

**JOB AID**  
**International Building Code**  
**2021 Edition**  
**Allowable Building Area Adjustment Equations**

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**INTRODUCTION**

The *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) allows building sizes to be adjusted for maximum usage based on occupancy, construction type, setbacks (called “frontage”) from adjacent exposures, and built-in fire protection. These increases are measured in percentages above the values derived from Table 506.2 “Allowable Area Factor in Square Feet.”

IBC Chapter 5 “General Building Heights and Areas” employs five equations the designer and building code official use to determine the eventual maximum allowable area a building can be.

For most of this job aid, the subject building will be a Group B (Business) of Type VB construction, non-sprinklered. (See Illustrations No. 1 and No. 2). When we get to mixed-occupancy buildings, we will add a Group S-2 open parking garage of Type IIB construction non-sprinklered and the Group B will become VA construction.

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**TABULAR ALLOWABLE BUILDING AREA**

IBC Table 506.2 includes allowable area factors based on occupancy and construction type.

Each occupancy table value is further refined when the building is sprinklered.

Refer to the second column in Table 506.2:

NS = Not sprinklered.

S1 = Maximum one-story above grade building value based on NFPA 13 sprinkler design.

S13R = Group R occupancy building value based on NFPA 13R design.

SM = Two- or more-story above grade building value based on NFPA 13 sprinkler design.

For this job aid, we are proposing a building that measures 50 feet by 180 feet or 9,000 sq. ft. The perimeter lengths are:

Side	Length (feet)
A	180
B	50
C	180
D	50
<b>Total</b>	<b>360</b>

For most of this this job aid, we arbitrarily select the following area factors from Table 506.2:

Occupancy	Sprinklers	Construction Type	Area Factor
B	NS	VB	9,000

We also will assume the building is symmetrical: all floors are the same size.

For the “Mixed Occupancy – Multi-story Building” example, we arbitrarily select the following area factors from Table 506.2:

Occupancy	Sprinklers	Construction Type	Area Factor
B	SM	VA	54,000
S-2	NS	IIB	26,000

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**ALLOWABLE AREA INCREASES BASED ON WHERE THE BUILDING SITS ON THE PROPERTY**

To qualify for an area increase based on frontage, a building perimeter must have at least 25% of its perimeter on a *public way* or open space with a minimum distance (W) of 20 feet measured at right angles to the closest interior lot line, the entire width of a street, alley, or public way, or the exterior face of an adjacent building on the same property. The 20-foot open space must be accessible to the fire department for manual firefighting.

A *public way* is “a street, alley or other parcel of land open to the outside air leading to the street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet.” [IBC §202]

The frontage increase factor is selected from the following Table 506.3.3\*. The frontage increase must be based on the smallest public way that is 20 feet wide or greater, and the percentage of the building having a minimum 20 feet public way or open space.

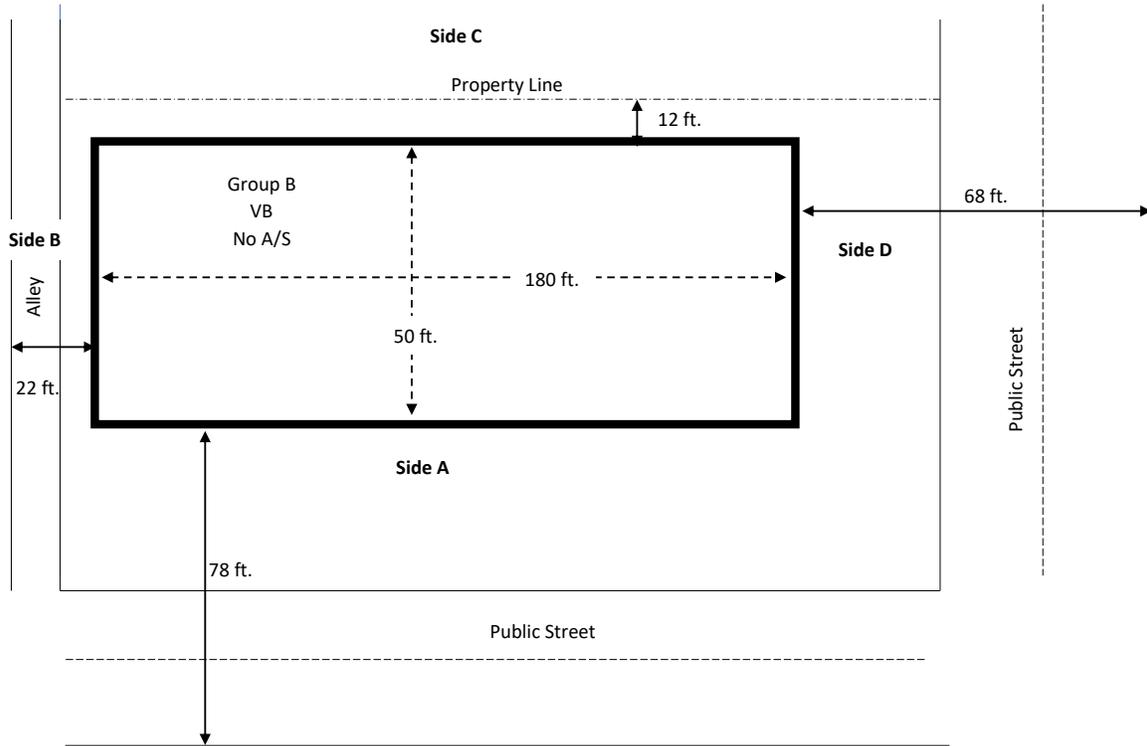
**Table 506.3.3**  
**Frontage Increase Factor**

Percentage of Building Perimeter	Open Space (Feet)			
	0 to Less than 20	20 to less than 25	25 to less than 30	30 or greater
0 to less than 25	0	0	0	0
25 than less to 50	0	0.17	0.21	0.25
50 than less to 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

\*For unlimited area buildings, see Table 506.3.3.1.

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**Frontage Increase Factor Example**



In this example, the building perimeter measures 460 linear feet. The three sides that are open more than 20 feet are A, B and D that total 280 linear feet. The percentage of the building perimeter that is open is  $280/460$  or 60.8%. Referring to the drawing, we see Side B is the smallest open space at least 20 feet wide (actual width = 22 feet).

From the Table, we select the following cell (in bold italic) that becomes our frontage increase factor:

Percentage of Building Perimeter	Open Space (Feet)			
	0 to Less than 20	20 to less than 25	25 to less than 30	30 or greater
0 to less than 25	0	0	0	0
25 than less to 50	0	0.17	0.21	0.25
<b><i>50 than less to 75</i></b>	0	<b><i>0.33</i></b>	0.42	0.50
75 to 100	0	0.50	0.63	0.75

The building perimeter is open 60.8% and the narrowest open space is 22 feet (20 to less than 25) so the frontage increase factor for the subsequent equations is 0.33. (Interpolation between cells is permitted.)

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**FRONTAGE AND SPRINKLER INCREASES**

Once the open frontage values are determined, allowable area increases can be computed. The IBC uses additional equations to compute the allowable area for:

One-story, single occupancy building (Equation 5-1)

Multiple-story single occupancy building. (Equation 5-2)

Multiple-story, multiple occupancy building (Equation 5-3)

**ONE-STORY SINGLE OCCUPANCY BUILDING**

IBC allows area increases when the building is protected by sprinklers *and* meets frontage minimums. If the building contains one occupancy classification and is a single story above grade, the following equation is used to compute area:

$$A_a = A_t + (NS \times I_f) \quad \text{(Equation 5-1)}$$

Where:

$A_a$  = Allowable area in square feet.

$A_t$  = Table 506.2 allowable area factor for sprinklered building

$NS$  = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

$I_f$  = Area factor increase for frontage.

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**One-story Single Occupancy – Not Sprinklered:**

*Note: For this equation, we will solve using the one-story building without sprinklers from Illustration No. 2. From Table 506.2 the Group B, Type VB non-sprinklered area is 9,000 sq. ft.*

$$A_a = A_t + (NS \times I_f)$$

$$A_a = 9,000 + (9,000 \times .33)$$

(50.2% was the result of the weighted average of the perimeter from Equation 5-5.)

$$A_a = 9,000 + (2,970)$$

∴ Allowable area for this building is 11,970 sq. ft.

**One-story Single Occupancy Sprinklered:**

*Note: For this equation, we will solve using a one-story building from Illustration No. 2 protected by a NFPA 13 design sprinkler system. From Table 506.2 the Group B, Type VB sprinklered area is 36,000 sq. ft.*

$$A_a = A_t + (NS \times I_f)$$

$$A_a = 36,000 + (9,000 \times .33)$$

$$A_a = 36,000 + (2,970)$$

∴ Allowable area for this building is 38,970 sq. ft.

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**MULTI-STORY SINGLE OCCUPANCY BUILDING**

If the building has multiple stories with a single occupancy classification, we use a different equation.

$$A_a = [A_t + (NS \times I_f)] \times S_a \qquad \text{Equation 5-2}$$

Where:

$A_a$  = Allowable area in square feet.

$A_t$  = Table 506.2 allowable area factor for non-sprinklered or sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

$I_f$  = Area factor increase for frontage.

$S_a$  = Actual number of stories above grade not to exceed three\*

\*For Group R buildings protected with a NFPA 13R design, use the actual number stories above *grade plane*, not to exceed four.

No individual story may exceed the allowable area ( $A_a$ ) from this equation using the value  $S_a = 1$ .

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**Multiple-story Single Occupancy – Not Sprinklered:**

*Note: For this equation, we will solve for a two-story building without the sprinkler system.*

$$A_a = [A_t + (NS \times I_f)] \times S_a$$

$$A_a = [9,000 + (9,000 \times .33)] \times 2$$

$$A_a = [9,000 + (2,970)] \times 2$$

$$A_a = [11,970] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 23,940 sq. ft.

**Multiple-story Single Occupancy – Sprinklered:**

*Note: For this equation, we will solve for a two-story building with the sprinkler system.*

$$A_a = [36,000 + (9,000 \times .33)] \times 2$$

$$A_a = [36,000 + (2,970)] \times 2$$

$$A_a = [38,970] \times 2$$

∴ Allowable area for this two-story non-sprinklered building is 77,940 sq. ft.

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**MULTI-STORY MIXED-OCCUPANCY BUILDING**

Multi-story mixed occupancy buildings can be confusing when computing allowable areas.

*Each story* of a mixed-occupancy building with more than one story above grade plane must individually comply with the IBC mixed occupancy and use requirements. This means that some buildings must include fire-resistive rated separations between occupancies yet others are permitted to be constructed without them (see IBC §508.3: Nonseparated and §508.4: Separated)

For the purpose of this handout, let's assume the proposed building is four stories tall: two levels of open parking garage (Group S-2) with two levels of office space (Group B) above it. The building's top two floors will be sprinklered in accordance with IBC §903.3.1.1 (NFPA 13 design), but due to cold conditions the open parking garage will not. The designer wants each floor area to be 24,300 sq. ft. (See Illustration No. 3). Note also, that to allow a B occupancy on the fourth floor, the construction type has changed to VA.

We will assume the designer has elected to create one-hour horizontal fire separation between the two occupancy types. We will use a same weighted perimeter value of 55.5% due to the increased building perimeter.

Now that we know how to compute increases using sprinklers, we will modify our inputs to install sprinklers in the Group B occupancy. The open parking garage is not sprinklered. To keep it simple, we will assume the building is symmetrical: all floors are the same size.

<b>Occupancy</b>	<b>Sprinklers</b>	<b>Construction Type</b>	<b>Allowable Area</b>	<b>Proposed Area*</b>
B	SM	VA	54,000	24,300
S-2	NS	IIB	26,000	24,300

\*Per floor

For buildings with more than three stories above grade plane, the total building area is limited so the aggregate sum of the ratios of the actual area of each story divided by the allowable area of each story does not exceed three. (See IBC §506.2.2.1 for special rules about Group H-2 and H-3 occupancies.)

The equation to determine the allowable area for each story is familiar: we used it as Equation 5-1. For the multi-story mixed occupancy calculations, it is referred to as Equation 5-3.

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$$A_a = [A_t + (NS \times I_f)] \quad \text{Equation 5-3}$$

Where:

$A_a$  = Allowable area in square feet.

$A_t$  = Table 506.2 allowable area factor for sprinklered building

NS = Table 506.2 allowable area factor for a non-sprinklered building (regardless of whether the building is sprinklered)

$I_f$  = Area factor increase for frontage.

We will work this equation in steps.

**Solution:**

**Step 1.** Determine the allowable area for the first-floor sprinklered open parking garage:

$$A_a = [A_t + (NS \times I_f)]$$

$$A_a = [26,000 + (26,000 \times .33)]$$

$$A_a = [26,000 + (8,580)]$$

$$A_a = 34,580 \text{ sq. ft.}$$

∴ Allowable area for this sprinklered story 34,580 sq. ft. per story.

**Step 2.** Since the building is symmetrical, we know the second floor of the sprinklered Group S-2 also is 24,300 sq. ft.

**Step 3:** Floor three is a Group B, VA sprinklered space measuring 24,300.

$$A_a = [54,000 + (9,000 \times .33)]$$

$$A_a = [54,000 + (2,970)]$$

$$A_a = 56,970 \text{ sq. ft.}$$

**Step 4.** Since the building is symmetrical, we know the fourth floor of the Group B also is 24,300 sq. ft.

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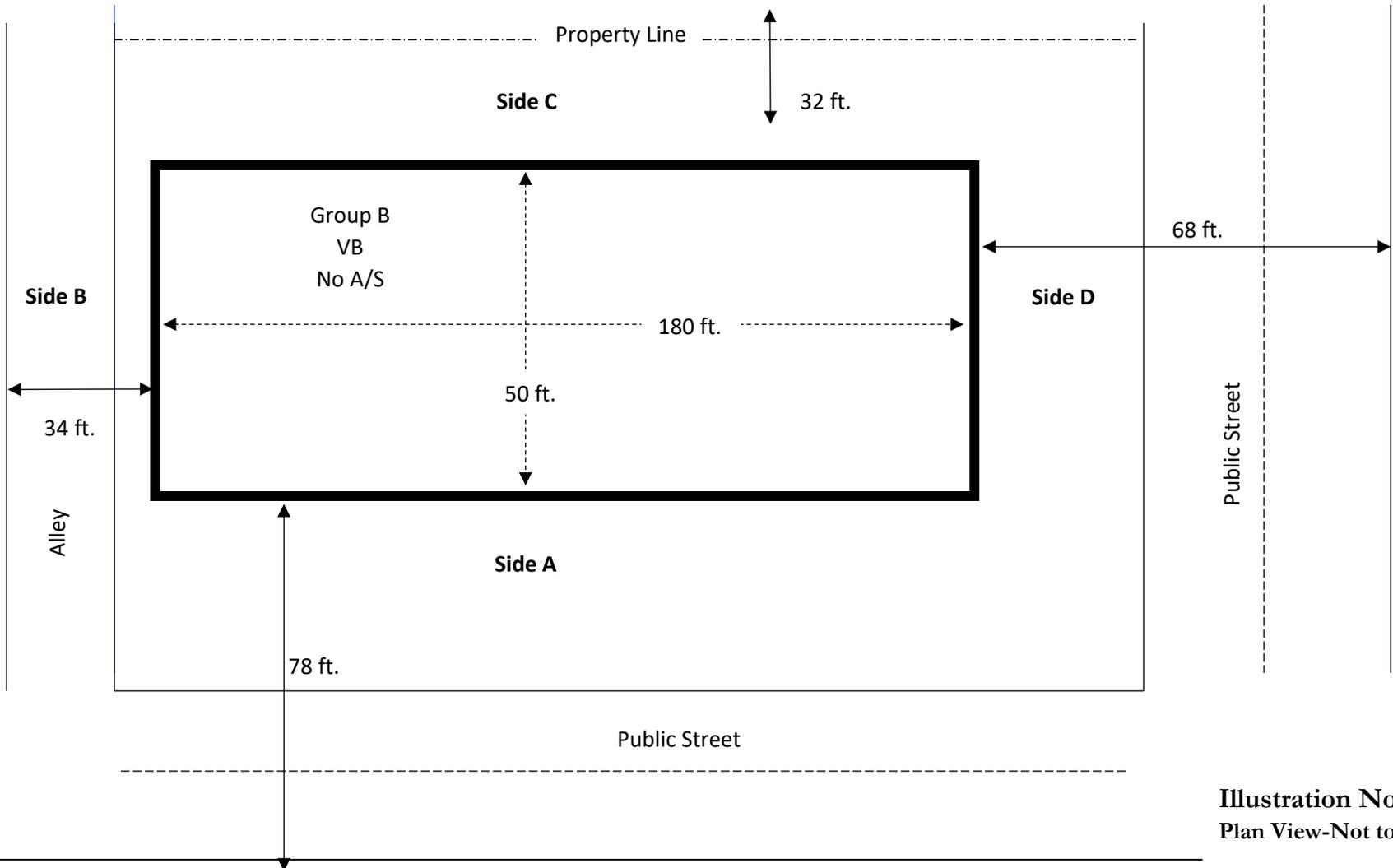
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**Step 5:** Calculate the sum of the ratios of actual area divided by allowable area:

<b>Floor</b>	<b>Actual</b>	<b>Allowable</b>	<b>Ratio</b>
1	24,300	34,580	0.702
2	24,300	34,580	0.702
3	24,300	56,970	0.426
4	24,300	56,970	0.426
		<b>Sum</b>	2.256

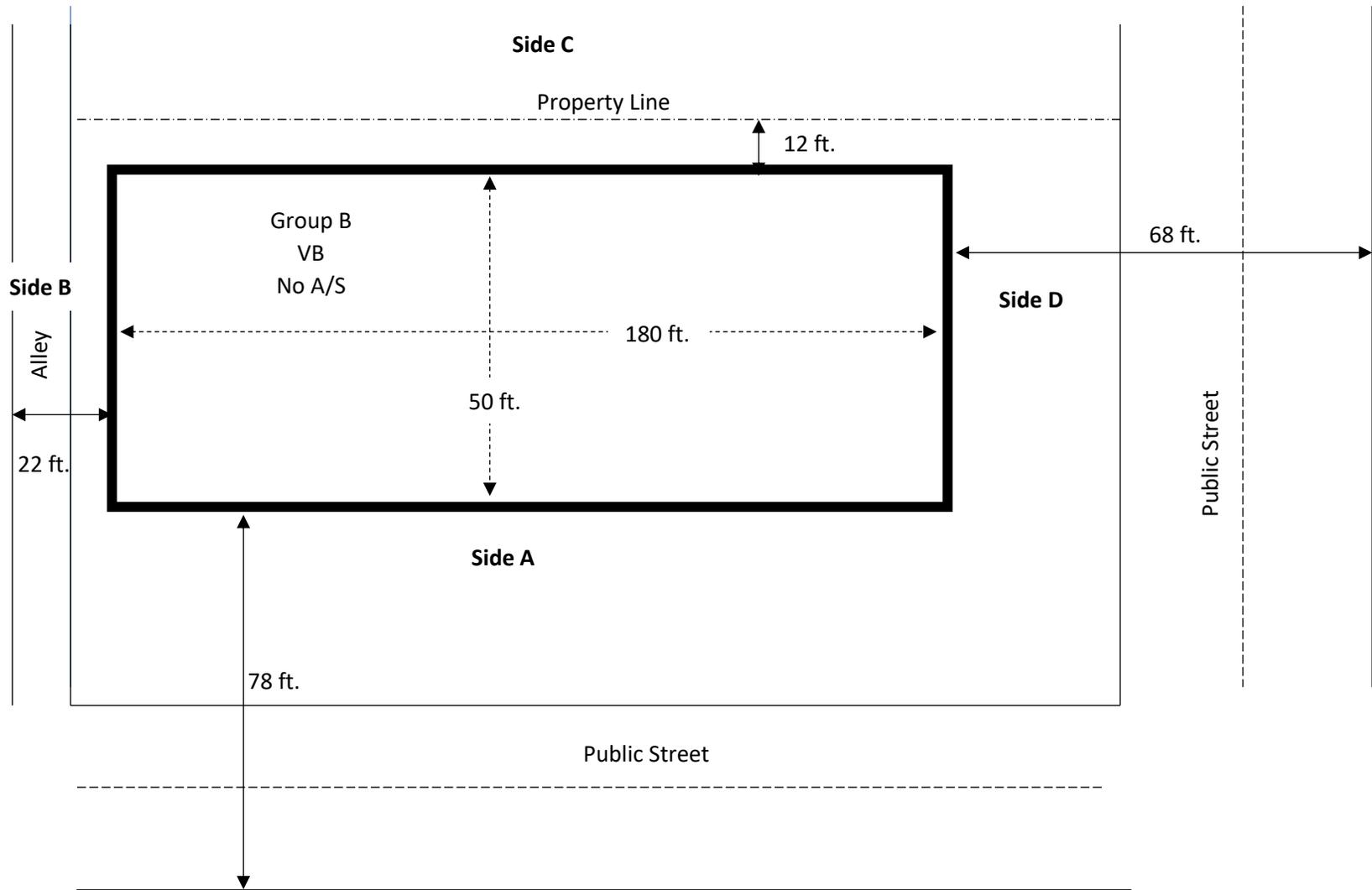
∴ The building passes the sum of the ratio analysis (less than three).

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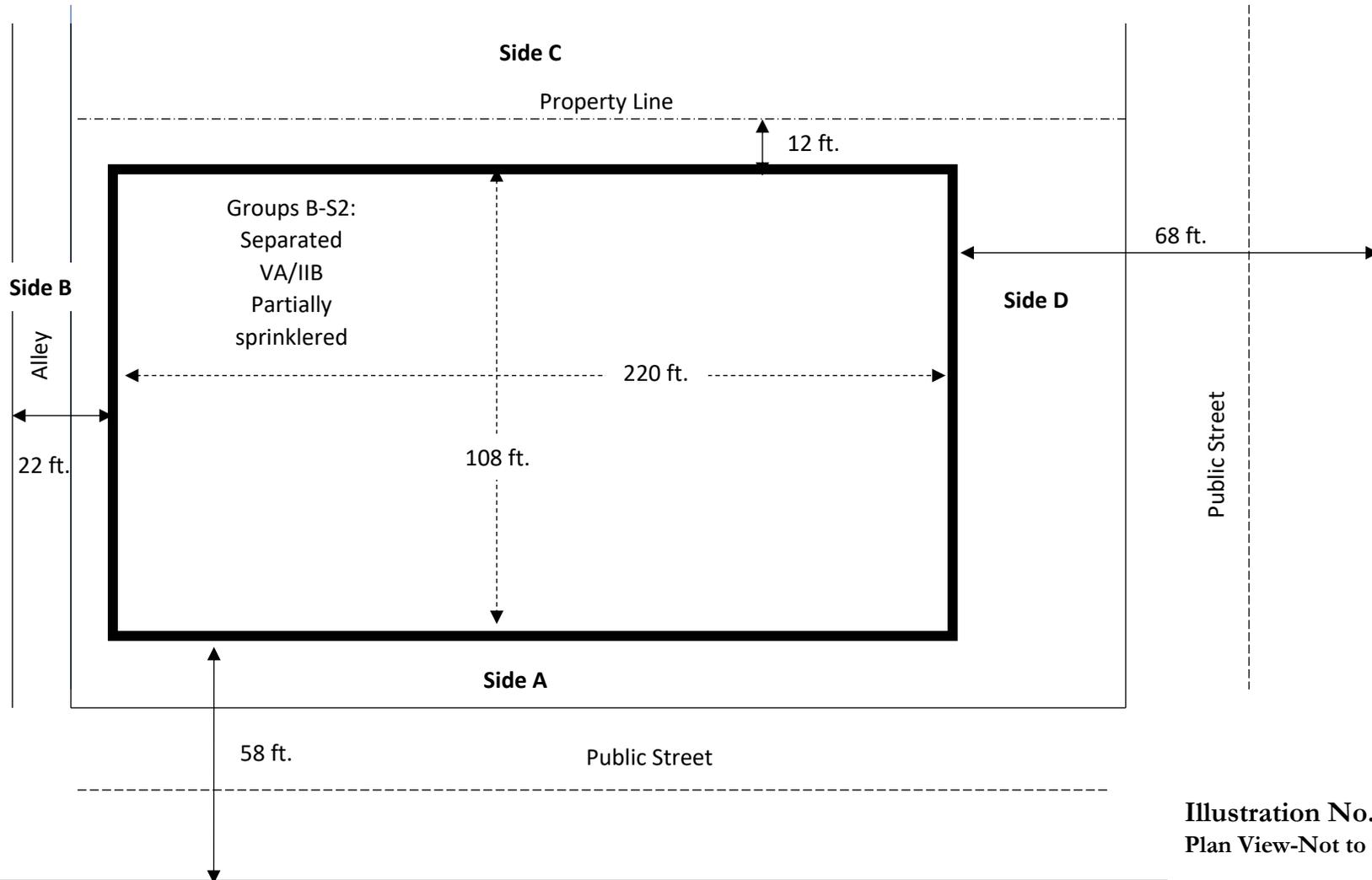


**Illustration No. 1**  
**Plan View-Not to Scale**

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**Illustration No. 3**  
**Plan View-Not to Scale**