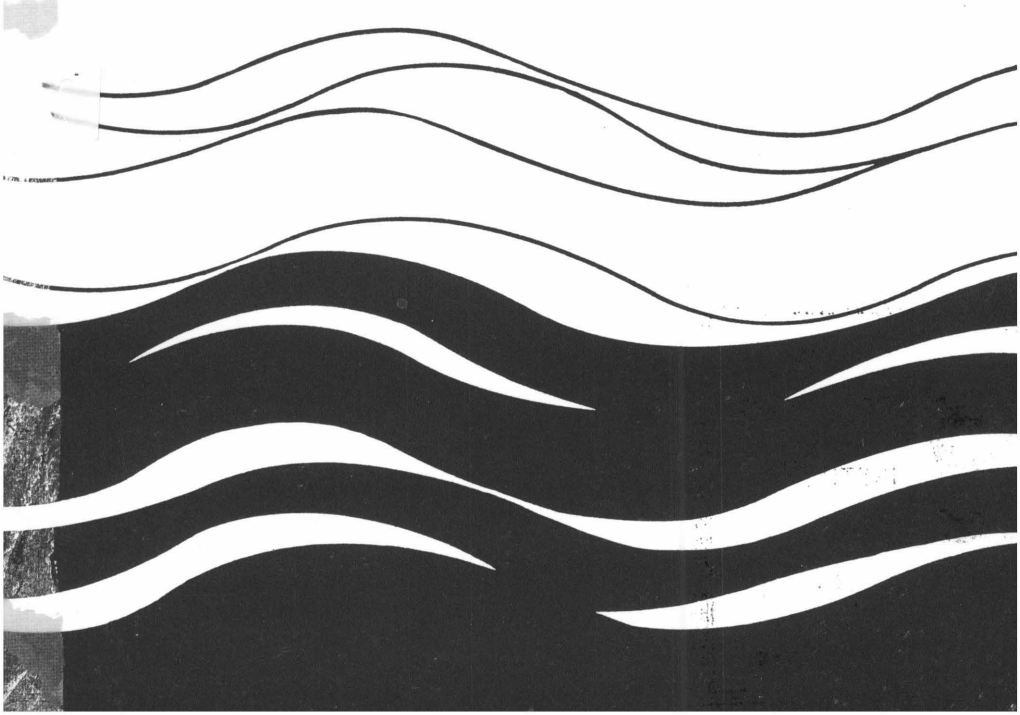
Virginia Water Resources Research Center
Virginia Polytechnic Institute and State University

Bulletin 136

A Financial Assessment of Virginia's Outdoor Recreation Planning

Leonard Shabman & Reid Ostrander



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August 1982

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Leonard Shabman
Reid Ostrander

Department of Agricultural Economics
Virginia Polytechnic Institute and State University

The work upon which this report is based was supported in part by funds provided by the United States Department of the Interior, Office of Water Research and Technology, as authorized by the Water Research and Development Act of 1978 (P.L. 95-467).

Project A-089-VA
VPI-VWRRC-BULL 136
4.5C

A publication of
Virginia Water Resources Research Center
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24060-3397

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Special acknowledgment is made to the following, who generously gave their time to a critical review of the manuscript: Louise M. Arthur, Economics and Statistics Service, U.S. Department of Agriculture, Corvallis, Oregon; John Davy and Rob B. Blackmore, Virginia Commission of Outdoor Recreation, Richmond; and E. Glenn Carls, Department of Recreation and Parks, Texas A&M University, College Station. Acknowledgment is made also to Nancy L. Chapman for editorial processing and typesetting and to Gretchen S. Bingman for layout composition.

ABSTRACT

This research evaluated financial implications of outdoor recreation planning practices in Virginia. Using a linear programming model, it assessed the possibility of providing projected facility needs for recreation within expected budget levels and concluded that the state's recreation planning procedures are not realistic since those needs identified in the planning process cannot be met. The study recommends revising current planning practices and suggests options for obtaining additional revenue to supplement the state's recreation allocation. Planners in other states will benefit from this information since Virginia's recreation planning situation is representative of that of many states.

Key Words: Recreation, Outdoor Recreation, Recreation Planning, Land Use, Public Investment, Linear Programming

PROBLEM STATEMENT

In recent years, large public budgets for recreation have encouraged state agencies to develop planning tools that can yield more effective spending decisions [Comptroller General of the United States, 1981]. Such tools are used to project future recreation participation and the capacity of recreation facilities for specific activities. A recreation facility need is said to exist when projected participation exceeds current capacity. Once needs are identified, expenditures for recreation development can be directed to priority needs. However, since funds available for recreation development are limited, all identified facility needs may not be met.

This study evaluating recreation planning in Virginia was guided by two principal questions: (1) Are current recreation planning standards realistic, that is, can currently specified recreation needs be met within expected budget constraints? (2) What additional revenue sources might be developed to support recreation development?

THE RECREATION PLANNING PROCESS

Recreation planning in most states proceeds in the general sequence evidenced in Virginia's program. First, the agency responsible for recreation planning is given a generally worded mandate to provide the state's citizens with recreation facilities. Virginia's Commission of Outdoor Recreation (COR), for example, has a mandate to:

> . . . create and put into effect a long-range plan for the acquisition, maintenance, improvement, protection and conservation for public use of those areas of the State best adapted to the development of a comprehensive system of outdoor recreational facilities in all fields, including, but not limited to: parks, forests, camping grounds, fishing and hunting grounds, scenic areas, waters and highways, boat landings, beaches and other areas of public access to navigable waters, and to facilitate and encourage the fullest public use thereof [*Virginia Code Annotated*].

Second, to fulfill the mandate, the agency receives a budget and implied authority to request revenues from bond financing and to recommend recreation user fees.

COR administers the Virginia Outdoors Fund (VOF) to be used for developing recreation areas. It may include appropriations from the state and grants from the federal Land and Water Conservation Fund (LAWCON). VOF funds usually are matched on an equal basis with local funds. In addition, VOF funds can be used to provide 50 percent of the revenue for projects sponsored by the Virginia Commission of Game and Inland Fisheries [COR, 1979]. COR has recommended that bonds be issued to expand VOF. Only a $5-million general obligation bond issue for park and recreation facilities has been offered to the voters of Virginia [Marshall, 1977], although an $84-million bond proposal was proposed by COR in 1974.

Since VOF funds are not unlimited, decisions must be made about how to allocate the available money. However, COR's mandate is stated too generally to be applied directly to the budget allocation problem. Therefore, recreation facility needs were established by COR planners and specific procedures developed for meeting them.

First, COR measured the public's participation in recreation activities

by a recreation user survey. Information from the survey was used to project design day participation, in terms of activity days, for selected outdoor activities. A design day is the peak participation in an activity during an average week in the prime season for that activity. Expected design day participation was projected through the year 2000 on the basis of expected changes in population, leisure time, disposable income, and other socioeconomic factors [COR, 1973a].

Then, the facilities required to accommodate projected design day participation were estimated through the use of facility design standards that indicate the daily capacity, in terms of activity days, of particular recreation facilities. To determine whether existing facilities could accommodate expected design day participation, COR inventoried available public and private recreation facilities in Virginia. Whenever available facilities were insufficient to serve design day use, COR projected a facility need.

COR attempts to allocate VOF funds for recreation development in accordance with these projected facility needs, but it also has established other criteria to guide fund distribution. Funds are allocated for the immediate acquisition of outstanding natural areas and special ecological areas to protect these resources from commercial development and to ensure that they remain available in their natural state [COR, 1974]. Also, COR distributes recreation funds equitably throughout the state. Localities that have not previously received a COR grant are given special consideration. As such, concern over the regional distribution of funds is important in COR's decision making.

COR's decision problem can be stated in the following way: COR has limited funds for providing recreation activity days. By allocating funds among regions and over time for the development of recreation facilities, COR can finance recreation facility developments with the capacity to accommodate a particular mix of activities. Knowing the capacity and cost of each type of recreation facility, and recognizing the limited funds at its disposal, COR must determine the combination and timing or development that will provide some level of activity days at minimum cost over time. That is, the accounting stance taken by COR is in terms of minimizing costs made for a prespecified level of recreation development subject to an expectation of available VOF funds. This accounting stance differs from a "social" accounting stance where the benefits and costs of spending on alternative recreation activities would be com-

pared before setting development goals, and spending on recreation itself would be compared with alternative spending decisions. The analysis in this report adopts the cost-minimization accounting stance rather than the broader social one.

RESEARCH TECHNIQUE

A computational technique, linear programming, was used to address the COR decision problem. An alternative to simple addition of the costs needed to meet projected facility needs, its advantage is in the computational ease it offers for assessing the cost implications of alternative spending strategies that COR might pursue. The programming model is described generally below. A detailed description of the model and data used is provided in the *Appendix.*

The model considers the provision of recreation activity days over a 20-year (1981-2000) planning horizon. This 20-year planning horizon is divided into four time periods to correspond with COR's five-year planning process: 1981-1985, 1986-1990, 1991-1995, and 1996-2000. In accordance with COR's recreation needs analysis, a minimum level of activity days (during the design day period) must be provided for 12 different recreation activities during each of the planning periods: bicycling, outdoor games, hiking and nature walks, swimming in pools, fishing, beach use, picnicking, boating, hunting, horseback riding, tennis, and family camping.

The model allows land to be purchased for the development of intensive parks, natural parks, or game and fish areas. Intensive parks are defined as urban recreation areas with less than 100 acres of land; natural parks are larger than 100 acres and are situated in a natural setting; game and fish areas are similar to natural park areas but are acquired solely for fishing or hunting purposes. Recreation facilities for each park type are built to provide for some mix of recreation activities. For example, intensive park facilities can support such activities as tennis or swimming in pools, while facilities for activities like hiking and camping can be developed in natural parks. COR used basic standards to determine the maximum number of activity days that a facility can support. One tennis court, for example, can support 32 activity days. These capacity standards for each activity were used to compute facility needs to meet the projected activity day requirements.

Actions COR may take within the model framework are: (1) acquiring intensive park lands, natural park lands, and game and fish lands; (2) acquiring land in one time period and transferring acquired park land to a future period to avoid land price escalations; (3) developing specific recreation facilities within intensive parks, natural parks, and game and

fish areas; and (4) borrowing to provide funds necessary for land purchases and facility development to meet COR needs projections. The linear programming model minimizes the 1985 present value of costs associated with the actions COR takes to meet projected activity day requirements during the period 1981-2000. To compute the 1985 present value of costs, all costs after 1985 were discounted using a 7 percent discount rate. For analytical convenience, all of the costs associated with these actions are considered to be incurred at the end of each of the five-year planning periods.

Expected public budgets for recreation development over time are limited. Therefore, as the model allocates money for land acquisition and facility development, it may exhaust these limited funds before meeting the projected activity day requirements. By borrowing, the public recreation budget can be expanded. Borrowed funds are acquired through the sale of general obligation bonds, which have maturity periods of 5, 10, 15, and 20 years.

FACILITY NEEDS AND BUDGET CONSTRAINTS

The linear programming model was first used to compute the least-cost strategy for meeting COR's currently projected facility needs. The present value of costs for meeting all projected facility needs, $5.74 billion, greatly exceeded the expected budget for the 20-year period. As a result, the following levels of borrowing were needed in each time period to meet projected recreation needs: 1981-1985, $4.6 billion; 1986-1990, $332 million; 1991-1995, $286 million; and 1996-2000, $290 million. Detailed information on the present value of expenditures for land acquisition and facility development is presented in *Table 1.* The first column indicates the final year of the planning period in which the recreation expenditures occurred, and the remaining columns show the pattern of expenditures in each time period. The results indicate that facilities accommodating hunting, hiking, and horseback riding required the most expenditure—$1.7 billion for hunting land and $1.3 billion to support hiking and horseback riding. It should be noted that the time pattern of expenditures need not match the rate of growth in participation for each activity. In some cases, land and facility cost increases were rapid enough to call for facility development before its expected use to minimize costs over the planning period. This is well illustrated by the model's choice to develop all swimming pools in the 1985 period.

Previous borrowing proposals and historical budget trends indicate that a plan to meet all currently projected facility needs through VOF would not be realistic. For example, an $84-million recreation bond request was proposed by COR in 1974 but never approved. If projected to 1985, using the change in the consumer price index from 1974 to 1980 as a projection base, this bond request would amount to $167.6 million. Thus, for purposes of this study, $167.6 million can be considered the maximum acceptable level of public indebtedness for recreation programs. Furthermore, based upon the historical budget pattern from 1966 to 1978, the annual budget during the period 1981-2000 was estimated to be $6.6 million, including $3.3 million in local matching funds and $3.3 million in VOF funds. In 1985 present value terms, these annual budget funds would amount to $136.7 million to acquire and develop recreation areas. The sum of the present value of budget funds and the maximum borrowing level ($305.3 million) was used as one cost guideline for determining the level of recreation facilities that could be provided through COR programs.

Of course, COR does not propose meeting all projected activity day requirements through its program but hopes to develop its program to be complementary to private, local, and federal activities which will contribute to the projected facility needs. However, a 1977 COR inventory of recreation lands and facilities in Virginia indicated that the private sector provides little over half the recreation activity days in Virginia; therefore, it may be necessary for the public sector to support as much as 50 percent of the projected future recreation activity days if the projected needs are to be met [COR, 1978].

To determine what share of projected activity day requirements could be provided within the limits of COR borrowing and budget expectations, the activity day requirements were modified. First, COR-projected requirements for each activity day category were reduced incrementally from 100 percent to 10 percent of their projected levels. However, COR provision of only 10 percent of projected activity day requirements still involved present value costs of $891.8 million and $512.5 million of borrowing.

Thus, a second modification was necessary to reduce the activity day requirements to be consistent with historical budget trends and acceptable levels of public indebtedness. Since the cost of providing hunting areas accounted for nearly 30 percent of the total expenditures in the original model, and since the Game and Fish Commission is responsible for developing lands for public hunting, the hunting activity day requirement was reduced to zero. Effectively, this placed responsibility for public hunting land development on the game and fish budget. Activity day requirements for hiking and horseback riding were also reduced to zero since the costs associated with satisfying these constraints were extremely high. Hiking and horseback riding could be accommodated in other park developments or on private land, thus eliminating the need for special trails. After hunting, hiking, and horseback riding activity day requirements were removed from the linear programming model, the present value of costs to meet 10 percent of the projected activity days for the remaining categories was computed. The costs were $347.5 million, with borrowing of $148.8 million—figures consistent with historical budgets and borrowing proposals.

Clearly, current levels of COR revenues will be insufficient to develop facility needs to serve only 10 percent of the projected requirements for the 12 activity day categories. However, if the implication of the

required borrowing is examined, it is not clear that even these greatly reduced activity day requirements can be met. Even without hunting, hiking, and horseback riding, the Commission would need to rely upon $148.8 million in general obligation bonds to finance the acquisition and development of recreation areas. However, as these bonds were retired, interest and principal payments would need to be made. Therefore, in the future, some source of revenue will be required, both for making recreation investments in that period and for meeting bond repayment requirements. This revenue requirement was also examined. To consider alternative levels of budget revenues, the annual COR budget, including the local matching funds, was doubled and then tripled. The implications for borrowing and bond repayment to meet the greatly modified facility projections, described earlier, were examined in each case.

The results of this analysis are summarized in *Table 2.* The repayment schedule shown for each budget level reflects principal and interest payments that will have to be made as the bonds are retired. For each budget level, any funds not required to meet recreation facility needs are excess budget funds. The compounded value of excess budget funds accruing in each year of a given time planning period are reported so that these unspent funds can be compared with expected future bond repayments.

The results of *Table 2* are quite striking. At the current budget level, $148.4 million is borrowed over the planning period. While this appears consistent with historically proposed borrowing levels, the $6.6-million annual budget will not permit meeting the repayment schedule for even the sharply reduced facility needs. Doubling the budget to $13.2 million sharply reduced the borrowing level and the money needed for repayment. However, still no excess budget funds were available for bond repayment. Tripling the budget reduced borrowing to zero and provided excess budget funds in future years. These funds could be used either to develop recreation facilities in excess of the modified levels considered in this model after 2000, or could be used to support current borrowing by issuance of bonds that mature in those periods. The general conclusion of the analysis is that to meet even the sharply reduced activity day requirements used in this study, the available recreation budget would need to be greatly expanded by increased funds to VOF and/or increases in local government matching funds.

IMPLICATIONS

I. Revision of Recreation Planning Practices

Since the private sector currently provides little more than half of the recreation facilities in Virginia and since there is no indication that this share will change significantly in future years, the results of this study suggest that most of COR's projected activity day requirements cannot be met through public or private facility development programs. As a result, COR will need to develop more realistic recreation planning practices. Toward this end, several of the guidelines and assumptions that form the basis for COR's facility needs projections need to be reconsidered.

First, the facility capacity standards used by COR (and in this study) to determine the acreage and facilities required to support given levels of activity days need revision. Although COR recently increased its capacity standards for most of the recreation facilities considered in the linear programming model, their published deficit projections do not reflect this revision. Application of the revised capacity standards would greatly reduce COR's projected land and facility needs. A comparison of these standards is provided in *Table 3*.

Second, the assumption that recreation activities must occur in specially designed facilities should be evaluated. Certain activities, such as bicycling, horseback riding, hiking, and walking, do not always require special areas or trails. For example, bicyclists can use low-volume roads, and horses can be ridden on private farm lands. Furthermore, hiking and nature walking can occur in open spaces. By including these areas in their inventory of available recreation resources, COR could reduce the projected need to provide additional facilities.

Third, COR may have to change its goal of planning for expected design day participation. As indicated by the results of this study, the costs of developing enough recreation facilities to accommodate the greatest expected participation at any one time for all 12 activities are prohibitively high. Recreation planners might consider basing their projections of needed recreation facilities on the expected average daily participation during the prime season. Although people would have to be turned away from facilities on peak days, recreation developments consistent with such projections would be adequate to accommodate recreationists at

other times. Furthermore, differential park entrance fees could be used to discourage peak day visitations and to encourage the use of recreation areas on other days.

Fourth, COR may find it prudent to consider the relative value of different outdoor recreation activities when revising their projections of needed recreation lands and facilities. Relative-value estimates would permit COR to establish priorities among activities when allocating its budget. In COR's facility needs analysis, and in this study, all outdoor recreation activities are presumed to be of equal value. However, the value of alternative activities may differ depending upon consumer demand for the activity. According to economic theory, the value of a particular recreation activity is measured in terms of the willingness of recreationists to pay for the opportunity to participate in a specific recreation activity. Approximations of consumer willingness to pay for reccreation opportunities can be developed [Dwyer, Kelley, and Bowes, 1977]. COR could use the results of existing or specially commissioned demand studies as broad guidelines for assigning relative values to different recreation activities.

On the other hand, COR may select other criteria for choosing among the recreation activities it will provide. For example, activities like picnicking and nature walking that require only modest investments by individuals of time and money may be chosen by COR, rather than activities like horseback riding that require substantial training and financial investments. Another criterion for choosing among recreation activities may relate to the costs of providing particular recreation services. For example, costly activities like swimming in pools may be assigned a lower priority than less expensive activities like outdoor games. This was the approach used to set priorities among activities in this study when an examination of *Table 1* indicated that expenditures on hunting and horseback riding were significant drains upon available budgets.

Whatever approach to setting priorities is adopted, it will be necessary to adjust projected facility needs from their current unrealistic level. Without such adjustments, the COR planning process will not be reasonably related to the spending choices actually available.

II. Development of Alternative Revenue Sources

Current budget levels will be insufficient to develop even a small share

of the currently projected facility needs and also repay the debt that would be incurred. Adding over $12 million to current budget levels would be the only strategy for attaining even the sharply reduced level of facilities considered for this study. A question to consider is whether such an increase in budget funds is feasible.

One possible source of revenue is recreation user fees. The demand for outdoor recreation activities is price inelastic [U.S. Department of the Interior, 1973]. This price inelasticity means that if a user fee for an outdoor recreation activity is increased, the percentage decrease in the quantity of activity days will be less than the percentage increase in user fee. Thus, the total revenue from the user fee on a given activity will increase as user fees are raised. The fact that the demand for outdoor recreation is price inelastic implies that public agencies could generate additional revenues by increasing user fees for outdoor recreation activities.

However, there are limits on the use of such fees. In particular, collection costs for many activities may be higher than the revenues earned from the fee. For example, it would be difficult to collect fees for unorganized outdoor games. On the other hand, collection mechanisms are already in place for other activities—admission fees at state parks and local swimming pools and license fees for fishing, boating, and hunting privileges, for example.

Although precise estimates are not possible, approximations of the potential revenue from user fees can be made, given a perfectly price inelastic demand. In 1980 approximately 3.5 million people visited Virginia's state parks [King, 1981]; a $0.50 additional user fee charge at state parks could generate $1,750,000 in revenues. In addition, approximately 776,000 Virginians purchased fishing, boating, and hunting licenses [Wineburg, 1981]; a $0.50 addition to license fees could generate $388,000 in revenues. COR estimated 34 million activity days of swimming pool use during 1980 [COR, 1973a]. If 25 percent of this participation occurred in public facilities, as many as 8.5 million activity days of public swimming pool use occurred in 1980; a $0.50 additional user fee at public swimming pools could generate an annual revenue of $4,250,000. In sum, a $0.50 additional user fee on these activities would provide total revenues approximately equal to the $6.6-million current annual budget, although such a charge may reduce participation at swimming pools and parks. This revenue source appears promising but is

unlikely to be able to greatly increase current budget levels.

State general tax funds have not been utilized for recreation developments since 1976. Increasing the allocation of general tax revenues to COR should be given serious consideration. Tax receipts of $4.92 billion were generated from approximately $41.5 billion of personal income in Virginia in 1978 [U.S. Department of Commerce, 1979]. Assuming that personal income increases at a modest annual rate of 5 percent and that tax receipts remain at their current level of approximately 12 percent of personal income, Virginia's tax collections in 1990 would increase by $4 billion over 1978 collections; by 2000, the increase would be $9.4 billion. Although COR will face competition from other government agencies for a share of these increased tax receipts, COR may well qualify for a portion of the expected additional tax revenues. Only 1 percent of the expected annual increase in state revenue between the years 1984 and 1985 would generate $4.0 million for recreation; 1 percent of the expected annual increase in state revenues between the years 1999 and 2000 would generate $9.4 million. These sums from state tax revenues, together with receipts from recreation user fees, would enable public agencies to expand their expected annual budgets by significant amounts.

III. Conclusion

This analysis has examined the budget constraints on Virginia's Commission of Outdoor Recreation and their effect on meeting the projected recreation activity day requirements reported in existing state recreation plans. The results of this study are unequivocal. More realistic planning practices must be established because current planning practices identify facility needs that are so unrealistic as to be without any merit for budget planning.

A first priority for COR would be to revise current recreation planning practices to reduce facility need projections and to set priorities among different types of facilities. However, unless additional funds are secured, even a greatly reduced facility development program is not feasible. Even if bonds are sold now to finance recreation facilities, future commitments to bond repayment will require user fees or increased funds for general revenues to retire future debts. The revenue alternatives appear to be user fees combined with increased general tax revenues.

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TABLES

TABLE 1

Present Value of Recreation Expenditures by Park Type (Millions of Dollars)

Year	Tennis Courts	Swimming Pools	Bicycle Paths	Outdoor Playing Fields	Outdoor Playing Fields/ Picnic Area	Picnic Areas/ Camping	Boat Access	Hiking/ Horse Trails	Beach	Fishing Access	Hunting Access
1985	112.34	799.46	124.91	461.76	156.40	426.69	84.85	984.95	3.17	5.45	1,576.30
1990	19.19	0	22.66	75.42	27.83	36.51	7.48	127.20	1.44	2.17	53.17
1995	19.76	0	23.35	69.30	23.75	49.60	7.99	88.76	1.16	1.55	33.61
2000	42.57	0	23.49	56.43	22.41	47.20	9.29	80.30	0.97	1.11	28.34
Total	193.86	799.46	194.41	662.91	230.39	560.00	109.61	1,281.21	6.74	10.28	1,691,42
										Grand Total	5,740.29

TABLE 2

Repayment Schedule for Bond Issues to Meet Reduced Facility Development Levels (Millions of Dollars)

Year	$6.6-Million Budget, $148.8-Million Bonds		$13.2-Million Budget, $43.9-Million Bonds		$18.8-Million Budget, No Borrowing	
	Repayment Schedule	Excess Budget Funds	Repayment Schedule	Excess Budget Funds	Repayment Schedule	Excess Budget Funds
1990	102.0	0	29.2	0	0	0
1995	85.8	0	25.4	0	0	0
2000	69.6	0	20.6	0	0	92.1
2005	53.3	0	15.8	0	0	69.2

TABLE 3
Comparison of Outdoor Recreation Planning Standards

Activity	Facility Unit	1979 Activity Days/Unit*	1980 Activity Days/Unit†
Bicycling	1-mile bike path	250	400
Outdoor games	1 field	60	88
	1 court		60
Swimming (pool)	1 olympic pool (11,250 sq ft)	900/pool (0.08/sq ft)	4,950/pool (0.44/sq ft)
Beach	1 acre land	600	300
Tennis	1 court	32	48
Hiking/Walking	1-mile trail	30	75
Picnicking	1 table	8	8
Fishing	1 boat dock	—	120
	1 acre water	0.5	0.5
Boating	1 boat dock	—	120
	1 acre water	0.5	0.5
Canoeing	1-mile stream	36	96
Hunting	1 acre land	0.12	0.17
Camping	1 campsite	4	3
Horseback riding	1-mile path	10	80

*Source: Adapted from COR [1979], p. 176. These 1979 standards represent the standards that COR utilized in its deficit projections.

†Source: Adapted from COR [1980]. These 1980 standards represent COR's revised standards.

APPENDIX
Programming Model and Data

I. Introduction to the Model

The linear programming model facilitated the computation of the cost of meeting alternative projections of activity day requirements. The model considers the production of minimum levels of 12 categories of recreation activity days at the end of each of the following time periods: 1981-1985, 1986-1990, 1991-1995, and 1996-2000. The 12 activities included are bicycling, outdoor games, hiking and nature walks, swimming (in pools), fishing, beach use, picnicking, boating, hunting, horseback riding, tennis, and family camping. Also, to satisfy the regional funds distribution requirement of COR, a minimum level of recreation activity days was produced in each of four geographic regions of Virginia *(Figure A-1).*

In the model, land acquisition and facility development activities produce recreation activity days. Land can be purchased for the development of intensive parks, natural parks, or game and fish areas. Within each of the park types selected, recreation activities can be developed by combining land and facilities in fixed proportions. Once produced, these facilities provide a specific mix of recreation activity days. For example, intensive park facilities can support activities such as tennis and swimming in pools. Then, the developed recreation facility units can produce the activity day levels, shown in *Table 3* (p. 22) under "1979 Activity Days/Unit."

The objective of the linear programming model is to minimize the 1985 present value of costs associated with the production of alternative levels of COR's projected activity day requirements through the year 2000. Minimum requirements are imposed on the production of recreation activity days in different time periods and regions of the state. These requirements represent COR's projected design day participation for 12 outdoor recreation activities from 1981 to 2000.

Actions for producing recreation activity days are: (1) the acquisition of intensive park lands, natural park lands, and game and fish lands; (2) the transfer of acquired park land from one time period to another; (3) the development of recreation facilities within intensive parks, natural parks, and game and fish areas; and (4) borrowing to provide the

necessary recreation funds for land purchases and facility development. The costs of producing activity days over time and in various regions of the state occur in the model as a result of these actions. For analytical convenience, all of these costs are considered to occur at the end of each of the five-year planning periods. An interest rate of 7 percent is used to discount all costs to the end of the first planning period, 1985. This 7 percent rate was chosen to represent COR's rate of time preference for recreation expenditures.

Funds for producing recreation facilities are available from COR and the Commission of Game and Inland Fisheries. Because COR funds are matched by local governments, available funds from local sources are also considered. As the model allocates money for land acquisition and facility development, it uses up limited budget funds. However, the recreation budget can be expanded by borrowing. Borrowed funds are acquired through the sale of general obligation bonds, which have maturity periods of 5, 10, 15, and 20 years. The costs of borrowing are reflected through the interest rates that must be paid.

II. The Computer Model

The linear programming model described above is presented in tabular form in *Table A-1.* The input data analyzed by the linear programming model are represented in the *Table* by generalized notation, which is explained in *Table A-2.* The columns in *Table A-1* represent the actions that can be undertaken to meet recreation requirements over time in the various regions of the state. The objective function for the model is described in the "MINPV" row, where the coefficients represent the present value of costs associated with each action. The land acreage and the amount of recreation funds required by an action are entered in the rows section. Also, the number of recreation activity days generated from an action is entered in the rows section.

Minimum restrictions on the level of activity days that must be produced for each of the model's 12 recreation activities are listed under the column titled "RHS." Furthermore, constraints on recreation budgets provided by COR and the Commission of Game and Inland Fisheries are entered in this last column. As indicated by the coefficient in the "BCOR" row and the "BCAP" column, each dollar of borrowed capital adds a dollar to COR's recreation budget.

III. Cost Data

Actions to produce recreation activities involve three major costs: (1) recreation land acquisition costs, (2) facility development costs, and (3) interest costs associated with borrowing. The analysis that established the cost of the land-buying activities proceeded in two steps. First, cost and size (acreage) data on all recreation land acquisition financed by VOF from 1966 to 1979 were obtained from COR and classified by park type. Urban land areas totaling 100 acres or less which were acquired for neighborhood parks, community parks, or other local parks were classified as intensive park lands. Rural land areas totaling more than 100 acres which were acquired for regional parks, state parks, or natural parks were classified as natural park lands. Land acquired by COR and the Commission of Game and Inland Fisheries solely for fishing or hunting purposes were classified as game and fish lands. Second, a linear trend was established in the costs of recreation land over time to predict future recreation land costs in each region of the state. Predicted recreation land costs are presented in *Table A-3.*

The model allows recreation facilities to be developed at intensive parks, natural parks, or game and fish areas. Once produced, these facilities can accommodate a particular mix of recreation activities. A description of these alternative facilities is provided in *Table A-4,* which also shows the 1980 cost of developing such facilities. Information collected from consultants, contractors, and administrators of state and local recreation departments was utilized to compute these 1980 costs. For example, cost estimates for tennis courts, bicycle paths, outdoor game fields, camping areas, trails, picnic facilities, and parking areas were obtained from the *Waynesboro Parks and Recreation Study* [Land Planning and Design Associates, Inc., 1979]. A professional engineer and swimming pool contractor in Roanoke, Virginia, provided cost information on swimming pool facilities. Conversations with local recreation program administrators provided additional information on facility costs and overhead expenses such as design fees.

Future costs for developing the recreation facilities described in *Table A-4* were projected in the following way. The *Engineering News Record* building cost index for U.S. cities was reviewed to determine the percentage increase in building costs over the last five years [*Engineering News Record,* 1980]. Since no Virginia cities were included in the index, Baltimore's index was examined because of that city's proximity to Vir-

ginia. From December 1975 to December 1980, the building cost index for Baltimore increased from 204 to 310, indicating a 51.9 percent increase in building costs. Use of the 1970-1980 period to compute the trend resulted in higher rates of cost increases. The 1975-1980 trend was extrapolated to compute the cost of developing recreation facilities in Virginia between 1980 and 2000. Projections of future facility costs for each park development type described in *Table A-4* are presented in *Table A-5.*

The interest cost of borrowing was computed in the following way. Since the state of Virginia has the highest bond rating, information on past borrowing rates for municipalities with a Triple A bond rating was obtained from *Moody's Bond Record* [1980]. From this information, Triple A municipal bond yields for the years 1972-1980 were calculated, and a linear trend was then utilized to predict future borrowing rates. Projections of these future borrowing rates for the state of Virginia are presented in *Table A-6.*

To calculate the total interest cost on each dollar borrowed, a plan for debt retirement was established. Bonds were assumed to be retired over a 20-year period with 1/4 of the principal being retired every five years and interest being paid annually on the outstanding balance [Marshall, 1977]. Using this bond retirement schedule and the borrowing rates from *Table A-6,* the expected interest costs for each dollar of capital borrowed in 1985, 1990, 1995, or 2000 were computed.

IV. Activity Day Requirements

Minimum requirements for recreation activity days in different time periods and regions of the state were based upon COR's regional projections of needed facilities for 12 activities from 1981 to 2000. The minimum activity day requirements were derived in the following way. From COR's projections in *The Virginia Outdoors Plan—1979,* design day facility needs in each of the model's four regions and time periods were calculated for all 12 activities [COR, 1979]. These facility needs were then multiplied by the conversion factors which represent the daily activity day capicity of particular recreation facilities (see Table 3, p. 22). The activity day deficits were used in the model as the minimum recreation day requirements.

V. Budget Constraints

Recreation funds are available from the Commission of Outdoor Recreation, the Commission of Game and Inland Fisheries, and local governments, which match the COR budget. The state agencies' budgets for each time period were derived in the following way.

For the COR budget, figures were obtained from *The Virginia Outdoors Plan—1979* [COR, 1979]. As shown in *Table A-7,* available funds during the years 1966-1978 amounted to $39,582,717, or $3,298,560 per year. This annual figure was then doubled because LAWCON funds must be matched on an equal basis with local or regional funds. Since no particular trend was discernible from the historical pattern of available funds, the annual COR budget was assumed to remain constant over time. The resulting budget figure of $6,597,120 was assumed to be available on an annual basis for meeting projected facility needs through the year 2000. For the game and fish budget, figures from Virginia's 1978-1980 budget [Commonwealth of Virginia, Division of the Budget, 1978] were used to estimate an annual budget for the Commission of Game and Inland Fisheries. Capital outlay expenses for game and fish areas during the biennium 1978-1980 amounted to $4,250,000, or $2,125,000 per year. This annual figure of $2,125,000 was assumed to be available on an annual basis for meeting projected fishing and hunting facility needs through the year 2000. The budget in each of the model's four time periods was computed by compounding the annual budget to the end of each time period.

FIGURE A-1
Recreation Planning Regions Used in Model

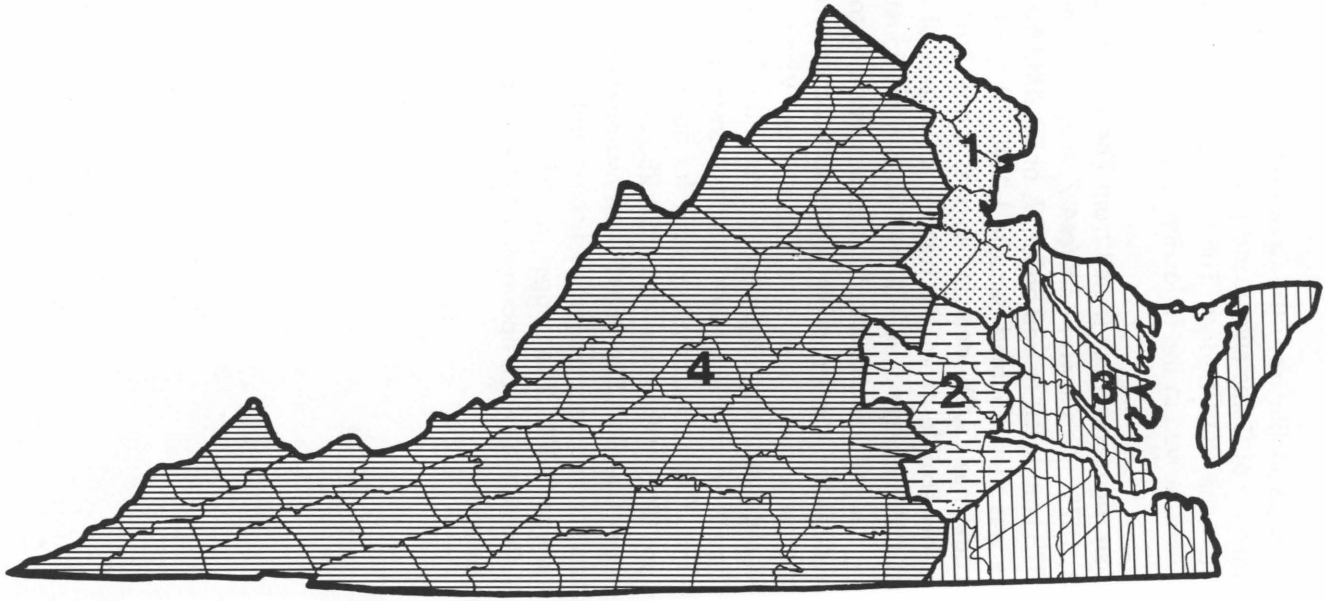

TABLE A-1
Linear Programming Model

Constraints	Activities																		
	$BLPI_{tr}$	$BLPN_{tr}$	BLG_{tr}	$TLPI_{tr}$	$TLPN_{tr}$	TLG_{tr}	PIT_{tr}	PIS_{tr}	PIB_{tr}	PIA_{tr}	$PIAP_{tr}$	$PNPC_{tr}$	$PNFB_{tr}$	$PNHH_{tr}$	PNB_{tr}	PGF_{tr}	PGH_{tr}	$BCAP_t$	RHS
MINPV	$\frac{C_{BLPI_{tr}}}{(1+i)^n}$	$\frac{C_{BLPN_{tr}}}{(1+i)^n}$	$\frac{C_{BLG_{tr}}}{(1+i)^n}$				$\frac{C_{PIT_{tr}}}{(1+i)^n}$	$\frac{C_{PIS_{tr}}}{(1+i)^n}$	$\frac{C_{PIB_{tr}}}{(1+i)^n}$	$\frac{C_{PIA_{tr}}}{(1+i)^n}$	$\frac{C_{PIAP_{tr}}}{(1+i)^n}$	$\frac{C_{PNPC_{tr}}}{(1+i)^n}$	$\frac{C_{PNFB_{tr}}}{(1+i)^n}$	$\frac{C_{PNHH_{tr}}}{(1+i)^n}$	$\frac{C_{PNB_{tr}}}{(1+i)^n}$	$\frac{C_{PGF_{tr}}}{(1+i)^n}$	$\frac{C_{PGH_{tr}}}{(1+i)^n}$	$\frac{C_{INT_{tr}}}{(1+i)^n}$	
$BIKE_{tr}$									AD/UNIT										$\geqslant AD^*$
$GAMES_{tr}$										AD/UNIT	AD/UNIT								$\geqslant AD^*$
$POOL_{tr}$								AD/UNIT											$\geqslant AD^*$
$BEACH_{tr}$															AD/UNIT				$\geqslant AD^*$
$TENNIS_{tr}$							AD/UNIT												$\geqslant AD^*$
$HWALK_{tr}$														AD/UNIT					$\geqslant AD^*$
$PICNIC_{tr}$											AD/UNIT	AD/UNIT							$\geqslant AD^*$
$FISH_{tr}$													AD/UNIT			AD/UNIT			$\geqslant AD^*$
$BOAT_{tr}$													AD/UNIT						$\geqslant AD^*$
$CANOE_{tr}$																			$\geqslant AD^*$
$HUNT_{tr}$																	AD/UNIT		$\geqslant AD^*$
$HORSE_{tr}$														AD/UNIT					$\geqslant AD^*$
$CAMP_{tr}$												AD/UNIT							$\geqslant AD^*$
LPI_{tr}	-1			1			AC/UNIT	AC/UNIT	AC/UNIT	AC/UNIT	AC/UNIT								$\geqslant 0$
LPN_{tr}		-1			1							AC/UNIT	AC/UNIT	AC/UNIT	AC/UNIT				$\geqslant 0$
LG_{tr}			-1			1										AC/UNIT	AC/UNIT		$\geqslant 0$
$BCOR_t$							$\frac{C_{PIT_{tr}}}{(1+i)^n}$	$\frac{C_{PIS_{tr}}}{(1+i)^n}$	$\frac{C_{PIB_{tr}}}{(1+i)^n}$	$\frac{C_{PIA_{tr}}}{(1+i)^n}$	$\frac{C_{PIAP_{tr}}}{(1+i)^n}$	$\frac{C_{PNPC_{tr}}}{(1+i)^n}$	$\frac{C_{PNFB_{tr}}}{(1+i)^n}$	$\frac{C_{PNHH_{tr}}}{(1+i)^n}$	$\frac{C_{PNB_{tr}}}{(1+i)^n}$			-1	$\leqslant B^*$
$BC\&F_t$																$\frac{C_{PGF_{tr}}}{(1+i)^n}$	$\frac{C_{PGH_{tr}}}{(1+i)^n}$		$\leqslant B^*$

TABLE A-2
Key for Table A-1

Subscripts and Superscripts

t = time period; t = 1981-1985, 1986-1990, 1991-1995, 1996-2000

r = the region; r = 1, 2, 3, 4

i = the discount rate; an interest rate of 7 percent was utilized to discount the future cost of public recreation projects to the year 1985

n = the number of years over which discounting occurs

Coefficients

C = the nominal cost of acquiring land, developing recreation facilities, or borrowing capital (example: $^{C}BLG_{tr}$ = the nominal cost of acquiring an acre of fish or game land in period t and region r)

AD/Unit = the number of activity days generated from the development of one facility unit of the recreation activity being considered

AC/Unit = the land acreage required to develop one facility unit of the recreation activity being considered

AD* = COR'S suggested minimum level of activity days needed for the recreation activity being considered

B* = the constraint on recreation funds provided by the COR or the Commission of Game and Inland Fisheries

Columns

BLPI = buying land for intensive parks

BLPN = buying land for natural parks

BLG = buying land for game or fish areas

TLPI = intensive park land acquired in one time period is reserved for park developments in subsequent time periods

TLPN = natural park land acquired in one time period is reserved for natural park developments in subsequent time periods

TLG = game or fish land acquired in one time period is reserved for park developments in subsequent time periods

PIT = intensive park with one tennis court

TABLE A-2 (continued)

PIS = intensive park with one olympic-size swimming pool

PIB = intensive park with 1 mile of bicycle path

PIA = intensive park with outdoor game fields for softball, football, soccer, volleyball, and basketball

PIAP = intensive park with outdoor game fields and picnic facilities

PNCP = natural park with 1 acre of picnic facilities and 1 acre of camp sites

PNFB = natural park with one fish/boat dock

PNHH = natural park with trails for hiking, walking, and horseback riding

PNB = natural beach area

PGF = fishing area

PGH = hunting area

BCAP = borrowed capital

Rows

MINPV = objective row that has the function of minimizing the present value of costs associated with the production of COR's recommended level of recreation services; costs entered in this row include discounted land acquisition costs, discounted facility development costs, and discounted interest on borrowed capital

BIKE = bicycling on hard-surfaced bicycle trails in urban areas

GAMES = playing outdoor games such as softball, football, basketball, volleyball, and other competitive sports on multi-purpose playfields that are developed in intensive park areas

POOL = swimming in public swimming pools

BEACH = use of natural beach areas for swimming and other beach-oriented activities

TENNIS = playing tennis on regulation tennis courts in intensive park areas

(continued)

TABLE A-2 (continued)

HWALK = hiking, backpacking, and nature walking on footpaths and trails that are situated in a natural setting

PICNIC = picnicking in developed areas with picnic tables, grills, and trash receptacles

FISH = fishing in natural areas

BOAT = flat water boating activities in natural parks

CANOE = canoeing in wilderness areas

HUNT = game hunting in natural areas

HORSE = horseback riding on specially designed horse trails in natural parks

CAMP = tent camping at developed campsites in rural areas

LPI = available land inventories for developing intensive parks

LPN = available land inventories for developing natural parks

LG = available land inventories for developing fish or game areas

BCOR = recreation funds available from the Commission of Outdoor Recreation that are matched on an equal basis with state, local, or regional funds

BG&F = recreation funds available from the Commision of Game and Inland Fisheries that are used solely for fishing and hunting areas

TABLE A-3
Projected Recreation Land Costs (Dollars per Acre)

	Intensive Park Lands				Natural Park Lands				Game and Fish Lands*			
	Region				Region				Region			
Year	1	2	3	4	1	2	3	4	1	2	3	4
1985	24,716	4,917	13,603	8,895	4,550	4,336	6,214	3,149	4,550	1,159	6,214	1,599
1990	31,532	6,082	17,558	11,352	5,040	5,130	8,089	3,993	5,040	1,439	8,089	2,010
1995	38,347	7,248	21,513	13,810	5,530	5,926	9,963	4,837	5,530	1,720	9,963	2,422
2000	45,164	8,413	25,409	16,268	6,020	6,721	11,837	5,681	6,020	2,000	11,837	2,834

*No data were available to project future land costs for game and fish areas in regions 1 and 3. These projected costs were assumed to be the same as the projected land costs for natural parks.

TABLE A-4
Recreation Facilities—1980 Cost Information

Park Type	Description of Alternative Park Developments	1980 Cost	Acreage
Intensive Park Lands			
1. PIT—Intensive park with tennis facilities			
	1 tennis court with fencing	$14,500	0.2
	Parking	500	0.05
	Overhead (10%)	1,500	
	Total	$16,500	0.25
2. PIS—Intensive park with swimming pool			
	1 olympic-size pool	$400,000	0.75
	Bath facilities	200,000	
	Parking—100 cars	10,000	0.75
	Overhead (10%)	61,000	
	Total	$671,000	1.5
3. PIB—Intensive park with bicycle facilities			
	1-mile paved bicycle path (6 ft wide) (3,520 yds @ 304/sq yd)	$10,700	0.7
	Overhead (10%)	1,070	
	Total	$11,770	0.7
4. PIA—Intensive park with outdoor game facilities			
	1 softball-baseball field	$ 5,000	1.25
	1 football-soccer field	5,000	2.25
	1 basketball-volleyball court	2,500	0.15
	Parking	2,500	0.35
	Overhead (10%)	1,500	
	Total	$16,500	4.00
5. PIAP—Intensive park with active and passive facilities			
	Outdoor game facilities (see above)	$12,500	3.65
	5 picnic tables, receptacles, grills	2,500	0.25
	Parking	3,000	0.4
	Overhead (10%)	1,800	
	Total	$19,800	4.30

TABLE A-4 (continued)

Park Type	Description of Alternative Park Developments	1980 Cost	Acreage
Natural Park Lands			
1. PNPC—Natural park with picnicking and camping			
	1-acre picnic site—20 tables, grills, receptacles, parking	$10,000	1
	1-acre campsites—5 sites @ $1,000 each	5,000	1
	Outside bathroom	25,000	
	Overhead (10%)	4,000	
	Total	$44,000	2
2. PNFB—Natural park with fishing, boating, and canoeing			
	1 fish/boat dock	$10,000	2
	Parking	1,000	
	Overhead (10%)	1,100	
	Total	$12,100	2
3. PNHH—Natural park with hiking and horseback riding			
	1-mile hiking trail	$1,500	5
	1-mile horse trail	1,500	1
	Parking	2,000	
	Overhead (10%)	500	
	Total	$5,500	6
4. PNB—Natural beach area			
	1-acre beach (No facility costs)	—	1
Game and Fish Lands			
1. PGH—Hunting area			
	No facility costs	—	6
2. PGF—Fishing area			
	1 fish/boat dock	$10,000	2
	Parking	1,000	
	Overhead (10%)	1,100	
	Total	$12,100	2

TABLE A-5
Projected Facility Costs

Year	PIT	PIS	PIB	PIA	PIAP	PNPC	PNFB	PNHH	PGF
1985	$25,064	$1,019,249	$17,879	$25,064	$ 30,076	$ 66,836	$18,380	$ 8,355	$18,380
1990	38,072	1,548,239	27,158	38,072	45,685	101,524	27,919	12,690	27,919
1995	57,832	2,351,775	41,253	57,832	69,396	154,215	42,409	19,277	42,409
2000	87,840	3,572,347	62,664	87,846	105,413	234,252	64,420	29,282	64,420

TABLE A-6
Projected Borrowing Rates for Virginia

Year	Projected Borrowing Rate
1985	7.53
1990	8.48
1995	9.43
2000	10.39

TABLE A-7
Available LAWCON Funds, 1966-1978

Biennium	Available LAWCON Funds
1966 to 1968	$ 4,083,074
1968 to 1970	2,129,199
1970 to 1972	10,132,050
1972 to 1974	5,552,023
1974 to 1976	7,001,152
1976 to 1978	10,685,219
Total	$39,582,717

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- It studies the state's water and related land-use problems, including their ecological, political, economic, institutional, legal, and social implications.
- It sponsors, coordinates, and administers research investigations of these problems.
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- It provides training opportunities in research for future water scientists enrolled at the state's colleges and universities.
- It provides other public services to the state in a wide variety of forms.
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Virginia Water Resources Research Center
Virginia Polytechnic Institute and State University
617 North Main Street
Blacksburg, Virginia 24060-3397
Phone (703)961-5624