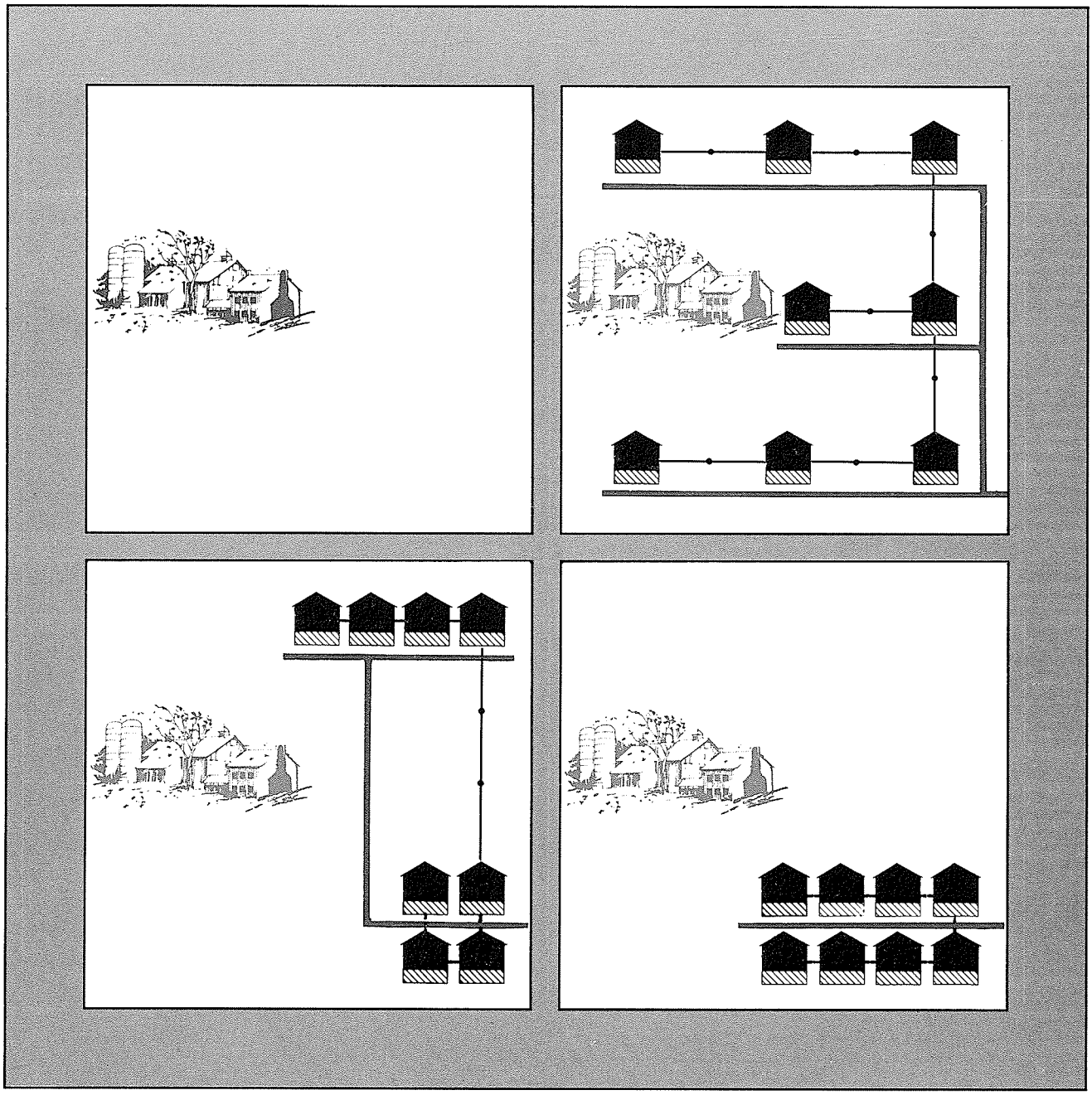
Density-Related Public Costs



American Farmland Trust

Density-Related Public Costs

American Farmland Trust 1920 N Street, NW Suite 400 Washington DC 20036 (202) 659-5170

Local governments are increasingly being faced with higher public costs for schools, roads, water and sewer, public safety, health and welfare and general government administration. At the same time, revenues are being squeezed from every level of government.

It is within this environment that local elected officials are attempting to cope with managing public expenditures while ensuring that their community maintains a high quality of life for all of its citizens. The job is not an easy one -- and it is compounded by pressures on local officials from all sides, including developers, school boards, citizen groups and state and federal agencies as well.

The purpose of this report was to examine one key aspect of the issue of public costs to determine to what extent it affected the others. The question often raised in debates over land-use issues is whether or not low-density development (one housing unit per five or ten acres) is more costly to service than higher-density or more compact development.

The enclosed report deals specifically with this question. Loudoun County, Virginia, was selected as a suitable site to test this question as it is situated within the Washington, D. C., metropolitan area and is experiencing tremendous growth pressures. Loudoun is also an excellent agricultural county and is not unlike many good farming communities around the country that are adjacent to metropolitan areas being faced with difficult choices regarding development needs while trying to maintain a strong agricultural industry.

These two goals do not need to be mutually exclusive. However, it is clear from the evidence gathered in this report that large lot development is more costly in terms of major public services required. Additionally it is clear that on the whole residential units cost more from the standpoint of services demanded as compared to tax revenue generated.

We hope you find this report useful in analyzing the density-related public costs within your own community.

Robert J. Gray
Director of Policy

ACKNOWLEDGEMENTS

Many individuals made significant contributions to the preparation of this report.

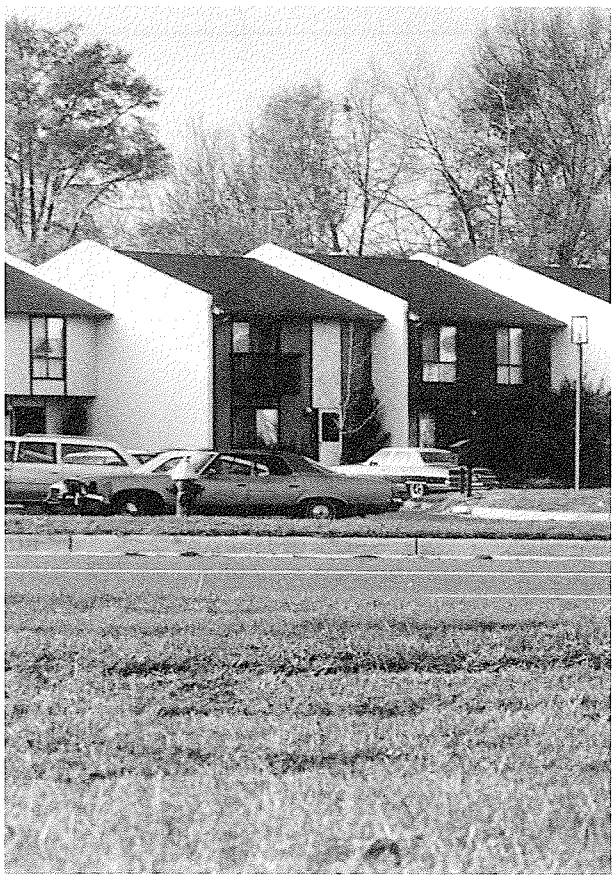
Robert B. Smythe, currently a resources consultant from Chapel Hill, North Carolina, and formally senior staff with the President's Council on Environmental Quality, was the principal researcher and writer for this study. Mr. Smythe was willing to devote a great deal of extra time and effort in securing the necessary information to make this report as comprehensive and readable as it is. He was assisted by Charles D. Laidlaw, a planning consultant from Baltimore, Maryland.

The report would not have been possible without the strong support of the Loudoun County Board of Supervisors. I would especially like to thank Supervisors James Brownell and Frank Raflo for their time and effort in reviewing and critiquing the results of this analysis.

We are also particularly grateful to Milton Herd and Richard Calderon of the Loudoun County Planning Staff for continuous assistance throughout the project.

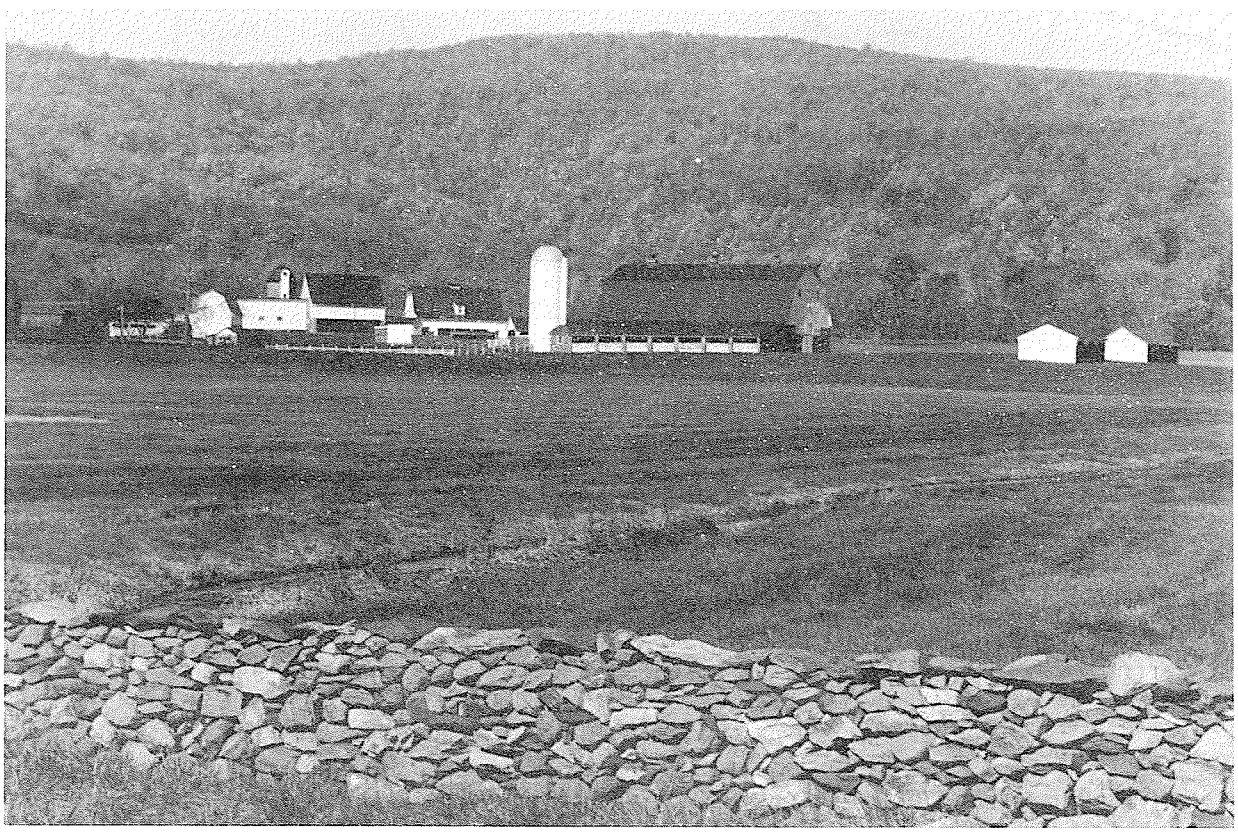
The final preparation of the report was the responsibility of Carol Fesco, a graduate of Loras College in Dubuque, Iowa. Ms. Fesco interned at AFT during the fall of 1985. It was largely through her diligent efforts that the report was finalized and published.

Peter H. Dunning, a photographer and resident of Loudoun County, provided all of the photographs for the report. Mr. Dunning is the Executive Director and co-founder of the Bluemont Concert series which is having its tenth anniversary this year.

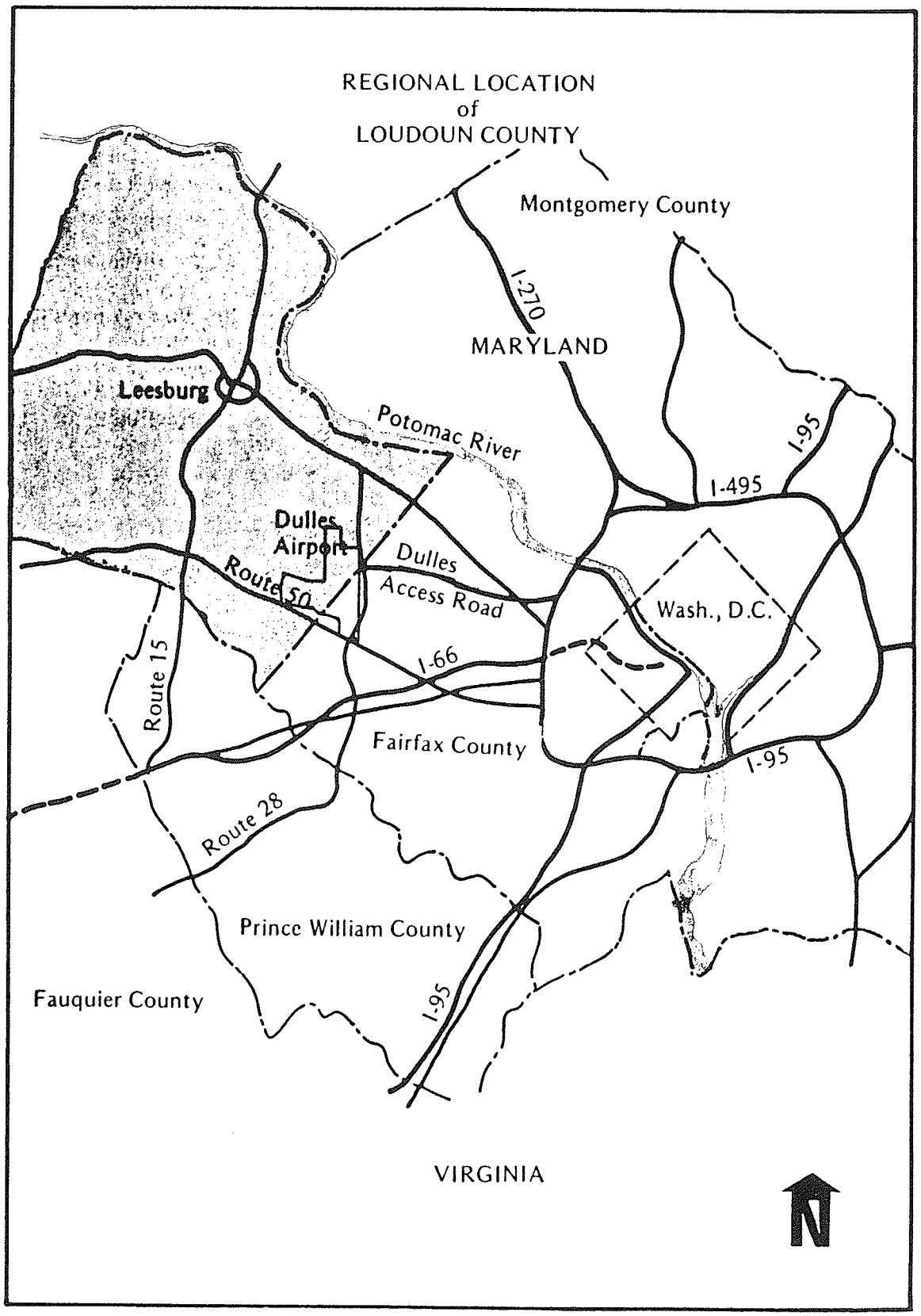


Loudoun County Virginia lies entirely within the Washington DC metropolitan area. Bordered on the north by the Potomac River and Maryland, – to the west by the Blue Ridge Mountains, Loudoun is growing rapidly. In the 1970's Loudoun grew by 55 percent. Its present population is 66,500. Its annual budget is now $85 million. In the last decade, enough land in eastern Loudoun was zoned residential to double the 1980 population of the county. Two thousand undeveloped plats wait in western Loudoun where most of the farms remain. Yet, Loudoun remains one of Virginia's best farming counties.

The question is: "For how long?".



Photographs throughout by Peter H. Dunning


REGIONAL LOCATION
of
LOUDOUN COUNTY
Montgomery County
I-270
MARYLAND
Leesburg
Potomac River
I-95
I-495
Dulles
Airport
Dulles
Access Road
Route 50
Wash., D.C.
I-66
Route 15
Fairfax County
I-95
Route 28
Prince William County
Fauquier County
I-95
VIRGINIA
N

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Between 1978 and 1982 Loudoun lost 25,000 acres of land in farms. This represents 10% of its current farmland base.

RESIDENTIAL GROWTH IN LOUDOUN COUNTY -- DENSITY-RELATED PUBLIC COSTS

I. Executive Summary

Issues and Objectives

The conversion of agricultural and other rural lands into residential communities generates economic, social, and environmental changes. Of special concern to local governments are the changes in public costs and revenues associated with such development. Public officials who are responsible for planning, zoning, raising revenues, and providing public services have sought better ways to estimate the net fiscal impacts of residential growth, in order to make more informed decisions about the future quality of life in their communities.

Several different approaches to fiscal impact analysis have been developed and applied; in virtually all cases the increased public costs (for education, health, welfare, safety, and other public services) associated with new residential developments have been shown to exceed the increased public revenues generated by them. A few studies have also suggested that the net public costs resulting from low-density or "sprawl" development patterns are likely to be higher than those resulting from higher density or "cluster" development for the same number of dwelling units.

Although this hypothesis should be of central concern to county governments faced with residential growth pressures, it has rarely been tested using actual county-level data, nor has any standard methodology been developed for doing so.

The primary objective of this study, which was sponsored by the American Farmland Trust and the government of Loudoun County, Virginia, was to develop a methodology, using actual county data wherever possible, to estimate not only what the net public costs of new residential development in the county were likely to be, but also whether these costs could be expected to vary significantly with the density of such development, and if so, how.

This objective was achieved, with results that show a net public revenue shortfall from new residential development in Loudoun County for all densities tested -- from one unit per five acres to 4.5 units per acre. Net public costs were estimated to be approximately three times as large per new dwelling unit for the lowest density as for the highest density within this range.

Methodology

This objective was pursued in several steps: first, the major categories of public costs and revenues for Loudoun County were identified; second, a representative demographic profile of a new 1000-household residential community was developed, based on census tract data from recently developed areas within the county; third, four alternative density distributions were developed for this prototype community, spanning a range of dwelling unit densities considered representative of those in the county; fourth, and most difficult, detailed cost and revenue analyses were carried out for each of these four community types, using real data from comparable areas within Loudoun County wherever possible.

Public Costs and Revenues: these were determined for major categories on a current annual basis, using the latest county budget and other published fiscal records. The results, which are presented in greater detail in Part III, Table 1, indicate that public education, including school debt service, consumes 2/3 (68%) of the county's budgeted funds, followed by health and welfare (9%) and public safety (8%). Major public revenues include general property taxes (48%), funds received from the Commonwealth of Virginia (31%), and other local taxes (9%). In addition, two significant public cost/revenue items are not reflected in the county budget: water and sewer services, which are provided by separate sanitation authorities, and public road maintenance and construction, which at present is carried out entirely by the state using state revenues. For the 1983-84 fiscal year, total public expenditures within the county from various sources were approximately $70 million for a population of approximately 63,000, or about $1100 per county resident.

Demographic Profile: Age-specific census data for tracts in different parts of Loudoun County were examined. Although the differences were not striking, a composite "new community" profile was developed by combining data from several subareas in the eastern part of the county where much of the recent residential growth had occurred. These data indicated that a new community of 1000 such households, or dwelling units, would consist of approximately 3260 persons, of whom 940 would be public school students, with 670 in grades K through 6 and 270 in grades 7 through 12. Nearly 50% of the people in such a community would be in the age group from 19 through 44, which is typical of the relatively young professional families now settling in Loudoun County.

Density Distributions: This prototype community was then transformed into four alternative development patterns, described in Part III, Table 2. The four patterns reflected the range of average dwelling unit densities found in the county:

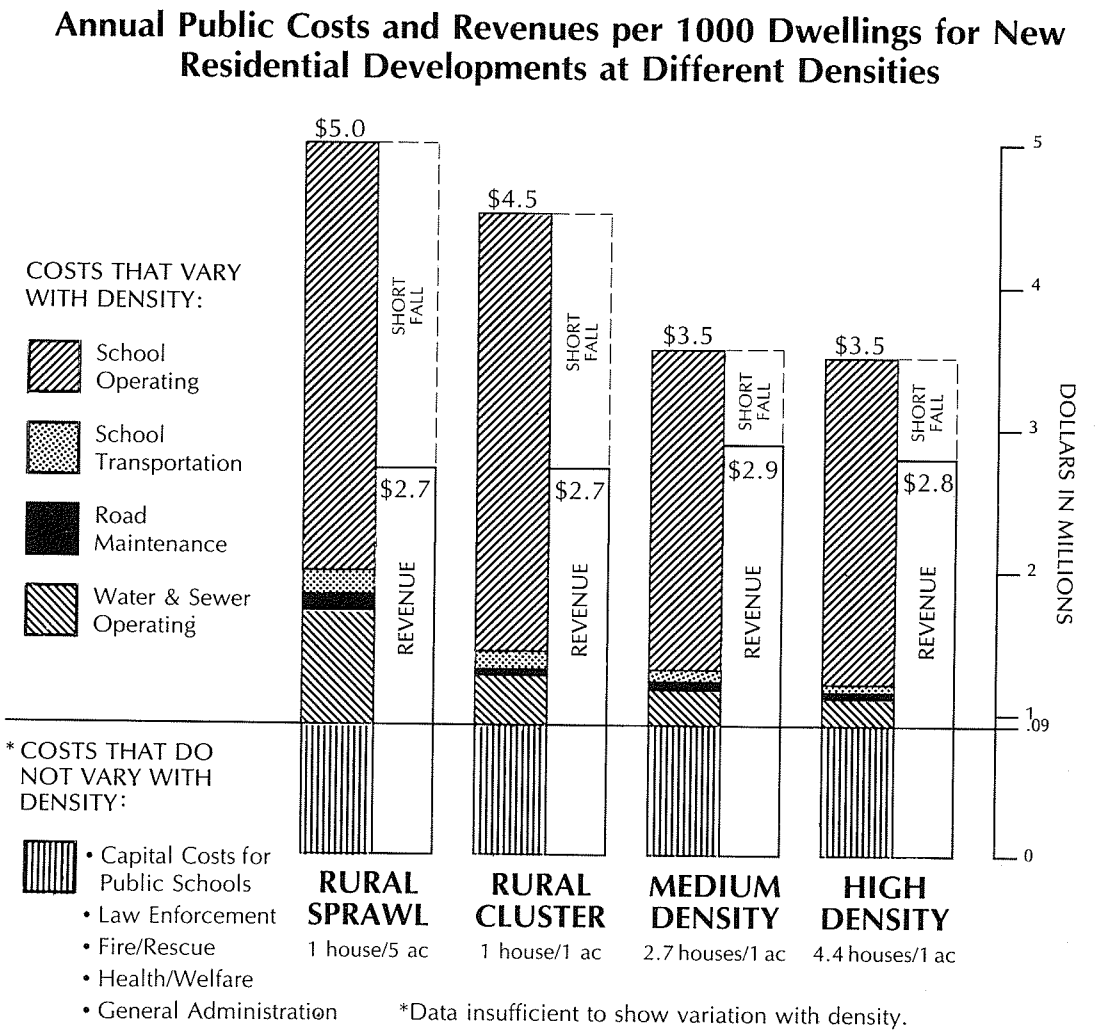
rural low density:	1 dwelling unit per 5 acres
rural cluster:	1 dwelling unit per 1 acre
medium density:	2 2/3 dwelling units per acre
high density:	4 1/2 dwelling units per acre

Total population, age structure, and number of dwellings were held constant across all four community types; only the dwelling unit density was varied, in order to test for variations in public costs and revenues directly related to density.

Cost and Revenue Analysis: Specific estimates of annual public costs and public revenues were made for each major fiscal category for each of the above community types. The detailed methodology and computations are set forth in Parts IV and V of the main report: Table 4 displays the results of the cost analysis; Table 5 displays the results of the revenue analysis and the net public costs for each community type. Summary results are presented graphically for costs and revenues in Figure 1 below.

Figure 1

Major annual public costs and revenues for four different 1000-household residential community types in Loudoun County, Va.



As shown in the detailed cost analysis, four major categories of public costs were found to vary significantly (and inversely) with the density of residential development:

	(rural sprawl / high density)
school operating & instruction:	1.35 / 1
school transportation:	5.59 / 1
road maintenance & construction:	4.30 / 1
water and sewer services:	2.95 / 1

Although school operating and instruction costs showed less variation proportionally than the other three categories, this variation accounted for the largest difference in dollars because it was such a large cost category in the county budget. School transportation costs were the most sensitive to variations in density, but constituted a much smaller cost category. Other major costs could not be found to vary significantly with dwelling density, in part because of the lack of area-specific data for the costs of police, fire, rescue, and other county services, and in part because some county-wide services such as health and welfare are provided in ways that are probably unrelated to the density of dwelling units in residential communities.

The detailed revenue analysis also showed variations due to density, but over a narrower range than costs. Real and personal property taxes were slightly higher for low-density development, but this was more than offset by the absence of revenue from water and sewer services. Thus overall, slightly higher revenues were projected from the higher-density communities.

It should be emphasized that this analysis reflects known public costs and revenues, regardless of which public entity is at present responsible for them, because that responsibility may shift in the future from one entity to another. For example, it was assumed that the necessary revenues would be forthcoming from the Commonwealth of Virginia to provide nearly 100% of the public road maintenance and construction costs for all four community types. If these funds become limited by the state's allocation formula, then the revenue projected for the lowest-density community type would likely be adversely affected first, since it is the highest amount. The county or other level of government would then have to act to raise additional revenue to maintain the level of service previously provided entirely by the state.

Subtracting the total average annual projected revenues for each community type from the corresponding total average annual projected costs (per Table 5) reveals an annual revenue shortfall, or deficit, for all densities of residential development analyzed in the study. This is consistent with other studies. These results also indicate that the annual deficit for the two lower-density communities is two to three times as large as for the two higher-density communities, supporting the hypothesis which the study was designed to test -- that higher ongoing net public costs are associated with lower-density residential development.

Principal Conclusions and Recommendations

- It is possible and feasible, based on our experience in Loudoun County, to construct a fiscal impact analysis at the county level for a given residential development at different densities, using existing data for major categories of public costs and revenues.

- The results of this analysis show that over a wide range of densities (0.2 units/acre to 4.5 units/acre) the ongoing public costs of new residential development will exceed the revenues from such development.

- For Loudoun County, the average annual revenue shortfall or net public cost to the county would be approximately three times as large ($2200 per dwelling) from the lowest-density residential community projected in the study as from the highest-density community ($700 per dwelling).

- County revenue shortfalls resulting from the conversion of rural agricultural or forest land to residential development will have to be made up either by reducing existing public services, raising taxes, attracting additional commercial revenues, or through some combination of these methods.

- Relatively low-density residential development (one to five or more acres per dwelling unit) generates higher net public costs primarily because it requires inefficient expenditures for public school operating, instructional, and transportation services, and also because it creates potentially higher public liabilities for road maintenance and future provision of public water and sewer services.

- Relatively high-density residential development (two to five or more dwelling units per acre) is almost certain to be located in areas served by or adjacent to existing public water and sewer systems. Public schools built to serve such communities can be larger and more economical to staff and to operate; the majority of students can walk to and from these schools, which greatly reduces school transportation costs.

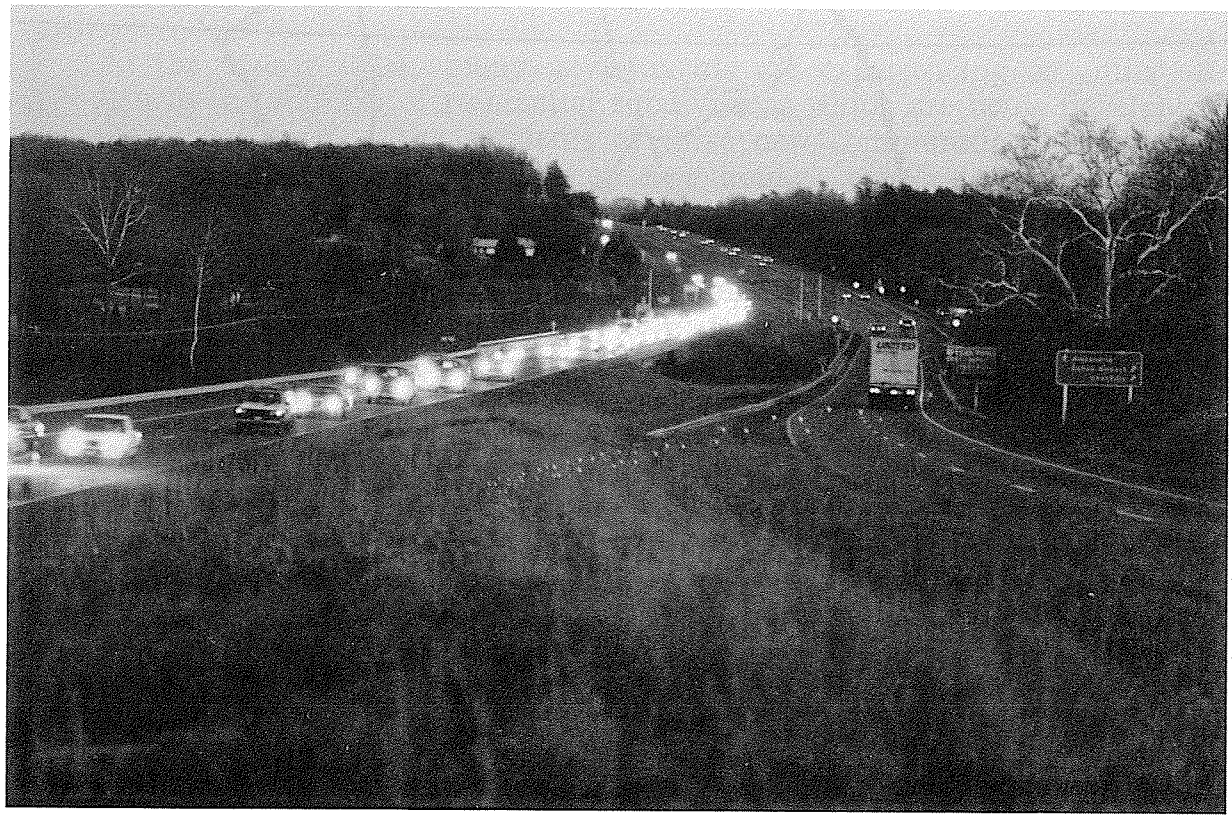
- Low-density residential subdivisions, usually located in rural areas, remove relatively large amounts of land from agricultural uses while requiring public services (education, health and welfare, public safety, etc.) which are similar on a per-dwelling or per-capita basis to those required by high-density subdivisions that convert far less land from existing agricultural or other economic uses.

- Loudoun County has a stated planning objective to maintain an existing agricultural economy wherever it is viable, while minimizing the revenue shortfall resulting from new residential development. To help achieve this objective, zoning and other land-use policies should be adopted to encourage

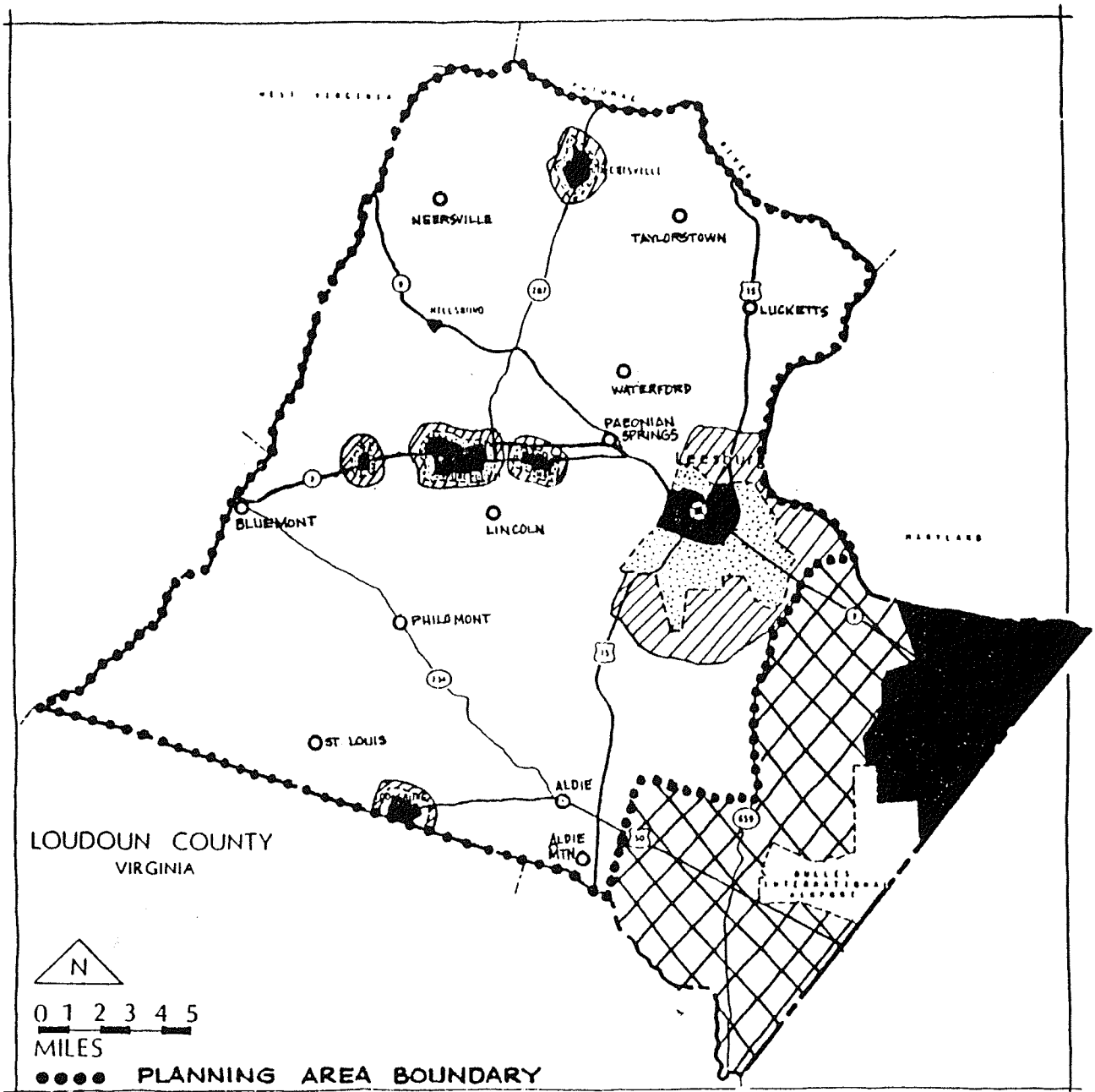
and direct new residential development to locate within or adjacent to existing urban and residential development where adequate community water and sewer service is already available, and where higher (and thus more cost-effective) housing densities are most feasible.

- If a county government seeks to estimate more accurately the net public costs of residential development in the future, it should consider compiling data for some of the major cost and revenue categories used in this study for specific regions within the county on an annual basis. For Loudoun County, the existing school districts provide such a breakdown for school-related costs; it would, however, be useful to know whether law enforcement, fire and rescue services, and health and welfare costs vary from one part of the county to another on a per-capita or per-dwelling basis, and if so whether they vary in some direct relation to the density of residential communities.

  This would entail annual reporting on a district or area basis of major services provided and expenditures made. Such districts need not be the same for all services -- data could be compiled for existing police patrol districts, fire and rescue service zones, etc. -- as long as the data could be related to the density of residents and/or dwelling units in these districts. Compilation of this information would require some relatively minor changes in record-keeping, but should enable county departments to relate their costs and their budget projections more closely to current and anticipated patterns of residential growth.



Highways carry commuters from Washington to Loudoun at the end of the day.



Rural Land Management Plan — Figure 3

LAND USE POLICY AREAS

- INCORPORATED AREA OF TOWN AND/OR AREAS WITH CENTRAL WATER AND SEWER
- --- URBAN LIMIT LINE (DETERMINED BY AREA PLANS)
- RURAL FRINGE AREA
- O RURAL VILLAGE
- AGRICULTURAL CONSERVATION AREA
- POTENTIAL URBAN GROWTH AREA (TO BE DETERMINED BY ASHBURN/ARCOLA/PLEA. VALLEY PLAN)
- URBAN GROWTH AREA (TO BE SPECIFICALLY DETERMINED BY AREA PLANS)

II. Introduction and Scope of Study

From Colonial times to the present, we Americans have been converting forests and farmland into residential communities. At first, undeveloped land was considered a wilderness to be tamed; only recently have we begun to ask questions about the economic and environmental consequences of this conversion process.

At the county level, many governments are experiencing or anticipating rapid growth in the form of residential subdivisions which are being developed in previously rural areas. The residents of these new communities, having made substantial personal investments in their new homes, expect to receive adequate public services in return for the property taxes they must pay.

When public officials seek to deal with this situation, they face a difficult challenge: how to make reasonable estimates of the public costs and revenues -- and thus the overall net fiscal impacts -- of residential development in rural areas.

In pursuing this question one encounters at least two basic hypotheses about the consequences of subdividing rural land. The first is a familiar one: it is that local governments should welcome and encourage residential subdivisions because they serve to expand the tax base. The statement in this form begs the question of what are the costs of doing so. This hypothesis stated properly should be, "residential development of rural land produces public revenues in excess of public costs." Stated this way, the hypothesis has almost always proven false; the costs of the public services required to serve new residential communities usually exceeds the tax revenues generated by them.

The second hypothesis is one which was examined in the now widely-cited 1974 study sponsored by the Council on Environmental Quality and other federal agencies, entitled The Costs of Sprawl. It may be summarized in the statement that, for a given number of dwelling units, the public economic and environmental costs are higher for low-density "sprawl" development than for higher-density "cluster" development. The "Costs of Sprawl" study was an analysis of prototype development patterns, not of actual developments; although it affirmed the hypothesis, it was not generated from any given county growth patterns or fiscal data.

The study presented in this report was sponsored by the American Farmland Trust and undertaken in cooperation with the government of Loudoun County, Virginia. It is an attempt to discern whether actual county-level data and growth patterns can be used to develop a reasonable estimate of the fiscal impacts of residential development over a range of different densities; and if so, how the county's most significant public costs and tax revenues are likely to vary with density. Or, in other words, are there likely to be significant "costs of sprawl" in Loudoun County which can be estimated from the available data?

Fiscal impact analysis can be time-consuming and expensive; for this reason most county governments have not made extensive use of the models which have been developed in the professional literature. A principal objective of this study was to develop a methodology which was straightforward enough to be understood and replicated without requiring cumbersome linear programming models or other mainframe computer technology. A second objective, related to the first, was to rely as much as possible on data and information readily available from county government or other local sources, in order to generate cost estimates that are directly related to actual public expenditures in Loudoun County.

To meet these objectives it was necessary to avoid making an exhaustive analysis of all public income and expenditures in the county, and to focus instead on the major categories of public costs and revenues which are or appear to be associated with residential development. It was also necessary to make several simplifying assumptions in the course of developing estimates for these categories. Where we have done so we have tried to make reasonable assumptions that are based on the best available information, and to state what those assumptions are. We have also made an effort to set forth our cost analysis in such a way that the calculations can be repeated using different assumptions to generate other estimates if the reader so desires.

In developing this study methodology, much consideration was given to the appropriate time-frame for the analysis. After an initial investigation we determined that the most significant public costs were those which were likely to be incurred either on a continuing annual basis or during the first 20 years of the life of a residential community. We decided that a complete "life-cycle" cost/revenue analysis (which would require making projections over a period of 50-80 years) would involve too many uncertain assumptions and would not contribute significantly to the basic goals of this study.

As the CEQ Costs of Sprawl report points out, there are a variety of economic, environmental, natural resource, and social costs and benefits, both public and private, associated with different types of development; we have limited our quantitative analysis to the public economic aspects of residential growth.

Nevertheless, as the Rural Land Management Plan for Loudoun County clearly states, the conversion of rural land to urban and suburban uses involves these other important values which, although they may not be amenable to fiscal or other quantitative analysis, may be of primary concern to citizens attempting to preserve and maintain an enjoyable quality of life. Our limited analysis should therefore not be read as an attempt to prescribe or promote any particular pattern of residential development, but only as an attempt to provide more specific information on some density-related public costs than has heretofore been available.

The Impermanence Syndrome: Anticipating development farmers reduce investments in farm buildings and facilities.

III. Methodology

A. Literature Review

We obtained and reviewed the County's 1979 Resource Management Plan and the July 1983 draft of the Rural Land Management Plan developed by the Citizens' Committee. Both these documents present useful data on rural land use in the county; the Rural Land Management Plan sets forth a strategy and a series of recommendations for managing growth to "preserve and further develop the many benefits of an ongoing agricultural industry and community for Loudoun County." We also reviewed and made extensive use of the County of Loudoun Adopted Budget, FY 1983-84.

We reviewed the published professional literature on ways of estimating the costs of different patterns of urban and suburban development. One recent publication by Burchell and Listokin, 1980, Practitioner's Guide to Fiscal Impact Analysis, provides a lucid and useful overview of several methods for projecting direct public costs and revenues associated with new development. In general, these methods employ averaging or aggregation techniques which obscure the potential differences in public costs which might arise from different development densities. However, the analysis we later developed makes partial use of two of the methods they describe -- the Per Capita Multiplier and the Case Study methods.

Perhaps the most notable attempt to assess the costs of different types of residential development was The Costs of Sprawl, a 1974 report prepared by Real Estate Research Corporation for the Council on Environmental Quality (CEQ). This study, which was an analysis of prototype development patterns, produced estimates of the economic, environmental, and personal costs associated with different defined neighborhood types and community development patterns. The study concluded that "planned" communities with higher densities result in lower economic costs, environmental costs, natural resource consumption, and some other personal costs for a given number of dwelling units. However, the study was based on a number of assumptions about community infrastructure and service requirements that have been questioned and which limit its direct applicability to actual communities with differing household characteristics, infrastructure, and development styles.

A 1981 report by the Urban Land Institute entitled The Urbanizing Countryside cites the prevalence of inefficient land development in rural areas. This report also suggests that the initial public costs of low-density development are not great, as long as such development does not overtax existing roads, schools, groundwater supplies, or septic percolation capacities. However, the report states, typical rural development patterns may create conditions which are difficult and costly to overcome in later years because needed improvements such as roads, water and sewer lines, and other public facilities may be constrained by existing development and/or prohibitively expensive. There are no methods included in the paper for calculating these costs.

A recent paper on farmland preservation presented by Prof. John Hutchinson of the University of Virginia suggests that legal and economic factors must be carefully considered in constructing any viable program for protecting agricultural land use. There appears to be a market threshold for rural land (in the range of $5000 to $6000 per acre) above which continued agricultural land use is usually not feasible on a long-term basis, and residential or other urban uses gradually become dominant. It is thus particularly important, he concludes, that zoning or other designation of land for ongoing agricultural use be based on solid evidence of past and present agricultural profitability, general community acceptance of the land as farmland, and lack of significant speculative ownership.

In addition to the above information, we reviewed several other publications. These included three guidebooks or manuals designed to be used for cost/revenue analysis in specific regions of the country: the State of Maine, Northern Virginia, and DeKalb County, Illinois. (See the Appendix for full citations.) Each of these guidebooks makes use of information and techniques which are suited to the locale for which it was prepared; this approach has the advantage of being easier to use in that locale. However, even with the handbook for Northern Virginia, we found that the methods of generalized cost estimation used could not be applied directly to answer the principal question raised in this study, that is, whether there are significant differences in public costs on a per-capita or per-household basis associated with differences in the dwelling-unit density of new communities.

In summary, we found that although much has been written on fiscal impact analysis over the past 20 years, relatively little has been done to develop a practical methodology to calculate net public cost estimates for specific patterns of residential development at the county level.

B. Major Public Costs and Revenues

Data from the most recent Loudoun County budget and other sources were used to compile the summary which follows; major costs are tabulated in rank order for use in the detailed cost analysis presented in Part IV. Note that some of the costs and revenues listed are not part of the County's budget: e.g., there is a separate county authority for water and sewer service; all road maintenance is currently provided by the Commonwealth of Virginia. Other costs, including certain certain types of educational, health, and welfare costs, are included in the County's budget but are partially reimbursed by revenue from state or federal sources. As is explained further in section IV, we felt that it was important for the purposes of this study to consider all major public costs in our analysis.

TABLE 1

Major Public Costs and Revenues, Loudoun County, Va. FY 1983-84[1]

Item	Amount	Percent of Co. budget
Major public costs:		
* school instruction, transportation, and operation	$38,403,000	62 %
* health and welfare	5,653,000	9
* public safety (law enforcement, fire and rescue services, courts)	4,781,000	8
* school debt service	3,406,000	6
* water and sewer services (separate public authority)	[3,045,000]	-
* general government administration	2,819,000	5
* road maintenance (state responsibility in Va.)	[2,200,000]	-
Major public revenues:		
* general property taxes	$29,982,000	48 %
* other local taxes	5,292,000	9
* other local revenue	3,100,000	5
* revenue from the Commonwealth of Va. included in county budget	18,892,000	31
* federal payments, grants, etc.	1,816,000	3
* water and sewer authority revenues	[3,045,000]	-
* road maintenance (state funds to VDHT)	[2,200,000]	-
[1] Total budgeted expenditures (and revenues):	$61,901,244	

As is typical of county governments, public education costs dominate; when school debt service is included, education costs consume 2/3 of the county's budgeted funds. State revenues cover 30% of the public school operation and maintenance costs at the present time; this is a transfer item which may not be maintained by the state at this level in the future.

The Loudoun County Sanitation Authority provides water and sewer service for most of the areas served in eastern Loudoun County outside Leesburg . The Authority buys water at cost from the City of Fairfax, and sewage treatment at cost from the District of Columbia. The Authority is relatively well-capitalized and has no debt at present.

For all public roads in the county, both construction and operating costs are incurred by the Virginia Department of Highways and Transportation (includes

Farmettes and Horsettes: a consuming use of land (5-10 acres lots).

grading, paving, patching and resurfacing, snow removal, etc.). The state legislature appropriates funds to cover 100% of these costs, up to an annual "ceiling" which is uncertain from year to year but which has not yet been exceeded in Loudoun County. For any road work in excess of this ceiling, the county would have to assume the costs; this has occurred in neighboring Fairfax County.

C. Demographic Profile

An analysis was made of the federal government's 1980 age-specific census data for Loudoun County. By combining data for the appropriate census tracts, age distributions were developed for three areas of the county: the Sterling area, the Leesburg area, and the rest of the county. The results are shown below.

	Loudoun County Subareas:		
Age Group	Sterling sub-area	Leesburg sub-area	Rest of county
under 3	5.3%	4.7%	5.1%
3-4-5	5.8	4.5	5.4
6-7-8-9	9.1	6.8	8.4
10-11-12-13	9.2	6.2	8.4
14 thru 18	9.9	8.1	9.4
19 thru 24	7.3	10.8	8.3
25 thru 34	23.0	20.9	22.5
35 thru 44	18.2	12.2	16.6
45 thru 54	7.4	7.0	7.3
55 thru 64	3.2	7.9	4.5
65 +	1.6	10.8	4.1

Although the differences among these three areas are not striking, it can be seen that the Sterling area (where much of the recent growth has occurred) has the youngest profile, and the Leesburg area the oldest (this primarily due to the location of a retirement/nursing home within the census tract). Because Eastern Loudoun, including the Sterling area, has been the primary focus of residential development during the past several years, we considered the composite profile from the five Sterling subarea census tracts to be a reasonable indication of the demographic character of prospective Loudoun County residential growth over the next five to ten years.

Based on this composite "growth profile" we then projected that one thousand households added to Loudoun County in the near future would have approximately the following distribution:

	percent	rounded number	implied population
1 person	9.1%	100	100
2 person	24.1	240	480
3 person	21.9	220	660
4 person	27.8	280	1120
5 person	11.5	110	550
6 person +	5.6	50	350
	100.0%	1000	3260 *

* This is an average of 3.26 persons per household.

Similarly, we would expect the distribution of housing units stated in terms of bedrooms to resemble the following profile:

	percent	rounded number
1 bedroom	2.4%	20
2 bedroom	9.7	100
3 bedroom	56.0	560
4 bedroom	25.3	250
5 bedroom +	6.6	70
	100.0%	1000

For such a 1000-household community, we then computed the following distribution of students:

80	nursery school students
670	kindergarten and elementary students
270	high school students
180	college students (living in the county)

Although nursery school enrollment in the county is at present about 80% private, elementary school enrollment is 95% public and high school enrollment is 98% public; therefore we will assume full county responsibility for education of all students from kindergarten through grade 12. The total public costs for county college students are at present approximately $30,000 per year (in the form of county support of the Northern Virginia Community College system) and were not utilized further in our school cost analysis.

This community profile was then expressed in terms of four alternative development patterns and densities; a reasonable range for Loudoun County was considered to be the following:

1) Rural sprawl: 0.2 dwelling units (DU) per acre, with individual wells and septic disposal systems

2) Rural cluster: 1.00 DU/acre, wells & septic systems

3) Medium density: 2.67 DU/acre, public water & sewer

4) High density: 4.44 DU/acre, public water & sewer

Additional summary data on each of these four community types are given in Table 2 below. It should be noted that the number of persons, the age structure, and the number of households is the same in each community type; the only significant variable to be altered is the amount of land associated with each household. This is necessary in order to avoid complicating the analysis of public costs and revenues with effects not directly related to density.

TABLE 2

Four Alternative Density Distributions for a 1000-Household Community of 3260 Persons in Loudoun County, Virginia

land use	dwelling unit distribution	acreage developed	dwelling units per resid. acre	average resid. acres/person	average persons per resid. acre	farm units converted *
RURAL SPRAWL	1000 SFD houses; avg. lot size 5 acres, + 1000 acres for streets, park, schools	residen.: 5000; other public: 1000	1000/5000 = 0.2	1.53	.652	20
RURAL CLUSTER	1000 SFD houses; avg. lot size 1 acre, + 200 acres for streets, park, schools	residen.: 1000; other public: 200	1000/1000 = 1.0	.307	3.26	4
MEDIUM DENSITY	500 1/2 acre SFD houses + 250 1/4 acre SFD + 250 SFA townhouses	residen.: 375: other public: 125	1000/375 = 2.67	.115	8.69	2
HIGH DENSITY	100 1/2 acre SFD houses + 300 1/4 acre SFD or SFA + 600 SFA town house/condo.	residen.: 225; other public: 75	1000/225 = 4.44	.0690	14.5	1

* assumes average farm unit size of 300 acres

IV. Detailed Cost Analysis

The purpose of this analysis was to generate projections of public costs, that is, government expenditures, that are directly associated with residential development. Therefore this analysis did not include estimation of public or private costs associated with non-residential development, or opportunity costs of other foregone alternative land uses. It should be noted, however that in the conversion of agricultural land to residential use there are indirect public costs associated with the loss of income and employment from the terminated agricultural business activity. The income and employment benefits of new subdivision residents may exceed those lost, but they may be gained primarily where those residents work and shop, rather than where they live. Such indirect costs and benefits are very difficult to quantify, and were considered to be beyond the scope of this study.

Our principal objective was to obtain or to estimate direct public costs, on a per-capita or per household basis, for those major categories which our literature review and budget analysis revealed as being affected most directly by additional residential growth in the county. We identified these categories as:

* public school costs:
  - capital costs
  - operating costs
  - transportation costs
* public road maintenance costs
* water and sewer construction/maintenance costs
* law enforcement costs
* fire and rescue service costs
* health and welfare costs

We then looked for evidence that these costs might vary with the density of a new residential community, using as examples each of the four community types developed as described above. This phase of the analysis proved, as we expected, to be the most difficult. The difficulties have several dimensions:

First, units of county government do not collect data in a form which allows a direct estimation of their per-capita or per-household annual expenditures, other than by dividing their total county expenditures by the total population. Nor does the county have any standard regional administrative divisions for which records are compiled which might reveal variations in expenditures related to population or dwelling-unit density differences.

There are magisterial districts for election of Supervisors, but the principal public expenditures are not broken down by district. The county is divided into four public school systems, each consisting of a high school, a middle school, and feeder elementary schools. Some data for operating costs are compiled on an individual school basis, and can be aggregated on the basis of these four systems. The county Sheriff's department divides the county into five patrol sectors, but

does not appear to compile operating and personnel costs on the basis of these sectors. Fire and rescue emergency services are provided from a series of volunteer service centers, but training, inspections, and other non-emergency services are on a county-wide basis and cannot be meaningfully partitioned.

Second, as indicated above, not all public costs are county government costs. This is particularly true of road paving and maintenance, which is currently performed by the Virginia Department of Highways and Transportation entirely with state funds. About 30% of public school operating/maintenance costs are met with state transfer funds. The local and county water and waste treatment operating costs are at present met by fees and service charges levied by the authorities that provide them. Other programs receive federal grants and cost-sharing revenues. We did not find any indication that the distribution of these funds varied in any systematic way with the density of residential development. As we have also indicated, some of the services provided by these funds may become county government obligations in the future; therefore we have attempted to identify all major public costs associated with residential development, and have not subtracted out those costs which are at present collected or reimbursed from other sources.

Third, and perhaps most difficult (although potentially most important), is the problem of deferred public costs. Some large capital costs, such as construction of roads, water and waste treatment systems, and in some cases recreational facilities, are "internalized" by the developer into the price of a new dwelling unit and are amortized by the private sector via the purchaser's mortgage (and by the public via the tax deductions taken on the interest payments by the homeowner). But the subdivision roads, and water and sewer lines, become public property and eventually require public maintenance and replacement. Wells and septic systems, although privately maintained, have finite lifetimes and have often required replacement by public water and sewer systems which involve huge capital investments. There is also the well-known "threshhold effect" associated with the addition of young children, which results in the need for new school construction at some time in the future when existing school capacities are exceeded. Thus for a meaningful tabulation of average annual public costs, these costs should be estimated and incorporated where possible to provide a more complete picture of at least the potential overall public costs associated with residential developments. We have attempted to do so, and have explained the estimation procedures we used in the sections which follow.

A. School capital costs

New residential subdivisions inexorably lead to new schools; even if there are overall declines in school enrollment, large new local concentrations of children often require new school construction in one area of a county while an older school in another location is being closed or converted. In Loudoun County new school capital costs are not budgeted per se -- they are obtained by borrowing funds

through bond issues, and thus appear as school debt service in the county budget. There are various methods for estimating the additional school capital costs attributable to an increase in residential dwellings; these methods generally use a "pupil generation factor" associated with different types of dwelling units, plus an estimate of the partial, or average incremental, capital construction costs for each new pupil. (This estimate is obtained by dividing new school construction costs by the total number of pupils which the school would be designed to accommodate.)

Since our census-based demographic profile provided us with an independent indication of the number of school-age children to be expected in our 1000-household community prototypes, we used those numbers (670 kindergarten and elementary school students, 270 high school students) to estimate the incremental capital costs of their addition to the public school system. The number 670 is close to the optimum elementary school size which county officials prefer for educational program reasons. There is, however, some excess classroom capacity in all the county public schools at present (see Table 3). Since the capital costs have already been incurred for these available spaces, it is necessary to make adjustments to reflect the ability of the schools to absorb some children at little or no additional capital cost.

The computation below is based on a procedure set forth in the Northern Virginia Planning District Commission handbook cited in the list of references in the Appendix. The initial step is to determine the number of pupils to be expected for a given new development. For our community prototypes this number is 940. The NVPDC handbook provides a procedure for computing this number based on average pupil generation factors for each dwelling type. Although the results would have been similar, we did not use pupil generation factors for dwelling types, since we derived the age distribution directly from census data and since we held that distribution constant for the four community types in order to allow direct comparisons.

The second step is to correct for excess capacity. If this computation is being made for an actual subdivision with a given location, then the known excess capacity of the schools serving that location can be utilized (or redistricting can be factored into the computation). For example, elementary schools in the Park View system are presently operating at 81% of their use capacity, while those in the Broad Run and Loudoun Valley systems are operating at 47% of use capacity. But the addition of 670, or even 350, elementary students to any <u>single</u> elementary school district in the county would exceed its current excess use capacity. For our calculations we have assumed that, on the average, the county public schools in the vicinity of our prototype communities could absorb 1/2 of the 940 new pupils. Therefore,

$$940 \text{ pupils} \times 1/2 = 470 \text{ pupils in excess of capacity.}$$

Third, this number must be multiplied by an estimate of the current capital school construction cost per pupil. The NVPDC Handbook gives a 1980 statewide

average figure of $4608; persons we have consulted consider this a low estimate. We have conservatively increased it by just over 10% to produce an estimate of $5070 for Loudoun County new school construction costs per pupil. Thus our total education capital cost estimate for 470 additional students in the Loudoun County public school system is:

$$470 \times \$5070 = \$2,383,000.$$

Some Loudoun County officials who reviewed a draft of this report felt that the $5070 estimate was much too low. Therefore we asked school planning officials to examine this question in more detail. Statewide school capital cost figures for 1981-83 obtained from the Virginia Department of Education showed average per-pupil capital costs to be $3960 for elementary schools, $5525 for middle schools, and $5936 for high schools. Applying these figures to the above 470 "excess" new pupils in the proportions expected (335 elementary and 135 middle/high school) we obtained a total capital cost estimate of $2,100,150. This estimate is lower than the one above, largely because it reflects the lower costs of construction for elementary school pupils who make up the majority of our new community school-age children.

However, Loudoun County school planners also developed other capital cost estimates based on recent school construction bids. Converted from a square-foot basis to a per-pupil basis, these estimates were $4743 for elementary schools, $6752 for middle schools, and $9575 for high schools. Applying these figures to the 470 pupils gave a total capital cost estimate of $2,691,000 or approximately $5725 per pupil. Although we believe that this figure, which is about 13% greater than the one we used, may be a better estimate of current per-pupil capital costs in Loudoun County for our community prototypes, we have retained the $5070 figure as a conservative estimate for our overall cost-revenue analysis. The use of either figure does not appreciably change the results.

The school capital cost computation for a new community can be summarized more generally as follows:

> new community school capital cost = (total pupils - school excess capacity) x per-pupil construction cost.

Like most counties, Loudoun does not appropriate funds for these capital costs as they occur, but instead borrows the funds for new school construction as needed through issuance of bonds. To convert such total cost figures to an average annual cost in the form of debt service on a bond issue, the NVPDC Handbook provides a loan amortization table. We selected a factor which represents bond repayment at 8% simple interest over 20 years, based on the County's favorable rating in the bond markets; this produced the following computation:

$$\$2,383,000 \times 0.10185 = \$242,700$$

which represents the annual payment of school capital costs for the additional 470 pupils (or slightly over $500 per pupil per year). Because this computation is much more sensitive to the size and specific location of a new subdivision than to the density of its dwelling units, we simply used the above value for each of the four community types. This computation, as well as those that follow, can be redone using more site-specific data if a more site-specific public cost analysis is desired.

B. School Operating Costs

Operation of the public school system is by far the largest single function of the Loudoun County government, and requires over 60% of the annual budget. The total public school budget for 1983-84 is $38,402,717 (County of Loudoun, Adopted Budget, FY 1983-84). For total enrollment of 12757 pupils (Table 3) this constitutes an average per-pupil expenditure of $3010 this year.

Because we wanted to address public school transportation costs separately, it was necessary to determine those costs and subtract them from the total budget. For FY 1982-83, the latest year for which actual transportation expenditures were available, they constituted 4.65% of the budget (see computations for that item). Deducting this same percentage from the current year's per-pupil expenditure yields the following:

$$100.00\% - 4.65\% = 95.35\%; \qquad 95.35\% \times \$3010 = \$2870$$

which estimates the average in-school operating cost (instruction included) per pupil in the Loudoun County public school system.

But such costs actually vary widely from school to school for several reasons, such as location, grade levels, enrollment, special programs, physical plant, and so forth. Some of these differences were identified and discussed for elementary schools in the 1981 report of the Small School Study Committee of the School Board. Using school-specific data from the 1979-80 school year, the Committee found that, excluding school debt service and transportation costs, a small (125 pupils or less) school's operating costs were approximately $1450 per pupil while a large (300 or more) school's operating costs were approximately $750 per pupil. [These figures are both smaller than the average cost computed above because they are from four years earlier, dealt only with elementary schools, and excluded a number of costs not attributable to individual schools, such as special education programs and teachers, resource teachers, and central staff.] It was noted that for FY 1980-81 these costs had increased by more than $300 per pupil for small schools, about $250 per pupil for medium-size schools, and about $160 per pupil for large schools.

Schools consume 2/3 of the county's budgeted funds. In 1985 the school board requested $45-50 million in bonds to accomodate new growth in the 1985-86 school years.

Table 3

Loudoun County Public Schools
Design and Use Capacities vs. Enrollment, 1983-84

	Design Capacity	Use Capacity		9-83 Enrollment		Excess Design Capacity	Excess Use Capacity
Broad Run Area							
Arcola Elem.	560	490		144		416	346
Ashburn Elem.	215	177		63		152	114
Meadowland Elem.	760	680		355		405	325
Sugarland Elem.	760	654		381		379	273
TOTAL ELEM.	2295	2001	-47%-	943		1352	1058
Seneca Ridge M.S.	1200	1080		760		440	320
Broad Run H.S.	1325	1193		913		412	280
TOTAL AREA ENROLLMENT:					**2616**		
Park View Area							
Guilford Elem.	660	605		540		120	65
Rolling Ridge Elem	760	654		496		264	158
Sterling Elem.	660	580		504		156	76
Sully Elem.	660	564		401		259	163
TOTAL ELEM.	2740	2403	81%	1941		799	462
Sterling M.S.	1050	945		912		138	33
Park View H.S.	1500	1350		1190		310	160
TOTAL AREA ENROLLMENT:					**4043**		
Loudoun County Area							
Aldie Elem.	190	140		70		120	70
Catoctin Elem.	910	702		550*		360	152
Leesburg Elem.	760	563		485*		275	78
Lucketts Elem.	230	190		91		139	99
Middleburg Elem.	190	140		70		120	70
TOTAL ELEM.	2280	1735	73%	1266		1014	469
Simpson M.S.	1200	1080		812		388	268
Loudoun Co. H.S.	1300	1170		1025		275	145
TOTAL AREA ENROLLMENT:					**3103**		
Loudoun Valley Area							
Banneker Elem.	290	240		75		215	165
Emerick Elem.	560	426		172		388	254
Hamilton Elem.	380	327		187		193	140
Hillsboro Elem.	190	140		69		121	71
Lincoln Elem.	215	215		134		81	81
Lovettsville Elem.	560	490		208		352	282
Round Hill Elem.	315	290		137		178	153
Waterford Elem.	190	140		82		108	58
TOTAL ELEM.	2700	2268	47%	1064		1636	1204
Blue Ridge M.S.	1050	945		761		289	184
Loudoun Val. H.S.	1375	1238		1108		267	130
TOTAL AREA ENROLLMENT:					**2933**		

* Includes a total of 35 pre-school

Douglas School (spec. ed. and pre-school)	62
TOTAL PUBLIC SCHOOL SYSTEM ENROLLMENT:	12757

(Source: Loudoun County Board of Education, Oct. 1983)

Overall, the report stated, small schools generally cost 30% more to operate than medium schools and 75% more than large schools. Incorporating this information into our analysis of the prototype communities presented a problem: can the in-school per-pupil operating costs be expected to vary with the density of new residential communities? If so, in what way? Like the school capital costs discussed above, specific per-pupil operating costs are a function of the specific school or schools affected; but some more general considerations can be employed in determining costs for our four prototype communities:

1. Less densely-settled areas of the County generally have smaller schools, which cost more to operate on a per-pupil basis. These are generally areas in Western Loudoun County where water and sewer connections are not yet available, and are therefore more likely to be developed at lower densities because the land is less expensive and larger lots are needed for septic system drainage fields.

2. Regardless of dwelling-unit density, pupils from new developments in Western Loudoun would initially reduce the excess capacity in these small schools, thereby increasing their operating efficiency and reducing the average cost per pupil until that excess capacity is eliminated. But because these schools are small, that excess capacity is relatively small in absolute numbers, and would be rapidly consumed.

3. New housing developments in Eastern Loudoun, where land values are much higher, will almost certainly continue to be of much higher density (units per acre rather than acres per unit); this will lead to rapid elimination of the excess capacity of schools in that area, necessitating new school construction. However, both existing and new schools, being closer to optimum size and capacity, will continue to have much lower operating costs than small rural schools.

To incorporate these probable effects, we have introduced one relevant difference into our analysis as applied to the four prototype communities: we assumed that, due to relative land values and the limited availability of water and sewer service, the two rural (less dense) community types will be located in the Loudoun Valley school system, and the two more dense types will be located in or near the Park View system. We also assumed, perhaps too generously, that the increased occupancy of the small rural schools will lower their average per-pupil operating costs to that of medium-size schools, which are about 35% higher than the large schools, according to the Study Committee report.

Given the previously computed county-wide average in-school operating cost of $2870 per pupil, we estimated the average per-pupil operating costs for both the medium and the high-density communities to be about $2400, and computed the average per-pupil operating costs for the rural communities to be 35% higher:

$2400 x 35% = $840; $2400 + $840 = $3240

We then computed total annual school operating costs for our two different prototype community locations as follows:

rural:	$3240 x 940 pupils	=	$3,045,600
suburban:	$2400 x 940 pupils	=	$2,256,000

This represents the largest single difference in estimated public costs between community types. We stress that this is not a difference which can be attributed directly to a variation in dwelling-unit densities, but instead is due to a difference in community location as a consequence of differences in density. This means that the computation is sensitive to differences in school system operating costs which are in part a function of the amount of excess capacity the system is "carrying"; we have tried to make an adjustment for that fact. School officials indicated that some of the higher cost of operating rural schools was due to the nature of the physical plants as well: smaller and older schools are less efficient to heat and cool, and have fewer options for maximizing effective use of classrooms and staff.

C. School Transportation Costs

Pupil transportation costs can be expected to vary from one school to another in direct relation to the household density of the communities which they serve -- the more dispersed, the higher the cost per pupil. However, we found that such costs were not actually calculated on a per-school basis. The main reason is that school buses often transport students for more than one school on a single route. This is a desirable strategy for efficient use of time and money, but makes our analysis more complex. We found that although bus route miles traveled per number of pupils carried could not be determined for individual schools, route mileages, pupils carried, and number of daily trips were available on data sheets compiled for each school bus. Summary data obtained for all school buses in the county showed that the overall operating costs were $1,302,357 for 1,004,130 miles (excluding special trips and transportation between schools), or $1.297 per vehicle mile for the 1982-83 school year.

Using this information, the data could be aggregated to arrive at transportation costs for any of the four regional school systems (consisting of a high school, a middle school, and their feeder elementary schools) since specific school buses were assigned and operated within one of these systems throughout a given school year. We made such computations for two of the four systems -- Park View and Loudoun Valley -- to use in estimating the additional public school transportation costs which each of our four prototype communities could be expected to generate. We have summarized those computations below; more detailed figures may be found in the Appendix.

In order to keep all our cost estimates based on the current fiscal year (1983-84) it was necessary to project forward the latest available actual school transportation costs, which are for the previous (1982-83) fiscal year. For that

year the total county school public school expenditures were $36,173,869 for 12846 pupils; school transportation costs were as follows:

school bus transportation:	$1,302,357	=	3.65% of total	($101.38/pupil)
school bus replacement:	$ 379,405	=	1.05% of total	($ 29.53/pupil)

Since data from previous years did not show great variations in these percentages, we applied these percentages to the total public school budget amount and enrollment for the current fiscal year ($38,402,717 for 12720 pupils, grades K through 12) in order to estimate this year's county-wide total and average per-pupil transportation costs:

school bus transportation:	3.65% of total	=	$1,401,700	($110.20/pupil)
school bus replacement:	1.05% of total	=	$ 403,230	($ 31.70/pupil)

Therefore, if they were distributed evenly throughout the county, the FY 1983-84 school transportation costs (including school bus replacement) would be approximately $141.90 per pupil. But in reality, of course, these costs vary widely. First, in high-density areas such as Park View, the majority of the pupils walk to school; second, for the pupils who are transported by bus the daily route lengths are much longer in low-density areas such as Loudoun Valley.

Our area-specific analysis showed that, for FY 1982-83, actual school bus transportation costs in the Loudoun Valley system were $147.99 per pupil, or 146% of the average; the same costs for the Park View system were $28.13 per pupil, or 27.7% of the average. Note that these figures are for all pupils in each system, riders and non-riders; this calculation is appropriate in order to reveal the primary effect of higher residential dwelling unit density on school transportation costs: more students walk. Because of their relative proximity to the schools in the Park View system, only 36.1% of the pupils in that system are bused, whereas in the Loudoun Valley system 93.5% of the pupils are bused.

Of the four community prototypes used in this study, the first (rural sprawl) is intended to represent low-density housing development similar to that in the Loudoun Valley system. The high-density type is similar to the Park View system density, and the other two types represent intermediate densities, which would consequently have intermediate school transportation costs.

Therefore, based on the above analysis, the county average FY 1983-84 per-pupil school transportation cost of $141.90 was multiplied by a factor representing the differential effect of density on this average for each of the four community types. School bus replacement costs ware assumed to vary in the same proportion as bus operating costs. The factors used, based on the actual area-specific analysis

discussed above, were: rural sprawl, 140%; rural cluster, 115%; medium density, 50%; high density, 25%. For 940 public school children in each community, the following cost estimates were computed:

rural sprawl:	$141.90 x 140% x 940	=	$186,740.00
rural cluster:	$141.90 x 115% x 940	=	$153,390.00
medium density:	$141.90 x 50% x 940	=	$ 66,690.00
high density:	$141.90 x 25% x 940	=	$ 33,350.00

These estimates were rounded to the nearest $100 for use in the cost summary presented in Table 4. They represent only costs of regular transportation between home and school and do not include the cost of special trips or transportation between schools for educational or sports activities. Although these school transportation cost estimates do not represent a large proportion of the total public costs of residential development, they are the most directly sensitive to the density of such development.

D. Road Maintenance Costs

Accurate current estimates of the annual cost of road maintenance in Loudoun County were difficult to determine for several reasons. Information obtained from officials with the Virginia Department of Highways and Transportation indicated that Loudoun County has approximately 370 miles of unpaved road (gravel) and 343 miles of hard surface road, which is maintained entirely at state expense at present. The FY 1983-84 budget allocation from the state, based on the number of miles of road, is $2.2 million, which is separated into $1.5 million for ordinary maintenance (fixing potholes, snow removal, grading and small repaving jobs) and $0.7 million for maintenance replacement (upgrading gravel to asphalt and major repaving jobs). However, knowledgeable persons expressed the view that this allocation was not enough to keep up with the road maintenance required by increasing traffic volume and escalating costs. No breakdown was available with regard to the allocation of this budget to work done on paved vs. unpaved roads. The VDHT is shifting from direct repair work by state personnel and equipment to contract work, which has the effect of increasing per-mile costs since contracts include overhead costs which were previously borne by the Department in other accounts.

To develop estimates for the purposes of this study, we assumed that $1.1 million, or 1/2 of the total allocation, should be applied to paved road maintenance. We consider this to be a conservative assumption, given that the miles of paved road are increasing, while lightly traveled rural gravel roads (which are less costly to maintain) will gradually be converted to hard surface in response to increased development. VDHT officials said such upgrading becomes desirable when traffic exceeds 50 vehicles per day.

Recent contracts for upgrading and major road repaving have ranged from about $160,000 to $280,000 per mile for some short sections of road. We have not attempted to include a greater proportion of such costs in our estimates than does the state budget, since virtually all new subdivision roads are initially paved to state specifications at the expense of the developer. However, traffic associated with new subdvisions does result in additional wear on existing public roads. And as we have noted above, eventually major repairs and resurfacing of all public roads becomes a public expense which may not continue to be met by state appropriations.

To get a per-mile cost for annual maintenance of paved roads in the county, we divided the $1.1 million estimate by the miles of paved road:

$1.1 million / 343 miles = $3207 per mile

Rounding this figure to $3200, we must then estimate the number of paved road miles to be generated by each of the four community types in our study. For a rural sprawl pattern, an examination of several subdivision plats in Loudoun County indicated that a typical pattern of 5-acre lots in a rural subdivision would have about 360 feet of road frontage per lot; dividing by two (for lots on both sides of the road) yields the following estimate:

rural sprawl: frontage = (360 ft. / 2) = 180 ft.; then
1000 units x 180 ft. = 180,000 ft, or approx. 34.1 road miles;
34 miles x $3200 per mile = $110,000 annual maintenance costs.

For the rural cluster development, lot size is 1/5 of the above, but effective road frontage is expected to be at least 180 ft. / 2 = 90 ft., x 1000 units for a total of 17 miles; this resulted in the following estimate of annual maintenance costs:

rural cluster: 17 miles x $3200 per mile = $ 55,000

For medium density, we assumed the internal roads required would be reduced to 12 miles for the 1000 units; therefore annual maintenance costs were estimated as:

medium density: 12 miles x $3200 per mile = $ 38,000

For high density, internal road mileage was estimated to be 8 miles, again based on figures from actual subdivision plat maps; therefore the annual maintenance cost calculation was:

high density: 8 miles x $3200 per mile = $ 26,000

These estimated costs would obviously vary with the layout of any particular development, and could be computed on that basis; nevertheless we believe that these are reasonable approximations.

In the late 1980's new zoning in Eastern Loudoun alone, provided for new development that would double the county's 1980 population of 57,000.

E. Water and Sewer Costs

The public costs of constructing, operating, and maintaining water and sewer services in the county are not included in the county budget documents, because they are not presently paid from general county revenues. In years past much of the cost of constructing the wastewater treatment plant and interceptor sewers which serve eastern Loudoun County was paid for via grants from the federal government. Most of western Loudoun County does not have these services; instead, water for domestic use is obtained from private wells and wastewater is treated in individual septic systems. In eastern Loudoun, as well as in Leesburg and a few other towns, there are separate sanitation authorities which operate and maintain municipal water and sewer systems. These authorities are intended to be self-sustaining; they cover their operation and maintenance costs from service revenues plus fees and connection charges for new hookups. They do not, however, accumulate capital reserves for extending water or sewer services to new developments outside their service areas.

Of the four residential community types analyzed in this study, we specified that the two higher density types would have municipal water and sewer systems, as a consequence both of their inherent density and the likelihood that they would be located in eastern Loudoun. Information compiled by the Loudoun County Sanitation Authority, which serves much of eastern Loudoun, indicates that their typical customer, a single-family residential unit, uses 84,000 gallons of water per year, and pays a combined annual water and sewer bill of $260.00.

This figure was the best estimate we found for the average annual public cost of water and sewer service for dwellings in communities similar to our medium density prototype. Since the installation and connection costs for new dwelling units are paid by the developer and passed on to the homeowner, we included only operation and maintenance costs, represented by the average annual payment per unit given above, in our calculation of the annual public water and sewer costs for this community type:

medium density:	$260 x 1000 units	=	$260,000 per year

For our high density type, we allowed for some reduction in water consumption due to smaller yards to be watered, fewer cars to wash, etc., but no significant reduction in wastewater volume because each community type houses the same population. Allowing a $20 per unit reduction, the annual cost estimate is as follows:

high density:	$240 x 1000 units	=	$240,000 per year

Estimating public costs of water and sewer systems for new communities in rural areas appears at first to be inappropriate, since, as stated, wells and septic systems are constructed and operated at the (private) expense of the homeowner. However, these systems have finite lifetimes: for septic systems this is in the range

of 15 to 30 years. Where such systems fail, they can sometimes be rebuilt; but the gradual failure of such systems has often resulted in contamination of groundwater which has in turn required the abandoning of wells as drinking water sources. When this happens in rural subdivisions, as it frequently has, the only feasible solution is the introduction of public water and sewer systems at considerable public cost.

We attempted to estimate what that cost would be for the two rural community types used in this study, based on recent cost estimates for water and sewer construction in Loudoun County and those reported in the DeKalb County, Illinois study. A recent sewer system study for western Loudoun projected a $5 million cost for installation of 18 miles of sewer, two pumping stations, and a package treatment plant. This would be approximately $278,000 per mile, and is within the range of per-mile cost estimates that are given in the Dekalb County study. That study indicated that water line construction costs are about 1/2 the cost per mile of sewer lines. Based on these figures, a reasonable estimate of the combined costs per mile for installation of a water and sewer system in a rural subdivision would be:

sewer:	$278,000	(includes treatment system)
water:	139,000	(assumes existing treatment system)
combined:	$417,000	(assumes simultaneous installation)

As with road construction, the actual cost of constructing a water and sewer system for any specific new development would be affected by its location and layout, and would likely vary from the above estimate of an average cost per mile. In keeping with the generality of our community types, we will use the estimate derived above, and will assume that the miles of water and sewer construction required are roughly equal to the internal road miles which were previously estimated. These assumptions then generate the following estimates:

rural sprawl: $417,000 x 34 miles = $14,178,000

rural cluster: $417,000 x 17 miles = $ 7,089,000

Note that these estimates are present-year dollar costs, and assume the use of package or other local sewage treatment plants, rather than connection with large existing treatment plants via long-distance interceptor sewers, which would greatly increase these cost estimates.

If, in anticipation of the likelihood that such expenditures will be required in the future, the County or the Sanitation Authority were to establish a "sinking fund" to accumulate these funds, then how much should be paid into the fund each year, i.e., treated as an annualized future water/sewer cost for each new rural community of this size? We made the simple assumption that if these amounts should be accumulated within 20 years, then the annual cost should be 1/20 of

these amounts, allowing for the interest accumulated during that period to offset inflation in the expected costs. On this basis, the average annual "sinking fund" water/sewer allocations for anticipated future public costs would be:

rural sprawl: $14,178,000 / 20 = $709,000

rural cluster: $ 7,089,000 / 20 = $355,000

An alternative approach would be to attempt to raise these funds at the time such construction is needed, through a bond issue and/or tax increases; such methods would also have annual public costs, but the assumptions required to make estimates about inflation and interest rates 20 years in the future led us to prefer the method above, at least for comparative purposes.

F. Law Enforcement

Annual public costs for law enforcement in Loudoun County are reflected in the Sheriff's budget, which includes costs of operating the jail and the Court as well as direct costs of law enforcement and traffic control. The county budget shows an estimated expenditure for these purposes in FY 1982-83 of $2,821,911, and an approved budget for FY 1983-84 of $3,157,780. Dividing the latter figure into the total county population of 62,582 (April 1984 estimate, Department of Planning and Zoning) results in an average expenditure estimate of $50.46 per person for law enforcement in Loudoun County this year.

Although we made repeated efforts to determine whether the costs of law enforcement varied in any systematic way with the density of residential dwellings, we were unable to do so. The Sheriff's Department does not compile operations and cost data on a regional basis within the county such that, for example, patrol costs in rural areas could be compared with those in more dense suburban areas. Officials in the Department were of the general opinion that demands on personnel and equipment were increasing in rather direct proportion to the increase in population, but they did not perceive significant differences in these demands in relation to the density of dwelling units.

We therefore simply used the average estimate of $50.46 per person to estimate the increased public cost of law enforcement associated with the introduction of the 3260 persons in each of our four community types:

$50.46 x 3260 = $164,494 (rounded to $165,000)

G. Fire and Rescue Services

County fire and rescue services are under the jurisdiction and the budget of the Fire Marshal; although many services are actually provided by volunteers, public expenditures are made for communications, training, fire protection programs, facilities and equipment (and some personnel backup) for the volunteer fire and rescue squads, and inspections of buildings and equipment. Estimated expenditures for these services in FY 1982-83 totaled $1,070,000; the approved budget for FY 1983-84 was $1,099,588.

Using the same procedure as for law enforcement, we divided the latter figure by the total population to produce an average expenditure of $17.57 per person in the county for fire and rescue services for this fiscal year.

We encountered difficulties similar to those with law enforcement in attempting to break down this average cost figure in relation to variations in community type or density. Since many of the services are provided on a county-wide basis there is no meaningful way to assign such costs to specific communities. We did learn that one growing problem is the lack of daytime volunteers to operate fire and rescue equipment in the higher-density communities. This problem occurs at least in part because residents in these newer communities hold salaried jobs in business or government offices outside their neighborhoods and are therefore not available to answer calls from about 8 am until about 6 pm. This has necessitated the hiring of paid personnel to staff some fire and rescue companies during these hours. This trend is likely to continue for newer residential subdivisions.

We could not, however, find a basis for assigning such costs to our community types on a differential basis in relation to density; we therefore computed an average annual community cost and assigned this cost equally to the four community types:

$17.57 x 3260 persons = $57,300 (rounded to $58,000)

H. Other Cost Considerations

There are two other significant categories in the Loudoun County budget, as shown in Table 1 of this report: these are health and welfare, and general government administration. Like the categories of law enforcement and fire and rescue, we found that these services were provided to all county residents from central facilities, or through programs which were available throughout the entire county, and could not be related to the density of residential communities. Therefore for both of these categories we computed average county per-capita costs for the current year as was done for the previous two categories.

For health and welfare, average annual per-capita costs were computed to be $5,653,000 / 62,582 persons, or $90.33; community costs for entry in Table 4 were then calculated as follows:

$90.33 x 3260 persons = $294,475 (rounded to $295,000)

For general government administrative costs, average annual per-capita costs were $2,819,000 / 62,582 persons, or $45.04; the estimated cost for the communities in Table 4 were thus:

$45.04 x 3260 persons = $146,830 (rounded to $147,000)

We would emphasize that the "total average annual costs" for each community type shown in Table 4 do not encompass all public costs associated with residential development; the incremental costs for parks and recreation and several other minor budget categories were not included, in part because we were uncertain that such costs could be said to rise in direct proportion to the addition of new communities and in part because they would be quite small in any case. The cost categories which are tabulated in Table 4 encompass approximately 90% of the present Loudoun County budget, plus two categories now funded by other entities.

This tabulation is sufficient to draw a basic conclusion from our analysis: overall, the public costs of new residential community development are substantial and are inversely related to dwelling unit density. We will discuss this conclusion in further detail in Section VI.

Table 4

Major annual public costs projected for four different 1000-household communities in Loudoun County, Virginia[1]

	rural sprawl	rural cluster	medium density	high density
dwelling units per res. acre	0.2	1.0	2.67	4.44
total residents	3260	3260	3260	3260
public school capital costs	$ 242,700	$ 242,700	$ 242,700	$ 242,700
pub. school oper. & instr. costs	3,045,600	3,045,600	2,256,000	2,256,000
public school trans. costs	186,700	153,400	66,700	33,400
public road maint. costs	110,000	55,000	38,400	25,600
water & sewer operat. costs	709,000[2]	355,000[2]	260,000[3]	240,000[3]
law enforcement costs	165,000	165,000	165,000	165,000
fire/rescue service costs	58,000	58,000	58,000	58,000
health and welfare costs	295,000	295,000	295,000	295,000
gen. govt. admin. costs	147,000	147,000	147,000	147,000
total average annual costs	$4,959,000	$4,516,700	$3,528,800	$3,462,700
% of col. 1	100.0%	91.1%	71.2%	70.2%
% of col. 4	143.2%	130.4%	101.9%	100.0%

[1]The cost estimates are of total public costs; they are paid at present from county, state, federal, and other revenues.

[2]Annual allocation by County or Sanitation Authority to cover costs of installing public water & sewer system after 20 yrs.

[3]Operating and maintenance costs collected by Loudoun County Sanitation Authority to cover services provided.

Agriculture is still Loudoun County's largest industry with annual sales $44 million.

Each acre of land in farms yields $160 in market value of agricultural products per year.

V. Revenue Analysis

In most any economic analysis of a proposed or anticipated activity, the determination of net benefits or costs is what is ultimately of interest. New residential communities generate income for local governments, as well as expenses; in fact, the projected income from an "expanded property tax base" is quite frequently presented as a principal reason why local governments should grant approval to a new subdivision plan. But, as other fiscal impact analyses have demonstrated, responsible public officials should consider these potential benefits in relation to potential costs, particularly where long-term commitments of land and other resources are involved.

One objective of this study was to develop a relatively simple framework, or methodology, for considering public economic costs and benefits of residential growth in relation to dwelling unit density. Like the preceding cost analysis, the purpose of the revenue analysis was to generate projections of direct public revenues which could reasonably be expected to result from new residential development. Again, it should be noted that we did not attempt to include revenues associated with non-residential development, nor did we estimate private income derived directly or indirectly from investment in new residential communities.

As was presented in Table 1, the public revenues in Loudoun County can be grouped into the following major categories:

* general property taxes
* other local taxes
* other local revenues
* revenues transfered from the Commonwealth of Va.
* federal government payments, grants, etc.
* water and sewer authority revenues
* road maintenance (state allocation to VDHT for county)

In parallel with the methodology used in our cost analysis, we sought to estimate the average annual revenues in each of the above categories for each of the four 1000-household community types as developed in Part III above. This approach was intended to show how much variation in the amount of revenue is related to the density of dwelling units, as well as to provide an overall estimate of annual revenues to be expected from such communities.

As expected, we encountered some of the same difficulties in making these revenue estimates as we did in the cost analysis. County revenues are not all compiled uniformly from divisions within the county; this prevented us from making many direct inferences about revenue variations related to the density of existing residential communities. Most of the estimates used in compiling Table 5 were generated from overall county figures, using the per capita multiplier method; however, we did use some actual real estate sales and assessment data to generate

estimates of the annual real property taxes from each community type. The specific data and calculations for each major revenue category are given below.

A. Real Property Taxes

Real property taxes represent a very significant portion of the county's annual revenues. For this reason we wanted to be as accurate as possible in estimating the annual real property tax revenues which each of our four community types could be expected to generate. We had determined that each community would have the same number of residents (3260) and dwellings (1000) in order to avoid introducing other variables not related to density; this objective also required that the different lot sizes and mix of housing units specified for each community be a reflection of the occupants' choice of life style, not of differences in social or economic status.

In Loudoun County, new housing units consist almost entirely of single family detached homes on lots of varying sizes, and attached townhouses on relatively small lots. Using data on recent property assessments and actual sales provided by the County Appraiser's office, we sought to determine the average current market price for detached units and for townhouses. These data represent an aggregation of factors reflecting land, building, location, and amenity values; they also include housing units of different ages. Since we did not have construction-year information for individual units, we did not attempt to adjust for appreciation and inflation versus current construction costs. We averaged data for each housing type from three different locations in which new housing construction was occurring. The actual data used were:

Single Fam. Houses:	no. of units	avg. assessed value	avg. sale price	ass./sale (%)
Middleburg	2	$112,430	$125,750	93.2
Sugarland	20	85,936	87,752	97.9
Sterling Pk.	57	74,407	79,885	93.1
total units:	79 (a)			
total of units x avg. sales price/unit:			$6,559,986 (b)	
avg. sale price, single family home (b/a):			$ 83,037 (c)	
avg. assessed valuation:		**(c x 95%):**	**$ 78,900**	

Town Houses:	no. of units	avg. assessed value	avg. sale price	ass./sale (%)
Hamilton	4	$60,640	$66,000	91.9
Sugarland	39	62,790	67,880	92.5
Sterling Pk.	9	51,960	55,760	93.2
total units:	52 (d)			
total of units x avg. sales price/unit:			$3,413,160 (e)	
avg. sale price, townhouse		(e/d)	$ 65,638 (f)	
avg. assessed valuation:		**(f x 95%):**	**$ 62,700**	

Note that although properties in Loudoun County are to be assessed at actual market value, there is usually a minor lag between most recent assessed value and market sale price. Based on the above data we used 95% of average sale price to calculate the average assessed value for property tax purposes, and the current tax rate of $1.13 per $100 of assessed value to compute the average annual real property tax for each unit type:

single family house:	$78,900 x $.0113	=	$892
town house:	$62,700 x $.0113	=	$709

We then computed the annual real property taxes for each of the four community types, using a housing mix consistent with that shown in Table 2. Note that because we did not have separate data on building versus land values, we show no difference between the two rural community types, although one takes up five times as much land. While this is not strictly correct, the net tax revenue from the additional land included in the "rural sprawl" community would only be the difference between what it would now yield and what it yielded previously. Although such land might cease to qualify for an agricultural use rate, we did not believe the difference was large enough, or certain enough, to try to include it. Those who would attempt to do so should also consider that there is some finite loss of public revenues associated with the idling of formerly productive agricultural land, which might well cancel out any real property tax gains from reassessment of the open land in large-lot subdivisions.

Rural Sprawl:	1000 single family homes @ $892		=	$892,000
Rural Cluster:	1000 single family homes @ $892		=	$892,000
Medium Density:	750 s.f. homes @ $892	= $669,000		
	250 townhouses @ $709	= 177,250		
	total:			$846,250
High Density:	400 s.f. homes @ $892	= $356,800		
	600 townhouses @ $709	= 425,400		
	total:			$782,200

B. Personal Property Taxes

Based on current budget figures, the average per-capita personal property tax paid annually in Loudoun County is $75.28 ($4,711,500 / 62582); this would yield approximately $245,000 per year for a community of 3260 persons. While such taxes would not vary greatly with dwelling unit density, we assumed that there would be a small variation, with rural residents having some additional need for vehicles, lawn and garden equipment, etc. and townhouse residents spending more of their income on dining out, travel, entertainment, etc. We therefore

increased the estimated tax yields for the Rural Cluster and Rural Sprawl communities by 2% and 4%, respectively, over the average estimate of $245,000, and decreased the yields for the Medium Density and High Density communities by the same respective amounts, to produce the values entered in Table 5.

C. Other Local Taxes and Revenues

These revenues did not appear to be subject to any density-dependent differentials, and so were calculated from total county per capita figures, as follows:

Other local taxes: $5,292,000 / 62,582 = $84.56 per person
$84.56 x 3260 = $275,665 (rounded to $275,700)

Other local revenue: $3,100,000 / 62,582 = $49.54 per person
$49.54 x 3260 = $161,500 (per community)

These entries assume that incoming county residents in these communities would generate these revenues in the same manner and at the same rate per capita at which they are generated by county inhabitants at present.

D. County Revenue Received From the Commonwealth

These revenues were expected to total $18,892,000 in FY 1983-84 and are an essential part of Loudoun County's budget. The funds are mostly in the form of categorical aid programs for education, welfare and social services, County Attorney, Sheriff, and others. These amounts are determined mostly by formula based on population; on the assumption (which is not a certainty) that the state will continue these programs at the same levels on this basis, we made the calculation of additional revenue based on the current per capita figure as follows:

$18,892,000 / 62,582 = $301.88 per person
$301.88 x 3260 = $984,115 (rounded to $984,100)

E. Federal Payments and Grants

Although the county was to have received $1,816,000 from various federal government sources this year, the odds that these revenues will be continued at the same levels are not good. Some but not all of these funds are determined by census data. We chose to base projections for increased revenue only on that portion of federal revenues directed to categorical aid programs such as welfare and education -- the amount of funds for these programs was budgeted at $1,041,000. We converted this to a per capita figure and then to a community revenue estimate in the same manner as above, by dividing the total by 62,582, the latest estimate of

Loudoun County's population; this came out to $16.63. Multiplying that amount by 3260 persons per community resulted in an annual revenue estimate of $54,213, rounded to $54,200.

F. Water and Sewer Authority Revenues

These revenues are not shown in the county's budget because they are collected by separate sanitation authorities. We have included revenue estimates in Table 5 equal to the cost estimates which we included in Table 4 in order to make comparisons of the totals from the two tables more realistic. There are no entries for the rural communities because there is at present no tax or other allocation of revenue to cover the future public cost as projected for this category in Part IV.

G. Road Maintenance and Repair

The entries in this category are not actually revenues to the county, but estimates of the amount of additional state revenues which should be allocated to this purpose <u>if</u> the Commonwealth makes appropriations to the Virginia Department of Highways and Transportation for Loudoun County at the same rate per road-mile that it did this year: $2,200,000 for 713 miles of paved and unpaved road, or $3086 per mile.

If this formula holds, then the additional roads built in each of the four communities would generate the following revenue increases on an annual basis:

Rural Sprawl:	34 miles x $3086	=	$104,900
Rural Cluster:	17 miles x $3086	=	$52,500
Medium Density:	12 miles x $3086	=	$37,000
High Density:	8 miles x $3086	=	$24,700

These estimates are slightly less than the estimated public costs for the same purpose as presented in Table 4; this reflects the apparent underfunding of this activity by the state. As we indicated earlier, the need for supplemental County funding of local road maintenance and repair is likely to increase in the future.

Table 5, which follows, contains a summary of this revenue analysis with totals for each community type. As with Table 4, these totals do not include <u>all</u> actual or potential sources of revenue, but reflect over 90% of the current sources of county revenues as well as the other major public revenues relevant to the public costs of residential development. We therefore feel that it is legitimate, with appropriate cautions, to subtract the Table 4 cost totals from Table 5 to obtain <u>an approximation</u> of the <u>net public costs</u> of residential development in Loudoun County.

Table 5

Major annual public revenues projected for four different 1000-household communities in Loudoun County, Virginia

	rural sprawl	rural cluster	medium density	high density
dwelling units per resid. acre	0.2	1.0	2.67	4.44
total residential acres	5,000	1,000	375	225
real property taxes	$ 892,000	$ 892,000	$ 846,300	$ 782,200
personal property taxes	255,000	250,000	240,000	235,000
other local taxes	275,700	275,700	275,700	275,700
other local revenue	161,500	161,500	161,500	161,500
revenue from Va.	984,100	984,100	984,100	984,100
federal payments and grants	54,200	54,200	54,200	54,200
water and sewer revenues	----	----	260,000	240,000
road maintenance & repair	104,900	52,500	37,000	24,700
total average annual revenues	**$2,727,400**	**$2,670,000**	**$2,858,800**	**$2,757,400**
total average annual costs from Table 4	4,959,000	4,516,700	3,528,800	3,462,700
annual net revenue loss:	**(2,231,600)**	**(1,846,700)**	**(670,000)**	**(705,300)**
net loss per dwelling:	($2,232)	($1,847)	($670)	($705)
net loss per person:	($685)	($567)	($206)	($216)

"Who pays for roads?" is a critical question for Loudoun County.

VI. Conclusions and Recommendations

Some of the statements below are derived directly from the above analysis; others, we believe, may be reasonably inferred from the results. However, they should not be read as an attempt to promote any particular pattern or density of residential development, but only as an effort to underscore what we believe are some useful implications to be drawn from this limited study.

A. Conclusions

- It is possible and feasible, based on our experience in Loudoun County, to construct a fiscal impact analysis at the county level for a given residential development at different densities, using existing data for major categories of public costs and revenues.

- The results of this analysis show that over a wide range of densities (0.2 units/acre to 4.5 units/acre) the ongoing public costs of new residential development will exceed the revenues from such development.

- For Loudoun County, the average annual revenue shortfall or net public cost to the county would be approximately three times as large ($2200 per dwelling) from the lowest-density residential community projected in the study as from the highest-density community ($700 per dwelling).

- County revenue shortfalls resulting from the conversion of rural agricultural or forest land to residential development will have to be made up either by reducing existing public services, raising taxes, attracting additional commercial revenues, or through some combination of these methods.

- Relatively low-density residential development (one to five or more acres per dwelling unit) generates higher net public costs primarily because it requires inefficient expenditures for public school operating, instructional, and transportation services, and also because it creates potentially higher public liabilities for road maintenance and future provision of public water and sewer services.

- Relatively high-density residential development (two to five or more dwelling units per acre) is almost certain to be located in areas served by or adjacent to existing public water and sewer systems. Public schools built to serve such communities can be larger and more economical to staff and to operate; the majority of students can walk to and from these schools, which greatly reduces school transportation costs.

- Low-density residential subdivisions, usually located in rural areas, remove relatively large amounts of land from agricultural uses while requiring public services (education, health and welfare, public safety, etc.) which are

similar on a per-dwelling or per-capita basis to those required by high-density subdivisions that convert far less land from existing agricultural or other economic uses.

B. Recommendations

- Loudoun County has a stated planning objective of maintaining an existing agricultural economy wherever it is viable, while minimizing the revenue shortfall resulting from new residential development. To help achieve this objective, zoning and other land-use policies should be adopted to encourage and direct new residential development to locate within or adjacent to existing urban and residential development where adequate community water and sewer service is already available, and where higher (and thus more cost-effective) housing densities are most feasible.

- If a county government seeks to estimate more accurately the net public costs of residential development in the future, it should consider compiling data for some of the major cost and revenue categories used in this study for specific regions within the county on an annual basis. For Loudoun County, the existing school districts provide such a breakdown for school-related costs; it would, however, be useful to know whether law enforcement, fire and rescue services, and health and welfare costs vary from one part of the county to another on a per-capita or per-dwelling basis, and if so whether they vary in some direct relation to the density of residential communities.

  Improving the county's capability to estimate costs of future development would entail annual reporting on a district or area basis of major services provided and expenditures made. Such districts need not be the same for all services; data could be compiled for existing police patrol districts, fire and rescue service zones, etc., as long as the data could be related to the density of residents and/or dwelling units in these districts. Compilation of this information would require some relatively minor changes in record-keeping, but should enable county departments to relate their costs and their budget projections more closely to current and anticipated patterns of residential growth.

- Additional measures, more specific to Loudoun County, which could help achieve the objective of maintaining agriculture and reducing rural "sprawl" development, include:

  -- strengthen existing Agricultural and Forestal District rules to preclude residential subdivisions more dense than one unit per 25 acres and extend the term for such districts to periods of 10 or more years;

-- implement the Density Transfer program set forth in the draft Rural Land Management Plan, and continue to seek authority from the state to implement a program of Transferable Development Rights (TDRs) which is based on the existing Agricultural and Forestal Districts;

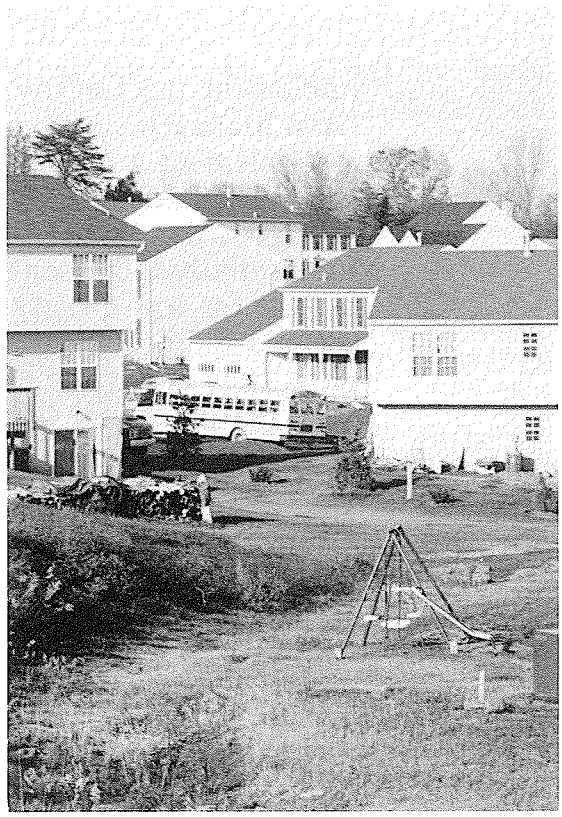
-- substantially increase the assessed value of undeveloped land when it is platted for low-density residential use, increase the fees for building permits and permits for wells and septic systems in rural areas, and reserve such funds for extension of public water and sewer systems in areas designated for high-density development.

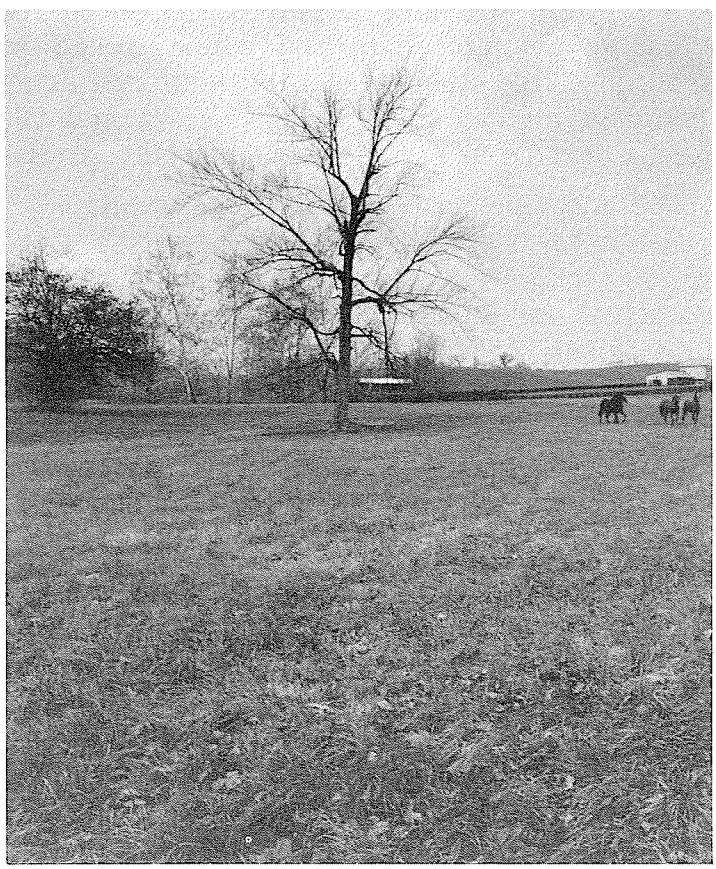
* * *

This study of the public costs of residential growth has examined in some detail the current situation in one county which is experiencing rapid conversion of agricultural and other rural land for residential growth and development. Although some of our findings reflect the specific conditions in Loudoun County, Virginia, we believe that the general observations and conclusions we have presented are applicable to many other counties where large areas of land are shifting from rural to urban uses.

In designing and conducting this study we have attempted to develop a methodology that makes maximum use of available data and which should be workable, with appropriate modifications, in other places without requiring massive data collection or use of complex mathematical models. We and the American Farmland Trust would like to hear from others who undertake similar fiscal or environmental impact analyses of residential development.

For every dollar in tax revenues received by the county, $1.28 in services are demanded by residential land uses.





For every dollar in tax revenues received by the county, $0.11 in services are demanded by open farmland.

VII. Appendix

A. References Cited in the Report

B. School Transportation Cost Computations for two systems in Loudoun County, 1982-83

A. References Cited in the Report

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B. School Transportation Cost Computations for two regional school systems in Loudoun County, 1982-83

Column:	a	b	c	d	e	f	g	h
	Total Pupils[1]	Pupils Transported	No. of Vehicles	bus miles Traveled	Total Cost	Cost/pupil Trans./yr	Cost/ mile	Cost/total pupils/yr
Loudoun County						(e / b)	(e / d)	(e / a)
Total, 1982-83:	12846	8094	136	1,004,130	$1,302,357	$160.90	$1.297[2]	$101.38
Park View System								
(Park View H.S. + Sterling M.S. + 4 Elem. Schools)				system mi. = 486.2 mi/day x 180 days[3]	(d x g)			
Total for system:	4034	1460	14	87,516	$ 113,508	$ 77.75	----[2]	$ 28.13
Loudoun Valley System								
(Loudoun Valley H.S. + Blue Ridge M.S. + 8 Elem. Schools)				system mi. = 1935.9 mi/day x 180 days[3]	(d x g)			
Total for system:	3054	2723	50	348,462	$ 451,955	$165.98	----[2]	$147.99

[1]These numbers are for the 1982-83 year and thus differ slightly from those in Table 3.

[2]Countywide cost per mile ($1.297) used to calculate regional system costs.

[3]Miles per day aggregated from individual school bus route records

Data compiled from Loudoun County School Transportation Inventory and Record, 1982-83; Transportation Office, Loudoun County Schools