A COMPUTERIZED MODEL FOR ANALYZING THE FINANCIAL IMPACT OF DEVELOPMENTS

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ABSTRACT

A computerized model has been developed for evaluating the financial impact of a new development on existing jurisdictions. It can be applied to many types of real estate development such as new towns, residential subdivisions or industrial parks to analyze their impact on jurisdictions such as the local city, county, school board or utility district. It can be used by both the jurisdictions in evaluating proposed development and by the developer in obtaining zoning changes, building approvals, etc. Outputs include a projected budget for up to twenty years for each jurisdiction and an impact statement with projected tax millage rates, and bonding margins.

The types of problems which this model solves and its general features are first explained in the introduction. Then the mathematical model structure and equations are presented. Finally, results from applying the model to the analysis of new community development and industrial plant construction are discussed.

INTRODUCTION

Governments and special interest groups are becoming aware that development often costs communities money. Developers are under increasing pressure to weigh the costs of providing community services versus the increased tax base due to the new development. Government bodies are also trying to make such evaluations in order to approve zoning changes and building permits and allocate revenue sharing funds. In examining the tools available to do such analyses, several shortcomings were found which the present model attempts to solve:

1. Many models are static, evaluating results at one particular time.

Some of the previous analyses such as that in Reference 1 have examined the fiscal impact at a single future time, usually after the initial effects of rapid growth are over. This approach ignores one of the most crucial problems associated with development, that the costs of providing services rises much faster than the supporting tax base. The fact that capital facilities should be financed and construction started before the facilities are actually required means that the impact of development may be much more negative in the first years than it will be later. The current model uses input data and produces results for each year, for a variable period of up to twenty years.

2. Most models are designed to provide information to the developers only.

As pointed out in Reference 1, most previous models have analyzed the "internal" financial impact on the developers, in terms of the cash flow, rate of return, etc. associated with land acquisition and development. Although this is very important, there are tools available to do such an analysis, and so it was decided to isolate those costs and revenues associated with providing services to the resulting community. Some of the costs may actually be paid for or subsidized by the developers and the information is very useful to them in obtaining approvals and zoning changes. However, the results of the current model are most useful to the government jurisdictions that provide community services, allowing them to compare proposed developments with other alternatives, including the case of no development.

3. Most models have inflexible input and output, with regard to data units, level of detail and formats.

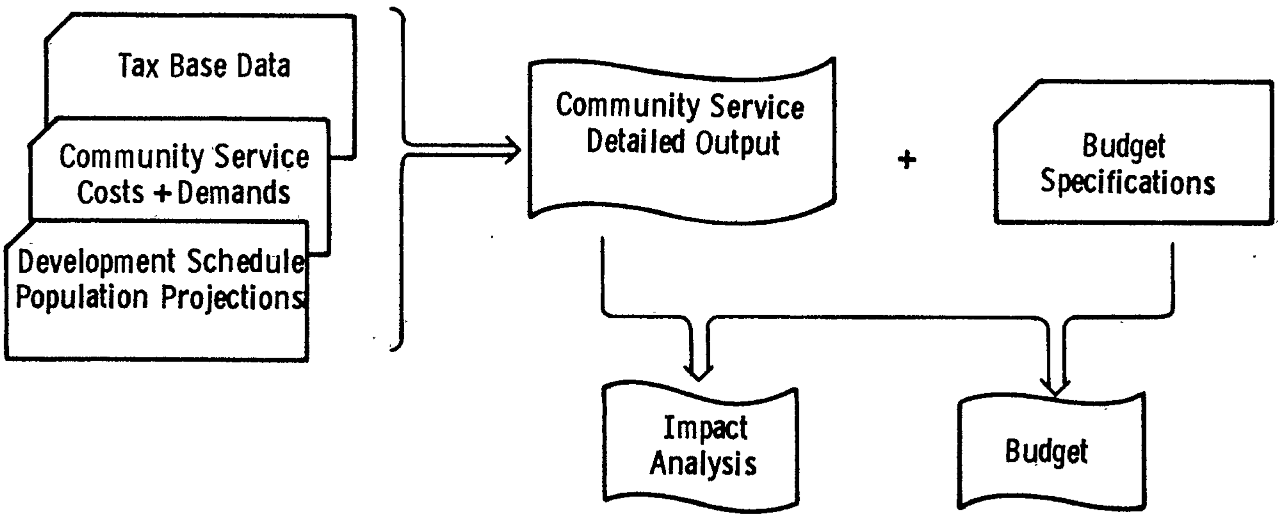
Most models analyze a specific set of community services from the point of view of specific jurisdictions. They thus embody assumptions about the units in which data are available and the desired format and amount of detail in the output. (See for example, References 2 and 5). The current model has been designed to be extremely flexible, so that it can be used to analyze a wide variety of impacts from many points of view. Details of this flexibility will be explained in the next section.

MATHEMATICAL MODEL DESCRIPTION

The flow of information in the Fiscal Impact Model is diagrammed in Illustration 1. The model is structured and used in two stages. In the first stage, information is processed concerning the demands for community services, the costs of providing service and the tax base. The output from the first stage is a detailed list of expenses and revenues associated with each community service, which is printed for the user and saved on a disk file for the second stage.

ILLUSTRATION 1

Fiscal Impact Evaluation System



In the second stage, information is entered to describe one or more jurisdictional budgets and the expenses and revenues to be included in each. These budgets are organized from the data stored on disk and an impact analysis is prepared for each budget. This evaluation is a projection of millage rates necessary to balance the budget, bonding capacity and bonding margin, and budget surpluses or deficits assuming the current tax rate is continued.

The data describing community service costs and demands is organized into "subsystems" chosen by the user, the subsystems generally corresponding to services such as education and wastewater treatment. Each subsystem is further divided into "components" such as pre-school and elementary components in the education subsystem. The components in turn have associated with them one or more operating, capital or revenue "elements." Individual elements might be for instance the cost of books, elementary school construction costs or school lunch fees, as indicated in Illustration 2. Any other logical organization of the data may be used. A subsystem may, for instance, correspond to data for one jurisdiction or to a set of data from one particular source. The organization of the data in service subsystems will be referred to in this section and in the discussion of applications.

1. DEMANDS FOR COMMUNITY SERVICES AND SOURCES OF REVENUES

The driving force for the calculation of expenses and revenues is a set of "demand base categories" defined by the user. These are the basic data describing the demands for community services and the sources of revenues. Usually a category will be a population group or type of land development, such as children aged 0-4 years, single family units or acres of industrial development. The total demand for a service component is found by summing the contributions from each demand base category and multiplying by one or more factors to change units:

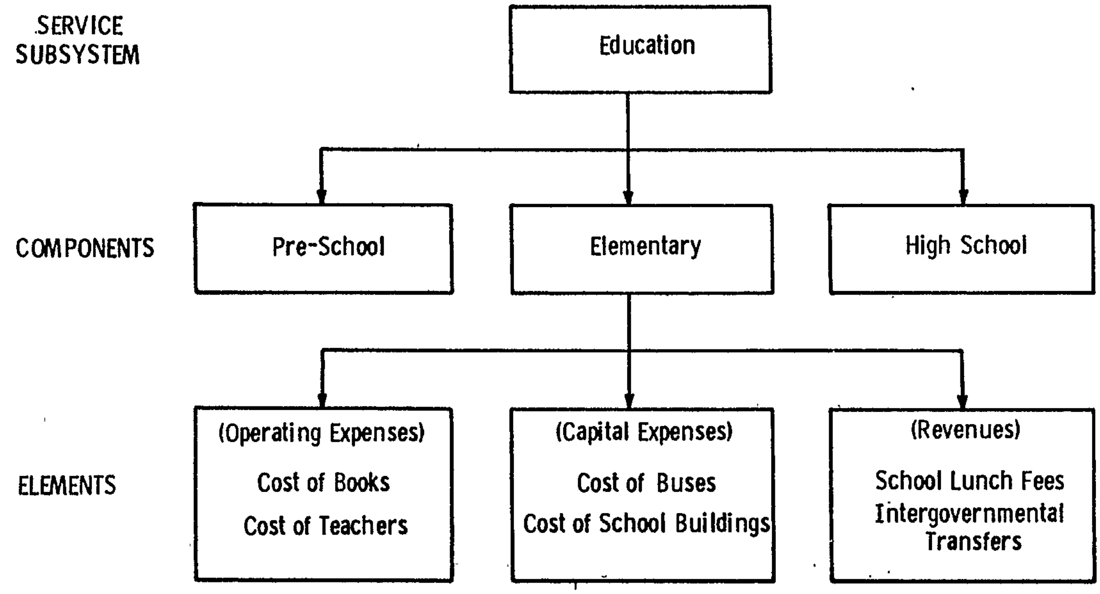
$$\begin{matrix}\text{Total} \\ \text{Demand} \\ (I,J,K)\end{matrix} = \sum_{M} \left[\begin{matrix}\text{Demand} \\ \text{Base} \\ (I,M)\end{matrix} * \begin{matrix}\text{Demand} \\ \text{Factor} \\ (J,K,M)\end{matrix} \right] * \begin{matrix}\text{Units Per} \\ \text{Demand} \\ (J,K)\end{matrix} * \begin{matrix}\text{Conversion} \\ \text{Factor} \\ (J,K)\end{matrix} \qquad (1)$$

where the following indices will be used throughout the discussion:

I = year
J = subsystem
K = component
M = demand base category

The demand factor is the contribution of the M^{th} demand base to the demand for the component. The units per demand and conversion factor change the demand to units more appropriate for the component. For example, the total demand for a solid waste disposal component, expressed in tons of garbage annually, may be found as follows:

ILLUSTRATION 2
Sample Organization of Service Subsystem Data



$$\text{tons of garbage}_{(I)} = [\text{total population}_{(I)} * 1.0] * \text{lbs. of garbage per person annually} * \text{.005 lbs. per ton}$$

where demand factors for the demand bases other than total population are zero. It is also possible to enter total demand for a component directly, if for instance, independent projections of the user population are available.

In the first applications of the Fiscal Impact Model the demand base categories were generally development schedules or population projections. A demographic model reported in Reference 6 was used to derive the population projections.

Equation 1 also defines the total source of revenues for a component, by substituting "total source" for "total demand."

2. OPERATING, CAPITAL AND REVENUE ELEMENTS

When the demand and revenue sources have been calculated for a component, individual revenues and expenses are generated. Elements in a component can be operating, capital or revenue elements. Operating expenses are calculated as follows:

$$\text{Operating Expense}_{(I,J,K,L)} = \frac{\text{Total Demand }(I,J,K)}{\text{Total Demand Per Operating Unit }(J,K,L)} * \text{Expense Per Operating Unit }(J,K,L) * \left[1 + \text{Inflation}_{(J,K,L)}\right]^{I-1} \quad (2)$$

where L is the index of the element. The rate of inflation is expressed as a decimal. The operating unit is defined by the user and might be, for example, square feet or personnel. In the case of elementary education an element may be teacher wages and the operating unit teachers:

$$\text{elementary teacher wages}_{(I)} = \frac{\text{elementary pupils }(I)}{\text{pupils per teacher}} * \text{wages per teacher} * (1 + \text{Inflation})^{I-1}$$

Any other operating requirements such as the number of personnel or amount of materials required can be calculated with Equation 2 by substituting "requirement" for "expense." For example, the number of teachers is found by inputting the expense per teacher as 1 and the inflation percent as 0.

Capital facilities are measured in modules which are defined by the user, and the resulting expense depends on the number of new modules planned to satisfy the demand:

$$\text{Capital Expense}_{(I,J,K,L)} = \text{New Modules Planned}_{(I,J,K,L)} * \text{Cost Per New Module}_{(J,K,L)} * \left[1 + \text{Inflation}_{(J,K,L)}\right]^{I-1} \quad (3)$$

The size of new modules and current capacity are measured in capital units which are defined by the user and might be for instance square feet.

The number of capital units required depends on the demand:

$$\text{Capital Units Required }(I,J,K,L) = \text{Total Demand }(I+N,J,K) * \text{Capital Units Per Total Demand }(J,K,L) \quad (4)$$

N is the number of years between planning and construction of a facility and accounts for construction time. Thus the number of new modules constructed is just the number of modules planned, delayed by N years.

The capacity depends on the number of modules constructed and the number of modules that have worn out and need to be replaced:

$$\text{Capacity }(I,J,K,L) = \text{Capacity }(I-1,J,K,L) + \left\{ \left[\text{New Modules Constructed }(I,J,K,L) - \text{New Modules Constructed }(I-P,J,K,L) \right] * \text{New Module Size }(J,K,L) \right\} \quad (5)$$

where P is the lifetime of modules.

The model also calculates the excess capacity:

$$\text{Excess Capacity }(I,J,K,L) = \text{Capacity }(I,J,K,L) - \text{Capital Units Required }(I,J,K,L) \quad (6)$$

The number of new modules planned depends on whether the capacity will be greater or less than the number of capital units which will be required. There are two cases:

(a) If $\left[\text{Capacity }(I+N,J,K,L) \geq \text{Capital Units Required }(I+N,J,K,L) \right]$

and if $\left[\dfrac{\text{Capacity }(I+N,J,K,L) - \text{Capital Units Required }(I+N,J,K,L)}{\text{New Module Size }(J,K,L)} \right] \leq \left[1 - \text{Percent Capacity When Build }(J,K,L) \right]$

then $\text{New Modules Planned }(I,J,K,L) = 1 \quad (7)$

(b) If $\left[\text{Capacity }(I+N,J,K,L) < \text{Capital Units Required }(I+N,J,K,L) \right]$

then

$$\text{New Modules Planned }(I,J,K,L) = \text{INT} \left[\frac{\text{Capital Units Required }(I+N,J,K,L) - \text{Capacity }(I+N,J,K,L)}{\text{New Module Size }(J,K,L)} + 2 - \text{Percent Capacity When Build }(J,K,L) \right] \quad (8)$$

where INT implies the integer value of the argument.

The "percent capacity when build" parameter is the fraction of facility utilization at which construction of a new facility should begin. This is an alternate way of accounting for the construction time. In the first case, if the facility will have capacity left but the excess will be less than the point at which new facilities should be planned, one module is planned. If the capacity will be less than required, as in Equation 8, one or more modules are planned. The module construction schedule can be inputted directly by the user, in which case all of the above calculations are the same except that Equations 7 and 8 are omitted. This feature allows proposed capital construction to be evaluated. The excess capacity will correspond to the difference between inputted and required capacity and will indicate a shortage if negative.

The number of acres required for new construction can be calculated for capital elements by inputting the number of modules per acre:

$$\text{New Acres Required }(I,J,K,L) = \frac{\text{New Modules Planned }(I,J,K,L)}{\text{Modules Per Acre }(J,K,L)} \quad (9)$$

The capital expenses calculated are either "non-debt expenses" which are paid for out of the operating budget, or "debt-expenses" which are financed by floating bonds and paying the debt service out of the operating budget. The interest and principal payments are calculated for each year's expenses using a level payment algorithm from Reference 3. This assumes that the total debt service including interest and principal for a single expense in year I is constant for each year of the bond term:

$$\text{Annual Debt Service}(I,J,K,L) = \text{Capital Expense}(I,J,K,L) * \left[1 + \frac{1}{-1 + \left(1 + \text{Interest Rate}(J,K,L)\right)^{\text{Term}(J,K,L)}}\right] * \text{Interest Rate}(J,K,L) \quad (10)$$

$$\text{Interest Payment}(II,J,K,L) = \text{Remaining Principal}(II,J,K,L) * \text{Interest Rate}(J,K,L) \quad (11)$$

$$\text{Principal Payment}(II,J,K,L) = \text{Annual Debt Service}(I,J,K,L) - \text{Interest Payment}(II,J,K,L) \quad (12)$$

$$\text{Remaining Principal}(II,J,K,L) = \text{Remaining Principal}(II-1,J,K,L) - \text{Principal Payment}(II,J,K,L) \quad (13)$$

The term is the number of years in which the bonds are paid off. The variable II is indexed from I to (I+ Term (J,K,L)) and is used to clarify the relationship between a capital expense in year I and the debt service payments on it in year II.

A simple algorithm is used to calculate revenues:

$$\text{Revenues}(I,J,K,L) = \text{Total Demand}(I,J,K) * \text{Revenues Per Unit of Demand}(J,K,L) \quad (14)$$

Generally only miscellaneous revenues other than property taxes are calculated in the first stage of the model. In the second stage, the tax millage necessary to balance the budget is calculated and budget surpluses or deficits are projected using the current millage.

Any other requirements can be calculated using the algorithms for the operating, capital and revenue elements. All titles, units, etc. are variable and defined by the user, and any expense or requirement can be entered directly by the user rather than being calculated.

3. TAX BASE

The third type of input data in Illustration 1 is used to calculate the value of all real estate, income, etc. that might be used as a tax base to calculate tax rates in the second stage. The user can specify up to ten tax base categories, each one being a weighted sum of the demand bases:

$$\text{Market Value}(I,Q) = \sum_{M} \left[\text{Demand Base}(I,M) * \text{Market Factor}(Q,M)\right]$$

where Q = tax base category.

For example the residential market value in a new development might be:

$$\text{Residential Market Value}(I) = \left[\text{Total Single Family Acres}(I) * \text{Single Family Value/Acre}\right] + \left[\text{Total Townhouse Acres}(I) * \text{Townhouse Value/Acre}\right] + \left[\text{Total Apartment Acres}(K) * \text{Apartment Value/Acre}\right]$$

The projected market value in each year can also be inputted directly for any tax base category.

4. BUDGET AND IMPACT ANALYSIS

In the second stage of the model the user can structure one or more budgets, corresponding to jurisdictions, physical boundaries, etc. He indicates the revenues, expenses or other requirements that he wants to include in each budget using keys printed on the detailed output from the first stage. Individual elements or totals for components can be referenced from any of the service subsystems. Totals in six categories are calculated from all of the referenced requirements, for each budget and each year:

Debt Capital Expense (I,R)
Non Debt Capital Expense (I,R)
Operating Expense (I,R)
Principal Expense (I,R)
Interest Expense (I,R)
Revenues (I,R)

where R refers to the budget.

The user can define any other budget categories he desires and include any requirements in them. Requirements for individual years can be included and they can be multiplied by a factor before being added to the budget. For example, 50% of the preschool operating expenses in years one through five can be allocated to the developer's budget, the remaining operating expenses to the school board. The viability of various funding schemes and compromises between the developer and the jurisdictions, the effect of revenue sharing funds, etc. can be evaluated by allocating revenues and expenses in various ways.

Any requirements entered in a budget can also be related to the demand base categories in the first stage. The requirement, corresponding to an operating, capital or revenue element or to a sum, can be divided by a weighted sum of the demand bases. For example, if an operating expense is referenced:

$$\text{Budget Entry} = \frac{\text{Operating Expense }(I,J,K,L)}{\sum_{M}\left[\underset{(I,M)}{\text{Demand Base}} * \underset{(R,M)}{\text{Factor}}\right]} \qquad (16)$$

This algorithm can be used to calculate per unit charges or requirements. For example, the user might define a budget category "Per Pupil Operating" in the school board budget and include in it the results of the following:

$$\text{Elementary Per Pupil Expenses }(I) = \frac{\text{Elementary Operating Expense }(I)}{\text{Elementary Pupils }(I) * 1}$$

In addition to a budget with the categories, formats, etc. specified by the user, the model can produce an impact analysis corresponding to each budget. This evaluation includes the millage rate necessary to balance the budget in each year:

$$\text{Millage Rate }(I,R) = \frac{\text{Amount to be Financed by Taxes }(I,R)}{\text{Tax Base }(I,R)} \qquad (17)$$

Depending on the expenses, revenues and tax base included in the budget, the millage rate may apply to property taxes, income taxes, etc. The total tax base depends on the assessment rate for each market value category:

$$\text{Total Tax Base }(I,R) = \sum_{Q}\left[\underset{(I,Q)}{\text{Market Value}} * \underset{(Q,R)}{\text{Assessment Rate}}\right] \qquad (18)$$

The amount to be financed through taxes is the difference between the total operating expenses and the revenues (other than property taxes, income taxes or whatever tax for which millages found in Equation 16):

$$\text{Amount to be Financed by Taxes }(I,R) = \text{Total Operating Expenses }(I,R) - \text{Revenues }(I,R) \qquad (19)$$

where total operating expenses are given by:

$$\text{Total Operating Expenses }(I,R) = \text{Operating Expenses }(I,R) + \text{Interest Payments }(I,R) + \text{Principal Payments }(I,R) + \text{Non Debt Capital Expenses }(I,R) \qquad (20)$$

The surplus or deficit calculation answers the question of what would happen to the budget if the current tax millage were continued in the future:

$$\text{Surplus or Deficit }(I,R) = \left[\underset{(I,R)}{\text{Tax Base}} * \underset{(R)}{\text{Current Millage}}\right] + \text{Revenues }(I,R) - \text{Total Operating Expenses }(I,R) \qquad (21)$$

Even if a development is viable in terms of the millage necessary to support community services, the financing of debt capital expenses must not raise the bonded debt above the legal limit. Accordingly the bonded debt in each year is found by subtracting all previous principal payments from the total previous debt capital expenses:

$$\text{Bonded Debt }(I,R) = \sum_{S=1}^{I} \text{Debt Capital Expenses }(S,R) - \sum_{S=1}^{I} \text{Principal Payments }(S,R) \qquad (22)$$

The legal limit on bonding is a fraction of the tax base:

$$\text{Bonding Capacity }(I,R) = \text{Tax Base }(I,R) * \text{Bonding Limit }(R) \qquad (23)$$

The remaining capacity to bond or bonding margin can be expressed in dollars or as a percent of capacity:

$$\text{Bonding Margin in Dollars }(I,R) = \text{Bonding Capacity }(I,R) - \text{Bonded Debt }(I,R) \qquad (24)$$

$$\text{Bonding Margin as Percent }(I,R) = \frac{\text{Bonding Margin in Dollars }(I,R)}{\text{Bonding Capacity }(I,R)} * 100 \qquad (25)$$

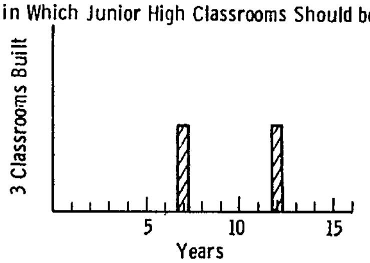
APPLICATIONS.

The Fiscal Impact Model has been used in two comprehensive case studies. The studies vary in the size and type of development and the impacts that are being evaluated. One project that was evaluated was the development of a new community, largely residential, with an ultimate population of about 30,000 people. Several types of housing would be included, attracting middle to upper income residents. Approximately 18 percent of the land area would be devoted to an industrial park and commercial center. The important consideration was whether the community could support the necessary public services and what the impact would be on existing jurisdictions within whose boundaries the new community would be built. We were particularly interested in the effect on the local school board since the community would not have a large industrial or commercial tax base to support school millages.

Some results of the new community analysis are shown in Illustrations 3 through 7. The first of these indicates the years in which capital facilities would have to be built for junior high education. It was assumed that an additional 735 pupils could be accommodated in an existing junior high nearby and that new facilities would be built in modules of 89,400 square feet or three classrooms. Facilities would be financed and construction started when the number of pupils expected in two years exceeded 90 percent of current capacity. The years in which a junior high classroom module would need to be built are shown in Illustration 3.

ILLUSTRATION 3

Years in Which Junior High Classrooms Should be Built



In order to evaluate the viability of new community schools, a budget and impact analysis was prepared including only the revenues, expenses and tax base for the new community. The resulting millage is plotted in Illustration 4 beginning with year four when the first capital expenses occur. The millage for the first year is high because few homes have been built and the tax base is too small to support the construction of new elementary facilities to accommodate the number of pupils in year five. Even after the third year the required millage would be unreasonably high.

ILLUSTRATION 4

School Millages for New Community by Itself

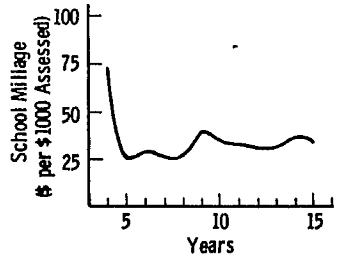
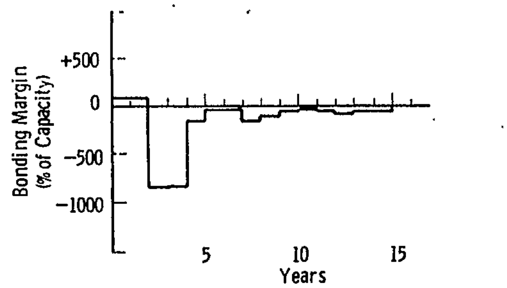


ILLUSTRATION 5

Bonding Margin for New Community Schools



The total bonding margin plotted in Illustration 5 also indicates that the new community schools would not be self supporting. Beginning in year three when bonds would be floated to finance construction, the new community schools would always be overbonded. In years three and four they would be bonded more than 800 percent beyond the legal limit.

However, if the new community school board were consolidated with the existing local school board, the situation is somewhat different. A budget and impact analysis was prepared including revenues, expenses and the tax base for the new community and the additional area in the existing school board. The required millage and resulting bonding margin are shown in Illustrations 6 and 7.

The millage for a consolidated school board would rise to more than twice the current rate but would reach a maximum of 29 mills. With the calculated capital facility construction, the bonding margin would be negative in a few of the years, but the school board would be no more than 24 percent overbonded. Thus with some adjustments in capital scheduling and a fairly high millage rate, a consolidated school board could support itself. Results of the new community analysis were similar for the remaining

ILLUSTRATION 6

Millage Rate for Consolidated School District

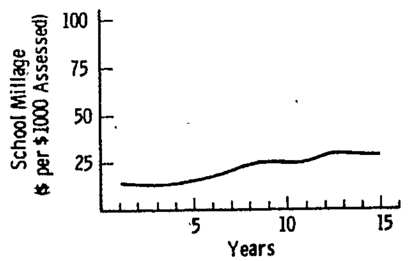
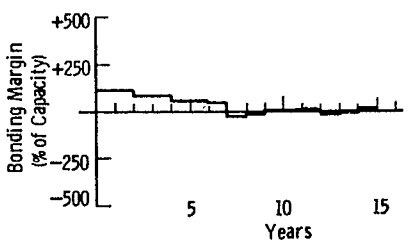


ILLUSTRATION 7

Bonding Margin for Consolidated School District



jurisdictions. The new community would cost most of the effected jurisdictions money but they would generally be able to bear the added expense.

Another application of the Fiscal Impact Model was analyzing alternative plans for development of resources in a limited geographic area. Alternatives were defined involving various configurations of industrial plants, levels of resource utilization, and numbers of employees in different job classes. The resulting community of 2000 to 4000 people would be largely a "company town" with many community services other than education provided by the developers. Some questions investigated were the costs of providing services, the impact on the state taxes and county expenses, and the potential of attracting private commercial development to the community.

Some of the health care services in the community would be provided by the county, others by private physicians and hospitals nearby. Selecting the tenth year after plant construction, the personnel, facilities and services that would be required for three of the alternative configurations are given in Table 1.

TABLE 1

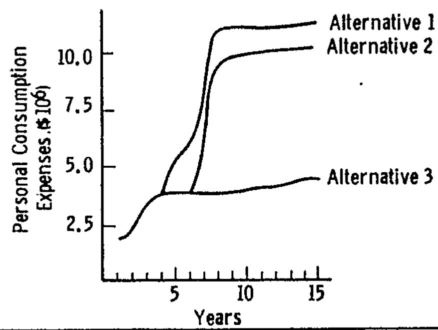
Required Health Care Services

	Alternatives		
	1	2	3
Personnel:			
Physicians	5	4	1
Dentists	2	2	0
Nurses	16	14	3
Pharmacists	18	16	4
Facilities:			
Hospital Beds	31	27	6
Services:			
Annual Hospital Admissions	885	778	178

The potential for commercial development was measured by the dollars of personal consumption expenditures by the resulting community. The results for each of the above alternatives in each year was as shown in Illustration 8.

ILLUSTRATION 8

Personal Consumption Expenditures for Company Town



These results are a small subset of a more complete analysis, which in general indicated that the project would have a favorable financial impact on concerned jurisdictions. Since some community service costs would be borne by the industry which would also provide a large tax base, the state and county would benefit financially. Nearby towns would also capture part of the demand for commercial facilities. Important differences were pointed out, however, in the relative benefit of the various alternatives. And, of course, the environmental and political issues are a different but related matter.

CONCLUSIONS

A computerized model has been developed for analyzing the financial impact of real estate development on government jurisdictions. The Fiscal Impact model has been tested and applied in two comprehensive case studies of developments varying in size and composition. It is a useful tool for evaluating the community services and facilities required, the costs of providing community services, and the impact on millage rates and bonding margins of local jurisdictions.

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