Seismic Evaluation

University of California, Los Angeles,

Lake Arrowhead Conference Center Facility 1

Lake Arrowhead, California

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Englekirk
INSTITUTIONAL

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Seismic Evaluation

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Lake Arrowhead, California

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1.0 INTRODUCTION

1.1 General

This report presents the findings of our seismic performance review of UCLA Lake Arrowhead Conference Center Facility 1 located at Lake Arrowhead, CA. The evaluation was based on a review of the structure using the American Society of Civil Engineer's *Seismic Rehabilitation of Existing Buildings,* ASCE 41-17 Tier 1 and Tier 2 Procedures, the *2019 California Existing Building Code (CEBC)*, Chapter 3, and the *2017 University of California Seismic Safety Policy*. The evaluation was undertaken to determine if the building satisfies the requirements of the University of California Seismic Safety Policy.

The building, as shown in Figure 1.1, is located at the UCLA Lake Arrowhead Conference Center, having latitude and longitude coordinates of 34.2673399 and -117.1844899, respectively.

Figure 1.1: Building East (Front) Elevation

1.2 Information Reviewed

A title report prepared by Chicago Title Company, dated June 2017, was reviewed. Existing structural drawings of the building are not available; however, the record drawings of the adjacent Facility 2, prepared by Jimmie N. Cartee Architect, dated September 5, 1975, were reviewed for potentially applicable information. A geotechnical soils report is not available. A site visit was performed to review the structure and assess the condition of the existing elements.

The scope of this study is limited to the seismic evaluation of the structure and does not include issues related to nonstructural components. Our review and the findings presented herein are limited to the observable conditions.

1.3 Tasks Performed

The following tasks were performed as a part of our review of the building:

- Perform a site visit to survey the existing condition of the building. Dimensions of the walls were obtained for the evaluation.
- Review record drawings of an adjacent building constructed in approximately the same era.
- Obtain response spectra parameters consistent with the *University of California Seismic Safety Policy*.
- Review Fault Locations and Liquefaction Zones based on information from the San Bernardino County Land Use Map.
- Perform an ASCE 41 Tier 1 seismic evaluation to identify key potential deficiencies in the building.
- Perform an ASCE 41 Tier 2 analysis to study potential deficiencies identified in the Tier 1 review. In the absence of record structural drawings, assumptions were made regarding the location, length, plywood thickness, and nailing pattern of shear walls in the building. At some point in the future, these assumptions must be verified in the field to confirm the building's seismic rating.
- Based on the results of the analysis, prepare an evaluation of the anticipated seismic performance of the existing structure and provide a seismic rating based on the *University of California Seismic Safety Policy* Table A.1.

2.0 BUILDING DESCRIPTION

2.1 General Building Description

UCLA LACC Facility 1 is a one-story wood structure with a mezzanine level at the southwest portion. The building was originally built under the 1970 Uniform Building Code based on a title report provided by the University. The building has an approximate footprint of 2,600 $ft.^2$ with a mezzanine of 540 $ft.^2$. The overall building height is approximately 30 ft. The first floor and mezzanine plans are presented in Figures 2.1 and 2.2.

Based upon field observations, the main structural system consists of roof and floor joists supported by beams and bearing walls, and the building was assumed to be a W1 building type per ASCE 41. The two pop-out rooms at the west elevation of the building may have been added after the original construction based on the presence of different exterior finishes observed during the site visit. The pop-out room at the northwest corner may have been added by removing part of the original exterior wall, which may have been a shear wall.

2.2 Lateral System

Based on observations during the site visit and the existing drawings of an adjacent building of similar construction (Facility 2) constructed in approximately the same era, the lateral system for the building is assumed to consist of wood shear walls sheathed with ½" structural I plywood. It appears that in a reroofing project, the roof diaphragm was improved by adding oriented strand board (OSB). See Figure 2.3 for a photograph of the roof diaphragm. No shear wall anchors or holdowns were observed since all the walls are covered by finishes. Based upon the apparent era of construction and a review of record drawings for Facility 2, it is our opinion that the bearing and shear walls are bolted to the concrete foundation and that some shear walls may have holdowns.

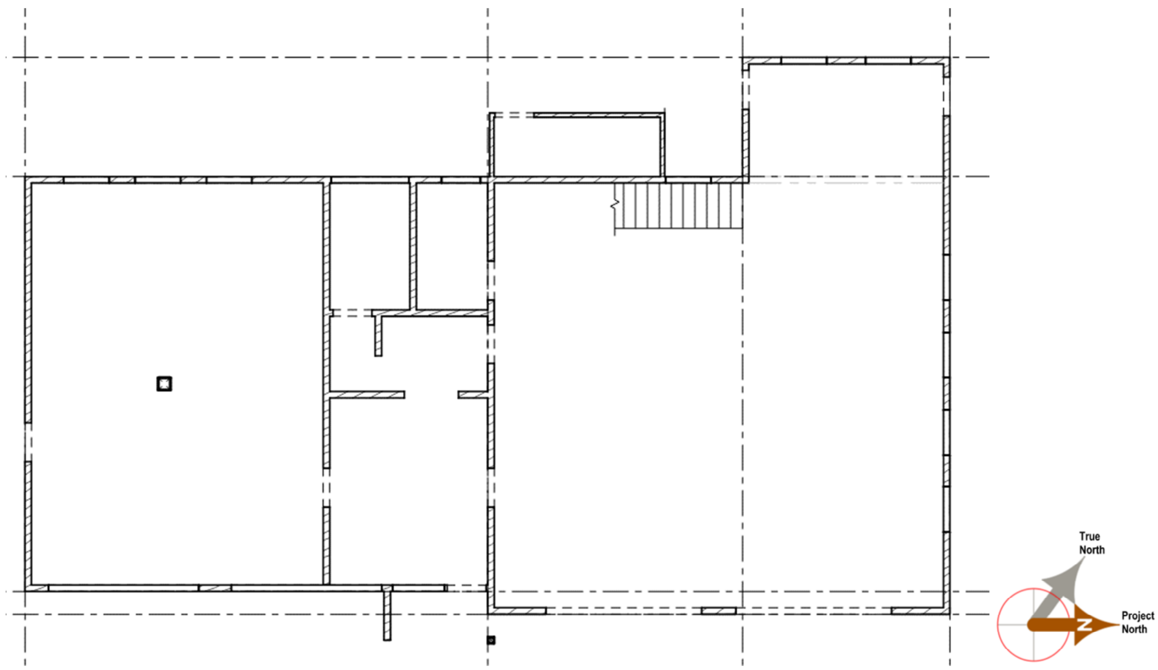


Figure 2.1: First Floor Plan

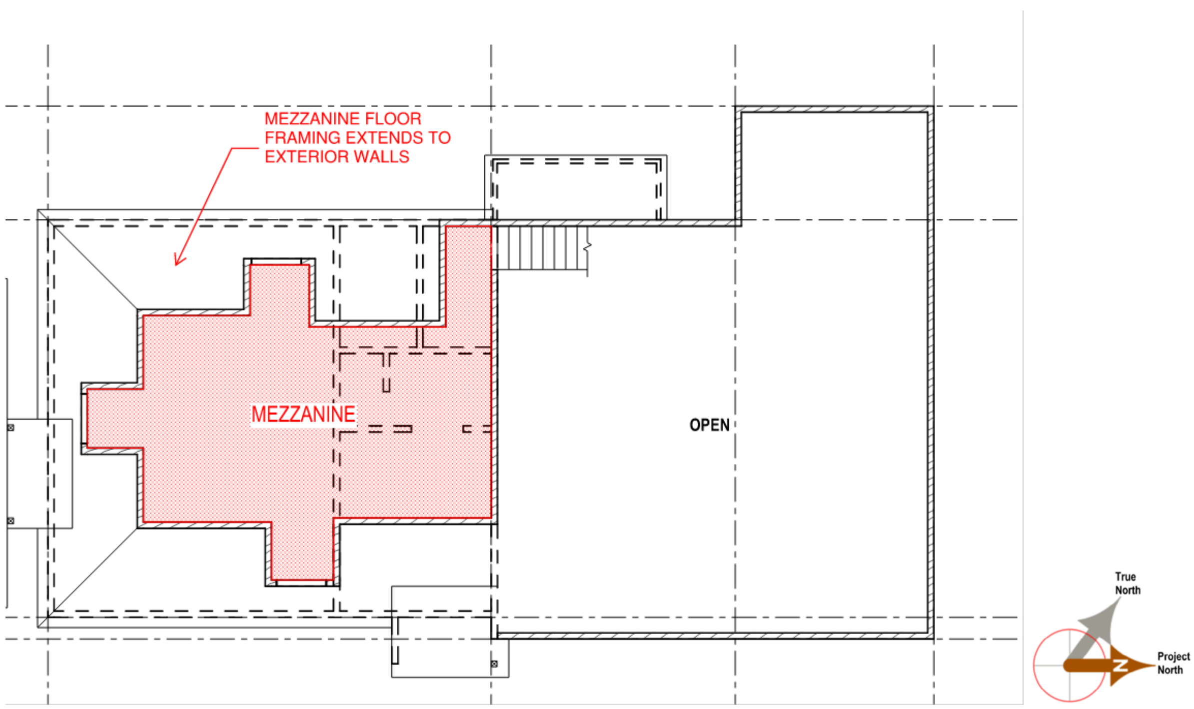


Figure 2.2: Mezzanine Floor Plan

Figure 2.3 As-built Roof Diaphragm Picture

3.0 SEISMIC EVALUATION METHODOLOGY

An ASCE 41-17 *Tier 1 Screening* forms the basis of the first step of the seismic evaluation and consists of checklists that allow identification of potential deficiencies of the building based on the lateral force resisting system type. It provides a qualitative review of the structure's performance under an established performance level. ASCE 41 defines Basic Performance Objectives for Existing Buildings (BPOE) depending on the building's Risk Category based on Table 1604.5 of CBC 2019. The evaluation is performed based on CBC Chapter 3 for this Risk Category II building. A BPOE of Collapse Prevention (S-5) under the BSE-C (similar to BSE-2E) hazard level per Table 317.5 of CBC 2019 has been defined for this structure. An explanation of hazard levels can be found in Section 4.

Tier 1 checklists applicable to this structure were completed for the appropriate performance level to assist in developing an opinion about the seismic performance of the building. Checklist items were marked as compliant, non-compliant, unknown or not applicable. Potential deficiencies discovered in a Tier 1 evaluation require further study through a Tier 2 deficiency-based evaluation. Additional analysis and evaluation of each potential deficiency were completed in accordance with Tier 2 procedures to either confirm the deficiency or demonstrate the adequacy of the structure as it relates to the potential deficiency. For instance, structural analysis was performed to evaluate shear stresses imposed on the assumed wood shear walls.

Based upon the results of the Tier 1 and Tier 2 evaluations, a seismic performance level was determined for the building per the *University of California Seismic Safety Policy*, Table A.1 (Figure 3.1), as discussed in Section 6.0.

Definitions based upon California Building Code (CBC) requirements for seismic evaluation of buildings using Risk Categories of CBC Table 1604A.5, depending on which applies, and performance criteria in CBC Table 317.5[2]	**Expected Seismic Performance Level** [1]
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria with BSE-1N and BSE-2N hazard levels replacing BSE-R and BSE-C as given in Chapter 3.	**I**
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria.	**II**
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria with BSE- 1N and BSE-2N hazard levels replacing BSE-R and BSE-C respectively as given in Chapter 3; alternatively, a building meeting CBC requirements for a new building.	**III**
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria.	**IV**
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria only if the BSE-R and BSE-C values are reduced to 2/3 of those specified for the site.	**V**
A building evaluated as not meeting the minimum requirements for Level V designation and not requiring a Level VII designation.	**VI**
A building evaluated as posing an immediate life-safety hazard to its occupants under gravity loads. The building should be evacuated and posted as dangerous until remedial actions are taken to assure the building can support CBC prescribed dead and live loads.	**VII**

Figure 3.1: Expected Seismic Performance Levels for Existing Buildings per *University of California Seismic Safety Policy* (2017), Appendix A

4.0 SITE SEISMICITY

4.1 Ground Motion Estimates

Part 10 of the *California Building Code* (CBC) regulates existing buildings. CBC Chapter 3 references American Society of Civil Engineers *Seismic Evaluation and Retrofit of Existing Buildings*, ASCE-41, as the standard for evaluating existing buildings. CBC Table 317.5 identifies the earthquake hazard to be used when seismically evaluating a building. The CBC definitions for earthquake ground motions to be assessed are summarized below for convenience.

- BSE-2: the 2,475-year return period earthquake ground motion, or the 150% of the Maximum Considered Earthquake ground motion for the site.
- BSE-C: the 975-year return period earthquake ground motion, similar to BSE-2E per ASCE 41
- BSE-1: two-thirds of the BSE-2, or the 475-year return period earthquake ground motion.
- BSE-R: the 225-year return period earthquake ground motion, similar to BSE-1E per ASCE 41

Spectral accelerations were obtained for the BSE-C hazard level (i.e., Basic Safety Earthquake-Collapse Prevention), which corresponds to an earthquake with an average return period of 1000 years or 5% probability of exceedance in 50 years. BSE-C spectral accelerations are used to construct the response spectra for investigating whether the building satisfies the ASCE 41 Collapse Prevention performance objectives, as specified in CBC Table 317.5. Response spectral acceleration information was obtained from the *ATC Hazards website (hazards.atcouncil.org)* for the UCLA Lake Arrowhead Conference Center. Since a geotechnical report was not available for review, site geotechnical conditions were assumed to be consistent with default Site Class D (ASCE 41, Section 2.4.1.6.2). For this project, the spectral acceleration parameters for the BSE-C and BSE-R hazards per the ATC Hazards by Location Tool for default Site Class D are:

BSE-C / BSE-2E: S_{CS} = 1.748g and S_{C1} = 0.953g
BSE-R / BSE-1E: S_{CS} = 0.918g and S_{C1} = 0.542g

Figure 4.1 presents the response spectra for the BSE-C hazard level using the spectral ordinates per the *ATC Hazards website*. Based on the 0.2 second and 1.0 second spectral accelerations, the level of seismicity at this site is "High" per ASCE 41 Table 2-4.

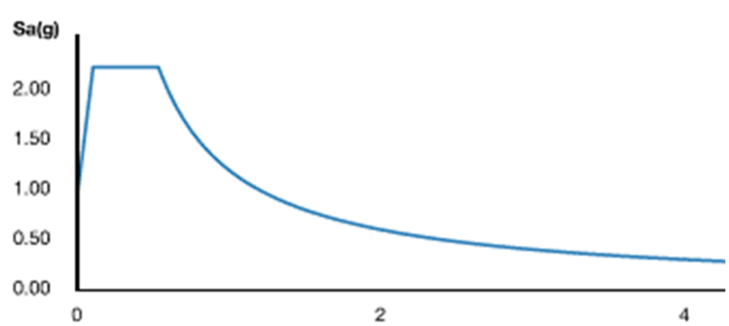
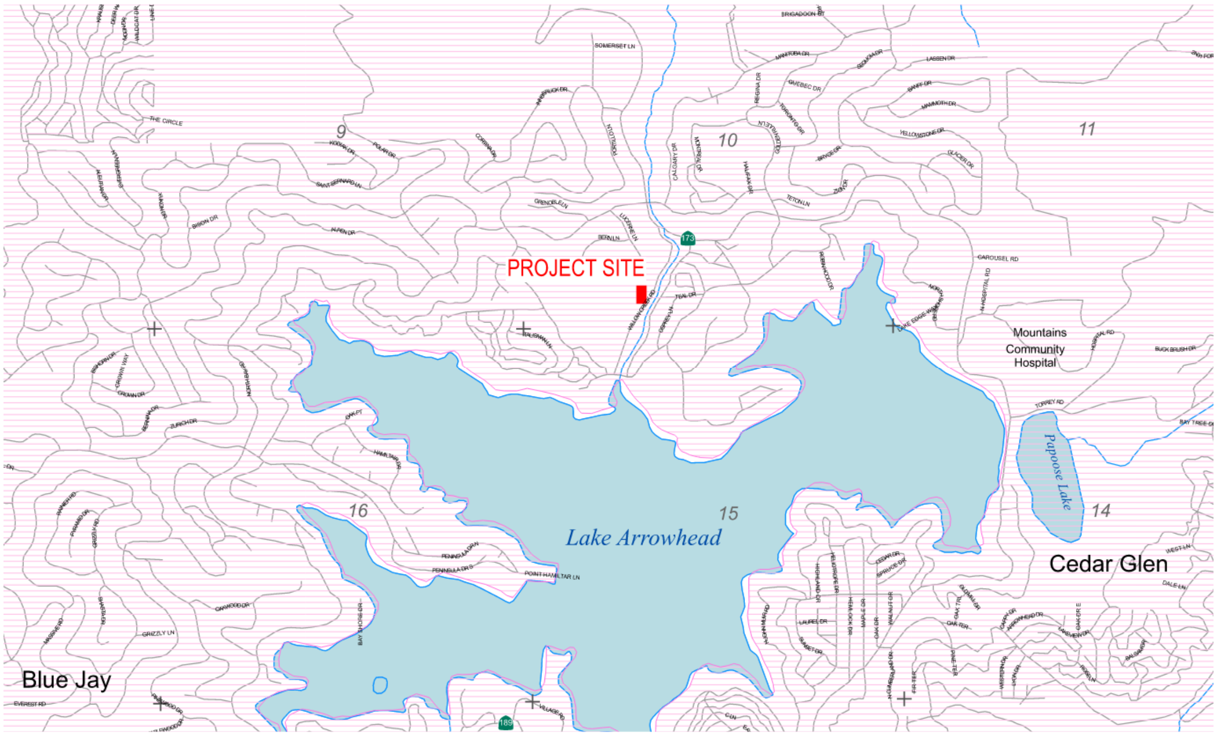


Figure 4.1: Horizontal Response Spectra for the BSE-C Hazard Level

4.2 Seismic or Geotechnical Hazards

The State of California has issued a set of regulatory maps detailing regions of potential liquefaction, landslide, and ground fault rupture. The *California Geological Survey* (CGS) maps were consulted to determine whether the building was constructed within an earthquake fault zone or in an area that would require evaluation of liquefaction or landslide potential. *San Bernardino County Land Use Service Geologic Hazard Maps* identifies the closest active fault to UCLA Lake Arrowhead Conference center as the San Andreas fault mapped at a distance of about 7.5 miles from the site. According to the hazard map, the LACC Facility 1 does not appear to be within a liquefaction zone per the partial map shown in Figure 4.2, and the landslide risk is low to moderate.



Generalized Landslide Susceptibility

- Low to moderate
- Moderate to high
- Mapped, Existing Landslide
- Rockfall/Debris-Flow Hazard Area (Forest Falls Only)

Map data originally compiled on 1:48,000 scale mosaicked maps photo-reduced from 7-1/2 minute USGS quads by D.M. Morton, U.S. Geological Survey, 1974 and by S.S. Tan, State Division of Mines and Geology, 1989.

Positional accuracy of map data is at best plus or minus 150 feet.

Zone of Suspected Liquefaction Susceptibility

- Zone of Susceptibility

The Zone of Suspected Liquefaction Susceptibility layer compiled by the San Bernardino County Geologist, 2009

Positional accuracy of map data is at best plus or minus 200 feet.

Generalized Liquefaction Susceptibility

- Low
- Medium
- High

Map data originally compiled on 1:48,000 scale mosaicked maps photo-reduced from 7-1/2 minute USGS quads by J.E. Matti and S.E. Carson, 1986.

Positional accuracy of map data is at best plus or minus 150 feet.

Earthquake Fault Zones

- Cities
- Earthquake Fault Zone Boundary
- County Designated Fault Zones

Map data compiled on 7-1/2 and 15-minute USGS quadrangle maps by the State of California, Division of Mines and Geology, 1987.

Positional accuracy of map data is at best plus or minus 150 feet.

NOTICE:
Effective January 1, 1994, the name "Special Studies Zones" has been changed to "Earthquake Fault Zones" and Chap. 7.5, Div. 2, of the Public Resources Code has been renamed the "Alquist-Priolo Earthquake Fault Zoning Act."

Figure 4.2: San Bernardino County Land Use Plan (General Plan Geologic Hazard Overlays)

5.0 SEISMIC EVALUATION

5.1 ASCE 41 Tier 1

Given the building type and assumed date of construction, the building does not satisfy the requirements of a benchmark building (e.g., it is not a wood light frames building constructed in accordance with the 1976 *Uniform Building Code*). In general, a benchmark building is deemed to satisfy the specified seismic performance levels and no additional review is required. In the case of this building, a Tier 1 analysis is required.

Tier 1 checklists were completed for the seismic force resisting system (SFRS) for the applicable building type in ASCE 41 Table 3-1. The SFRS for the main building consists of *W1: Wood Light Frames*. The following Tier 1 checklists were completed for the main building:

- Table 17-2: Collapse Prevention Basic Configuration Checklist.
- Table 17-4: Collapse Prevention Structural Checklist for Building Types W1 and W1a

All the checklist items were found to comply or not be applicable to this building, with the exceptions identified below. A non-compliant item does not mean that a structural deficiency necessarily exists but flags the item for additional review using a Tier 2 evaluation.

- **Non-Compliant Items for Collapse Prevention Basic Configuration Checklist:**
  - Overturning: The ratio of the least horizontal dimension of the seismic-force-resisting-system at the foundation level to the building height is less than 0.6Sa.
  - Shear Stress Check: The shear stress in the shear walls, calculated using the Quick Check procedure is less than the capacity values provided.
  - Narrow Wood Shear Walls: There are some narrow wood shear walls used to resist seismic force with an aspect ratio greater than 2-to-1.
  - Load Path: There is no shear blocking between the roof/floor joist to transfer the roof/mezzanine diaphragm loads to the shear walls. The mezzanine diaphragm does not extend to the exterior walls. The discontinuity also creates an incomplete load path.
  - Openings: The east elevation walls are with openings greater than 80% of the length but are not braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 nor are they supported by adjacent construction through positive ties capable of transferring the seismic forces.
  - Diaphragm Continuity: The mezzanine diaphragm does not extend to the exterior walls, which creates discontinuity.
  - Spans: The mezzanine diaphragm has a span greater than 24 ft but only consists of wood straight sheathing, not structural panels nor diagonal sheathing.

- **Compliant Items for Collapse Prevention Basic Configuration Checklist Based on Assumptions (Shall be verified in the field):**
  - Wood Post: There is a positive connection of wood posts to the foundation based on the assumption that the building has similar construction to the adjacent Facility 2 building.
  - Wood Sills: All wood sills are bolted to the foundation based on the assumption that the building has similar construction to the adjacent Facility 2 building.
  - Girder/Column Connection: There is a positive connection using plates, connection hardware, or straps between the girder and the column support based on the assumption that the building has similar construction to the adjacent Facility 2 building.
  - Wood Sill Bolts: Sill bolts are spaced at 6 ft (1.8 m) or less with acceptable edge and end distance provided for wood and concrete.
  - Roof Chord Continuity: All chord elements are continuous, regardless of changes in roof elevation.

5.2 ASCE 41 Tier 2 Seismic Evaluation

Based on the potential deficiencies outlined in Section 5.1, a linear static analysis (equivalent lateral force method) was performed to assess their significance on the seismic performance of the structure. The evaluation was performed using the ASCE 41 Tier 2 Deficiency-Based Evaluation. The roof diaphragm consists of plywood sheathing nailed to the discrete flat 1x members nailed to the roof joist or truss members as previously described. All exterior shear walls are assumed to have 3/8” thick plywood sheathing on both sides and all interior walls are assumed to have gypsum sheathing with edge and field spacing to be 4” and 12”, respectively. The layout of the assumed different types of shear walls is shown in Figure 5.1 The mezzanine diaphragm is assumed to have plywood nailed to the floor joist. The assumptions are made based on the record drawings of the Facility 2 building nearby and our professional judgment. Considering the similarity in appearance between the two buildings and the assumed similarity in construction dates, it is our opinion that it is reasonable to assume that they have similar construction attributes. Figure 5.2 shows a typical building section of the adjacent Facility 2 building.

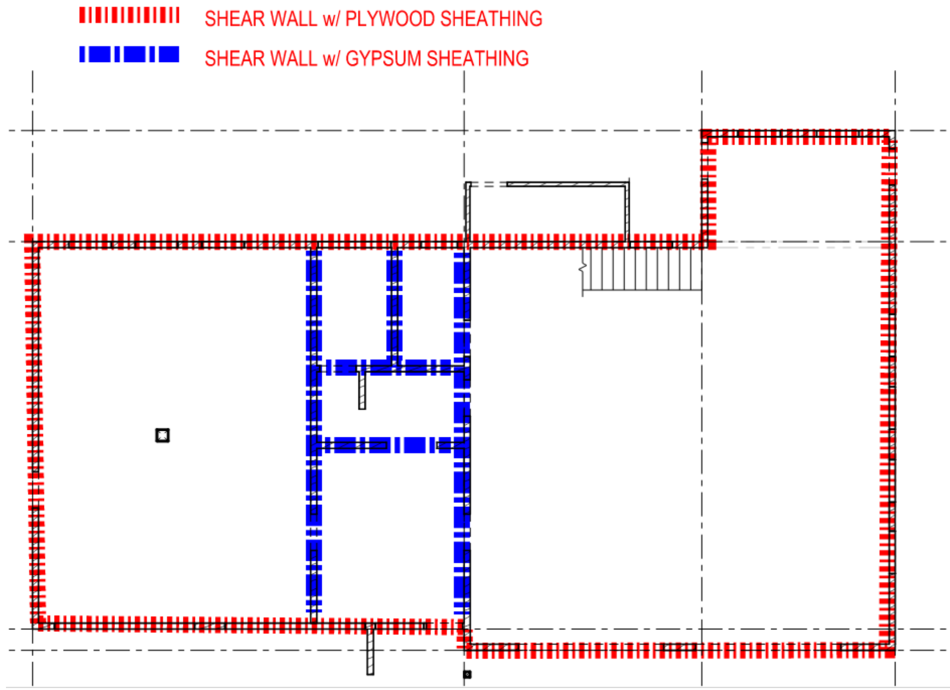


Figure 5.1: Building Shear Wall Layout

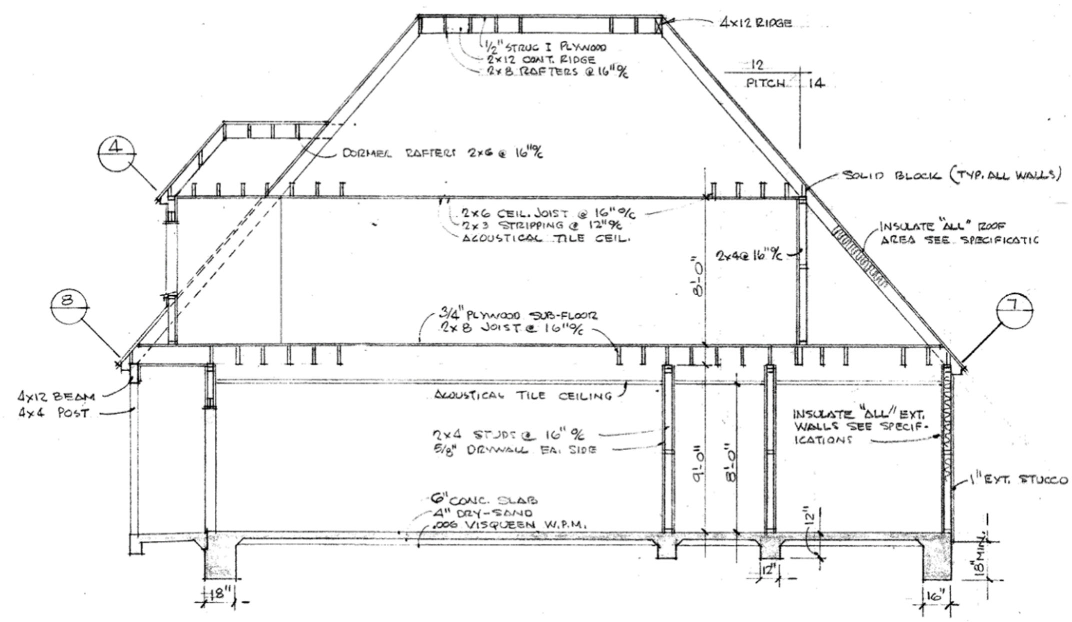


Figure 5.2: Adjacent Facility 2 Building Section

BSE-C versus BSE-R:

The building has been checked for both the BSE-C (Collapse-Prevention equivalent) and the BSE-R (Life-Safety equivalent) hazards; however, no deficiencies were found for the BSE-R hazard using the assumptions outlined above, The BSE-C hazard governed the evaluation due to higher element demand-to-capacity ratios.

5.2.1 Component Strength versus Acceptance Criteria

ASCE 41 classifies actions as deformation-controlled or force-controlled. A deformation-controlled action is defined as an action that has an allowable deformation greater than the deformation associated with the yield strength of a member, and a force-controlled action is defined as an action that has a deformation that is not allowed to exceed the deformation associated with the yield strength of the member. Members with limited ductility are considered force-controlled. Where actions are considered deformation-controlled, ASCE 41 allows the use of a component capacity modification factor, "*m,*" to account for the expected ductility associated with these actions at the selected Performance Level. The demand is then compared with the component's expected strength, calculated using conventional structural engineering methods and standards, and multiplied by a strength reduction factor, ϕ, equal to unity.

For deformation-controlled actions, the acceptance criteria and the equivalent lateral load, Q_{UD}, are defined as:

$$mkQ_{CE} \geq Q_{UD}$$

$$Q_{UD} = Q_G \pm Q_E$$

where:

Q_{CE} = Expected strength of the component

m = Component modification factor

k = Knowledge factor

A knowledge factor equal to 0.75 is considered appropriate for this review due to lack of record drawings, and with Chapter 6 of ASCE 41.

For force-controlled actions, the demands are compared with the lower bound strength, calculated using conventional structural engineering methods and standards, and multiplied by a strength reduction factor, ϕ, equal to unity. The acceptance criteria and the equivalent lateral load, Q_{UF}, are defined as:

$$kQ_{CL} > Q_{UF}$$

$$Q_{UF} = Q_G \pm Q_E/C_1C_2J$$

where:

Q_{CL} = Lower bound strength of the component

Q_G = Gravity load effect

Q_E = Seismic load effect

C_1 *and* C_2 = Modification factors specified for the structural component being evaluated

J = Force delivery reduction factor

5.2.2 Analytical Results

Based on analysis results conducted using Tier 2 procedures, the non-compliant conditions identified in the Tier 1 Screening were confirmed as still non-compliant under the Tier 2 requirements of ASCE 41. See detailed descriptions below.

5.2.2.1 Overturning

There are a number of large window and door openings at the east and west elevations of the building, which leaves very limited length of walls that were considered effective as shear walls. As a result of the openings, the walls have high aspect ratios, which results in high overturning demand. Even though the anchor bolts and holdowns are likely to exist based on the record drawings of Facility 2, the magnitude of the overturning demand exceeds the capacity of holdowns specified in the 1970s. The overturning check is still considered non-compliant.

5.2.2.2 Shear Stress Check

Assumptions were made that all exterior shear walls have plywood sheathing on both sides, and all interior walls have gypsum sheathing. Most of the shear walls in both the building longitudinal and transverse directions, other than the north and south exterior walls, have demand-to-capacity ratios greater than 1.3 in the Tier 2 analysis. The shear wall length may have been reduced due to the addition of the pop-out room at the northwest corner, which shall be considered a negative impact to the structure. The shear stress check is still considered non-compliant. Figure 5.3 shows the non-compliant shear walls with demand capacity ratio greater than 1.3. For the middle shear wall in the east-west direction, another check was made assuming plywood sheathing on both sides. But the demand capacity ratio is still greater than 1.6.

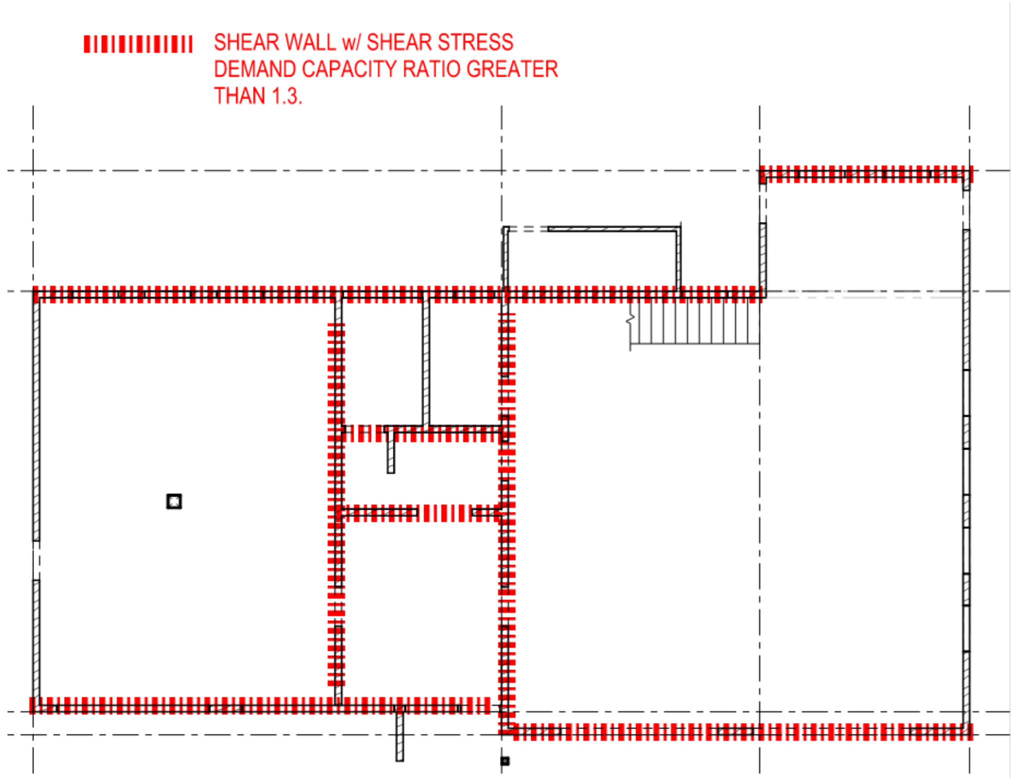


Figure 5.3: Shear Walls with DCR>1.3 Layout

5.2.2.3 Narrow Wood Shear Walls

Tall openings and limited length of shear walls available at the east and west elevations of the building create wall panels with high aspect ratios. In cases where the shear stress is low, the high aspect ratio may be a of less concern; however, the shear stress in nearly all shear walls appears to be high. The narrow wood shear walls check is still considered non-compliant.

5.2.2.4 Load Path

A Tier 2 analysis cannot justify the existing condition nor waive the requirement of the shear blockings between roof/floor joist to form a complete load path. The item is still considered non-compliant.

5.2.2.5 Openings

A Tier 2 analysis cannot justify the existing condition nor waive the requirement of the structural panel shear walls with aspect ratios of not more than 1.5-to-1 or the support by adjacent construction through positive ties capable of transferring the seismic forces. The item is still considered non-compliant.

5.2.2.6 Diaphragm Continuity

A Tier 2 analysis cannot justify the existing condition nor waive the requirement of the mezzanine diaphragm extending to the exterior walls with shear blocking to transfer the shear to the walls. The item is still considered non-compliant.

5.2.2.7 Spans

A Tier 2 analysis cannot justify the existing condition nor waive the requirement of the structural panels or diagonal sheathing at the mezzanine diaphragm. The item is still considered non-compliant.

6.0 CONCLUSIONS

Based on an evaluation of the building using ASCE 41-17 Tier 1 Checklists, the results from a Tier 2 analysis, site observations, and the requirements of the 2019 CBC Part 10, we recommend a Seismic Performance Rating of ***Level V*** as defined by the *University of California Seismic Safety Policy*, Appendix A.

To achieve a rating of IV or higher per *UC Seismic Safety Policy*, the upgrade recommendations are as follows:

- Strengthen the existing shear wall panels by using thicker plywood sheathing and adding nails to reduce the nailing spacing.
- Increase shear wall length by adding infill to some of the window openings.
- Add holdowns at the shear wall boundary elements to increase the overturning capacity.
- Add a moment frame on the inside face of the walls with large openings.
- Add plywood sheathing at mezzanine floor and extend the diaphragm to the walls with shear blocking between the joists to transfer the diaphragm force.

tas:jq:klc

Seismic Force Calculations per ASCE 41-17

1. Seismic Weight ASCE 41-17 s4.4.2.1					
	Floor		Ext. Wall		
	Area (sqft)	w (psf)	Area (sqft)	w (psf)	W Total (Kips)
Roof	2450.00	18	336.00	18.5	50
Level-02	610.00	14.6	1350.00	18.5	34

Structure Time Period Calc (4-4)	
Ct	0.02
Hn (ft.)	21.00
Beta	0.75
Tn (sec)	0.20
W (KIPS)	84.20
k	1.00

HAZARD LEVEL - BSE 1E						
INPUT VALUES						
Sx1	0.542					
SxS	0.918					
Sa	0.918	*(4-3)*				
C1.C2	1.4	*Table- (7-3)*				
Cm	1.00	*Table- (7-4)*				
V (kips)	108.2	*(7-21)*				
Level	Seismic Weight	Story Height	Total Height	$w_x h_x^k$	Fx	Vj
-	(kips)	(ft)	(ft)		(kips)	(kips)
Roof	50	11.00	21.0	1057	82	82
2	34	10.00	10.0	339	26	108
TOTAL	84.20	-	-	1395	-	-

HAZARD LEVEL - BSE 2E						
INPUT VALUES						
Sx1	0.953					
SxS	1.748					
Sa	1.748	*(4-3)*				
C1.C2	1.4	*Table- (7-3)*				
Cm	1.00	*Table- (7-4)*				
V (kips)	206.0	*(7-21)*				
Level	Seismic Weight	Story Height	Total Height	$w_x h_x^k$	Fx	Vj
-	(kips)	(ft)	(ft)		(kips)	(kips)
Roof	50	11.00	21.0	1057	156	156
2	34	10.00	10.0	339	50	206
TOTAL	84.20	-	-	1395	-	-

Shear Wall - Demand & Capacity per ASCE 41-17

Project: 840 Willow Creek, Lake Arrowhead
Building: Facility 1

Hazard Level - BSE 1E

Level	Vj(Kips)
Roof	82
2nd	108

Level -Roof

Direction - EW

Shear Line	Length(ft)	Area (sqft)	Vj (kips)	Shear Demand Qud(#/ft)	Qce per Sheathing (#/ft)	m factor (Table 12-3)	k (Table 6-1)	# of Sheathing	Qud/m.k.Qce
EW-1*	29	626	-	-	-	-	-	-	-
EW-3	27.5	1177	38.1	1383.9	514	2.2	0.75	2	0.8
EW-4	17	731	23.6						#DIV/0!
Total	*73.5*	*2534*	-						

**Seismic force at Shear line EW-1 transferred to Level-02 by Gable diaphgram*

Direction - NS

Shear Line	Length(ft)	Area (sqft)	Vj (kips)	Shear Demand(#/ft)	Qce per Sheathing (#/ft)	m factor (Table 12-3)	k (Table 6-1)	# of Sheathing	Qud/m.k.Qce
NS-1	35.5	1226	41.8	1177.6	514	3.8	0.75	2	0.4
NS-4	46	1177	40.1	872.5	514	3.8	0.75	2	0.3
Total	*81.5*	*2403*	-						

Level -02

Direction - EW

Shear Line	Length(ft)	Area (sqft)	Vj (kips)	Shear Demand(#/ft)	Qce per Sheathing (#/ft)	m factor (Table 12-3)	k (Table 6-1)	# of Sheathing	Qud/m.k.Qce
EW-1	29	378	16.0	552.0	514	3.8	0.75	2	0.2
EW-2	28.5	567	24.0	842.6	140	2.2	0.75	2	1.8
EW-3	27.5	856	36.3	1318.3	140	2.2	0.75	2	2.9
EW-4	17	754	31.9	1878.4	514	3.8	0.75	2	0.6
Total	*102*	*2555*	-						

Direction - NS

Shear Line	Length(ft)	Area (sqft)	Vj (kips)	Shear Demand(#/ft)	Qce per Sheathing (#/ft)	m factor (Table 12-3)	k (Table 6-1)	# of Sheathing	Qud/m.k.Qce
NS-1	17	1129	47.8	2810.5	514	3.8	0.75	2	1.0
NS-2	6.25	150	6.3	1015.7	140	2.2	0.75	2	2.2
NS-3	9	91	3.9	427.9	140	2.2	0.75	2	0.9
NS-4	21	1150	48.7	2317.5	514	3.8	0.75	2	0.8
NS-5	10	37	1.6	156.6	514	2.2	0.75	2	0.1
Total	*63.25*	*2557*	-						

*Shear wall aspect ratio's area >2 for NS-1 Level 1

Shear Wall - Demand & Capacity per ASCE 41-17

Project: **840 Willow Creek, Lake Arrowhead**

Building: **Facility 1**

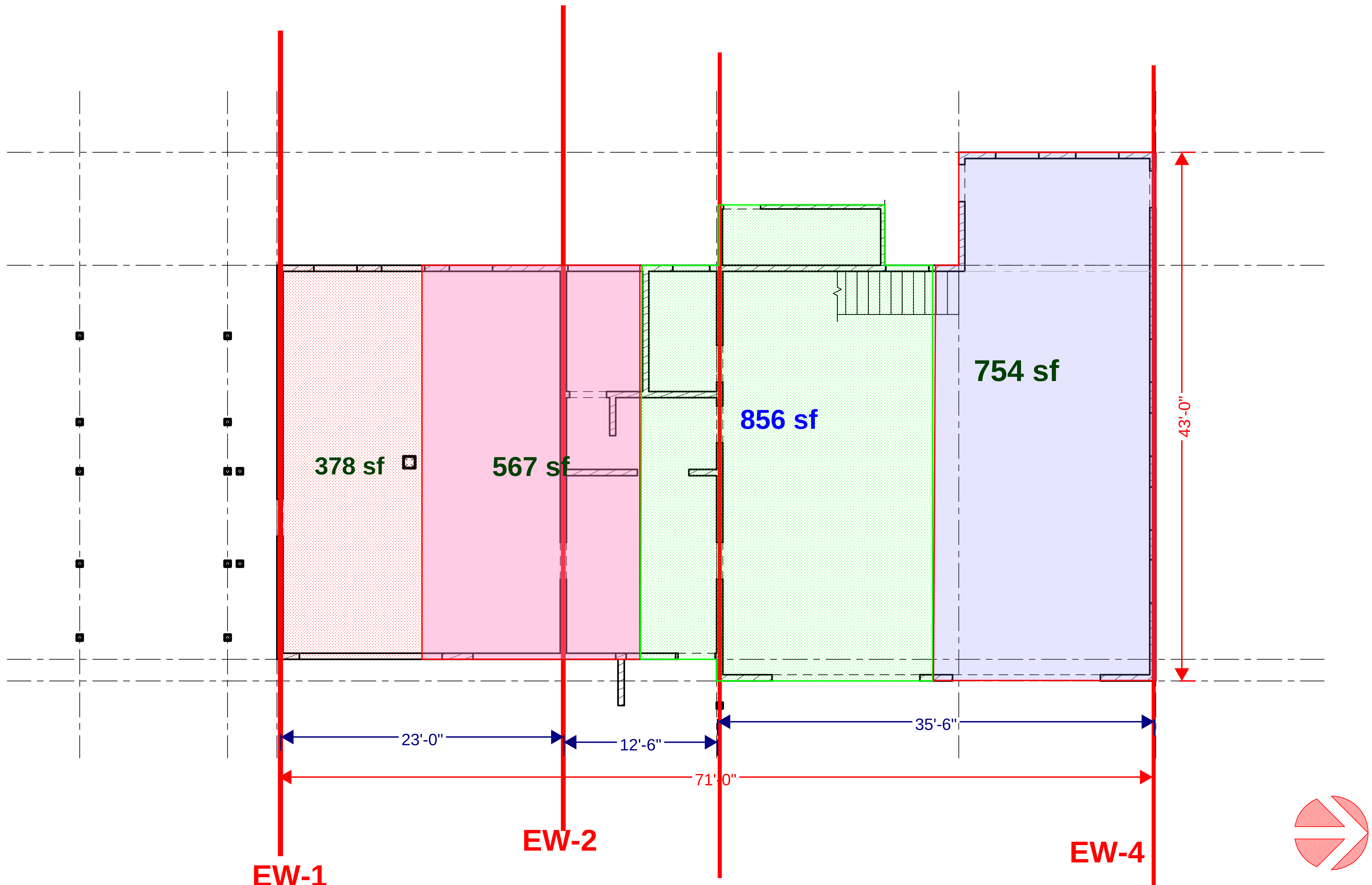
Hazard Level - BSE 2E

Level	Vj(Kips)
Roof	156
2nd	206

Level -Roof									
Direction - EW									
Shear Line	**Length(ft)**	**Area (sqft)**	**Vj (kips)**	**Shear Demand(#/ft)**	**Qce per Sheathing (#/ft)**	**m factor (Table 12-3)**	**k (Table 6-1)**	**# of Sheathing**	**Qud/m.k.Qce**
EW-1*	29	626	-	-	-	-	-	-	-
EW-3	27.5	1177	72.5	2635.2	514	2.5	0.75	2	1.4
EW-4	17	731							
Total	***73.5***	***2534***	-						
**Seismic force at Shear line EW-1 transferred to Level-02 by Gable diaphgram*									
Direction - NS									
Shear Line	**Length(ft)**	**Area (sqft)**	**Vj (kips)**	**Shear Demand(#/ft)**	**Qce per Sheathing (#/ft)**	**m factor (Table 12-3)**	**k (Table 6-1)**	**# of Sheathing**	**Qud/m.k.Qce**
NS-1	35.5	1226	79.6	2242.3	514	4.5	0.75	2	0.6
NS-4	46	1177	76.4	1661.3	514	4.5	0.75	2	0.5
Total	***81.5***	***2403***	-						

Level -02									
Direction - EW									
Shear Line	**Length(ft)**	**Area (sqft)**	**Vj (kips)**	**Shear Demand(#/ft)**	**Qce per Sheathing (#/ft)**	**m factor (Table 12-3)**	**k (Table 6-1)**	**# of Sheathing**	**Qud/m.k.Qce**
EW-1	29	378	30.5	1051.2	514	4.5	0.75	2	0.3
EW-2	28.5	567	45.7	1604.4	140	2.5	0.75	2	3.1
EW-3	27.5	856	69.0	2510.2	140	2.5	0.75	2	4.8
EW-4	17	754	60.8	3576.8	514	4.5	0.75	2	1.0
Total	***102***	***2555***	-						
Direction - NS									
Shear Line	**Length(ft)**	**Area (sqft)**	**Vj (kips)**	**Shear Demand(#/ft)**	**Qce per Sheathing (#/ft)**	**m factor (Table 12-3)**	**k (Table 6-1)**	**# of Sheathing**	**Qud/m.k.Qce**
NS-1	17	1129	91.0	5351.6	514	4.5	0.75	2	1.5
NS-2	6.25	150	12.1	1934.0	140	2.5	0.75	2	3.7
NS-3	9	91	7.3	814.8	140	2.5	0.75	2	1.6
NS-4	21	1150	92.7	4412.8	514	4.5	0.75	2	1.3
NS-5	10	37	3.0	298.2	514	4.5	0.75	2	0.1
Total	***63.25***	***2557***	-						

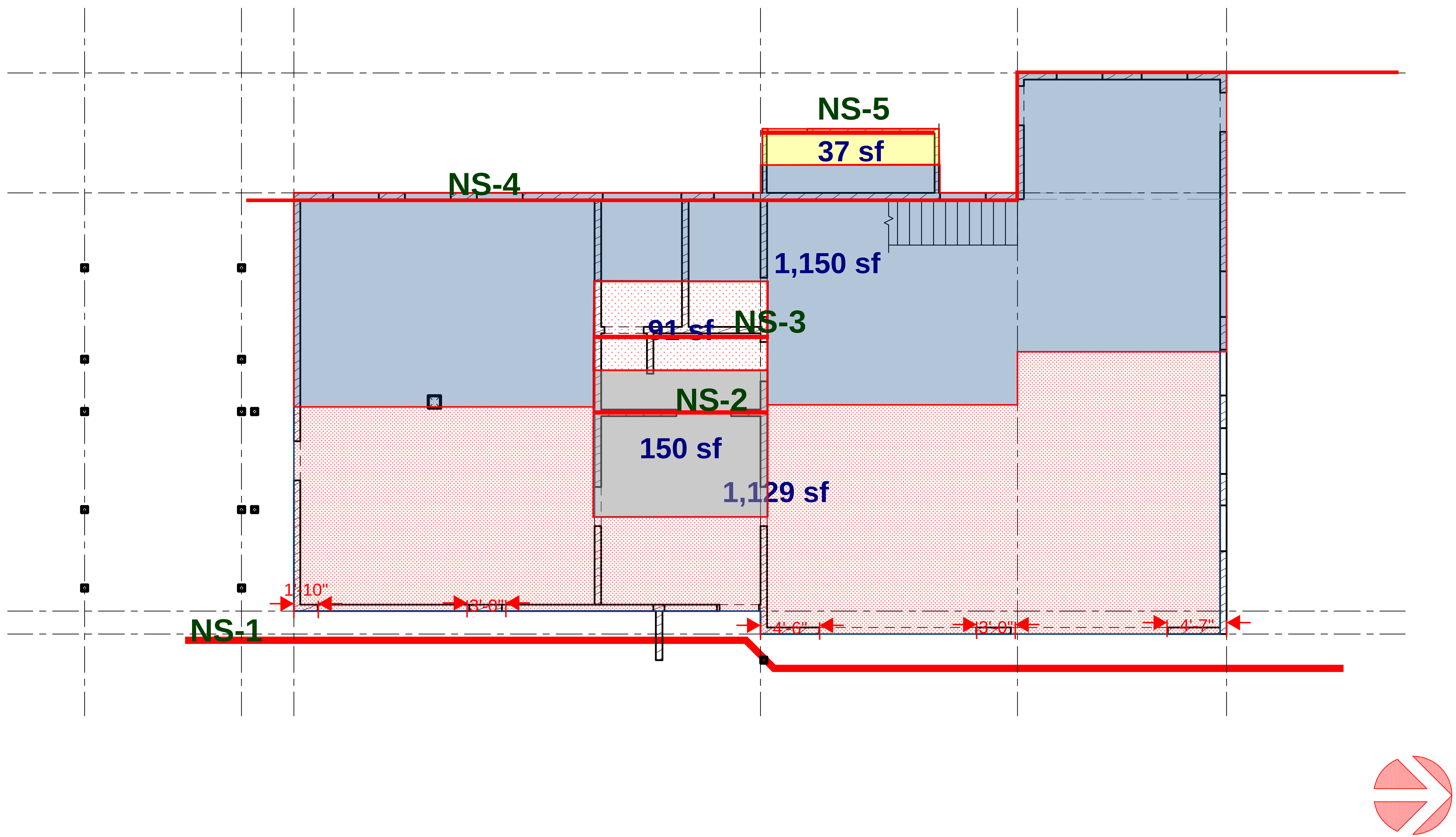
*Shear wall aspect ratio's area >2 for NS-1 Level 1



1ST FLOOR PLAN

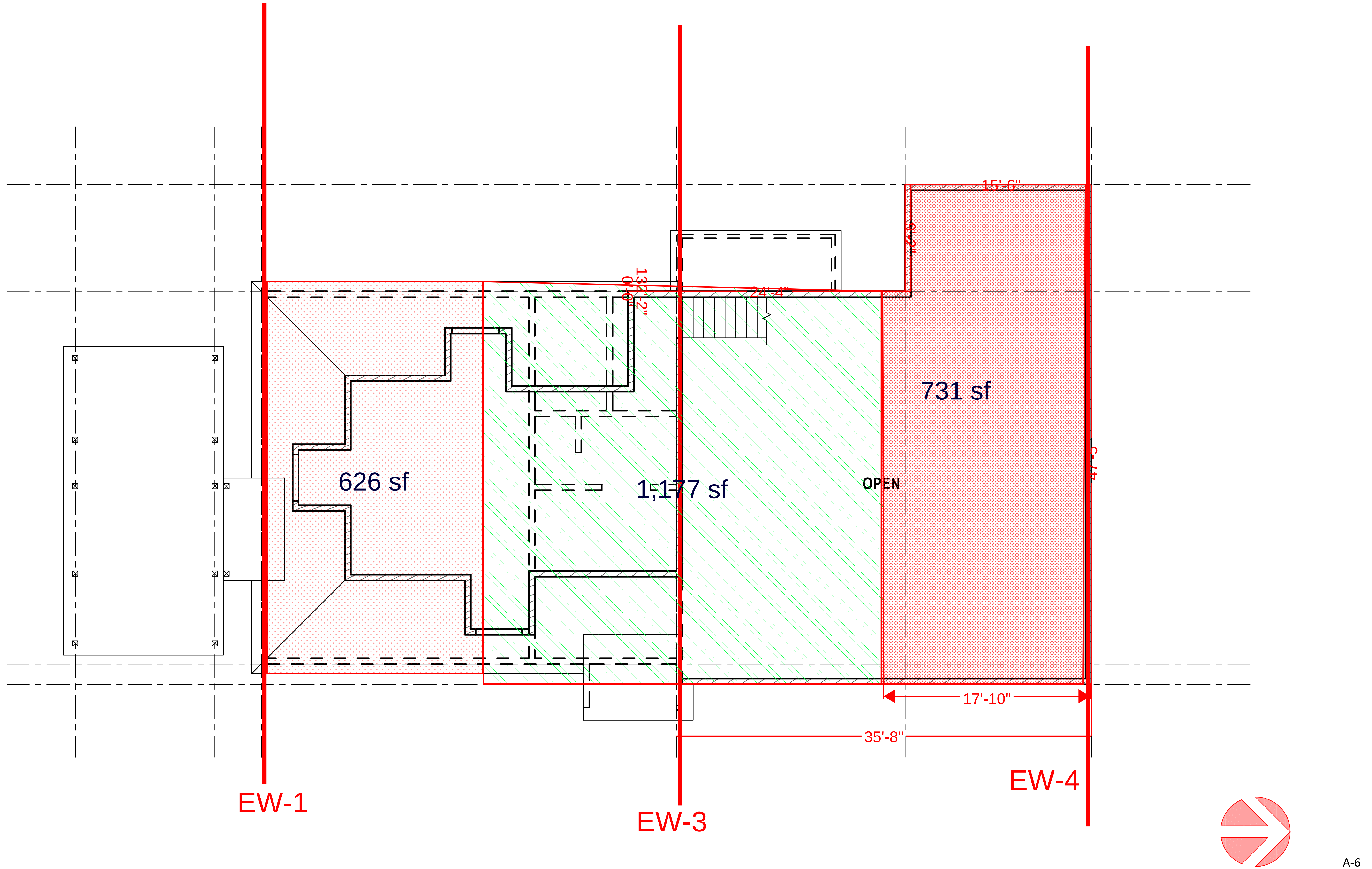
A

1/8" = 1'-0"

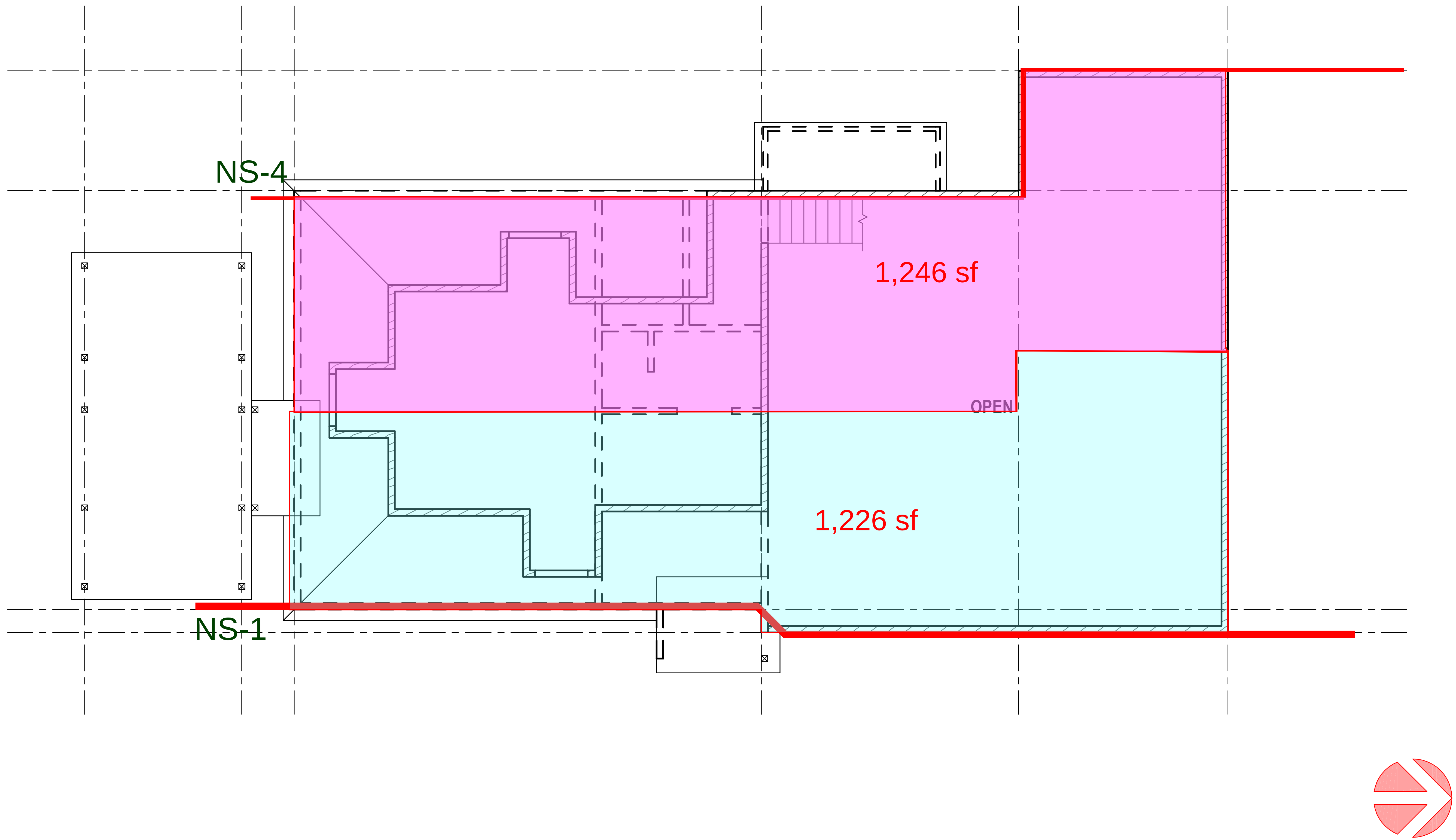


A-5

1ST FLOOR PLAN
1/8" = 1'-0"
A



2ND FLOOR PLAN
1/8" = 1'-0"
1



A-7

2ND FLOOR PLAN
1/8" = 1'-0"
1