Case 1: Building Envelope Analysis

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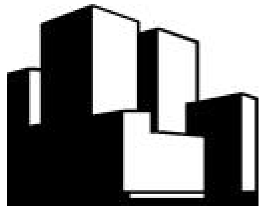


Revised October 7, 2008

Objective

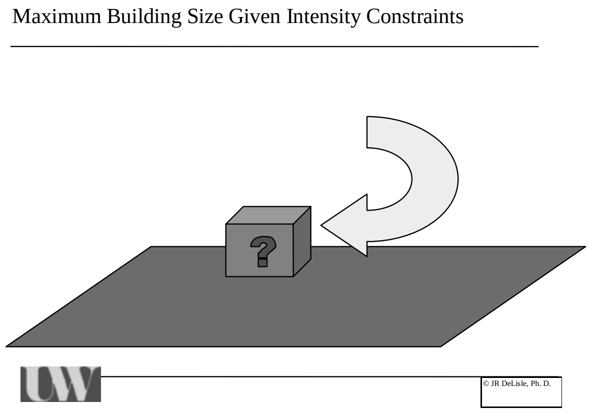
Real estate development decisions involve irretrievable commitments of scarce resources. As such, it is important to “get it right” in terms of selecting the optimal use for a particular site. Land use decisions involve a number of considerations including: 1) maximum permitted uses under existing zoning, 2) alternative use scenarios under rezoning, 3) maximum building envelopes applying various incentive and density bonuses, 4) politically palatable uses that will make it through design review and other public scrutiny, 5) marketable uses for which there is “effective demand” (i.e., the will and ability to pay) both now and in the future to ensure sustainability, and 6) economic viability whereby the resultant use provides an acceptable risk-adjusted return. This is the initial component of a series of cases that will present systematic ways of exploring these considerations. To present an integrated approach, the cases use the same basic site and development scenario. The specific objective of this case is to explore the initial consideration of maximization of land use under given zoning criteria; that is, what is the maximum building square footage (BSF_{max}) that can is legally permissible on the site under current zoning requirements? Using this input as a backdrop, the case extends the analysis to explore alternative building envelopes under rezoning and/or incentive programs. To apply extend the model to real world applications, the relevant zoning code and other criteria should be compiled for the subject property.

Background

One of the first steps in fundamental real estate analysis is to be able to evaluate alternative development scenarios for a given site. These alternatives are often constrained by entitlements or land use controls that constrain the maximum size of building that can be placed on a site. The major constraints involved in such calculations include

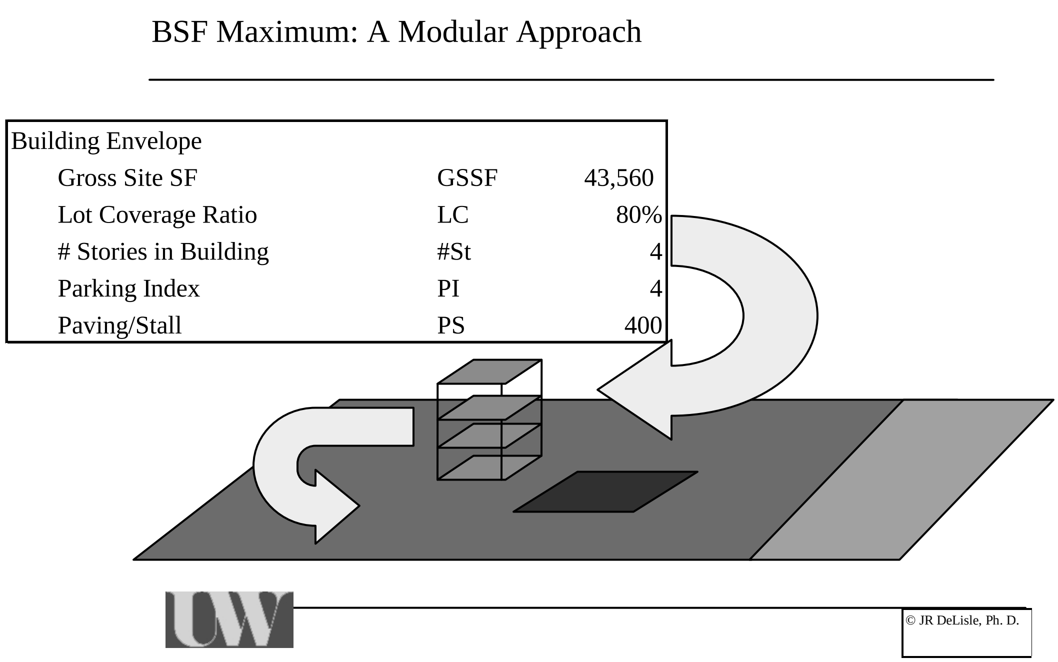
- **Lot Coverage Ratios.** The maximum percent of a site that can be covered by buildings and/or parking structures,
- **Reserve Site Ratios.** A percentage of a site that must be set aside for open space in addition to the lot coverage restriction,
- **Height Restrictions.** A maximum on the linear footage or number of stories above ground that a building can be developed,
- **Parking Indexes.** The index of parking requirements that states the number of stalls per 1000 square feet of building,
- **Floor Area Ratios (FARs).** A determination of the maximum square footage of eligible building and above ground internal parking that can be built per square foot of site.

Case 1 Core Question: How Big a Building Given Zoning?



Scenario 1: Current Zoning

Modular Approach. A company has hired a sales agent to find them a piece of land located near their downtown headquarters in the central business district, and that will satisfy their spatial needs and financial goals. After an exhaustive search, your agent has found a piece of property that she thinks will be great for you. You have viewed the site and are eager to run the numbers to assess the feasibility of locating the building there. They have also employed a local architecture firm to design the new branch. The zoning restrictions for the property allow for an 80% lot coverage ratio, and a maximum of 4 floors. The parking requirements specify a parking index of 4 per 1,000 SF and a stall size of 400 SF. In order to determine if the site will satisfy the spatial needs of the company, it is necessary to know the maximum size of the new building that can be constructed on the site.

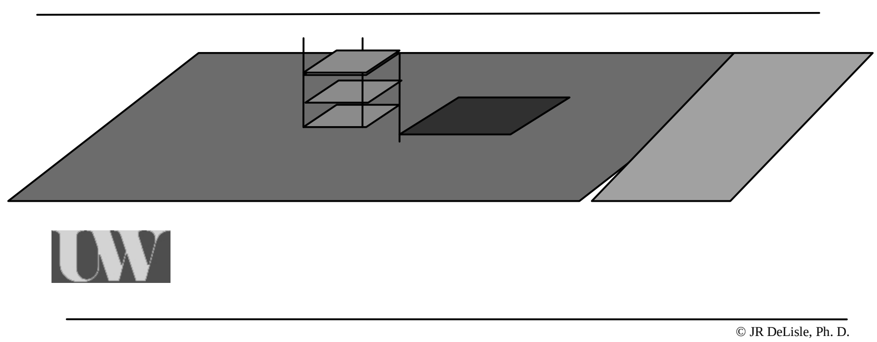


Building Envelope		
Gross Site SF	GSSF	43,560
Lot Coverage Ratio	LC	80%
# Stories in Building	#St	4
Parking Index	PI	4
Paving/Stall	PS	400

The parking index and parking stall requirements can be used to determine a building module. A parking index of 4 per 1,000 translates to 1 parking space per 250 SF in the building. Since there are 4 floors, the 250 sf will be divided over the 4 floors which indicates a surface coverage of 62.5 (or rounded, 63) feet of building for each stall of parking. Since every parking space requires 400 sf, the size of each module can be calculated:

Step 1: Calculate Module Square Footage

SF/Module	=	$\frac{1000 \;/\; PI}{\#St}$	+	PS
	=	$\frac{1000 \;/\; 4}{4}$	+	400
SF/Module	=	463		



*Note: 463 is 462.5 rounded

After calculating the size of a module, it is necessary to determine the number of modules that can fit on the site. The calculation must take into account that the total number of modules must fit within the allowed lot coverage on the site.

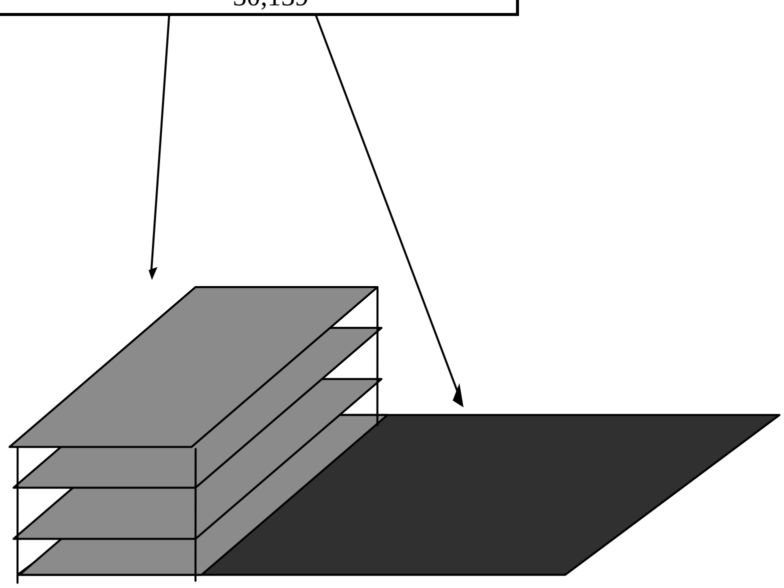
Step 2: Calculate Number of Modules

# Modules	=	$\frac{GSSF * LC}{SF/Module}$
	=	$\frac{43{,}560 \;*\; 80\%}{463}$
	=	75.3

This indicates that 75.3 modules will fit on the site, each with the respective spatial requirement. For parking, it is 400sf/module and for the building, it is 250sf which is the building requirement per stall indicated in the parking index of 4/1,000. So, to calculate the maximum building size, multiply the number of modules by the 250sf/module and repeat the same for the parking (i.e., 75.3 * 400sf). Thus, the maximum size of the building improvements (BSF_{max}) and the parking SF can be calculated as shown below.

Step 3: Calculate Improvement Size

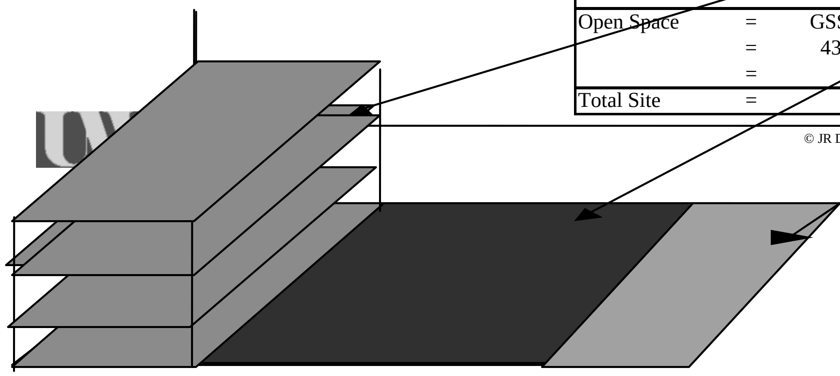
Building SF (BSFmax)	=	# Modules * (1,000/PI)
	=	75.3 * 250
	=	18,837
Parking SF	=	# Modules * PS
	=	75.3 * 400
	=	30,139



The building footprint can be found by dividing the BSF_{max} calculated above by the number of floors. Since the lot coverage ratio specifies the amount of space that can be built upon, the remainder is designated as open space.

Step 4: Allocate to Building, Parking, Open Space

Bldg Footprint	=	Building SF / #St	
	=	18,837 / 4	
	=		4,709
Parking Footprint	=	# Modules * PS	
	=	75.3 * 400	
	=		30,139
Open Space	=	GSSF * LC	
	=	43,560 * 80%	
	=		8,712
Total Site	=		43,560



Mathematical Approach. While the Modular Approach might be useful, the same answer can be established by using basic algebra. The alternative mathematical approach to the above calculations is shown below. As above, please note that the Building Envelope and Site Allocation equations are a mathematical identity; that is, they must converge to a 100% allocation unless there is an error.

Building Envelope and Site Allocation:
A Mathematical Approach

Step 1: Calculation Building Envelope

$$\frac{GSSF * LC}{(1/\# St) + [(1/(1000/PI)) * PS]}$$

Application of Mathematical Approach to Scenario 1

Building Envelope and Site Allocation:
A Mathematical Approach

Building Envelope		
Gross Site SF	GSSF	43,560
Lot Coverage Ratio	LC	80%
# Stories in Building	#St	4
Parking Index	PI	4
Paving/Stall	PS	400

Step 2: Allocate Site

$$BSF_{max} = \frac{GSSF * LC}{(1/\#St) + [(1/(1{,}000/PI)) * PS]}$$

$$= \frac{43{,}560 * 80\%}{0.2500 + [\ 1.6\ ]}$$

$$= \frac{34{,}848}{1.8500}$$

$$= 18{,}837 \text{ SF}$$

Building Footprint

$= BSF_{max}$ / #St

= 18,837 / 4

= 4,709 SF

Parking Footprint

$$= \frac{BSF_{max} * PS}{1{,}000/PI}$$

$$= \frac{18{,}837 * 400}{250}$$

= 30,139 SF

Open Space

= GSSF * (1 - LC)

= 43,560 20%

= 8,712 SF

Total Site

43,560 SF

Scenario 2: Sensitivity to Changing Height Restriction (6 vs. 4 Story)

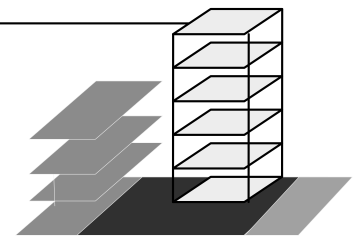
In this case, it is useful to look at some changes to the basic assumptions to determine the impact on the site planning. Assume the following changes:

		Original	New
Gross Site SF	GSSF	43,560	43,560
Lot Coverage Ratio	LC	80%	80%
# Stories in Building	#St	4	6
Parking Index (#/1,000)	PI	4	4
Paving/Stall	PS	400	400

Before calculating, think the solution through. The basic question is, will the greater building height result in a larger building if you max out the height on the site?

Building Envelope and Site Allocation:
Sensitivity Analysis Example

		Original	New
Gross Site SF	GSSF	43,560	43,560
Lot Coverage Ratio	LC	80%	80%
# Stories in Building	#St	4	6
Parking Index (#/1,000)	PI	4	4
Paving/Stall	PS	400	400



Step 1: Calculation Building Envelop

$$BSF_{max} = \frac{GSSF * LC}{(1/\#St) + [(1/(1{,}000/PI)) * PS]}$$

$$= \frac{43{,}560 \quad * \quad 80\%}{0.1667 \quad + [\quad 1.60 \quad]}$$

$$= \frac{34{,}848}{1.7667}$$

$$= 19{,}725 \text{ SF}$$

Original 18,837

Step 2: Allocate Site

							Original
Building Footprint							
	=	BSF_{max}	/	#St			
	=	19,725	/	6			
	=				3,288	SF	4,709
Parking Footprint							
	=	BSF_{max}	*	PS / 1,000/PI			
	=	19,725	*	400 / 250			
	=				31,560	SF	30,139
Open Space							
	=	GSSF *		(1 - LC)			
	=	43,560		20%			
	=				8,712	SF	8,712
Total Site					43,560	SF	43,560

Conclusion

In this case, we presented two basic approaches to calculating building envelopes: a modular approach, and a mathematical approach. We also explored the sensitivity of the outcomes to changes in assumptions that may emanate from consideration of sites with other current zoning restrictions, a re-zone of a current zoning designation, and the application of density bonuses or other incentives. This framework can be extended to apply to a range of land uses, as well as building configurations. To ensure the output is realistic, the basic building envelope, footprint (i.e., ground coverage) and other design features should be subjected to more thorough analysis, including rough schematics and other renderings which provide more insight into how the proposed envelope will actually look, whether it is structurally sound, whether it is marketable (i.e., floorplates are adequate for the intended market, whether they “fit” the neighborhood contexts, whether they are “affordable,” and whether they will withstand design review. These questions will be explored in future cases although they will likely indicate a revisiting of these basic calculations.