ (24,553 x 13.46)
+ (24,553 x 88.05)
+ 1,083,965
+ (50,655,081) x .017251)]
----- = 3,381,286 = 431.65
31,000

Source: Joint Legislative Audit and Review Committee, 1986.

Appendix 4.4

An example of the computation of Tax Effort

Tax Effort = Tax Revenue (Collections) / Revenue Capacity

Tax Revenue =

Real Estate Levies

+ (No. of Registered Motor Vehicles x Motor Vehicle License Fee)

+ Tangible Personal Property Levies

+ Sales Tax Revenue

+ Public Service Corporation Levies

+ Other Local Tax Revenue

-

Revenue Capacity

=====

Example: Accomack

(2,601,568

+ 122,765

+ 1,170,537

+ 1,083,965

+ 196,090

+ 1,472,603) 6,647,528

----- = ----- = 0.50 = Tax Effort
13,381,286 13,381,286

Source: Joint Legislative Audit and Review Committee, 1986.

Appendix 4.5

Summary of Results of Virginia Department of Health Survey of Virginia Water System "Needs" and "Wants"

	Publicly-owned*	Privately-owned	Total
Number respondents**	270	245	515
Percent of total total systems	37.9	29.1	35.4
Needs (\$M)***	392.446	5.108	397.554
Wants (\$M)	1099.029	22.716	1121.745
Total, needs and wants	1491.475	27.826	1519.302

*The survey excluded systems owned by the state or federal government.

**A total of 1460 forms were mailed.

***Data on gallons produced per year are not available for all systems included in the survey. Thus it is not possible to provide a summary of needs per gallon.

Source: Virginia Department of Health, 1990b.

VITA

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A handwritten signature in cursive script that reads "Janet R. Hunter". The signature is written in dark ink and is positioned in the lower right area of the page.