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Structural Calculations for:

Whitney-Gedeon Residence

4219 91st Ave SE, Mercer Island, WA 98040

Client: Live-Work-Play
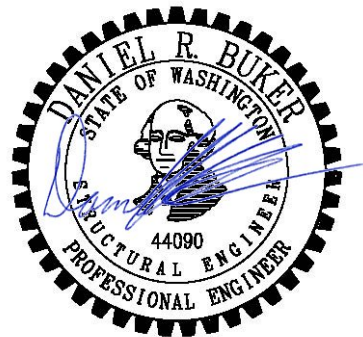
Code: 2015 International Building Code

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Scope: Structural Design of Single Family Residence Addition

September 23, 2019

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Seismic Design Loads (ASCE 7-10)

for a Wood Framed Structure

RISK CATEGORY II
OCCUPANCY CAT. II   Table 1-1
IMP. FACTOR 1   Table 11.5-1
SITE CLASS D   Table 20.3-1   SEISMIC
$R = 6.5$ Table 12.2-1   DESIGN CATEGORY D   11.6.1.1

$S_s = 1.407$
$S_1 = 0.54$
$F_a = 1.00$ Table 11.4-1
$F_v = 1.50$ Table 11.4-2   Seismic Dead Load: 15 ^{psf} Roof
$S_{DS} = 0.938$ 15 ^{psf} Floor
$S_{D1} = 0.540$ 20 ^{psf} Walls

$Cs_{ULT} = 0.144$ Eqn. 12.8-2 $W_{roof} = 15 + 10 = 25^{psf}$
$Cs_{ASD} = 0.103$ $W_{floor} = 10 + 10 + 10 = 30^{psf}$

Vertical Design Loads

Criteria
ASCE 7-10
IBC 2015

Dead Loads

Roof (Composit)	2.5 psf	Flooring	1 psf
1/2" Ply	1.5 psf	Sheathing	2.3 psf
Rafter/Truss	2 psf	Joist	2.6 psf
Insulation	1 psf	5/8" GWB	3.1 psf
5/8" GWB	3.1 psf	Misc. Mech	1 psf
Misc./Mech.	2 psf		10 psf
	12.1 psf		
Use	15 psf	Use	15 psf

Live Loads

Snow   25 psf
floor   40 psf

Soil Bearing

2000 psf

C1

$$\frac{H}{L_h} = \frac{49}{1047} = 0.05 \le 0.2 \quad \therefore \quad K_{zt} = 1.0$$

Whitney - Gedeon Residence

L1

Wind Design Loads (ASCE 7-10)

Directional Procedure - Part 1

Exposure B
V= 110 mph
K_d= 0.85
I= 1
G= 0.85

Table 26.6-1

26.9

Roof Angle = 11.31 degrees
Ground to top of roof 11 ft
Bottom of roof to top of roof 3 ft
(mean roof height) h= 9.5 ft

K_{zt}= 1.00

Pressure Coefficients
from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.5
Windward Roof	0.3
Leeward Roof	-0.6

*Note= Cp values are conservative
worst case values

Pressures:

Ht	K_z	q_z	$P_{ww\ walls}$	$P_{lw walls}$	Ultimate P_{walls} (psf)	**Allowable P_{walls} (psf)**
0-15	0.57	15.01	10.21	6.38	16.58	**9.95**
15-20	0.62	16.32	11.10	6.38	17.48	**10.49**
20-25	0.66	17.38	11.82	6.38	18.20	**10.92**
25-30	0.7	18.43	12.53	6.38	18.91	**11.35**
30-40	0.76	20.01	13.61	6.38	19.99	**11.99**

$P_{ww\ roof}$	$P_{lw roof}$	P_{roof} (psf)	P_{roof} (psf)
3.83	7.65	11.48	**6.89**

Use 12 psf on projected wind surfaces

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Project: Whitney-Gedeon Residence
4219 91st Ave SE
Mercer Island, WA 98040
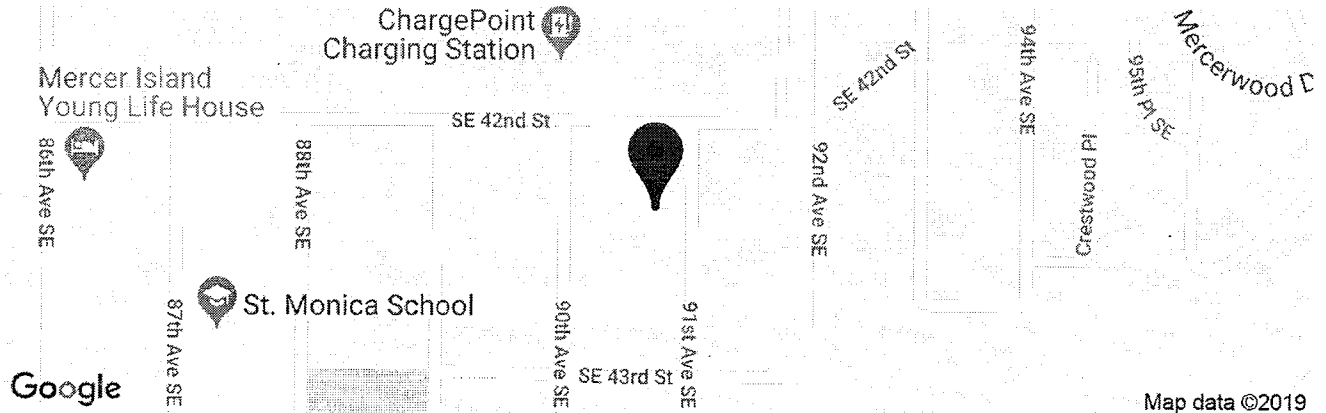
Date: 8/19/2019

Design: CRB

Whitney-Gedeon Residence

4219 91st Ave SE, Mercer Island, WA 98040, USA

Latitude, Longitude: 47.5702915, -122.21788370000001

Map data ©2019

Date	8/19/2019, 9:22:48 AM
Design Code Reference Document	ASCE7-10
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.407	MCE_R ground motion. (for 0.2 second period)
S_1	0.54	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.407	Site-modified spectral acceleration value
S_{M1}	0.81	Site-modified spectral acceleration value
S_{DS}	0.938	Numeric seismic design value at 0.2 second SA
S_{D1}	0.54	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.581	MCE_G peak ground acceleration
F_{PGA}	1	Site amplification factor at PGA
PGA_M	0.581	Site modified peak ground acceleration
T_L	6	Long-period transition period in seconds
SsRT	1.407	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.47	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	3.255	Factored deterministic acceleration value. (0.2 second)
S1RT	0.54	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.579	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.308	Factored deterministic acceleration value. (1.0 second)

Whitney-Gedeon Residence   L3

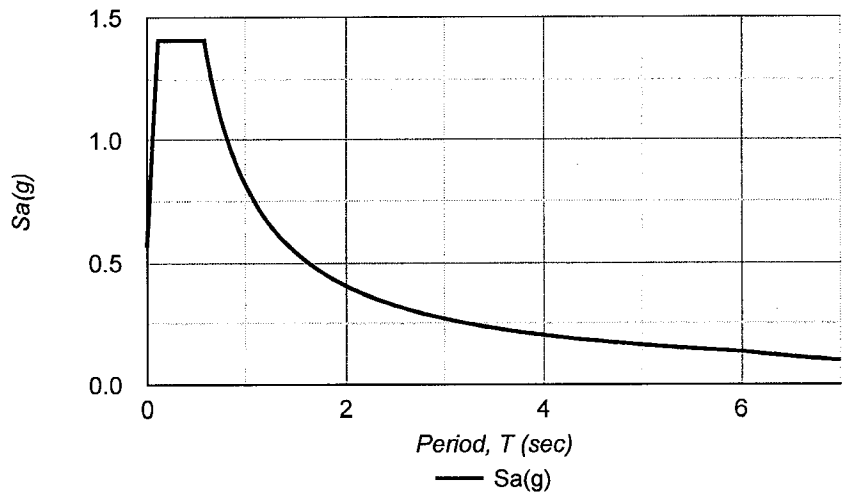| Type	Value	Description
PGAd	1.261	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.957	Mapped value of the risk coefficient at short periods
C_{R1}	0.933	Mapped value of the risk coefficient at a period of 1 s

House

$Cs = 0.144$

Level	Wx (K)	hx (ft)	Wxhx	Cvx	Fx (K)	
Roof	71.38	8	571	1.00	7.2	
Sum	71.38		571	1.0	7.2	**Allowable Base Shear**

Whitney - Gedeon Residence

L4

MCER Response Spectrum

Period, T (sec)

—— Sa(g)

Design Response Spectrum

Period, T (sec)

—— Sa(g)

Whitney- Gedeon Residence

L5

Lateral analysis
Shearwall KeyPlan
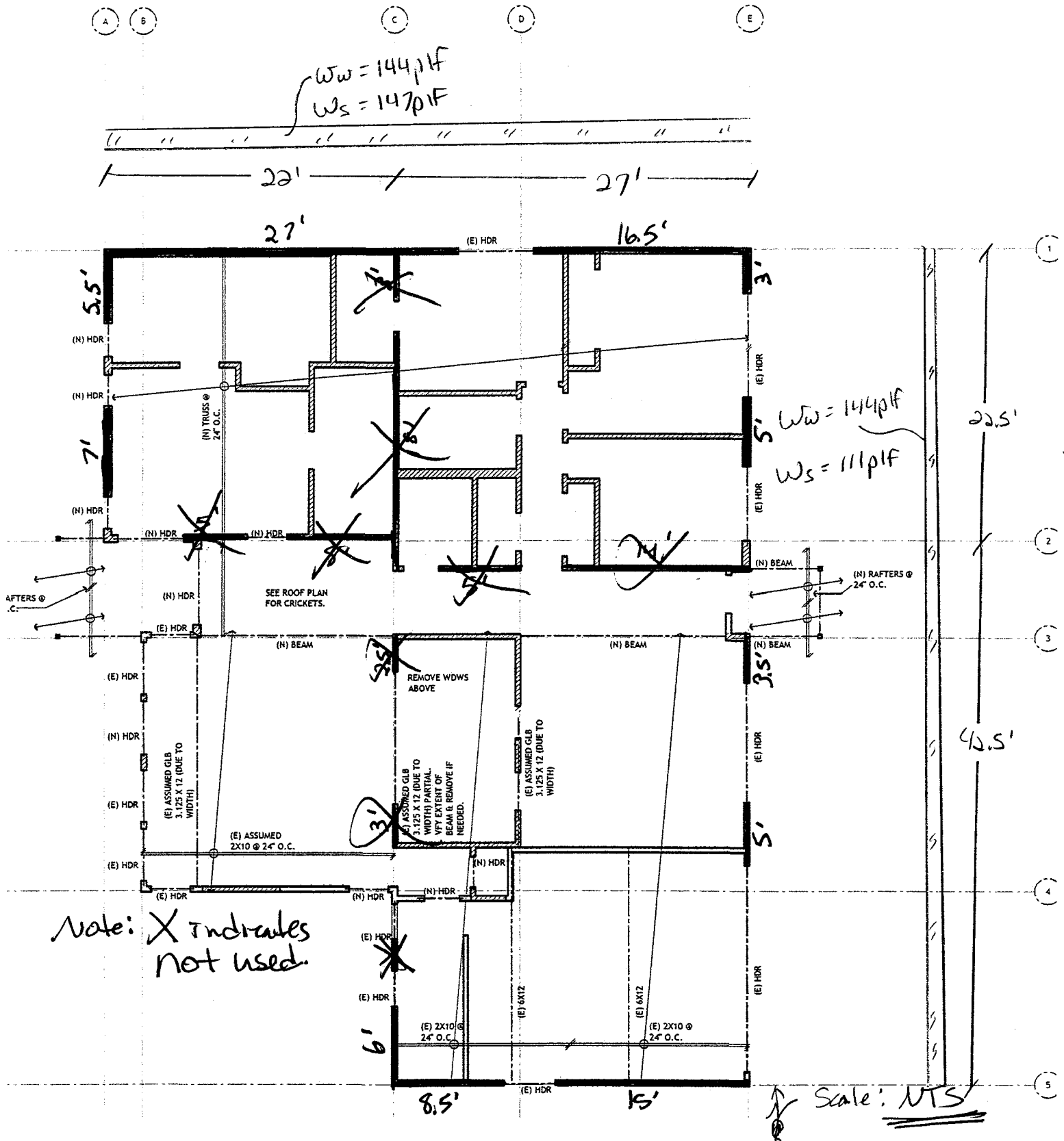
Whitney-Gedeon Residence

L6

Lateral Analysis   Roof Diaph/First Floor Walls   N/S Direction

Wind: W = 144 plf

Seismic: W = 147 plf

Grid:

49'

Wind:

3.5^k

3.5^k

Seismic:

3.6^k

3.6^k
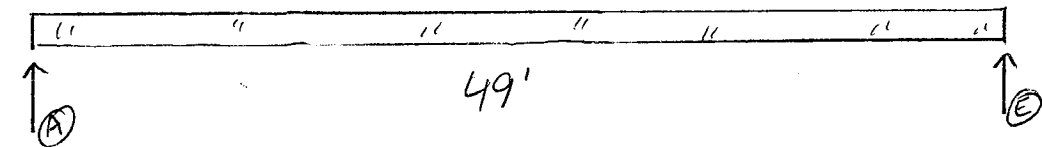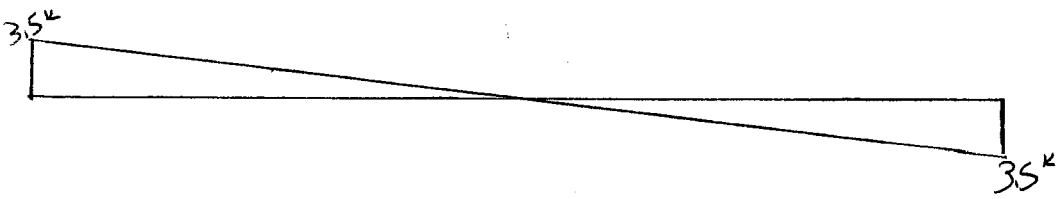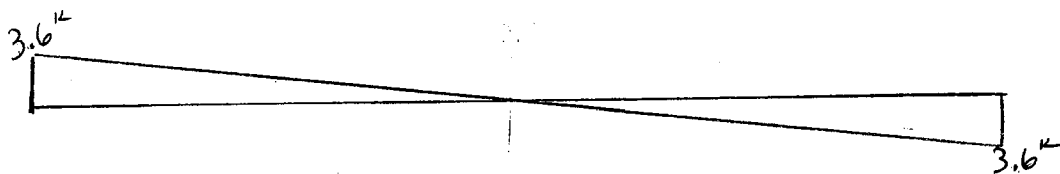
North/South Direction		
Grid	A	E
Vwind (kips)	3.5	3.5
Vseismic (kips)	3.6	3.6
Length of wall (ft)	12.5	16.5
v_wind (p/f)	280	212
v_siesmic (p/l)**	288	291
h (ft)	8	8
OTF_Wind (lbs)*	2240	1697
OTF_Seismic (lbs)*	2304	1745
Length of shortest wall pier (ft)	5.5	3
Apect Ratio Reduction for Seismic Loads	1.45	2.67
Siesmic Penalty	1.0	0.75
Shearwall	W4	W4
Holdown	HDU2	HDU2

*OTF does not take into account dead load and weight of the wall uno
**v_siesmic includes penalty

Lateral Analysis   Roof Diaph/First Floor walls   E/W Direction

Wind: W = 144 plf

Seismic: W = 111 plf

Grid:
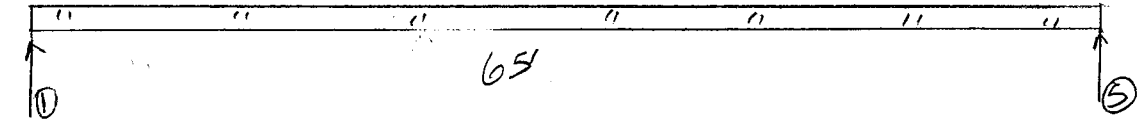
Wind:
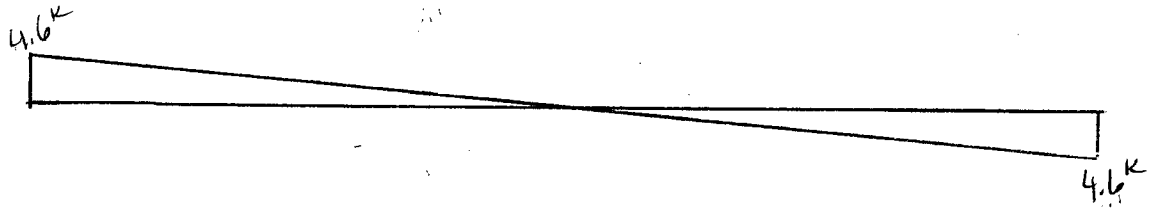
Seismic:
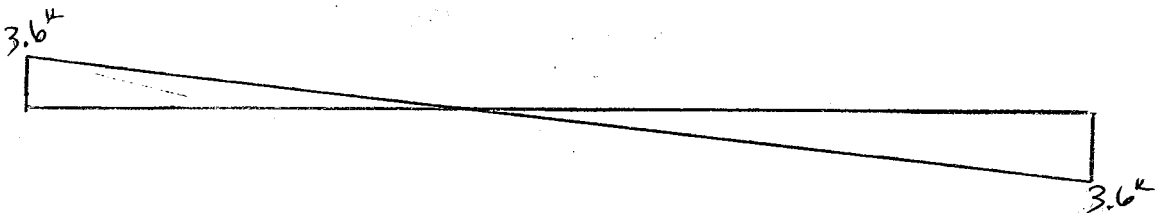
East/West Direction

Grid	1	5
Vwind (kips)	4.6	4.6
Vseismic (kips)	3.6	3.6
Length of wall (ft)	43.5	23.5
v_wind (p/f)	106	196
v_siesmic (p/l)**	83	153
h (ft)	8	8
OTF_Wind (lbs)*	846	1566
OTF_Seismic (lbs)*	662	1226
Length of shortest wall pier (ft)	16.5	8.5
Apect Ratio Reduction for Seismic Loads	0.48	0.94
Siesmic Penalty	1.0	1.0
Shearwall	W6	W6
Holdown	~~N/R~~ HDU2	HDU2

Line OK as Built

*OTF does not take into account dead load and weight of the wall uno
**v_siesmic includes penalty
N/R = Not Req'd

Whitney-Gedeon Residence Retrofit

Seismic Analysis (ASCE 7-10)

$S_s =$	1.407	$F_a =$	1.00	$S_{ms} =$	1.407	$S_{Ds} =$	0.94
$S_1 =$	0.54	$F_v =$	1.50	$S_{m1} =$	0.81	$S_{D1} =$	0.54

Site Class =	D	
Mean Roof Height =	25	ft
T =	0.22	sec
R =	6.5	
I =	1.0	
rho =	1.0	
Cs =	0.144	
W =	71.38	K
Allowable Base Shear V =	7.21	K

W=(1 stories)(2853 ft^2)(25 psf)
71.38 K

Wall	V (K)	Lw (ft)	V (plf)	Uplift (#)	Holdown*	Nailing	A.B./A35 **
North	3.61	27.0	134	0	Not Reqd.	4 o.c.	32/16
South	3.61	18.0	200	0	Not Reqd.	4 o.c.	32/16
East	3.61	28.0	129	0	Not Reqd.	4 o.c.	32/16
West	3.61	16.0	225	0	Not Reqd.	4 o.c.	32/16

* Holdown not required where wall length >= 2*wall height
** At full height foundation walls, provide FRFP @ 3'-0" o.c. or URFP @ 4'-0" o.c.

Seismic Retrofit on (E) Residence
@ full height Foundation walls

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L9

Roof Framing
Key Plan

Whitney - Gedeon Residence

F1

Scale: NTS

X = (E) Header
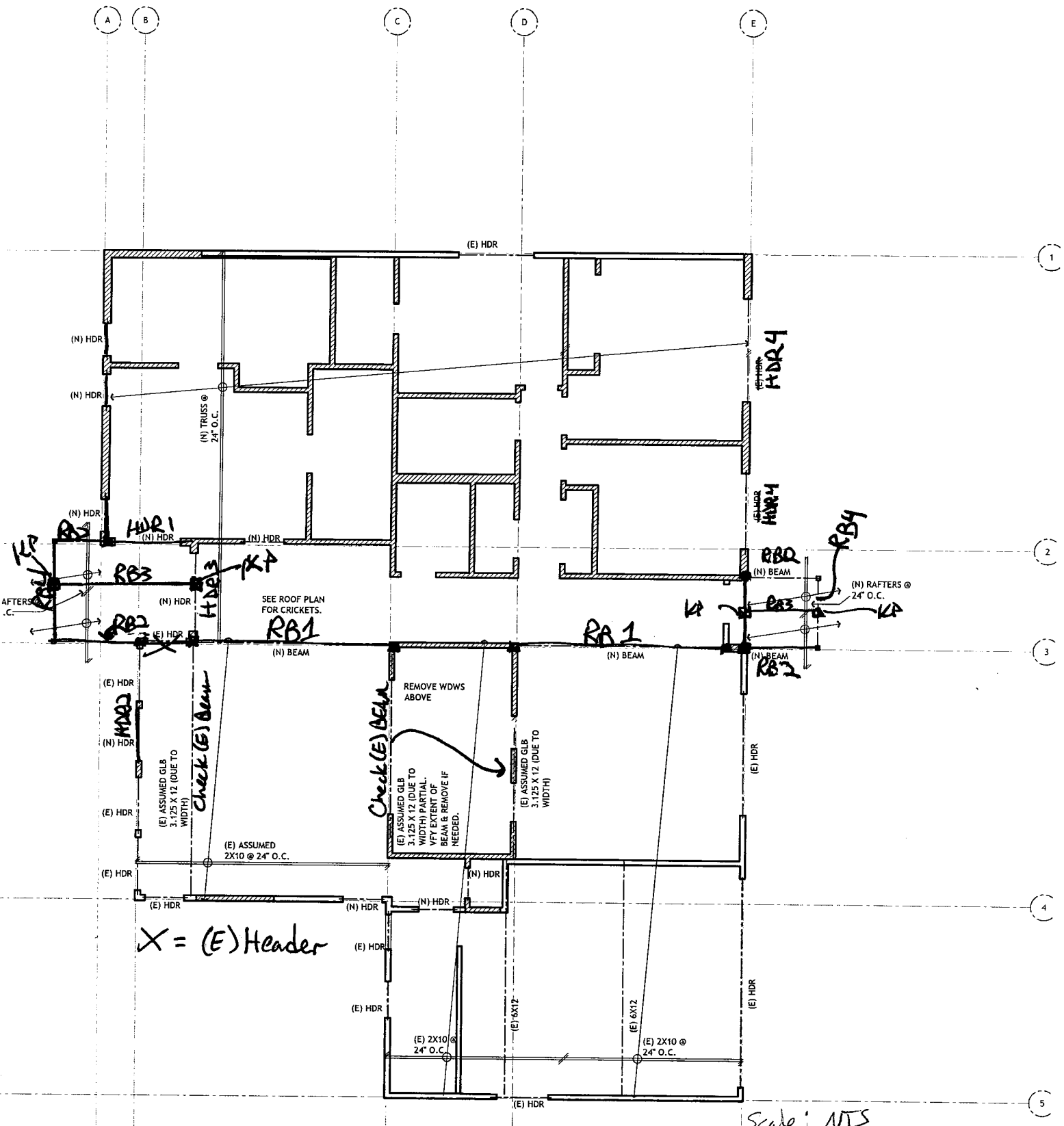
Section Properties & Capacities of Sawn Lumber

	b (in)	d (in)	Sx (in³)	Ix (in⁴)
2x4	1.5	3.5	3.06	5.36
2x6	1.5	5.5	7.56	20.80
2x8	1.5	7.25	13.14	47.63
2x10	1.5	9.25	21.39	98.93
2x12	1.5	11.25	31.64	177.98
2x14	1.5	13.25	43.89	290.78
3x4	2.5	3.5	5.10	8.93
3x6	2.5	5.5	12.60	34.66
3x8	2.5	7.25	21.90	79.39
3x10	2.5	9.25	35.65	164.89
3x12	2.5	11.25	52.73	296.63
3x14	2.5	13.25	73.15	484.63
4x4	3.5	3.5	7.15	12.51
4x6	3.5	5.5	17.65	48.53
4x8	3.5	7.25	30.66	111.15
4x10	3.5	9.25	49.91	230.84
4x12	3.5	11.25	73.83	415.28
4x14	3.5	13.25	102.41	678.48
6x6	5.5	5.5	27.73	76.26
6x8	5.5	7.5	51.56	193.36
6x10	5.5	9.5	82.73	392.96
6x12	5.5	11.5	121.23	697.07
6x14	5.5	13.5	167.06	1127.67
6x16	5.5	15.5	220.23	1706.78

	Hem-Fir No. 2		
M(#-ft)	Cd=1.0	Cd=1.15	Cd=1.6
(2)2x4	651	748	1,041
(2)2x6	1,393	1,602	2,228
(2)2x8	2,234	2,569	3,574
(2)2x10	3,333	3,833	5,333
(2)2x12	4,482	5,155	7,172
(2)2x14	5,596	6,435	8,954
	DF-L No. 2		
3x4	574	660	919
3x6	1,229	1,413	1,966
3x8	1,971	2,267	3,154
3x10	2,941	3,382	4,706
3x12	3,955	4,548	6,328
3x14	4,938	5,678	7,900
	DF-L No. 2		
4x4	804	924	1,286
4x6	1,720	1,979	2,753
4x8	2,989	3,438	4,783
4x10	4,492	5,166	7,187
4x12	6,091	7,004	9,745
4x14	7,681	8,833	12,289
	DF-L No. 1		
6x6	3,120	3,587	4,991
6x8	5,801	6,671	9,281
6x10	9,307	10,703	14,891
6x12	13,638	15,684	21,821
6x14	18,550	21,333	29,680
6x16	24,081	27,693	38,530

Whitney-Gedeon Residence

F2

Roof Framing   DL = 15psf
                                SL = 25psf
RB1
$\ell_{max} = 16'$ 5½×13½ 24F-V4 GLB
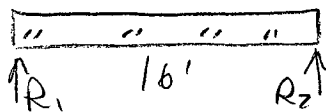
$$W = \left(\frac{30'}{2}\right)40psf = 600plf$$
$M = 19.2^{k \cdot i}$, $R_1 = R_2 = 4800^\#$
$f_b = 1380psi \leq F'_b = 2760psi$
$f_v = 100psi \leq F'_v = 304psi$
$\Delta_{TL} = 0.436" = \ell/440$

RB2   (2)2×10
$\ell = 7'$
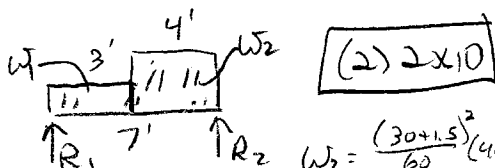
$$W_2 = \frac{(30+1.5)^2}{60}(40) = 662plf$$
$$W_T = \left(\frac{(4+1.5)^2}{8}\right)40 = 152plf$$
$M = 2990^{\# \cdot i}$ $R_1 = 1110^\#$ $R_2 = 1990^\#$
$f_b = 838 psi \leq F'_b = 898 psi$
$f_v = 108 psi \leq F'_v = 137 psi$
$\Delta_{TL} = 0.0978" = \ell/858$

RB3   (2)2×10
$\ell = 11'$
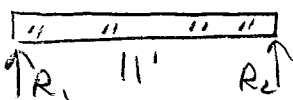
$$W = \left(\frac{4'}{2} + \frac{4'}{2}\right)40 = 160plf$$
$M = 2420^{\# \cdot i}$, $R_1 = R_2 = 880^\#$
$f_b = 679psi \leq F'_b = 781psi$
$f_v = 50psi \leq F'_v = 137psi$
$\Delta_{TL} = 0.204" = \ell/644$

RB4   P@4'   (2)2×10
$\ell = 8'$
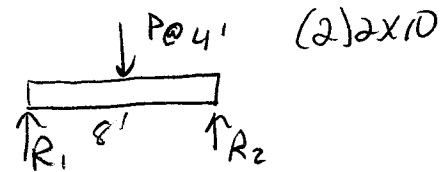
$P = 880^\#$ (RB3)
$$W = (2')40psf = 80plf$$
$M = 2400^{\# \cdot i}$, $R_1 = R_2 =$
$f_b = 673psi \leq F'_b = 977psi$
$f_v = \qquad \leq F'_v = 172psi$
$\Delta_{TL} = 0.0917" = \ell/1046$
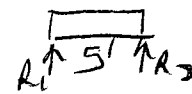
HDR1   (2)2×8
$\ell = 5'$
$$W = 152plf$$
$M = 475^{\# \cdot i}$, $R_1 = R_2 = 380^\#$
$f_b = 217psi \leq F'_b = 781psi$
$f_v = 30psi \leq F'_v = 137psi$
$\Delta_{TL} = 0.017" = \ell/4867$

HDR2   (2)2×8
$\ell = 4'$
See HDR1

HDR3   P@3'
$\ell = 6'$
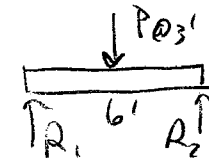
$P = 880^\#$ (RB3)
$$W = 2'(40) = 80plf$$
$M = 1680^{\# \cdot i}$, $R_1 = R_2 = 680^\#$
$f_b = 471psi \leq F'_b = 977psi$
$f_v = 40psi \leq F'_v = 172psi$
$\Delta_{TL} = 0.0357" = \ell/2016$

Whitney-Gideon Residence
Project

Project # CRB
Designer

Date

F3
Sheet

Roof Framing (con't)

HDR4

$l_{max} = 8'-0"$
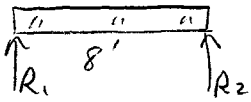
$(2)2\times8$

$$w = \frac{(2+2)^2}{4} \cdot 40 = 160 \, plf$$

$M = 1280 \, \#^{-1}$, $R_1 = R_2 = 640\#$

$f_b = 585 \, psi \le F'_b = 977 \, psi$

$f_v = 45 \, psi \le F'_v = 172 \, psi$

$\Delta_{TL} = 0.119" = l/806$

Check (E) Beams

$l = 11'$
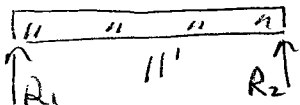
$3\frac{1}{8} \times 12" \, 24F-V4$ GLB Okay

$$w = \left(15\frac{1}{2} + 9\frac{1}{2}\right) 40 = 480 \, plf$$

$M = 7260 \, \#^{-1}$, $R_1 = R_2 = 2640\#$

$f_b = 1162 \, psi \le F'_b = 2400 \, psi$

$f_v = 106 \, psi \le F'_v = 265 \, psi$

$\Delta_L = 0.195" = l/676$

$l = 19.5'$
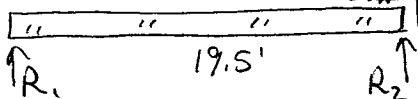
$5\frac{1}{2} \times 13\frac{1}{2}$ 24F-V4 GLB

$$w = \left(19\frac{9}{2}\right) 40 \, psf = 380 \, plf, \quad I_{req} = 1057 \, in^4$$

$M = 18.1 \, k^{-1}$, $R_1 = R_2 = 3705\#$

$f_b = 1298 \, psi \le F'_b = 2760 \, psi$

$f_v = 75 \, psi \le F'_v = 304 \, psi$

$\Delta_{TL} = 0.609" = l/384$

Check (E) Beam

$5\frac{1}{8} \times 13\frac{1}{2}$ 24F-V4 GLB

$l = 17'$
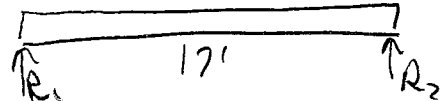
$$w = \left(\frac{17.25}{2} + \frac{9}{2}\right) 40 \, psf = 525 \, plf$$

$M = 19.0 \, k^{-1}$, $R_1 = R_2 = 4.5^k$

$I_{req} = 968 \, in^4$ try $5\frac{1}{8} \times 13\frac{1}{2}$ 24F-V4 GLB

$f_b = 1465 \, psi \le F'_b = 2400 \, psi$

$f_v = 100 \, psi \le F'_v = 265 \, psi$

$\Delta_{TL} = 0.522" = l/391$

Project: Whitney-Gedeon Residence

Project # CRA

Designer

Date

Sheet F4

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Floor Framing key plan

FJ1

FB1

(E) CRAWL

(N) X6 ENGR JSTS @ 16" O.C. FOR SHWR PAN

(N) 2X10 @ 16" O.C.

(N) BEAM

VENT

(N) 2X10 @ 16" O.C.

NEW CRAWL SPACE VENTED

(N) SPOT FTG

VENT

(E) ACCESS

NEW 36 WIDE CRAWL ACCESS @ EXIST FDN.

(E) ASSUMED STRUCTURAL DECK'G TO BE VERIFIED

(E) ASSUMED 4X8 BEAMS ON 12X12 SPOT FTGS TO BE VERIFIED, SPACING IS ASSUMED

(N) X6 ENGR JOISTS @ 16" O.C.

EXIST CRAWL SPACE

(N) SPOT FTG

(E) 6" CONC FDN WALL TYP.

(N) SPOT FTG

(N) SPOT FTG

(N) CONC FTG FOR (N) BEARING WALL ABOVE

(N) SPOT FTG

(N) 2X10 @ 16" O.C.

(N) 2X10 @ 16" O.C.

(N) SPOT FTG

(N) SPOT FTG

Ftg1 Typ

(N) SPOT FTG

(E) REMOVED CHIMNEY TO BE FILLED IN

(E) REMOVED CHIMNEY TO BE FILLED IN

(N) 2X10 @ 16" O.C.

(E) SUNKEN AREA @ EXIST DEN TO BE FILLED IN

FB2

(N) BEAM

(N) SPOT FTG

(N) SPOT FTG

(E) S-O-G

ALL STRUCT
NO ENGINE

Whitney-Gedeon Residence

F5

2x6 Floor Joists FJ1

$L =$	8 ft 0 in	Lumber Type =	Hem-Fir #2	
$w_{DL} =$	15 psf	$F_b =$	850 psi	
w_{LL}	40 psf	$F_v =$	150 psi	
Spacing =	16 in o.c.	$E =$	1,300,000 psi	
Joist Size	2x6	$C_D =$	1	
$S =$	7.56 in^3	$C_r =$	1.15	
$I =$	20.80 in^4	$C_F =$	1.3	
$A =$	8.25 in^2	incised	no	
$M =$	587 #-ft			
$R1 = R2 =$	293 #	$E' =$	1300000 psi	
$f_b =$	931 psi	$F_b' =$	1271 psi	**OK**
$f_v =$	53.3 psi	$F_v' =$	150 psi	**OK**
$\Delta_{DL} =$	0.068 in =	$L/$	1408	
$\Delta_{LL} =$	0.182 in =	$L/$	528	
$\Delta_{TL} =$	0.250 in =	$L/$	384	

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F6

2x10 Floor Joists FJ2

L =	13 ft 0 in	Lumber Type =	Hem-Fir #2	
w_{DL} =	15 psf	F_b =	850 psi	
w_{LL}	40 psf	F_v =	150 psi	
Spacing =	16 in o.c.	E =	1,300,000 psi	
Joist Size	2x10	C_D =	1	
S =	21.39 in^3	C_r =	1.15	
I =	98.93 in^4	C_F =	1.1	
A =	13.88 in^2	incised	no	
M =	1549 #-ft			
R1 = R2 =	477 #	E' =	1300000 psi	
f_b =	869 psi	F_b' =	1075 psi	OK
f_v =	51.5 psi	F_v' =	150 psi	OK
Δ_{DL} =	0.100 in	=	L/	1561
Δ_{LL} =	0.266 in	=	L/	585
Δ_{TL} =	0.366 in	=	L/	426

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Floor Framing   DL = 15 psf
                 LL = 40 psf

FB1 | (2) 2x10
$l = 6'$
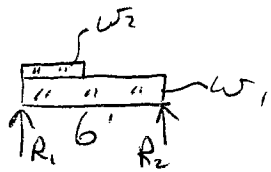
$W_1 = \left(\frac{8}{2} + \frac{13}{2}\right) 40\,psf = 420\,plf$

$W_2 = \left(\frac{8}{2}\right) 5\,psf = 20\,plf$

$M = 1920^{\#-1}$ $R_1 = 1300^{\#}$ $R_2 = 1270^{\#}$

$f_b = 539\,psi \le F'_b = 977\,psi$

$f_v = 71\,psi \le F'_v = 172\,psi$

$\Delta_{TL} = 0.0484'' = \frac{l}{1487}$

FB2 | (2) 2x10
$l = 7.5'$

$W = \left(\frac{7}{2} + \frac{2.75}{2}\right) 40 = 195\,plf$
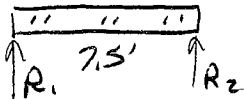
$M = 1372^{\#-1}$, $R_1 = R_2 = 732^{\#}$

$f_b = 385\,psi \le F'_b = 977\,psi$

$f_v = 40\,psi \le F'_v = 172\,psi$

$\Delta_{TL} = 0.05397'' = \frac{l}{1667}$

Ftg: $P_1 = 732^{\#} \Rightarrow d = 0.6$

      $\therefore$ use 2'□ w/(2)#4 E.W.

      $P_2 = 760 + 978^{\#} = 1738^{\#}$

      $d = \sqrt{1738/2000} = 0.93$

      $\therefore$ use 2'□ w/(2) #4 E.W.

buker
ENGINEERING LLC

Whitney - Gedeon Residence
Project

Project #
CRB
Designer

Date

Sheet   F8