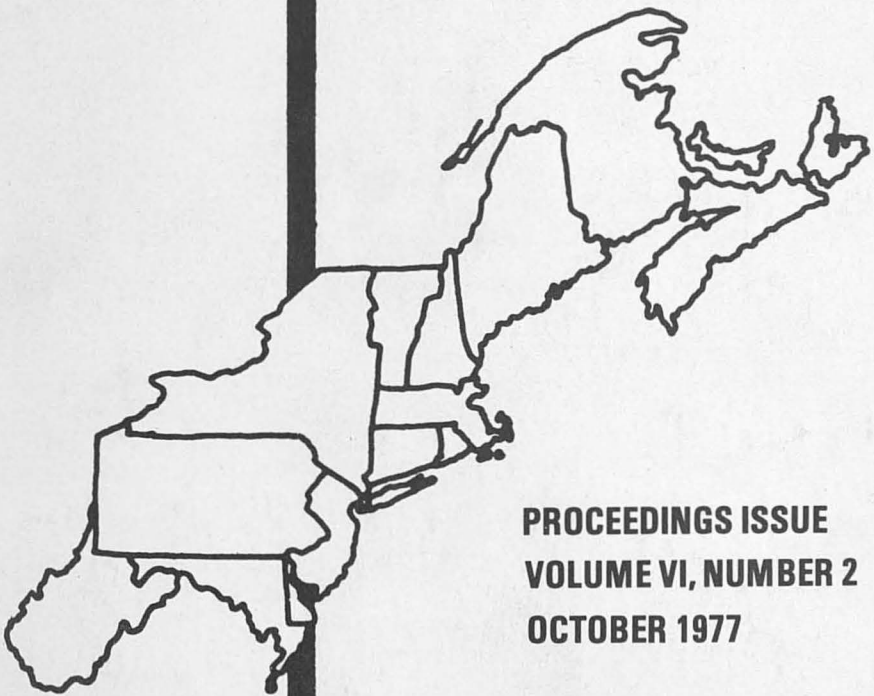
JOURNAL OF THE

Northeastern Agricultural Economics Council



PROCEEDINGS ISSUE
VOLUME VI, NUMBER 2
OCTOBER 1977

THE IMPACT OF HOUSING DENSITY ON SITE DEVELOPMENT COSTS*

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Introduction

During the past decade, the cost of constructing new homes has risen dramatically. While the overall consumer price index rose by 74 percent between 1967 and the end of 1976, the cost of constructing new housing rose by about 103 percent nationally [3]. This trend in costs has priced a growing proportion of lower and middle income groups out of the market for new houses. The national average price for new housing is currently $52,000 per unit [4]. This has led to expressions of public concern that efforts need to be undertaken to find ways by which these low and middle income groups can obtain access to new housing.

At the same time, there has been growing awareness that zoning ordinances further increase the cost of housing by prohibiting most moderate to high density residential developments. In the last few years a number of zoning ordinances have been challenged as exclusionary because of their failure to permit higher density development and smaller dwelling units. In several cases the courts have held that such ordinances must be modified so that the locality can provide for its "fair share" of regional housing needs for people of low and moderate incomes. In doing this, the courts have focused on the density and dwelling size requirements of the zoning ordinances, directing that they be revised to provide for an increased amount of higher density housing [2,5].

Housing costs are influenced by local ordinances not only through the density limitations imposed, but also by the myriad of regulations and specifications which they establish. Although much less widely

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* This paper is based upon continuing extension and research work funded under Title V of the Rural Development Act of 1972. The authors wish to acknowledge the valuable assistance of B. B. Chavoosian, George Neiswand, Vic Kasper, Peter Pizer and Sandy Morales. The input of the township of South Brunswick engineers and various real estate developers was invaluable.

discussed than the density limitations, the requirements relating to curbs, sidewalks and minimum street widths may have a substantial impact on housing costs. In recent testimony before a New Jersey Senate Committee a spokesman for the New Jersey Builders' Association argued that removal of "excessive" requirements in the ordinances of typical suburban communities could lower site preparation costs by over $1,500 per lot [1].

In spite of the amount of public interest in the impact of local ordinances on housing costs, relatively little information is available. This paper examines site development costs under a variety of densities ranging from low density single-family homes to high density garden apartments. Also considered are (1) the major components of site development costs; (2) the relative importance of each component; (3) how both total site development costs and each of the major components vary with density, and (4) how the site development costs might be reduced.

Methodology

Site development costs were calculated for 13 housing developments. Each development, consisting of either 180 or 192 living units, was laid out in conformance with the requirements of the ordinances of the township of South Brunswick in Middlesex County, New Jersey.[1/] Three types of housing were considered: single-family detached, single-family attached (townhouses) and garden apartments. Medium and high-rise apartment developments were eliminated from consideration as being inappropriate for a locality with large amounts of open space, and where the existing development pattern is composed largely of single-family homes. The range of densities considered was from 1.3 to 18 living units per gross acre. Densities below 1.3 per acre were not considered because at lower densities most construction would be custom-built homes, rather than the large tract-type developments considered in this study. The upper limit of 18 units per acre was selected as the highest density reasonably possible with two-story garden apartment units. The selection of the specific densities for the developments used in this study was based on consideration of both the densities allowed in the current South Brunswick zoning ordinance, and the densities of existing housing in other nearby communities. Hypothetical developments were laid out for 13 different situations: single-family

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1/ South Brunswick is reasonably representative of "developing" localities at the rural-urban fringe. With a total area of 24,500 acres, it has approximately 11,200 acres of land in farms. It was one of the communities whose zoning ordinances were challenged in 1976 by the Urban League of Greater New Brunswick [5].

detached houses at six different densities (1.3, 1.8, 3.0, 3.4, 4.0, and 5.0 units per gross acre); single-family attached (townhouse) units at three densities (6.0, 8.0 and 10.0 units per acre); and garden apartments at four densities (10.0, 12.0, 16.0 and 18.0 units per acre).

In order to isolate the effect of changing density on the cost of site development, an attempt was made to hold factors other than density constant among the thirteen layouts. Design was held as nearly constant as possible, although this proved to be easier to do in the case of developments involving single-family detached houses than in the cases of townhouses and garden apartments. In all cases, the minimum requirements of the ordinances of the township were followed. Where there was some question of how a regulation would be interpreted or applied, the appropriate officials of the township were consulted.

Site development costs consist of a large number of individual cost items, each of which was categorized into one of five broad categories: (1) land preparation; (2) utilities; (3) curbs and paving; (4) landscaping; and (5) fees. Land preparation includes components for the engineering costs of surveying and staking out the lots; for the cost of clearing the land and for the cost of moving the soil to prevent problems of erosion and sedimentation (earth balance). The utilities category includes the costs of the storm drains, sanitary sewers, and water lines, plus the amount which developers would be charged by the utility company for the underground electric grid. Costs for gas and telephone lines are not included since there would be no charge to the developer for the installation of these utilities. The curbs and paving category includes the cost of all the streets and off-street parking areas; the cost of curbs and sidewalks along the streets and the cost of sidewalk paths to the actual dwelling units. For single family houses, the off-street parking areas consisted of the driveways of the individual houses, while separate parking areas were required for townhouse and garden apartment layouts. The landscaping category consists of three components: seeding and sodding; shade trees required by the municipal ordinances; and street signs. The cost category for fees includes a variety of payments required by the municipal ordinances. These include building permits, fees for review of site development plans, subdivision approvals, certificates of occupancy, tie-in fees for water and sewer and the costs to the developer of performance bond requirements.

Based on the site plans and on the requirements of the municipal ordinances and regulations of South Brunswick township, the required physical quantity of each individual item of the various cost components was computed. Estimates of the costs for the land preparation category were based largely on information provided by the New Jersey Builders'

Association. Cost estimates for the utilities and paving categories were provided by Wood and Tower, Inc., a cost consulting firm located in Princeton, New Jersey. Landscaping costs were provided by landscape contractors. Municipal fees were based on the fee schedules of the township of South Brunswick.

Findings

Total site development costs per dwelling unit were found to decrease at a decreasing rate as density increased (Table 1 and Figure 1).

Table 1
Land Preparation Costs by Major Component
(dollars per housing unit)

Housing Type and Density	Land Preparation	Utilities	Curbs and Paving	Landscaping	Fees	Total
Single-family						
1.3	2135	3055	2838	254	703	8985
1.8	1782	2875	2529	224	674	8084
3.0	1439	2252	1965	180	614	6450
3.4	1323	2093	1739	162	586	5903
4.0	1205	2013	1684	157	581	5640
5.0	1077	1863	1648	152	576	5316
Townhouses						
6.0	903	1262	1249	617	518	4549
8.0	748	1181	1121	375	497	3922
10.0	690	1043	1114	266	495	3608
Garden Apartments						
10.0	677	949	1046	289	449	3410
12.0	640	872	1050	218	450	3230
16.0	583	730	830	132	436	2711
18.0	566	712	812	95	433	2618

The graphic presentation of Figure 1 suggests a functional relationship between site development costs and density of the form:

$$Y = aX^{-b}$$

where Y stands for the expenditures for site development per unit of

Figure 1. Site Development Costs per Housing Unit

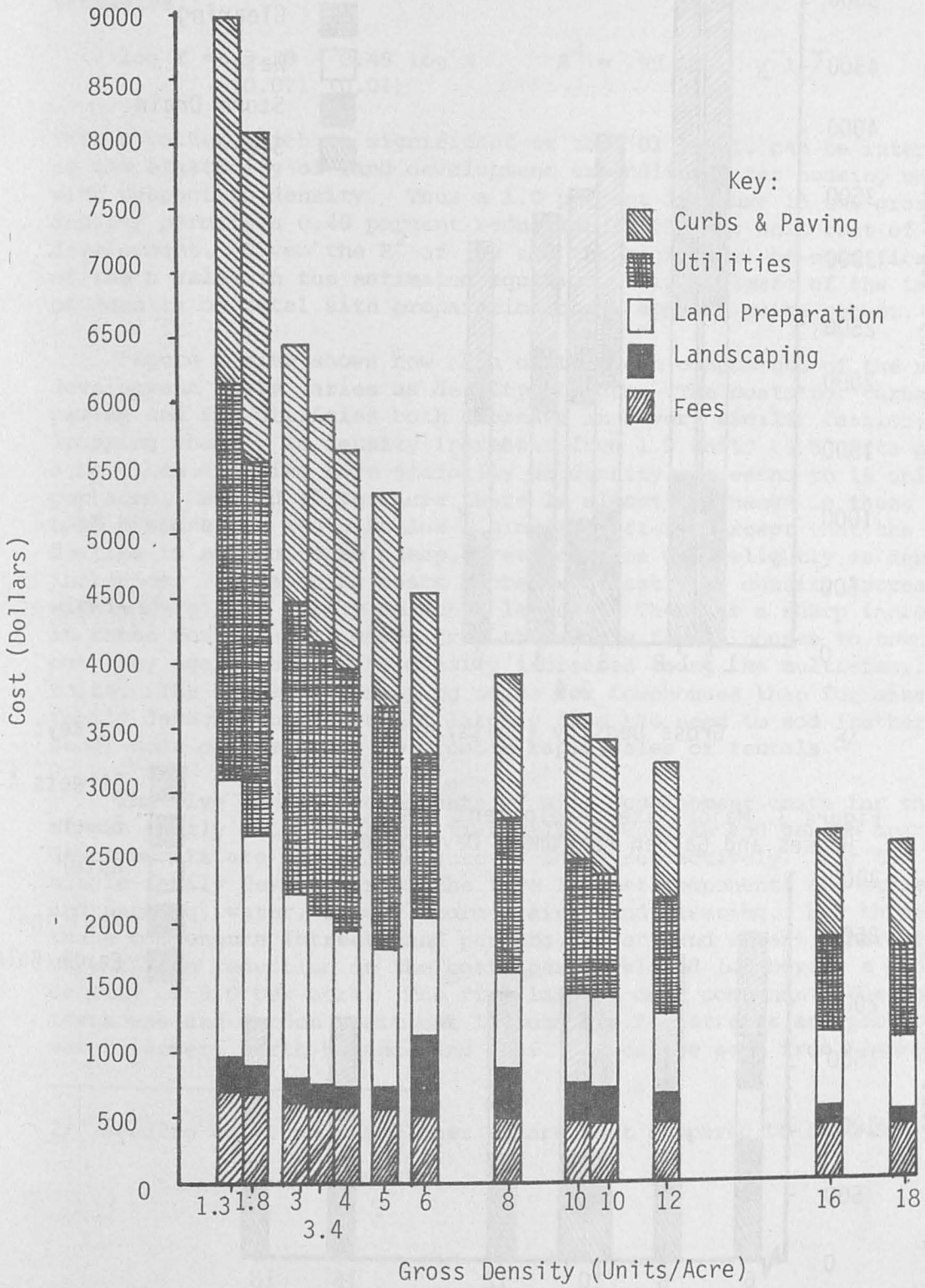


Figure 2. Major Site Development Costs, Single Family Developments

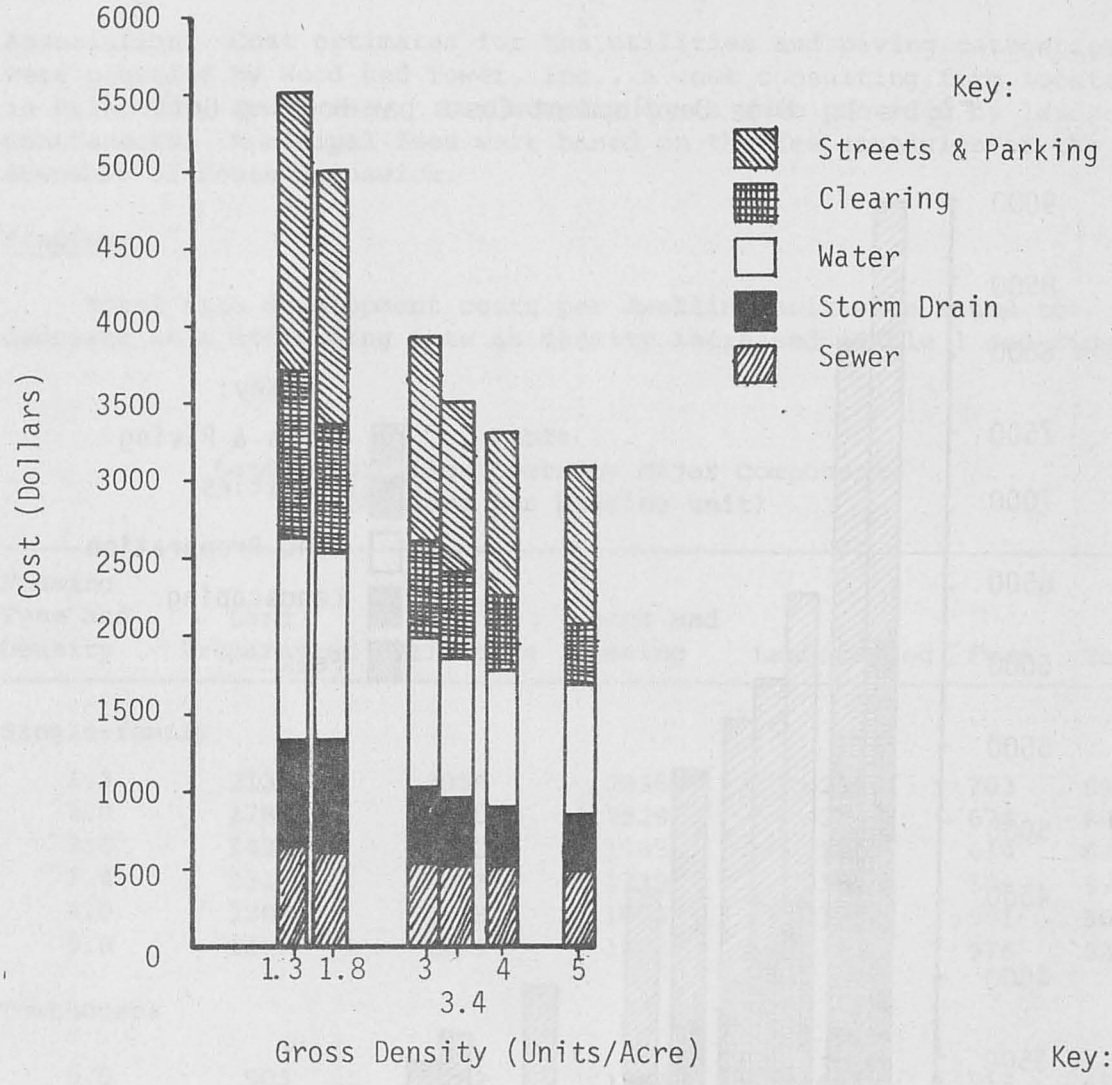
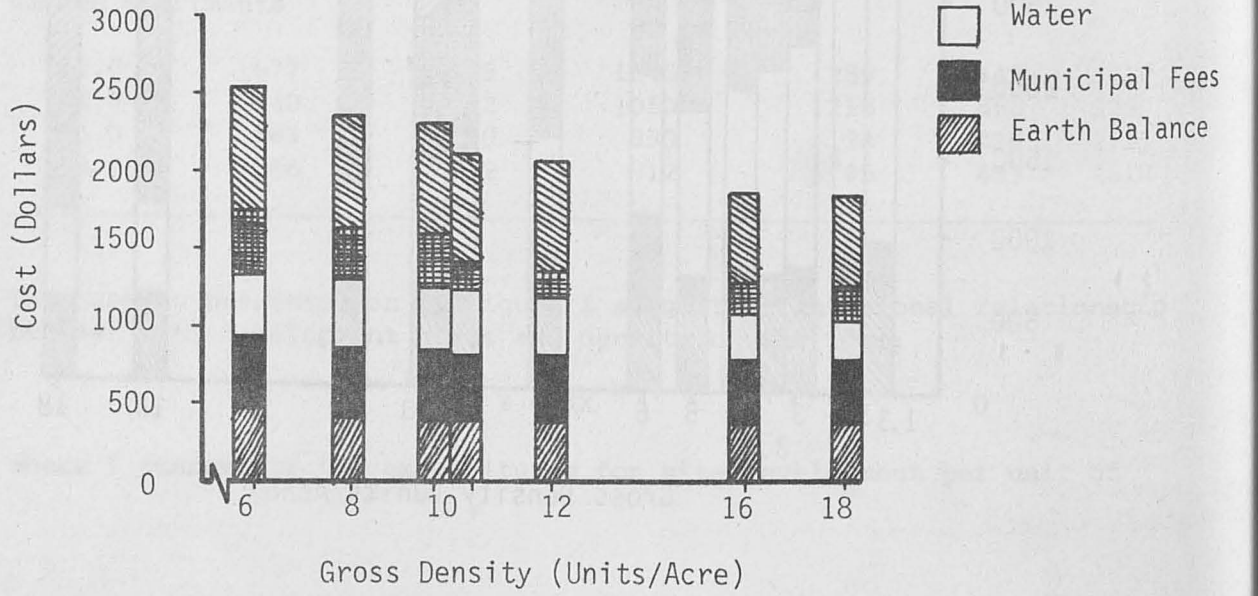


Figure 3. Major Site Development Costs, Town Houses and Garden Apartment Developments



housing and X is the gross density in units per acre. Using a natural logarithmic transformation, this equation was estimated by simple linear regression. The estimated equation is given below, with the standard errors of the coefficients given in parentheses below the estimates.

$$\log Y = \underset{(0.02)}{9.28} - \underset{(0.01)}{0.48} \log X \qquad R^2 = .99 \qquad /1/$$

This b value, which is significant at the .01 level, can be interpreted as the elasticity of land development expenditures per housing unit with respect to density. Thus a 1.0 percent increase in the gross density permits a 0.48 percent reduction in the per unit cost of site development. Given the R^2 of .99 and the high level of significance of the b value in the estimated equation, this estimate of the impact of density on total site preparation costs appears quite robust.

Figure 1 also shows how each of the main components of the site development costs varies as density changes. The costs for curbs and paving and for utilities both decrease in a very similar fashion, dropping sharply as density increases from 1.3 units to 6 units per acre, then dropping more gradually as density increases to 16 units per acre. Beyond 16 per acre there is almost no change in these costs. Land preparation costs follow a similar pattern, except that the decline is not quite so steep. Fees decline only slightly as density increases. Landscaping costs decrease modestly as density increases within the single family detached layouts. There is a sharp increase in these costs as one moves from the single family houses to townhouses, but they again decline as density increases among the multi-family units. The higher landscaping costs for townhouses than for single family detached units result largely from the need to sod (rather than seed) some of the areas to promote rapid sales or rentals.[2/]

The five largest components of site development costs for the single family and for the multi-family (townhouse and garden apartment) developments are shown in Figures 2 and 3 respectively. For the single family developments, the five largest components are streets and parking, water, sewer, storm drains, and clearing. For three of these components (streets and parking, sewer, and water), there is very little reduction in the costs per developed lot beyond a gross density of 3.0 per acre. The five largest cost components for the townhouse and garden apartment layouts are for streets and parking, water, sewer, earth balance and fees. As can be seen from Figure 3,

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2/ Seeding costs were $.07 per square foot compared to $.20 for sod.

most of these cost components change relatively little as density increases from 6 to 18 units per acre. The largest decreases are in the costs of the water and sewer systems, although the cost of sewers actually rises beyond a density of 12 units per acre. At the highest densities, municipal fees emerge as the second largest component. This reflects the fact that the per unit fees decrease very little as density increases from 1.3 units to 18 units per acre, in contrast to most of the other cost components.

Some of the basic physical information underlying the cost components is presented in Table 2. For some items the number of physical units per housing site developed are shown, while for others the total number of physical units required for the entire development is presented.

For purposes of planning, it is conveninet if costs of site preparation can be related to some simple factors which can be fairly readily calculated. A common rule of thumb is that for single family lots, site development costs are relatively constant per linear curb foot. As shown in Figure 4 this ratio is reasonably constant for single family sites, but much less so for townhouses and garden apartments. Further analysis, using multiple linear regression, revealed that site development costs could best be "explained" by a combination of linear curb feet and gross lot size. The equation giving the best fit to the data is indicated below, with the standard errors given in parentheses:

$$Y = \underset{(0.31)}{63.15X_1} + \underset{(0.008)}{0.145X_2} \qquad R^2 = .99 \qquad /\bar{2}/$$

where

Y = total site development costs in dollars per housing unit.
X_1= linear curb feet per housing unit.
X_2= 0 for all single family developments, and gross land area per housing unit (in square feet) for the townhouse and garden apartment developments.

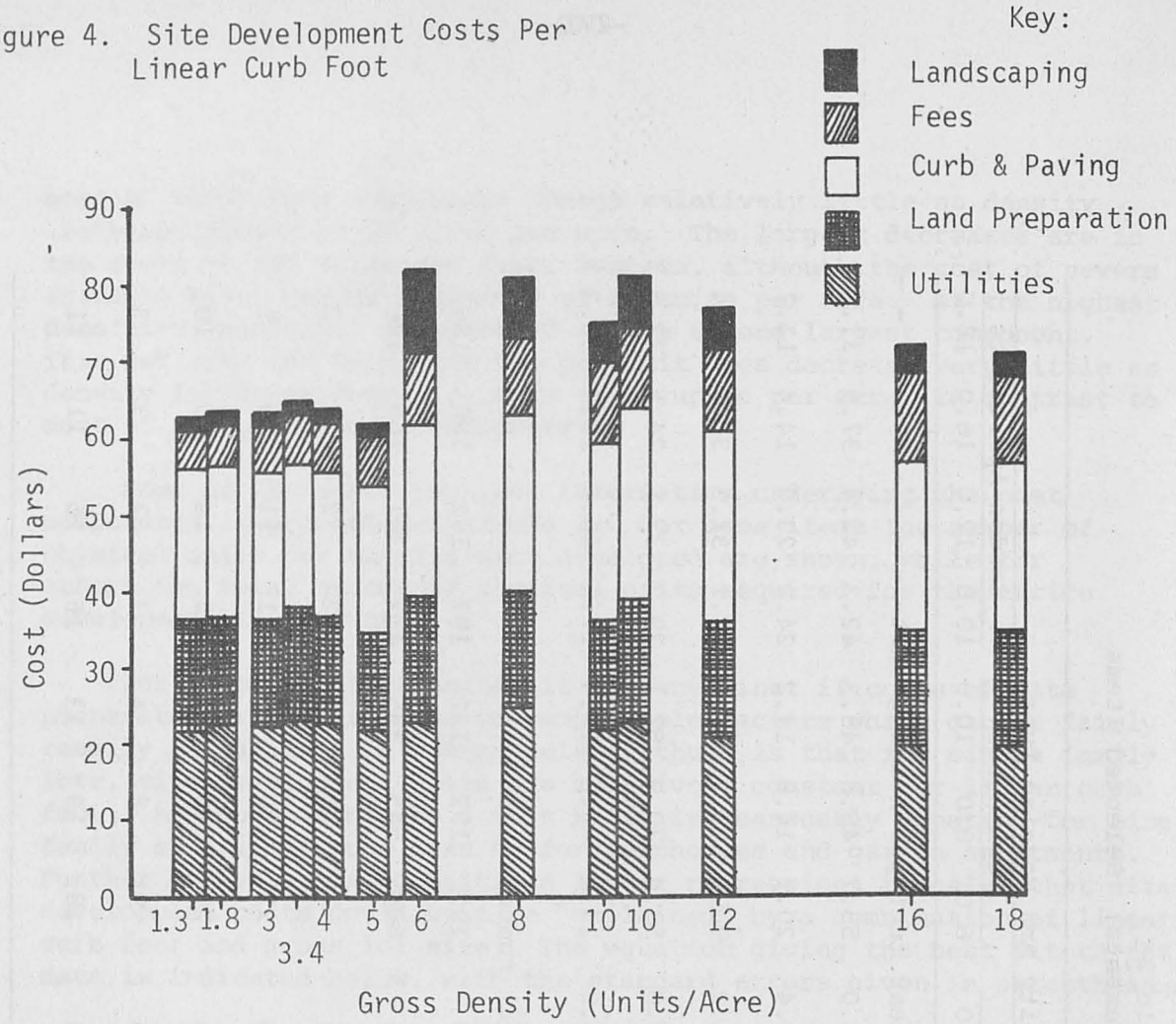
The equation was originally fitted using a constant term; however as this term was not significantly different from zero, it was dropped and the equation was re-estimated as indicated above. The coefficients of both X_1 and X_2 are significant at the .01 level.

The equation confirms the constancy of single family site development costs at approximately $63.15 per linear curb foot. For townhouses and garden apartments, site development costs are approximately $63.15 per linear curb foot plus $.145 per square foot of gross lot size. Both the high R^2 of the equation and the level of significance of the coefficients suggest that site development costs can be usefully estimated from these two basic physical variables.

Table 2
Site Development Requirements; Selected Items

	Gross Density and Housing Type												
	Single Family Detached						Townhouses			Garden Apartments			
	1.3	1.8	2.0	2.4	4.0	5.0	6.0	8.0	10.0	10.0	12.0	16.0	18.0
	- - - - - - - - - - - - - - - - - - linear feet per housing unit- - - - - - - - - - - -
Curbs	143.2	128.0	101.3	91.2	88.7	86.0	55.7	48.8	48.3	42.3	42.4	37.9	37.2
Sidewalks	141.1	126.1	99.8	89.8	87.3	84.4	20.7	14.8	14.2	24.2	23.2	14.4	13.7
Sewer pipe	134.9	125.5	110.2	102.5	101.4	95.2	90.4	69.7	67.9	32.1	31.3	38.2	32.4
Water pipe	151.8	143.1	119.2	112.6	110.4	103.0	53.4	70.9	57.1	39.7	32.9	24.5	22.5
Storm Drain pipe	42.2	41.8	33.8	31.1	30.0	28.8	23.4	22.6	15.4	17.1	16.5	10.7	10.2
	- - - - - - - - - - - - - - - - - - total number - - - - - - - - - - - - - - - - - -
Housing units	180	180	180	180	180	180	192	192	192	192	192	180	180
Shade trees	508	454	359	323	314	304	864	545	355	417	301	168	126
Street signs	8	8	5	5	5	5	1	1	1	2	2	2	2
Manholes	33	33	25	25	25	25	13	10	17	11	11	9	9
Water T	40	40	25	25	25	25	28	19	13	14	14	10	10
Hydrants	33	33	25	25	25	25	9	8	4	7	7	3	3
Storm Drain inlets	28	28	20	20	20	20	28	19	13	16	16	11	11

Figure 4. Site Development Costs Per Linear Curb Foot



Reducing Costs of Site Preparation

The preceeding discussion has given some indication of how site development costs can be reduced if the requirements of the building codes are maintained, but allowable densities are increased. A second question that must be considered is the magnitude of cost reduction which could occur if some of the requirements of the building codes were modified. The New Jersey Builders' Association has suggested that local codes are commonly excessive with regard to their requirements for sidewalks, curbs, and minimum street width [1]. The results of changes in each of these components are presented in Table 3.

The current ordinance requires sidewalks on both sides of the streets. Eliminating the street sidewalks completely would reduce site development costs by amounts ranging from $292 to $500 for single family homes, and from $52 to $88 for the townhouses and garden apartments. If sidewalks were built on only one side of the street, the cost savings would be approximately half of the amounts indicated in Table 3.

Table 3
Estimated Reduction in Site Development Costs Resulting from Elimination of Selected Improvements

Type and Density	Street Sidewalk Elimination	Curb Elimination	Reduction In Street Width	Total Cost Reduction	Total Reduction as % of Current Site Development Costs
	-dollars per housing unit-				Percent
Single-family					
1.3	500	530	247	1277	14.2
1.8	440	429	230	1099	13.6
3.0	350	349	177	876	13.6
3.4	318	320	158	796	13.5
4.0	322	311	158	791	14.0
5.0	296	304	160	760	14.3
Townhouses					
6.0	76	0	0	76	1.7
8.0	54	0	0	54	1.4
10.0	52	0	0	52	1.4
Garden Apartments					
10.0	88	0	0	88	2.6
12.0	86	0	0	86	2.7
16.0	54	0	0	54	2.0
18.0	52	0	0	52	2.0

Eliminating the requirement for curbs in the single family developments results in cost savings ranging from $304 to $530 per unit. Elimination of the curbs in the townhouse and garden apartment developments does not appear to be feasible because of the need for street parking.

In the testimony of the New Jersey Builders' Association, it is suggested that a street width of 24 feet is adequate for the minor streets in single family subdivisions [1]. This is six feet narrower than the requirements of the South Brunswick codes. The cost reductions associated with changing to a 24 foot street width range from $158 to $247. Street widths should not be reduced in the townhouse and garden apartment developments because of the heavier traffic flow in these developments, and the need to use the streets for parking.

Considering all three changes together, cost savings would range from only $52 per housing unit at a density of 18 per acre, to $1277 at a density of 1.3 per acre. Calculated as a percent of the total site development costs based on current requirements, the cost saving ranges from about 14 percent for single family developments to less than 3 percent for the townhouses and garden apartments.

Summary and Conclusions

Site development costs for three types of housing at 12 different gross densities ranging from 1.3 to 18 units per acre were estimated. Analysis of the results indicates that for small changes within this range of densities, a 1 percent increase in density results in a 0.48 percent reduction in site development costs. For all single family densities cost reductions of about 14 percent could also be achieved by reducing requirements for sidewalks, curbs and minimum street widths. There is little scope for cost reductions from these sources for the townhouse or garden apartment developments.

In terms of reducing the costs of site development, the modifications in the requirements for sidewalks, curbs and street widths could be considered as a substitute for increased density. The extent to which this substitution is possible can be estimated from the equation showing the relationship between site development costs and density (Equation 1). The results of such calculations show that for single family homes, the impact of the indicated modification in the building requirements on site development costs is equivalent to that of increasing the permitted density from as little as 0.6 units per acre (in the case of an original density of 1.8) to as much as 1.3 units per acre (in the case of an original density of 3.0). Thus while some cost reductions may be possible by modifications in the building requirements, they are modest in relation to the cost reductions that can result from increasing the permitted densities.

REFERENCES

1. New Jersey Builders' Association, "Statement of Leonard Dendelsky on Proposed 'Comprehensive and Balanced Housing Plan Act' (S-3100) and Effects of Municipal Practices on the Cost of Housing", Statement presented to the Senate County and Municipal Government Committe, July 11, 1975.

2. Southern Burlington County NAACP vs Township of Mount Laurel, 336 A.2d 713 (N.J. 1975), cert. denied, 423 U.S. 808 (1975).

3. U.S. Department of Commerce, Survey of Current Business, Vol. 57, No. 3, March 1977.

4. U.S. News and World Report, "Housing Industry Gets a New Lease on Life," pp. 37-38, February 7, 1977.

5. Urban League of Greater New Brunswick, et.al., vs the Mayor and Council of the Borough of Carteret, et.al., 142 N.J. Super. 11, 1976.