Appendix B:
Annotated Bibliography


* An excellent source for density definitions.

Net residential site area: the total land area devoted to residential facilities. Uses excluded: commercial and industrial areas, shopping and local business not directly beneath buildings, commercial garage space, public parks and playgrounds, vacant land reserved for future development, vacant unbuildable land, schools, churches, community facilities, etc.

District density: The number of persons, families, or dwellings per acre of land within a whole district, regardless of land use. District density corresponds to the term "gross density" as used by many city planners.

Net dwelling density: the number of dwelling units per acre of net residential land (land devoted to residential buildings and accessory uses on the same lots i.e. informal open space, drives, service areas, but excluding land for streets, public parking, playgrounds and nonresidential buildings).

Building coverage: the proportion of net or gross residential land taken up by buildings.

Neighborhood density: the number of dwelling units per acre of total neighborhood land (net residential land plus streets and land used for schools, recreation, shopping and other neighborhood community purposes); neighborhood land excludes non-neighborhood uses and unusable land within the neighborhood boundaries.
Gross dwelling density: defined as an outmoded term; defined here as the number of dwelling units per acre of gross residential land including 1/2 bordering streets. Recommends that the term gross residential density be replaced by over-all neighborhood density, usually expressed as families or persons per acre of total neighborhood land.

Gross residential density: The number of persons, families or dwellings per acre of gross residential site area.

Net residential density: The number of persons, families or dwellings per acre of net residential site area.


* A paper about scale—a topic which is important—well illustrated but so poorly written and conceptualized that it hardly serves any purpose other than consciousness-raising.

* Interesting example of disaggregation of density: population density, DUs per building, and FAR. He shows mathematically how zoning constraints in FAR, coverage, and height can affect housing prices and design. An interesting us: example of application, and proof of importance of understanding density measures for regulation, since regulation affects so much of what is built.

Aspects of housing considered: floor area, finishing cost of a dwelling unit, garden space, building height. Page 37, Fig.6: Demonstrates a competitive housing market with technical restraints. States in conclusion that a "competitive housing market in equilibrium requires narrow and tall buildings which lie close to the CBD. While the maximum building height is determined by either material properties or building codes, the minimum building area is determined by either technical considerations or building codes."

- Relationships between population densities, land use and housing in developing countries are considered. Defines overall gross density (p. 47) as persons/hectare. Measure for net density = net housing area i.e. "one hectare bounded by two parallel service roads linked by pedestrian ways between the housing, without any other significant land use whatever. Net housing density would relate to the total of the built areas, private open spaces, if any, and any local public open space including the footpaths and half the local road widths.

Cites three principal land uses: 1. farming and farm buildings 2. all other physical development than housing 3. net housing areas.

"Other physical uses include: play fields and parks, shops and offices, municipal and health buildings, industry, transport facilities, educational buildings." p. 48.


- Short, general essay; problems discussed are most relevant to New Zealand, but may have more general implications. Raises the question of the most appropriate measurement of residential density. Discussion focuses primarily on relationship between density and environmental stress, but raises one other issue: the extent to which communities are self-contained. What is the role (if any) of suburbs in density measures? Makes no distinction between net and gross densities; states that the most relevant measure (for measuring stress) would be in the residential environment i.e. the density of the population living in housing estates. Measures density in acres per 1000 population and the residential area as a percentage of the total area (these distinctions remain unclear).


- p 516: Comparison of densities for ideal communities: E. Howard, Le Corbusier, Wright, Perry, Sert, Gropius, Goodman & Goodman. Measures density using DU/gross acre (although Corbu uses ppa). p. 598: Recommended housing types based on gross area per family and ppa. Ranges from 4 ppa to 1600 ppa


- Discusses in Canadian context—many housing forms shown on p. 16 rather unusual—not common to American experience. Gives some ideas for possible generic prototypes and ground plans for various unit layouts. Stresses need to allow planning and construction of housing in "middle ranges of density" (i.e. non-high rise and non-single family housing) and points out that housing with FAR of .75 to 1.5 provides efficient alternative to high rise living accommodations. Refers to several density measures: DU/acre or hectare, FAR; does not clearly distinguish between net and gross density measures.


- Land Use Intensity (LUI) defined here (as it was in Minimum Property Standards for Multifamily Housing, Washington, D.C.: FHA 1963) as a measurement of the over-all structural mass and open space relationship in a developed property. Density measures are unresponsive to wide variables in living unit size and household size, and density measures can only be compared to LUI ratios in very general terms, with the possibility of gross error. Compared to density measures, LUI is more reliable because it there are fewer variations. Some comparison can be made if living unit size or household size is kept constant.

Gross density: Gross land area (gross acreage) defined here as living units related to all land which benefits or is used by the development; less streets, we have net density. This report acknowledges ambivalence and confusion regarding the definition of net density. Does net density include paved parking areas in bays along streets?
What about privately owned streets? etc., etc.

Intensity rating scale refers to the gross acres of all land benefiting a project, with land area including 1/2 abutting street right-of-way, 1/2 abutting river or park; claims that land use intensity measures are more realistic and reliable by measuring gross acreage rather than net.

LUI scale begins with FAR. Other variables included in the measure are open space ratio, livability space ratio, and recreation space ratio. The denominator in each case is the total floor area.


This book includes a good review of literature.

Empirical study limited but provocative: relation between block sizes and street frequencies in selected California cities and underestimation of net residential densities suggests relationship between net and neighborhood (and maybe even gross) densities affecting perceptions. Methodology: believes that subjects would not be able to relate DU/acre or persons per acre measures of density; developed 7 categories of perceived residential density:
1. less than 10 households/block,
2. 10-25 households/block,
3. 25-35 households/block,
4. 35-60 households/block,
5. 60-100 households/block,
6. 100-200 households/block,
7. 200+ households/block.

Shows no association between magnitude of actual density and correct perceptual density. Cites Jane Jacobs: visual breaks with shorter blocks and many intersections would cause objective density to appear lower than it actually is and thus increase density underestimates and lead to higher satisfaction scores. Another variable which could affect perceived density levels: topography.


Neighborhood density: calculated on the number of people living in a housing area per area of land (NET DENSITY) - distinguishes people per acre living over the whole neighborhood which would equal GROSS DENSITY. The area includes "all the small open spaces and gardens about which the buildings may be grouped, and the residential roads, but excludes school sites, the neighborhood center, and playing fields for the area as a whole." p. 256. Problem with expressing density in dwellings/acre: OK when development was limited to one kind of dwelling, but now that mixed developments are common, the measure
becomes useless. More appropriate to express density as the number of persons living on an area of land, or the number of habitable rooms. Converts population figures to dwelling numbers by diving by 3.3 ("safe average family size, 3.5 being the national [British] average") or can be converted to number of rooms (usually 1 person/habitable room--outdated--recommends 0.9 as more appropriate for shrinking family sizes). Most common density for housing developments: 30 to 40 ppa, with 9 to 12 semi-detached houses with small gardens. But the results from using this arrangement produced such wasteful and monotonous results that the trend is now towards higher densities. The limit for that type of arrangement would be about 50 ppa, but above that figure, narrower frontages would be required. With the extensive use of terrace houses (and economical garden planning), densities can be increased to about 70 ppa.


* p. 42: "Densitometer" measures relationship between various communities in the US and Japan using living units per gross acre as the standard. Hard for accurate comparative purposes: densitometer requires difficult and approximate conversions of limited data. pp.55, 56, 58, 59: Examples of HUD's Land Use Intensity Scale; definitions outlined on bottom of p. 59:

FAR: Floor Area Ratio: sq. ft. of total floor area for each sq. ft. of land use.

OSR: Open Space Ratio: sq. ft. of open space for each sq. ft. of floor area.

LSR: Living Space Ratio: sq. ft. of non-vehicular outdoor space for each sq. ft. of floor area.
RSR: Recreation Space Ratio: sq. ft. of recreation space for each sq. ft. of living space.

OCR: Occupant Car Ratio: number of parking spaces without parking time limits for each living unit.

TCR: Total Car Ratio: minimum number of parking spaces for each living unit.

Hanke states that Japan uses only FAR and not these perhaps more meaningful ratios to examine density. Recommends adoption of standard system of data collection and concept testing for measuring density, such as HUD’s land use intensity system. This system could serve as a starting point for further refinements in density measurement. Inclusion of the Recreation Space Ratio seems to suggest that the LUI scale combines elements of net and neighborhood density measures. Hanke develops a ‘Densitometer’ which measures living units per gross acre.


- Important analysis of housing densities in relation to these typologies. p.18: Geographical position (sunlight access) affects housing density—shows maximum net densities for residential areas in various cities (London, Berlin, Vienna, Naples, Barcelona). Steeper angle of the sun in southern regions allows for higher buildings and higher floor space index. Because of cloudier weather in northern cities, differences in sunlight intensities are increased. States that if floor space index is used to calculated density base on access to sunlight, New York could have a FSI of 10.00- same latitude as Naples, Italy. p. 24: Important tables showing relationships between FSI, population densities, dwellings/hectare, cubic content, range of possible typologies and appropriate climatic regions for each of the measures.


- Excellent example of development and application of prototypes. Advantages of low-rise, medium density housing over high rise discussed on p 179 in context of displaced families in Britain who lost ‘subtle environmental amenities’ when moved to high rise developments. P.180: Systematically classifies housing sections with various combinations of modules and analyzes spatial densities (p.181); variables considered: number of floors, maximum density ranges (bpa), average maximum density, percentage of car provision, percentage of residences with one access, percentage of residences with access first floor or above, etc. Figures 4 & 5, (p. 182) diagram relationships between maximum densities and number of floors as well as exterior private space versus number of floors.


* Important for density definitions: town density, net residential density, gross density. Provides examples of prototypical layouts. Town density: "provides a standard against which to check existing towns." Town density = "population related to all the urban activities and uses for the whole town." Net Density: what is measured: population in residential areas; includes dwellings and gardens, "incidental open space" (play areas, visitors' parking), 1/2 surrounding roads (up to 20'); excludes: shops, primary schools, most open space, all other developments. Gross Density: also measures population but includes wider mix of activities. Includes: land covered by housing, gardens, roads, shops, primary schools, most open spaces. Excludes: industrial lands, secondary schools, town parks and centers. Covers a whole sector/district of a town. Goals of high density development: economical use of land, preventing sprawl. Increases in gross densities save relatively little land while net densities increase disproportionately. Doubts value of raising densities to 70-80 ppa; recommends medium gross densities of 30-50 ppa which corresponds to net densities of 40 to 80 persons per acre. Other problems w/ high densities: personal preferences for private outdoor space, difficulty/complexity of designing at high densities, both from physical and intellectual perspectives. Cites Lionel March's concept of returning to peripheral buildings around a central court as an appropriate solution. Can achieve fairly high densities w/ low well lit buildings.


* Mentions change from building high rises to low rise housing projects as being influenced by sociological studies and other criticisms lodged against high rise developments. By the early 1970s, building industry evolved to such an extent that it became profitable for the building industry to develop low rise housing- became more widely seen esp. in smaller towns. Allowed greater variety in dwelling types- allowed residents' input into design and use of the environment. Notes increasing popularity in recent years of houses w/ very small lots (250 square meters)-a more traditional approach to housing. Developers looked to Danish traditions in housing when building newer housing estates. Findings based on research done in the 1970s are interesting from a behavioral point of view.
- Excellent source for high-density prototypes from around the world. Defines net density as number of persons accommodated on a given site, usually including perimeter roads. Gross density as defined here includes whole neighborhood area, with housing area, primary schools, local shops, community buildings and churches, service industry and workshops, provision for local roads and parking areas. Town density relates population of the town to the whole area of the town, including residential area plus central commercial district, industries, business and shopping areas, educational facilities, open spaces, playing fields, railways, etc.

- An excellent source for definitions (compare definitions here with James (1967)), particularly Chapter 18, pp.251-285. Definitions include Net Residential Density, Habitable Rooms per acre, and Number of Dwellings per acre (calculated by NRD in habitable rooms per acre divided by average number of habitable rooms per dwelling. NRD also used as an indication of garden space or private space per acre. Little connection between size of house and size of garden or open space required. Other measures include net population density and gross population density. Analyzes NRD requirements for neighborhoods of various sizes, pp. 257-258.

Table, p.261: Typical densities, plot dimensions and house types: could be very useful for detached/semi-detached housing types.

Figure 113 p. 262: Examples of plot shapes and sizes which produce various densities; ranges from 1/20 acre to 1/2 acre.

Figure 114, p. 263: Density chart; shows relationship between length and width of plots and the resulting number of plots per acre.

Figure 115, p. 264: The inter-relationship of building height and density; shows cross sections of space required for same building volumes. Ranges from 2 story buildings 60 and 120 ft apart to 12 story buildings 240 ft apart. Densities and habitable rooms/acre increase dramatically w/ each succeeding variation.

Table, p. 266: Effects on NRD and Town Size of variations in density of different types of dwelling occupancy rate. Shows how various combinations of houses and flats can be used to achieve different density ratios, in HRPA, PPA, density in HRPA and total residential acreage of town.

pp.276-284: several examples of residential neighborhood layouts, both generic and actual communities (British prototypes).

Measures cited: Habitable rooms/acre, net population density, gross
population density, average number of DUs/acre, average number of persons/DU, average number of persons/acre.


* Measures of density: DU/acre and floor space/acre. Using these two measurements, one can determine how many people can come to live in an area and a particular type of development can be prescribed. Opposes the Floor Space Index/Plot Ratio as well as Site Coverage: "left over from the days when planning control tried to modify itself on building regulation methods." States that by using DU/acre and floor space per acre "density should be regulated by prescribing a permitted number of dwellings and a permitted floor space per acre as a design control to ensure conformity with a preconceived plan for each residential neighborhood."


* Review of literature on crowding and stress (pp. 95-113), including "Characteristics of the Environment (objective physical conditions)" as contributing to stress through "experience of the environment" (p.96). Crowding is defined and related to "high density situations", and "molar" (i.e. within dwelling units) and "molar" (i.e. outside, or among, dwelling units) density measures are distinguishable (pp. 101-102). Crowding research and its implications are reviewed (pp. 102-112). It is concluded that density can be stressful, but that other factors (e.g. poverty, social class) are correlated with high densities and crowding, and are equally or more responsible for negative effects. Also included is a review of research on "defensible space" and the responses to Oscar Newman's studies.


Lanchester, H.V. "Height and Bulk of Buildings in Relation to their Requirements and Surroundings," Journal of the Town Planning Institute, 20:8 (June, 1934) pp. 213-222.

* Interesting from an historic point of view p.214: discusses the proportion of open space to residential lands. Standards have most likely changed, but it is interesting to note that the formulae seem to (slightly) favor lower density developments. Recommends that the proportion of open space in residential areas (inclusive of roads) be 8% + 1.5% per house per acre. e.g. 6 houses/acre = 8% + 9% = 17% Advantages of this system would include: 1. Roads would be kept to a minimum by virtue of their added expense; more space for play, parks, etc. 2. Balance related to density of population; 3. Cost of reserving traffic routes would be reduced- could be included in ratio; 4. Formula favors slightly lower density ratios; 5. Greater freedom in planning in place of restrictive regulations. Speaks in terms of CUBIC FEET PER ACRE. e.g. if typical house = 10,000 cubic feet, 16 DU/acre = 160,000 cubic feet. Under old laws it was possible to build houses 300,000 to
400,000 cubic feet/acre. Vertical controls implied, and cites (outdated?) laws in Calcutta that restrict the height of buildings by drawing a 45 degree angle from the middle of the road. Results of Lanchester’s recommendations challenged in discussion following paper (pp.217 ff).


* The most common method in Oregon for measuring densities: base standards on lot area; "Minimum Lot Area" would be designated for each zone or type of housing in residential zone. Usually, this would include 1. lot area and width and sometimes lot depth; 2. maximum percentage coverage; 3. specified amount of lot areas for each DU in areas where multifamily DUs are authorized. In Eugene, Planned Unit Development standards are based on density point calculations correlated to DUs and the number of bedrooms. Maximum densities within PUDs are derived by comparing points assigned by DU type for maximum density points assigned per gross acre for the zoning district. Density points are determined according to the size of the DU and the number of bedrooms. A bedroom is defined as an enclosed room containing the minimum square footage of floor space required by commonly used ordinances or a room that is easily converted to sleeping quarters. Included are family rooms and dens if they fit the definition, are separated from other areas by doors and walls and have access to bath without passing through another bedroom. Density points are added and can’t exceed a maximum set up in table (see p. 2) Gross Area is defined as an entire area internal to PUD including streets within the development and abutting streets provided by the developer. In Corvallis, the density measure is calculated according to the number of bedrooms per DU in residential districts. 2 classifications: R-M = Multiple family residential medium density district; R-H = High density multiple family residential district. FAR (# floors x coverage) used in conjunction with minimum lot area (width and depth) and building height regulations to obtain desired maximum density standard. Typical one family FAR = 0.3; multi-story, multi-family: 1.0. FAR usually includes off-street parking which increases the gross floor area per DU.

The Land Use Intensity Ratio developed by HUD is designed to limit the amount of activity on a given unit of land area i.e. limiting density. Need to differentiate between intensity and structural requirements (e.g. setbacks) Some density controls affect both: height restrictions (in stories, multiples of street width, etc.) percent coverage and FAR. LUI uses 6 measures: 1. "open space ratio" which is the minimum open space for each square foot of floor area- expressed as a % of the total floor space. 2. FAR = basic density control while OSR allows
increasing open space at ground level as the total floor area increases.

3. Living space ratio = minimum square footage of non-vehicular outdoor space required for each square foot of floor area. 4. Recreation space ratio = minimum square footage of recreation space required for each square foot of floor area - a component of "living space." 5. Total car ratio = minimum number of parking space per DU. 6. Occupant car ratio = minimum number of parking spaces without time limits required for each DU. LUI scale based on gross acreage, not net acreage. Scale ranges from 0.00 (actually 0.0125) for low rural land use to 3.0 for suburban type land use for "modest" DUs/gross acre to 8.0 for high intensity land use (high rise apartments).


* Methodology; relation of land use areas; some concepts; intensity of activity, etc. Uses one acre as the unit of analysis. Considers only the relationship between DU, immediate open space, access roads, utility systems. "To my dismay, little real concern for the actual differences between densities exists; the arguments seem simply rhetorical." (pp.184-85). Uses FAR; plots land use as a percentage of the total area plotted against density (persons per acre) using single family detached, semi-detached, multi-family 2 story walk-ups. Court buildings use land more efficiently than pavilions - same conclusion as Martin and March, et. al. States that intensity of activity is deduced from density--but how?


* Useful to show density measures. Distinguishes between Normative Standards (refer to recommended practice) and Positive Standards (refer to actual practice). 1969: studied how important residential density standards actually were in guiding planners. Ministry of Housing and Local Government (1962,59) stated that under 12 DU/acre was wasteful; need higher densities--up to 20 DUs/acre. Above 20 DUs/acre, increasing construction costs outweighed savings on land costs. In addition, above 20 DUs/acre, buildings larger than two story terraced development would have to be introduced. Used 4 residential density measures in his study: DUs, persons, habitable rooms and bedscores, all per acre. Stated that DUs/acre and persons/acre were most commonly used measures (by planners) However, DUs/acre and Habitable rooms/acre were the only two measures over which planners had control--after buildings are occupied, no control over persons/acre or bedscores/acre.


* p. 28: Develops theoretical combinations of town designs, ranging from 100 ppa to 70 ppa to 40 ppa when varying sizes of residential areas are placed in relation to a constant combination of industry, open spaces, main roads, public utility services, hospital, town center, and...
educational buildings. The NET DENSITY is the variable within a constant. The overall effect of these changes is that while the residential area increases in size dramatically, the effect on the radius of a circular town is small. There is a critical density at which services (e.g., schools) can be adequately supported without long journeys to and from places. Higher densities allow choice.


* Excellent source for typologies—wide range of housing types, sizes and combinations.

* Discusses two measures traditionally used in measuring density: floor space index (plot ratio) and daylight considerations.
Floor Space Index: Gross floor area of building (measured outside exterior walls) divided by the site area including 1/2 the width of perimeter streets. Plot Ratio: Gross floor area of building (measured outside exterior walls) divided by the net site area.
Daylight considerations: measured by use of special protractors and nomograms.
Article attacks the notion that high density buildings ("high tower buildings") use land more efficiently than other built forms. Three building types investigated in earlier study: pavilion, street, court. Variations of those forms considered here. Findings: court buildings use land more economically than high buildings (see James); plot ratios & FSI allow opening up of land or increasing density. Stresses need to find new relationship between building and road, i.e. roads tend to form site boundaries; can roads be incorporated into built areas to form a sequence of pedestrian spaces? "If urban land is to be developed economically, and if reliable measures of this are necessary, it is desirable to know which forms of buildings appear to make the most effective use of ground area." "A knowledge of the measures we are studying allows either for an opening up of land or an increase of density, when related to the existing plot ratio measure." (p. 14)

* Chapter 1, pp. 6ff: Martin contrasts two building forms, the pavilion and the court, each with 50% plot coverage. Demonstrates how court buildings create far more usable outdoor space compared to pavilions—contrasts "form" with "antiform" (pp. 20-21). p. 34:

Figure 2.2 illustrates the range of population density as a function of plot ratio on a given site. By using ratios established between floor areas and square footage per person, it demonstrates how varying degrees of efficiency in the use of the space can be produced - important
in considering the relationship between plot coverage, open space and building height.

McKean, C. "Giving People What They Want? The Case Against Low Density Housing." Royal Institute of British Architects Journal 86, no. 7 (1979) p 341.


Example of application of density and coverage measures (pp. 252ff). Argues (p. 255) for higher densities (5 to 6 story walk-ups) to avoid waste of lower density housing developments. Vertical density controls equal building height controls, the purposes of which are to ensure structural stability, privacy, creating beautiful cityscape, minimizing negative externalities to neighboring developments and owners. Yet, he finds space economies in high density forms of development. Cites U.N. Proceedings of the Seminar of the Supply, Development and Allocation of Land for Housing and Related Purposes (1952) for evidence of his argument. Measures used in Nigeria: DUs/population and density/acre or hectare. Uses building plot coverage, floor area per person or per room, plus building height controls. Lateral controls, (densities/acre or hectare) used to help solve overcrowding problems esp. in Lagos--raises question of the the ability of officials to enforce regulations-- but the housing problem in Nigeria is largely an income problem and can't be resolved by regulation. BUILDING PLOT COVERAGE: in high density residential areas, usually about 50% of building plot. Cultural differences apparent here: the 50% coverage allows adequate car parking, but in Nigeria only about 1 in 400 own cars! Maximum number of persons per habitable room: one person in low density areas, two persons in highest density areas. Net residential densities expressed in: number of persons per hectare or acre; maximum number of habitable rooms per hectare or acre; maximum number of persons per habitable room.


* "Proves" that denser development takes place on higher value land. Of little value on density because it uses "population" as a surrogate indicator.


* Conceptual distinction: physical density vs. perceived density; factors affecting perception (some are actually physical e.g. height, sight angles, etc.). Tries to distinguish between density and crowding: the former can be seen as a site measure, the latter as a measure of density within a dwelling; or, the former can be defined as a measure of persons per unit area, and the latter as a negative perception of excessive density (subjective). Perceived density has 2 aspects: physical and social. Makes a further distinction: density is the "perception and estimate of people present in a given area, the space available, and its organization, whereas crowding or isolation (which we could call affective density) is the evaluation or judgment of that perceived density against certain standards, norms, and desired levels of interaction and information. Put differently, affective density is the appraisal of certain conditions as unfavorable-the perception of the condition itself is perceived density." (pp.136-137). Cultural influences on perceptions. One must also consider function and different perceptions of density related to function (e.g. what one might not consider excessive density in an Eastern bazaar might be inappropriate for a North American shopping center). How to judge density: "density is "read" (decoded)"-certain clues are picked up from the environment. PP.138-140: list of variables which would influence one's perception of density, e.g. lights, noise, presence of cars, amount of activity, the presence of "unlike" people, etc. States that areas possessing high levels of these variables will be perceived as having high densities, no matter what the absolute number of people is (i.e. "whatever the number of people per unit area"). Homogeneity of people leads to the opposite perception (pp.141-42). It is necessary to extend beyond purely physical measurements of density to include what has been called behavioral space, action space, the cognitive space, etc. (p. 147). Classifies variables: Perceptual (large building space to height, signage, lights, people, noise, smells, cars); Associational (tall or short buildings, presence/absence of gardens); Temporal (fast/slow tempo, activities over 24 hours); Physical/Sociocultural (presence/absence of
adjacent places for use such as streets, meeting places, presence/absence of nonresidential land uses, fences, courtyards, etc.): Sociocultural (high/low levels of social interaction, lack/presence of control, heterogeneity/homogeneity).


* Considers heights of buildings, ground coverage, number of dwellings and measurable relations between them based on density designation of one acre. Emphasizes the spacing of buildings to preserve sunlighting access, especially with regard to "sun-starved" countries. Assumes spacing of buildings as 2.5 times their height.


* Chapter 9: "Zoning" by Eric Damian Kelly (pp. 274-275): The most common early form of regulating intensity or density of development was minimum lot sizes - still a common control in single family zones. Multifamily, mixed-use and planned unit development areas specify density as dwelling units per acre, usually supplemented by minimum lot-size requirements more as bulk control. Intensity also controlled by combination of minimum lot size and bulk measurements (height and coverage). More sophisticated zoning also employs the use of floor area ratios. Density and FAR requirements should specify NET or GROSS land area - "Net" defined as "the entire site less specifies undevelopable land...", "Gross" defined as "the entire site or that portion of it devoted to a particular use". These definitions are rather under specified.


* Important only for distinctions made in different definitions of density: Using houses or dwellings/acre is misleading in that the size of houses may vary. Calls number of habitable rooms/acre "accommodation density" - problem w/this definition: ignores # of people/room. Also, what is the definition of a habitable room? Furthermore, problem w/ habitable floor space/acre: does not account for # of people occupying
that floor space. More accurate definition: # of bed spaces/acre; weakness: not entirely clear—explained on p. 53. Persons per acre ('population density') does not reflect the concentration of people, as in an area of high-rise DUs. But persons per acre divided by accommodation density (# habitable rooms/acre) can provide an idea of the number of persons per habitable room ('occupancy rate'). In addition, no calculation of density accounts for the differences between daytime and nighttime use of a building or area. "The devices which control the size and shape of buildings, especially dwellings, are fairly uniform throughout the world." (p. 58) No one definition of density can explain concentration. "The hallmark of all these devices, where they have been reduced to legislative form, is inflexibility". Methods of calculating building height: multiplication factor applied to street width, plot ratio, or by "building envelope"—calculation made by taking angular plane from lot line. In addition: daylight controls.


* Analysis of criteria affected by changing density requirements, including health factors (water, sanitation and waste disposal, light, sunshine, air, noise, living space) social factors (private open space, privacy, protection, community facilities) technical factors (fire risk, available building land, access, ground conditions) and economic (land cost, locational factors, cost of essential services, availability of building materials, skills and equipment). Analyzes each of these variables (pp 12-14) in terms of effects on each of them if density is reduced or increased. Table 2 (p. 14) draws comparison of average floor space rates per person, ranging from 24 sq. ft./person in Hong Kong squatter settlements (1955) to standards set by the Ministry of Housing and Local Government for social housing in England (1953) of 135 sq. ft./person. Relevant definitions: Housing Area: "The area of land actually developed or to be developed for houses and including: (i) all house plots; (ii) All communal open space, i.e. any small public or private open spaces for the enjoyment and use of nearby households and not for the purpose of the neighborhood as a whole; (iii) half the width of any street on which land mentioned in (i) or (ii) abuts, except that where a curtilage abuts on a principal traffic road only 20 ft of the width of that road is included. Housing area density: "The total number of persons to be accommodated in the housing area divided by the housing area in acres. It is expressed as persons per acre. Floor Space Rate: The ratio of floor space to the number of inhabitants in a house or group of houses. It is expressed as square feet of floor space per person. Housing area ratio: The total floor space within the housing area divided by the housing area in square feet. Access index: The percentage of the housing area used for roads, footpaths or other means of public access not forming part of a house plot. Open space index: The percentage of the housing area used for small communal open spaces intended solely for the enjoyment and use of nearby households and not for the purposes of the community as a whole. Communal services index: The total percentage of the housing area used for access and open space.


- Density, as defined in Planning the Neighborhood (see), is "the number of units (persons, families, dwellings or rooms) per acre (or square mile)." Sussna uses the number of housing units or people for a specific area of land. Defines GROSS LAND AREA as an entire acre or parcel of land and NET LAND AREA as only that portion specifically devoted to residential uses, excluding streets, community facilities, open spaces and recreational areas. Purpose of "bulk" controls: to assure adequate daylighting, to control population density, provide open space. Cites a HUD International Brief that found that new community densities in the U.S. average about 2.5 living units per gross acre and often go as high as 5 lu/ga (Forest Hills has 8.2 lu/ga). Makes an important comparison of population and density standards for ideal communities on p. 9 including Le Corbusier, Wright, Goodman and Goodman's Communitas and others.


Tunnard, Christopher, Man-made America: Chaos or Control. New Haven, Yale University, 1964.


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* p. 284: Table 3: Residential Density Assumptions of the "Costs of Sprawl". Breaks down scale of analysis to neighborhood prototypes (1000 DUs) and community prototypes (10,000 DUs) with population, school children, floor area in square feet, floor area per resident, total floor area, gross unit density per acre and net unit density per acre. These measures are divided by typologies: single family conventional, single family clustered, townhouse clustered, walk-up apartment, high-rise apartment. Caveat in using these measurements for comparative purposes: densities range from 2 DUs/A (gross) for single family (2 DUs/A net) to 10 DUs/A (gross) for high-rise apartments (30 DUs/A net)-- all at the neighborhood level. However, floor area drops from 1600 sq. ft for single family housing to 900 for high-rise units. These assumption introduce lower standards for living space. Furthermore, The Costs of Sprawl doesn't "isolate density and planning from other important sources of variation in development costs or impacts, particularly floor area."


* Distinguishes between external density measures (overall measure of the number of persons per unit area of land) and internal density (unit area per person or the number of persons per room). Cites United Nations (1962) Statistical Indicators of Housing Conditions suggestion of an average density on one person per room as the maximum in which one could maintain a sense of privacy, with three or more persons per room as a measure of crowdedness. Older resettlement housing in Hong Kong used standard of 24 sq. ft./person, with high standard housing built using 35 sq. ft./person. Maintains that high-rise housing does not necessarily result in less living space (internal density) and more people/unit area (external density)."