BSC

Design Calculation or Analysis Cover Sheet

Complete only applicable items.

1. QA: QA
2. Page 1

3. System	4. Document Identifier
Receipt Facility (RF)	200-SYC-RF00-00900-000-00B

5. Title

Receipt Facility Soil Springs and Damping by New Soil Data

6. Group

Civil/Structural/Architectural

7. Document Status Designation

☐ Preliminary ☒ Committed ☐ Confirmed ☐ Cancelled/Superseded

8. Notes/Comments

Revision A of this calculation inadvertently superseded the calculation, 200-SYC-RF00-00300-000-00A, which is now resurrected as calculation, 200-SYC-RF00-01700-000-00A.

Revision A of this calculation was based on strain compatible soil properties given in Data Tracking Numbers (DTNs) MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002. These DTNs were un-qualified and were subsequently superseded by DTNs MO0801SCSPS5E4.003 and MO0801SCSPS1E4.003. Revision B of this calculation evaluates the new DTNs and assesses the impact on the computed impedance functions.

Attachments	Total Number of Pages
SEE SECTION 5	49

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. EGS (Print/Sign/Date)	16. Approved/Accepted (Print/Sign/Date)
00A	Initial issue (Supersede document 200-SYC-RF00-00300-000-00A)	76	E-8	J. Solowey (Attachment A) 8/9/07 A. Nikaeen (Attachment B) 8/9/07 W. Chang (Sect. 1 – 7) & (Attachments C, D, & E) 8/9/07	A. Nikaeen (Attachment A) 8/9/07 J. Solowey (Attachment B) 8/9/07 D. Karpinski (Sect. 1 – 7) & (Attachments C, D, & E) 8/9/07	J. Bisset 8/9/07	R. Rajagopal 8/9/07
00B	Revision is to provide depth of alluvium and building location relative to the Exile Hill Fault Splay. Evaluate and assess the impact of new DTNs for strain compatible soil properties on the impedance functions (See note in section 8 above). Revised Cover Sheet (p. 1), Contents (p. 3-4), Sections 2.1, 2.2 (p. 5), 2.4 (p. 6), 4.2, 4.3.1(p. 8) and 5 (p. 13). Deleted Assumption 3.1.1 (p. 6-7) and added Attachment F and G. Revised references call out in Attachment A.	94	G-16	S. Kothari 2/29/2008 E. Acaac (Attachment G) T. Frankert for E.A 2/29/08	E. Acaac T. FRANKERT for E.A 2/29/08 S. Kothari (Attachment G) 2/29/2008	T. Frankert 2/29/08	R. Rajagopal 2/29/08

DISCLAIMER

The calculations contained in this document were developed by Bechtel SAIC Company LLC (BSC) and are intended solely for the use of BSC in its work for the Yucca Mountain Project.

CONTENTS **PAGE**

FIGURES

Page

TABLES

1. PURPOSE

The purpose of this calculation is to compute foundation impedance functions (soil springs) for use in a response spectrum analysis of the Receipt Facility (RF). The basis of design for the Receipt Facility is defined in the *Basis of Design for the TAD Canister–Based Repository Design Concept* (Ref.2.2.1).

For the Tier-1 seismic analysis of the RF Facility a multiple lumped mass stick model is utilized to represent the structure. A lumped representation of the structure-foundation interaction at the base of the structure will consist of soil springs computed in accordance with ASCE 4-98 (Ref. 2.2.3) section 3.3.4.2. Results of this calculation will provide soil springs for use in the Tier 1 seismic analysis. Damping values will also be computed for use in the seismic analyses.

Soil spring and Damping values are calculated for the Design Basis Ground Motion (DBGM-2) 2000 year (Annual Exceedance Probability of 5E-4) and the Beyond Design Basis Ground Motion (BDBGM) 10,000 year (Annual Exceedance Probability 1E-4) seismic events. (Ref. 2.2.9)

2. REFERENCES

2.1 PROCEDURES/DIRECTIVES

2.1.1 EG-PRO-3DP-G04B-00037, Rev.010. *Calculations and Analyses*. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071018.0001.

2.1.2 IT-PRO-0011 Rev.007. *Software Management.* Las Vegas, Nevada, Bechtel SAIC Company. ACC: DOC.20070905.0007.

2.2 DESIGN INPUTS

2.2.1. BSC (Bechtel SAIC Company) 2007. *Basis of Design for the TAD Canister–Based Repository Design Concept.* 000-3DR-MGR0-00300-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071002.0042.

2.2.2. BSC (Bechtel SAIC Company) 2006. Receipt Facility Mass Properties 200-SYC-RF00-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061206.0001.

2.2.3. ASCE 4-98.2000. Seismic Analysis of Safety Related Nuclear Structures and Commentary, Reston, VA. American Society of Civil Engineers. TIC: 253158 [ISBN 0-7844-0433-X]

2.2.4. Bowles, J.E. 1996. *Foundation Analysis and Design.* 5th Edition. New York, New York: McGraw-Hill. TIC: 247039. [ISBN 0-07-912247-7]

2.2.5. MO0801SCSPS5E4.003. *Strain Compatible Material Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance*, Submittal date: 01/11/2008. [DIRS# 184682]

2.2.6. Young, W.C. 1989. *Roark's Formulas for Stress and Strain.* 6th Edition. New York, New York:McGraw-Hill.TIC:10191. [ISBN 0-072541-1]

2.2.7. Hadjian, A.H. and Ellison, B. 1985. "Equivalent Properties for Layered Media." *Soil Dynamics and Earthquake Engineering, 4,* (4), 203-209. [Southampton, England]: CML Publications. TIC: 255744. [ISSN 0267 – 7261]

2.2.8. Biggs, J.M. 1964. *Introduction to Structural Dynamics.* New York, New York: McGraw-Hill. TIC: 240633. [ISBN 07-005255-7]

2.2.9. BSC (Bechtel SAIC Company) *Project Design Criteria Document*. 000-3DR-MGR0-00100-000Revision 007. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071016.0005.

2.2.10. MO0801SCSPS1E4.003. *Strain Compatible Material Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance*, Submittal date: 01/11/2008 [DIRS# 184683]

2.2.11. BSC (Bechtel SAIC Company) 2008.Nuclear Facilities Buildings Receipt Facility Forming Plan at TOC El 0'-0". 200-DB0-RF00-00101-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080205.0002.

2.2.12 SNL (Sandia National Laboratories) 2008. *Technical Report: Geotechnical Data for a Geologic Repository at Yucca Mountain, Nevada.* TDR-MGR-GE-000010 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080206.0001. [DIRS 183779]

2.2.13 BSC (Bechtel SAIC Company) 2007. *Nuclear Facility Buildings Exile Hill Fault Splay Location Plan.* 100-S0K-MGR0-00101-000 Revision 00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071107.0001.

2.2.14 BSC (Bechtel SAIC Company) 2007. *Seismic Analysis and Design Approach Document.* 000-30R-MGR0-02000-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071220.0029.

2.3 DESIGN CONSTRAINTS

None

2.4 DESIGN OUTPUTS

This calculation will be used as input for the Tier-1 revised Seismic Analysis.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

3.1.1 Not used.

3.1.1 Not used. (Continued)

THIS PAGE INTENTIONALLY LEFT BLANK.

3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION

None

4. METHODOLOGY

4.1 QUALITY ASSURANCE

This calculation was prepared in accordance with EG-PRO-3DP-G04B-00037, *Calculations and Analyses*, (Reference 2.1.1). The RF building structure is classified as Important to Safety in Section 6.1.2 of the *Basis of Design for TAD canister-based depository design concept* (Reference 2.2.1). Therefore, the approved record version of this document is designated as "QA: QA".

4.2 USE OF SOFTWARE

Excel 2000 and Word 2000, which are part of the Microsoft Office 2000 Professional suite of programs, were used in this calculation. Microsoft Office 2000 as used in this calculation is classified as Level 2 software usage as defined in IT-PRO-0011 (Ref. 2.1.2). Microsoft Office 2000 is listed on the current Level 2 Usage Controlled Software Report. The software was executed on a PC system running Microsoft Windows 2000 operating system.

MathCAD Version 13 was utilized to perform design calculation. MathCAD was operated on a PC system running the Windows 2000 operating system. MathCAD as used in this calculation is considered as level 2 software usages as defined in IT-PRO-0011 (Ref. 2.1.2). MathCAD version 13 is listed on the current Level 2 Usage Controlled Software Report.

All MathCAD and Excel input values and equations are stated in the calculation. The MathCAD output is in section 6.0 and Excel output is in Attachments A, B, and G. Checking of the MathCAD and Excel calculations were done by using visual inspection and hand calculations to confirm the accuracy of the results.

4.3 CALCULATION METHOD

4.3.1 DETERMINATION OF SOIL PROPERTIES FOR 130' THICK ALLUVIUM CASE

The soil impedance functions computed in section 6 and summarized in sections 7.1.1, 7.1.2, 7.2.1 and 7.2.2 are based on data contained in DTNs MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002, which have been superseded by DTNs MO0801SCSPS5E4.003 (Ref. 2.2.5) and MO0801SCSPS1E4.003 (Ref. 2.2.10). The impact of the superseding data, given in Ref.2.2.5 and 2.2.10, on the computed impedance functions is addressed in Attachment G of this calculation. Results of this assessment are discussed in section 7.2.3.

The RF is a surface structure, which rests on a layered alluvial material with varying properties. The RF structure is located with respect to True North on the Northeast side of the Exile Hill Fault Splay. See Attachment F and Reference 2.2.13. At the RF, the depth of alluvium is currently estimated to be from about 127' to 141', with the 130' contour running close to the

center of the building. See Fig. 6.2-4, Alluvium Thickness Contour Map of Midway Valley, Nevada, *Geotechnical Data For A Potential Waste Handling Building And For A Ground Motion Analyses For The Yucca Mountain Site Characterization Project.* TDR-MGR-GE-000010 REV 00C., Ref. 2.2.12.

Two sets of soil spring data are determined, one each for the DBGM-2 and the BDBGM ground motions. It was decided that determining the soil springs parameters for only a 130' depth of alluvium case would therefore be appropriate for the RF.

Soil testing results for a 130' thick alluvium case, however, are not available. Soil properties are developed for the 130' case by utilizing data from the 100' and 200' cases in the following procedure (see also the e-mail in Attachment D):

The 130' alluvium case will be developed by using the data from the 100' and 200' case in the following manner:

a. For the first 100' of the alluvium the upper bound values of the shear wave velocities will be the highest value between the 100' and 200 cases; for the lower bound case the shear wave velocities will be the lowest between the 100' and 200' cases. In both cases, the compressive wave velocity will be that associated with the shear wave velocity selected to represent the 130' alluvium case, thus if the 100' results govern at a particular layer for the shear wave velocity then the compressive wave velocity and Poisson's ratio for that layer will also come from the 100' results.

b. For the first 100', the median results will be the average of the 100' and 200' cases.

c. For the next 100' to 130' of alluvium, values of the shear wave velocities, compressive wave velocities, and densities for all 3 sets of soils conditions (lower, upper and median) will come from the 200' case results.

d. For the next 130' to 200', where we are now into tuff, values of the shear wave velocities, compressive wave velocities, and densities for all 3 sets of soils conditions (lower, upper and median) will come from the 100' case results.

e. Below 200' the values for the tuff will be determined from the 100' and 200' cases in the same manner as was done for the alluvium.

The resulting densities, shear wave velocities, compressive wave velocities, and Poisson's ratio values will then be used to calculate spring stiffness and damping values for use in the subsequent seismic analyses.

4.3.2 EQUIVALENT ELASTIC MODULUS OF LAYERED SOIL

The Receipt Facility (RF) rests on a layered alluvial material with varying properties. For purposes of dynamic analysis of the soil-structure interaction problem it will be necessary to define the foundation impedance functions for use in the TIER 1 seismic analysis. In performing this analysis, a set of frequency independent soils springs, corresponding damping, and

percentage of critical damping will be computed in accordance with ASCE 4-98 (Ref. 2.2.3) section 3.3.4.2.
Frequency independent equivalent soil springs constants and corresponding equivalent percent of damping values for a rectangular foundation are given in ASCE 4-98 (Ref. 2.2.3) table 3.3-3 Soil springs are a function of the foundation plan dimensions B and L, the soil dynamic shear modulus and soil Poisson's ratio. Soil springs constants and damping values are computed using ASCE 4-98 (Ref. 2.2.3) table 3.3-1 and Fig. 3.3-3. Computation of the equivalent dynamic soil properties follows the procedure recommended in reference 2.2.7 and is summarized below:

Since the shear wave velocity and the corresponding dynamic shear modulus vary with depth, an equivalent shear modulus needs to be computed when determining the frequency independent soil springs. A method for solving this problem is discussed in the paper "*Equivalent Properties for Layered Media*" by A. H. Hadjian and Byrwec Ellison (Ref. 2.2.7). The method derived is adequate for use in the Tier 1 analysis calculations. The method discussed in the paper is summarized below:

The relative vertical layer displacements are given by:

$\Delta_1 = (P * h_1)/ (A_1*E_1) = (q_1*h_1)/ E_1$ (Ref. 2.2.6 Young 1989, Page 76, eq. 3)

$\Delta_2 = (P * h_2)/ (A_2*E_2) = (q_2*h_2)/ E_2$

$\Delta_n = (P * h_n)/ (A_n*E_n) = (q_n*h_n)/ E_n$

Where P = Applied vertical force at the soil surface
h_n = Thickness of soil layer n
A_n= Effective area at layer n

Δ_i (i=1…n)=Vertical displacement in layer i
E_n = Modulus of Elasticity for soil layer, n

q_n = Soil pressure at depth determined using the Newmark Charts Method as outlined in Section 4.3.3.

Thus the total displacement is: $\Delta = (q_1*h_1)/ E_1 + (q_2*h_2)/ E_2 + \ldots..(q_n*h_n)/ E_n$ (Eq. 1)

If the elastic modulus were uniform throughout the medium the total displacement would be calculated as:

$\Delta = (q_1*h_1)/ E + (q_2*h_2)/ E + \ldots..(q_n*h_n)/ E$

or $\Delta = \{(q_1*h_1) + (q_2*h_2) + \ldots..(q_n*h_n)\} / E$ (Eq. 2)

Equating (Eq. 1) and (Eq. 2) yields the equivalent modulus of elasticity as follows:

$E = \{(q_1*h_1) + (q_2*h_2) + \ldots(q_n*h_n)\} / \{(q_1*h_1)/ E_1 + (q_2*h_2)/ E_2 + \ldots(q_n*h_n)/ E_n\}$

Which may be rewritten as:

$$E = \frac{\sum_{i=1}^{n}(q_i * h_i)}{\sum_{i=1}^{n}(q_{i*}h_i / E_i)} \qquad \text{(Eq. 3)}$$

Once the equivalent modulus of elasticity E and equivalent Poisson's ratio μ (see section 4.3.4 below) have been determined, the dynamic shear modulus can be computed as

$$G' = E / 2*(1 + \mu) \qquad \text{(Eq. 4)}$$

where μ is the equivalent Poisson's ratio for the layered soil.

4.3.3 NEWMARK CHART AND INFLUENCE COEFFICIENT

As required in the calculation of equivalent modulus of elasticity in Sect.4.3.2, soil pressure in each layer is determined by Newmark Charts Method to obtain Influence Coefficient (Nq) as outlined here.

The foundation's footprint is plotted to determined scale on the Newmark's influence chart (Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th ed. Page 290). The depth at which the soil stress is being evaluated determines the scale of the chart. The line segment AB in the standard chart is set to a scale equal to the depth of soil layer at which the soil stress is desired. If the desired depth is 300 feet then AB is 300 ft in scale and is thus established for the entire foundation. The foundation's footprint, as shown in Attachment C Ground Floor Layout Plan (Ref. 2.2.11), is drawn to that scale.

The numbers of units covered by the foundation's footprint are summed up and the influence coefficient may be calculated by multiplying the total units by the influence value of the chart. In our case the charts influence value is 0.005. This procedure is plotted for depths of 50', 100', 200', 300', 400' and 500'. These plots are shown in Attachment E, pages E-3 to E-8. A plot of the resulting influence coefficients as a function of depth are given in Figure 2, page E-2. The influence coefficient values of different depth is calculated by interpolation as shown in Attachment A & B. This chart is used for both 5E-4 and 1E-4 events.

q_v = unit pressure at depth z under center of rectangular base
q_o = contact unit pressure under rectangular base (z = 0)
q_o is set to be = 1.0 ksf
Influence coefficient Nq = qv / qo

4.3.4 EQUIVALENT POISSON'S RATIO OF LAYERED SOIL

In the soil data, Poisson's ratio is defined in each layer μ_i. The equivalent effective Poisson's ratio is calculated by the following equation:

$$\mu = \frac{\sum_{i=1}^{n} (\mu_i * h_i)}{\sum_{i=1}^{n} (h_i)} \quad \text{(Eq. 5)}$$

4.3.5 CALCULATION PROCESS FOR SOIL SPRING

1. The soil has been divided into 45 layers for the 100' alluvium case and the 200' alluvium case. The 130' case data is developed from the 100' case and 200' case by the method explained above in section 4.3.1. The shear wave velocity, compression wave velocity, and Poisson's ratio for each layer are taken from the following DTN data files: MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002.

2. Compute dynamic shear modulus, G', for each layer based on the shear wave velocities and Poisson's ratio for that layer using Eq. 20-15 page 1108 from Bowles Foundation Analysis and Design, 5th Edition (Ref. 2.2.4).

3. Compute soil modulus E for each individual soil layer using the dynamic shear modulus, G' value as computed in step 2 and the Poisson's ratio for each layer.

4. Determine the influence coefficient (Nq) using Newmark Charts Method in section above, for the RF foundation at the depth of each layer. Values are calculated by interpolation in Attachment A for 5E-4 seismic event and Attachment B for 1.0E-4 seismic event.

5. Compute an equivalent E, and an equivalent μ for the entire depth to 500' using equation 3, and equation 5.

6. Using the equivalent E and μ from step 5, compute the dynamic shear modulus (equivalent shear modulus), G' using equation 4.

7. Compute soil spring values using method from ASCE 4-98 (Ref. 2.2.3) and the shear modulus values computed in step 6.

4.3.6 SOIL DAMPING VALUES

Equivalent damping coefficients are calculated for six degrees of freedom from Equations presented in Table 3.3-1 of (Ref. 2.2.3). These equations utilize an equivalent radius of a circular base mat calculated per equations in Table 3.3-3 of (Ref. 2.2.3).

The Critical damping values are calculated for each degree of freedom from equation 1.13, from (Ref. 2.2.8). The mass properties from (Ref. 2.2.2) and soil stiffness values (soil springs) from this calculation are used to calculate critical damping values. The ratio of damping coefficient and critical damping is presented as a percent of critical damping.

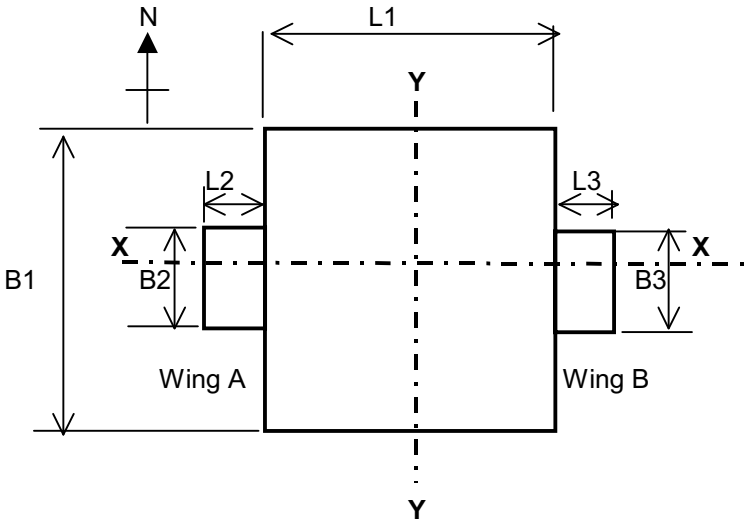
5.0 LIST OF ATTACHMENTS

		Total number of pages
Attachment A	Shear Modulus for 5E-4 Seismic Event	8
Attachment B	Shear Modulus for 1E-4 Seismic Event	8
Attachment C	Receipt Facility Ground Floor Plan at EL 0'-0"	2
Attachment D	E-mails on Soil Properties	5
Attachment E	Newmark Influence Charts	8
Attachment F	Exile Hill Fault Splay Location Plan	2
Attachment G	Assessment of Revised soil properties	16

6.0 BODY OF CALCULATION

6.1 Equivalent Rectangular Contact Area at Base Slab

The equations for soil springs and damping are based on the rectangular bases.
The RF steel vestibule portions do not extend the full width of the entire building mat foundation of 242ft.
Wing (vestibule) 'A' and 'B' dimensions are 42' x 78'.
Therefore, the lengths are calculated based on equivalent contact area for translation and moment inertia for rotation per ASCE 98, Section 3.3.1.4.1.



GROUND FLOOR PLAN SKETCH

(not to scale)

$L1 := 200.\cdot ft$ Length of base excluding wings

$L2 := 42.\cdot ft$ Length of Wing 'A'

$L3 := 42.\cdot ft$ Length of Wing 'B'

$B1 := 242.\cdot ft$ Width of base excluding wings

$B2 := 78.\cdot ft$ Width of Wing 'A'

$B3 := 78.\cdot ft$ Width of Wing 'B'

Areas $A1 := L1\cdot B1$ $A2 := B2\cdot L2$ $A3 := B3\cdot L3$

$A1 = 4.84 \times 10^4\ ft^2$ $A2 = 3.276 \times 10^3\ ft^2$ $A3 = 3.276 \times 10^3\ ft^2$

Total Area $AT := A1 + A2 + A3$ $AT = 5.495 \times 10^4\ ft^2$

Calculated Equivalent Length:

$$LE := \frac{AT}{B1} \qquad LE = 227.074\ ft$$

Use a 242' (B1) by 227' (LE) area for computation of soil pressure in Attachment A and B; use a 227' length for translation.

Centroid of area about Y-Y axis

$$M := (L1 \cdot B1) \cdot \left(L3 + \frac{L1}{2}\right) + L2 \cdot B2 \cdot \left(L3 + L1 + \frac{L2}{2}\right) + L3 \cdot B3 \cdot \frac{L3}{2}$$

$$M = 7.803 \times 10^{6}\ ft^{2}\ ft \qquad y := \frac{M}{AT} \qquad y = 142\ ft$$

Moment of Inertia about Y axis

$$Iyy := L1^{3} \cdot \frac{B1}{12} + L2^{3} \cdot \frac{B2}{12} + L3^{3} \cdot \frac{B3}{12} + \left(\frac{L1}{2} + L3 - y\right)^{2} \cdot A1 + \left(y - \frac{L3}{2}\right)^{2} \cdot A3 + \left[(L1 + L3) + \frac{L2}{2} - y\right]^{2} \cdot A2$$

$$Iyy = 2.582 \times 10^{8}\ ft^{4}$$

$$Ley := \sqrt[3]{\frac{Iyy \cdot 12}{B1}} \qquad Ley = 233.949\ ft$$

To find rocking constant $\beta\psi$– , use 234 ft as L dimension and 242 (B1 above) as B dimension for Rocking about Y axis. (See Ref. 2.2.3, fig. 3.3-3 page 30, and the skectch above.

Moment of Inertia about X axis

$$Ixx := L1 \cdot \left(\frac{B1^{3}}{12}\right) + L2 \cdot \frac{B2^{3}}{12} + L3 \cdot \frac{B3^{3}}{12} \qquad Ixx = 2.395 \times 10^{8}\ ft^{4}$$

$$Bex := 12 \cdot \frac{Ixx}{B1^{3}} \qquad \text{Equivalent length} \qquad Bex = 202.813\ ft$$

To find rocking constant $\beta\psi$ – use 242 ft length (B1 above) as L dimension and 203 ft as B dimension for Rocking about X axis . (See Ref. 2.2.3, fig. 3.3-3 page 30, and the sketch above.)

6.2 SOIL SPRINGS AND DAMPING FOR 5E-4 SEISMIC EVENT.

6.2.1 SOIL SPRINGS FOR 5E-4 SEISMIC EVENT

The following calculations determine translational and rotational springs (Kx, Ky, Kz, Kψx, Kψy and Kψz) per ASCE 4-98 Tables 3.3-1 & 3.3-3 (Ref. 2.2.3)

These results are summarized in section 7.

Note: All variables used in the computation of the equivalent soil springs and damping values are defined in ASCE 4-98 section 3.3 (Ref. 2.2.3) .

$k := 1000 \cdot lbf$

The soil springs will be calculated for 130' depth of alluvium for Lower Bound, Median and Upper Bound cases as followings:

Case 1 : Lower Bound Estimate : 130' Depth of Alluvium

Case 2 : Median Estimate : 130' Depth of Alluvium

Case 3 : Upper Bound Estimate : 130' Depth of Alluvium

Note: See Sect. 6.1 for equivalent rectangular contact area at base slab for calculation of spring constants.

6.2.1.1 Soil Properties : (Shear Modulus and Poisson's Ratios are from Attachment A)

Shear Modulus $G_s := \begin{pmatrix} 6807 \\ 13068 \\ 24797 \end{pmatrix} ksf$

Case 1 130' L (pg A-5)

Case 2 130' M (pg A-6)

Case 3 130' U (pg A-7)

Poisson's Ratio $\nu := \begin{pmatrix} 0.312 \\ 0.312 \\ 0.312 \end{pmatrix}$

Case 1 130' L (pg A-5)

Case 2 130' M (pg A-6)

Case 3 130' U (pg A-7)

6.2.1.2 Horizontal X (G' = G_s) (μ= ν)

For Seismic loads in the x-direction (227' building calculated equivalent length for translation):

$LE := 227 \cdot ft$ (equivalent length of basemat in direction of seismic motion)

$B1 := 242 \cdot ft$ (width of basemat perpendicular to direction of seismic motion)

$$\frac{LE}{B1} = 0.938$$

for LE/B1 = .938 $\beta x := .94$ $\beta z := 2.2$ (Ref. 2.2.3, figure 3.3-3)

$$Kx := \overrightarrow{\left[2 \cdot (1 + \nu) \cdot G_s \cdot \beta x \cdot \sqrt{B1 \cdot LE}\right]}$$ (Ref. 2.2.3, table 3.3-3)

$$Kx = \begin{pmatrix} 3.935 \times 10^6 \\ 7.555 \times 10^6 \\ 1.434 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.2.1.3 Vertical Z (G' = G_s) (μ=ν)

$\frac{LE}{B1} = 0.938$ $B1 = 242$ ft $LE = 227$ ft

$$Kz := \overrightarrow{\left(\frac{G_s}{1 - \nu} \cdot \beta z \cdot \sqrt{B1 \cdot LE}\right)}$$ (Ref. 2.2.3, table 3.3-3)

$$Kz = \begin{pmatrix} 5.102 \times 10^6 \\ 9.794 \times 10^6 \\ 1.858 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.2.1.4 Horizontal Y ($G' = G_s$) (μ=v)

For Seismic loads in the Y-direction (242' building dimension):

$L := 242 \cdot ft$ (length of basemat in direction of seismic motion)

$B := 227 \cdot ft$ (equivalent width of basemat perpendicular to direction of seismic motion)

$\frac{L}{B} = 1.066$

for L/B = 1.06 $\beta x := 1.0$ (Ref. 2.2.3, figure 3.3-3)

$Ky := \overrightarrow{\left[2 \cdot (1 + \nu) \cdot G_s \cdot \beta x \cdot \sqrt{B \cdot L}\right]}$ (Ref. 2.2.3, table 3.3-3)

$$Ky = \begin{pmatrix} 4.186 \times 10^6 \\ 8.037 \times 10^6 \\ 1.525 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.2.1.5 Rocking about X ($G' = G_s$) (μ= v)

For Rocking about X use 203'x242'.See page 15.

$L := 242 \cdot ft$ $B := 203 \cdot ft$ $\frac{L}{B} = 1.192$ $\beta\psi := 0.50$ (Ref. 2.2.3, figure 3.3-3)

$K\psi x := \frac{G_s}{1 - \nu} \cdot \beta\psi \cdot B \cdot L^2$ (Ref. 2.2.3, table 3.3-3)

$$(K\psi x) = \begin{pmatrix} 5.881 \times 10^{10} \\ 1.129 \times 10^{11} \\ 2.142 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.2.1.6 Rocking about Y (G' = G_s) (μ= ν) For Rocking about Y use 234' x 242'.See page 15.

$L := 234 \cdot ft \quad B := 242 \cdot ft \quad \frac{L}{B} = 0.967 \quad \beta\psi := 0.50$ (Ref. 2.2.3, figure 3.3-3)

$$K\psi y := \overrightarrow{\left(\frac{G_s}{1-\nu} \cdot \beta\psi \cdot B \cdot L^2\right)}$$ (Ref. 2.2.3, table 3.3-3)

$$K\psi y = \begin{pmatrix} 6.555 \times 10^{10} \\ 1.258 \times 10^{11} \\ 2.388 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.2.1.7 Torsion (L=Equivalent Width)

$L := 227 \cdot ft \quad B = 242\ ft$

$$R := \left[\frac{(B \cdot L) \cdot \left(B^2 + L^2\right)}{6 \cdot \pi}\right]^{.25} \quad R = 133.837\ ft$$ (Ref. 2.2.3, & table 3.3-3)

$$K\psi z := \frac{16 \cdot G_s \cdot R^3}{3}$$

$$K\psi z = \begin{pmatrix} 8.703 \times 10^{10} \\ 1.671 \times 10^{11} \\ 3.17 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.2.2 SOIL DAMPING FOR 5E-4 SEISMIC EVENT

LEGEND:

Gs = G' shear modulus of foundation medium (Calculated in Attachment A)
R = Equivalent radius of circular basemat
γ = density of foundation medium
g = acceleration of gravity
ρ = mass density of foundation medium
I_t (mt) = polar mass moment of inertia of structure and basemat
Io_x ($m\psi x$), Io_z($m\psi z$) = total mass moment of inertia of structure and basemat about rocking axis at base
k_x, $k\psi y$, $k\psi x$, kz, ky, kt = equivalent spring constants (note kt=$k\psi z$)
Cx, $C\psi x$, Cz, Ct, $C\psi y$,Cy = equivalent damping coefficients
Cc = critical damping value
$\beta\psi$ = constants that are functions of the basemat dimensional ratio, L/B

Damping Cases:
The equivalent soil damping coefficient and critical damping values will be calculated for 130' depth of alluvium for Lower Bound, Median and Upper Bound cases:

Case 1 : Lower Bound Estimate : 130' Depth of Alluvium
Case 2 : Median Estimate : 130' Depth of Alluvium
Case 3 : Upper Bound Estimate : 130' Depth of Alluvium

UNITS:

kips (k), feet (ft), radians (rad), seconds (sec)

RESULTS:

Results are summarized in section 7.

6.2.2.1 Equivalent Damping Coefficients

Determine Equivalent Damping Coefficients per ASCE 4-98 section 3.3, (Ref. 2.2.3) methodology for the Receipt Facility.

Calculated mass and mass moment of inertia : DI# 200-SYC-RF00-00100-000, Rev.00A p.27 (Ref. 2.2.2)

$$m_x := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$$ Horizontal X

$$m_y := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$$ Horizontal Y

$m_z := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$ Vertical Z

$Io_x := 3.23 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Rocking about X

$Io_y := 3.08 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Rocking about Y

$I_t := 4.51 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Torsion ($I_t = Iz$)

A) Horizontal X

Seismic load in the x-direction (227' building calculated equivalent length for translation)

$L := 227 \cdot ft$ (equivalent length of basemat in direction of seismic motion)

$B := 242 \cdot ft$ (width of basemat perpendicular to direction of seismic motion)

$R := \sqrt{\frac{B \cdot L}{\pi}}$ $R = 132.235\ ft$ (Ref. 2.2.3, table 3.3-3)

$\gamma := 0.11232 \cdot \frac{k}{ft^3}$ (Ref. 2.2.5, unit weight in soil data spread sheet)

$g = 32.174 \frac{ft}{s^2}$ $\rho := \frac{\gamma}{g}$ $\rho = 3.491 \times 10^{-3} k \cdot \frac{sec^2}{ft^4}$

$Cx := \overrightarrow{\left(0.576 \cdot Kx \cdot R \cdot \sqrt{\frac{\rho}{G_s}}\right)}$ (Ref. 2.2.3, table 3.3-1)

$(Cx) = \begin{pmatrix} 2.147 \times 10^5 \\ 2.974 \times 10^5 \\ 4.097 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$

Case 1 130' L

Case 2 130' M

Case 3 130' U

B) Horizontal Y

Seismic load in the y-direction (242' building dimension), R is same as Horizontal -X

$$Cy := \overrightarrow{\left[[0.576\cdot(Ky)]\cdot R\cdot\sqrt{\frac{\rho}{G_s}}\right]}$$ (Ref. 2.2.3, table 3.3-1)

$$Cy = \begin{pmatrix} 2.284\times 10^5 \\ 3.164\times 10^5 \\ 4.358\times 10^5 \end{pmatrix}\frac{k\cdot sec}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

C) Vertical Z

$L := 227\cdot ft \qquad B := 242\cdot ft$

$$R := \sqrt{\frac{B\cdot L}{\pi}} \qquad R = 132.235\ ft$$ (Ref. 2.2.3, table 3.3-3)

$$Cz := \overrightarrow{\left(0.85\cdot Kz\cdot R\cdot\sqrt{\frac{\rho}{G_s}}\right)}$$ (Ref. 2.2.3, table 3.3-1)

$$Cz = \begin{pmatrix} 4.107\times 10^5 \\ 5.69\times 10^5 \\ 7.838\times 10^5 \end{pmatrix}\frac{k\cdot sec}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

D) Rocking about X

$L := 242 \cdot ft \quad B := 203 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L^3}{3 \cdot \pi}} \quad R = 132.181\ ft$ (Ref. 2.2.3, table 3.3-3)

(See page 15)

$B\psi x := 3(1 - \nu) \cdot \frac{Io_x}{8 \cdot \rho \cdot R^5} \quad B\psi x = \begin{pmatrix} 0.059 \\ 0.059 \\ 0.059 \end{pmatrix}$ (Ref. 2.2.3, table 3.3-1)

$C\psi x := \left(\frac{0.3}{1 + B\psi x} \cdot (K\psi x) \cdot R \cdot \sqrt{\frac{\rho}{G_s}} \right)$

$(C\psi x) = \begin{pmatrix} 1.577 \times 10^9 \\ 2.185 \times 10^9 \\ 3.01 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$

Case 1 130' L

Case 2 130' M

Case 3 130' U

E) Rocking about Y

$B := 242 \cdot ft \quad L := 234 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L^3}{3 \cdot \pi}} \quad R = 134.678\ ft$

(See page 15)

$B\psi y := 3(1 - \nu) \cdot \frac{Io_y}{8 \cdot \rho \cdot R^5} \quad B\psi y = \begin{pmatrix} 0.051 \\ 0.051 \\ 0.051 \end{pmatrix}$ (Ref. 2.2.3, table 3.3-3)

$C\psi y := \left(\frac{0.3}{1 + B\psi y} \cdot K\psi y \cdot R \cdot \sqrt{\frac{\rho}{G_s}} \right)$ (Ref. 2.2.3, table 3.3-1) $R = 134.678\ ft$

$$C\psi y = \begin{pmatrix} 1.804 \times 10^9 \\ 2.5 \times 10^9 \\ 3.443 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

F) Torsion

$B := 227 \cdot ft \quad L := 242 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L \cdot \left(B^2 + L^2\right)}{6 \cdot \pi}} \quad R = 133.837\ ft$ (Ref. 2.2.3, table 3.3-3)

(See page 15)

$$Ct := \overrightarrow{\left(\frac{\sqrt{K\psi z \cdot I_t}}{1 + 2\frac{I_t}{\rho \cdot R^5}} \right)}$$

(Ref. 2.2.3, table 3.3-1)

$$(Ct) = \begin{pmatrix} 1.237 \times 10^9 \\ 1.714 \times 10^9 \\ 2.361 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.2.2.2 Critical Damping

$Cc := 2\sqrt{k \cdot m}$ eq. 1.13, Introduction to Structural Dynamics, Ref. 2.2.8.

Units for kx, kz, and ky is kip/ft, for kψx, kψz and kt is ft-k/rad, for mx, mz, my is kip-sec^2/ft, for mψx, mψz and mt is kip-ft-sec^2, for Ccx, Ccz, Ccy is kip-sec/ft and for Ccψx, Ccψy and Cct is ft-k-sec/rad. All k values are taken from summary of soil spring for 5E-4 pages 39 and 40.

A) Horizontal X $Ccx := 2\sqrt{Kx \cdot m_x}$

$$(Ccx) = \begin{pmatrix} 3.045 \times 10^5 \\ 4.219 \times 10^5 \\ 5.812 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

B) Horizontal Y

$$Ccy := 2\sqrt{Ky \cdot m_y}$$

$$Ccy = \begin{pmatrix} 3.141 \times 10^5 \\ 4.352 \times 10^5 \\ 5.994 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

C) Vertical Z

$$Ccz := 2\sqrt{Kz \cdot m_z}$$

$$Ccz = \begin{pmatrix} 3.467 \times 10^5 \\ 4.804 \times 10^5 \\ 6.617 \times 10^5 \end{pmatrix} \frac{1}{ft} k \cdot sec$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

D) Rocking about X

$$Cc\psi x := 2\sqrt{(K\psi x) \cdot Io_x}$$

$$(Cc\psi x) = \begin{pmatrix} 2.757 \times 10^9 \\ 3.819 \times 10^9 \\ 5.261 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

E) Rocking about Y

$$Cc\psi y := 2\sqrt{K\psi y \cdot Io_y}$$

$$Cc\psi y = \begin{pmatrix} 2.842 \times 10^9 \\ 3.938 \times 10^9 \\ 5.424 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

F) Torsion

$$Cct := 2\sqrt{K\psi z \cdot I_t}$$

$$(Cct) = \begin{pmatrix} 3.962 \times 10^9 \\ 5.49 \times 10^9 \\ 7.563 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.2.2.3 Damping values: Cc/Cci

A) Horizontal X

$$\left(\frac{Cx}{Ccx}\right) = \begin{pmatrix} 0.705 \\ 0.705 \\ 0.705 \end{pmatrix}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

70.5%

B) Horizontal Y

$$\frac{Cy}{Ccy} = \begin{pmatrix} 0.727 \\ 0.727 \\ 0.727 \end{pmatrix}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

72.7%

C) Vertical Z

$$\frac{Cz}{Ccz} = \begin{pmatrix} 1.184 \\ 1.184 \\ 1.184 \end{pmatrix}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

118.4%

D) Rocking about X

$$\left(\frac{C\psi x}{Cc\psi x}\right) = \begin{pmatrix} 0.572 \\ 0.572 \\ 0.572 \end{pmatrix}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

57.2%

E) Rocking about Y

$$\frac{C\psi y}{Cc\psi y} = \begin{pmatrix} 0.635 \\ 0.635 \\ 0.635 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 63.5%
Case 3 130' U

F) Torsion

$$\left(\frac{Ct}{Cct}\right) = \begin{pmatrix} 0.312 \\ 0.312 \\ 0.312 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 31.2%
Case 3 130' U

6.3 SOIL SPRINGS AND DAMPING FOR 1E-4 SEISMIC EVENT

6.3.1 SOIL SPRINGS FOR 1E-4 SEISMIC EVENT

The following calculations determine translational and rotational springs (Kx,Ky,Kz,Kψx,Kψy and Kψz) per ASCE 4-98 Tables 3.3-1 & 3.3-3 (Ref. 2.2.3)

Note: All variables used in the computation of the equivalent soil springs and damping values are defined in ASCE 4-98 section 3.3 (Ref. 2.2.3) .

$k := 1000 \cdot lbf$

The soil springs will be calculated for 130' depth of alluvium for Lower Bound, Median and Upper Bound cases as followings.

Case 1 : Lower Bound Estimate : 130' Depth of Alluvium

Case 2 : Median Estimate : 130' Depth of Alluvium

Case 3 : Upper Bound Estimate : 130' Depth of Alluvium

Note: See Sect. 6.1 for equivalent rectangular contact area at base slab used for calculation of spring constants.

6.3.1.1 Soil Properties : Shear Modulus and Poisson's Ratio (From Attachment B)

Shear Modulus $G_s := \begin{pmatrix} 4556 \\ 8988 \\ 17577 \end{pmatrix} ksf$

Case 1 130' L (pg. B-5)
Case 2 130' M (pg. B-6)
Case 3 130' U (pg. B-7)

Poisson's Ratio $\nu := \begin{pmatrix} 0.327 \\ 0.327 \\ 0.327 \end{pmatrix}$

Case 1 130' L (pg. B-5)
Case 2 130' M (pg. B-6)
Case 3 130' U (pg. B-7)

6.3.1.2 Horizontal X (G' = G_s) (μ= ν)

For Seismic loads in the x-direction (227' building calculated equivalent length for translation):

$LE := 227 \cdot ft$ (equivalent length of basemat in direction of seismic motion)

$B1 := 242 \cdot ft$ (width of basemat perpendicular to direction of seismic motion)

$$\frac{LE}{B1} = 0.938$$

for LE/B1 = .938 $\beta x := .94$ (Ref. 2.2.3, figure 3.3-3)

$$Kx := \overrightarrow{\left[2 \cdot (1 + \nu) \cdot G_s \cdot \beta x \cdot \sqrt{B1 \cdot LE}\right]}$$ (Ref. 2.2.3, table 3.3-3)

$$(Kx) = \begin{pmatrix} 2.664 \times 10^6 \\ 5.255 \times 10^6 \\ 1.028 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.3.1.3 Vertical Z (G' = G_s) (μ=ν)

$\frac{LE}{Bl} = 0.938$ $Bl = 242$ ft $LE = 227$ ft $\beta z := 2.2$

$$Kz := \overrightarrow{\left(\frac{G_s}{1-\nu} \cdot \beta z \cdot \sqrt{Bl \cdot LE}\right)}$$

(Ref. 2.2.3, table 3.3-3)

$$Kz = \begin{pmatrix} 3.491 \times 10^6 \\ 6.886 \times 10^6 \\ 1.347 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.3.1.4 Horizontal Y (G' = G_s) (μ=ν)

For Seismic loads in the Y-direction (242' building dimension):

$L := 242 \cdot ft$ (equivalent length of basemat in direction of seismic motion)

$B := 227 \cdot ft$ (width of basemat perpendicular to direction of seismic motion)

$\frac{L}{B} = 1.066$

for L/B = 1.06 $\beta y := 1.0$ (Ref. 2.2.3, figure 3.3-3)

$$Ky := \overrightarrow{\left[2 \cdot (1+\nu) \cdot G_s \cdot \beta y \cdot \sqrt{B \cdot L}\right]}$$

(Ref. 2.2.3, table 3.3-3)

$$Ky = \begin{pmatrix} 2.834 \times 10^6 \\ 5.591 \times 10^6 \\ 1.093 \times 10^7 \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.3.1.5 Rocking about X (G' = G_s) (μ= ν) For Rocking about X use 203'x242'. See sect. 6.1.

$L := 242 \cdot ft \quad B := 203 \cdot ft \quad \frac{L}{B} = 1.192 \quad \beta\psi := 0.50$ (Ref. 2.2.3, figure 3.3-3)

$$K\psi x := \left(\frac{G_s}{1-\nu} \cdot \beta\psi \cdot B \cdot L^2\right)$$ (Ref. 2.2.3, table 3.3-3)

$$(K\psi x) = \begin{pmatrix} 4.024 \times 10^{10} \\ 7.939 \times 10^{10} \\ 1.552 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.3.1.6 Rocking about Y (G' = G_s) (μ= ν) For Rocking about Y use 234' x 242'. See sect. 6.1.

$L := 234 \cdot ft \quad B := 242 \cdot ft \quad \frac{L}{B} = 0.967 \quad \beta\psi := 0.50$ (Ref. 2.2.3, figure 3.3-3)

$$K\psi y := \left(\frac{G_s}{1-\nu} \cdot \beta\psi \cdot B \cdot L^2\right)$$ (Ref. 2.2.3, table 3.3-3)

$$K\psi y = \begin{pmatrix} 4.485 \times 10^{10} \\ 8.848 \times 10^{10} \\ 1.73 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.3.1.7 Torsion (L=Equivalent Width)

$L := 227 \cdot ft \quad B = 242\ ft$

$$R := \left[\frac{(B \cdot L) \cdot \left(B^2 + L^2\right)}{6 \cdot \pi}\right]^{.25} \quad R = 133.837\ ft$$ (Ref. 2.2.3, & table 3.3-3)

$$K\psi z := \frac{16 \cdot G_s \cdot R^3}{3}$$

$$K\psi z = \begin{pmatrix} 5.825 \times 10^{10} \\ 1.149 \times 10^{11} \\ 2.247 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.3.2 SOIL DAMPING FOR 1E-4 SEISMIC EVENT

LEGEND:

Gs = G' shear modulus of foundation medium (calculated in Attachment B)
R = Equivalent radius of circular basemat
γ = density of foundation medium
g = acceleration of gravity
ρ = mass density of foundation medium
I_t (mt) = polar mass moment of inertia of structure and basemat
Io_x ($m\psi x$), Io_z($m\psi z$) = total mass moment of inertia of structure and basemat about rocking axis at base
k_x, $k\psi y$, $k\psi x$, kz, ky, kt = equivalent spring constants. (note kt=$k\psi z$)
Cx, $C\psi x$, Cz, Ct, $C\psi y$,Cy = equivalent damping coefficients
Cc = critical damping value
$\beta\psi$ = constants that are functions of the basemat dimensional ratio, L/B

Damping Cases:
The equivalent soil damping coefficient and critical damping values will be calculated for 130' depth of alluvium for Lower Bound, Median and Upper Bound cases:

Case 1 : Lower Bound Estimate : 130' Depth of Alluvium
Case 2 : Median Estimate : 130' Depth of Alluvium
Case 3 : Upper Bound Estimate : 130' Depth of Alluvium

UNITS:

kips (k), feet (ft), radians (rad), seconds (sec)

RESULTS:

Results are summarized in Sect. 7 Results.

6.3.2.1 Equivalent Damping Coefficients

Determine Equivalent Damping Coefficients per ASCE 4-98 section 3.3, (Ref. 2.2.3) methodology for the Receipt Facility.

Calculated mass and mass moment of inertia : DI# 200-SYC-RF00-00100-000, Rev.00A p. 27. (Ref. 2.2.2)

$m_x := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$ Horizontal X

$m_y := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$ Horizontal Y

$m_z := 5890.60 \cdot \frac{k \cdot sec^2}{ft}$ Vertical Z

$Io_x := 3.23 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Rocking about X

$Io_y := 3.08 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Rocking about Y

$I_t := 4.51 \cdot 10^7 \cdot k \cdot ft \cdot sec^2$ Torsion

A) Horizontal X

Seismic load in the x-direction (227' building calculated equivalent length for translation)

$L := 227 \cdot ft$ (equivalent length of basemat in direction of seismic motion)

$B := 242 \cdot ft$ (width of basemat perpendicular to direction of seismic motion)

$R := \sqrt{\frac{B \cdot L}{\pi}}$ $R = 132.235\,ft$ (Ref. 2.2.3, table 3.3-3)

$\gamma := 0.11232 \cdot \frac{k}{ft^3}$ (Ref. 2.2.5)

$g = 32.174 \frac{ft}{s^2}$ $\rho := \frac{\gamma}{g}$ $\rho = 3.491 \times 10^{-3}\, k \cdot \frac{sec^2}{ft^4}$

$Cx := \overrightarrow{\left(0.576 \cdot Kx \cdot R \cdot \sqrt{\frac{\rho}{G_s}}\right)}$ (Ref. 2.2.3, table 3.3-1)

$$(Cx) = \begin{pmatrix} 1.776 \times 10^5 \\ 2.495 \times 10^5 \\ 3.489 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L

Case 2 130' M

Case 3 130' U

B) Horizontal Y

Seismic load in the y-direction (242' building dimension), R is same as Horizontal -X

$Cy := \overrightarrow{\left[\left[0.576 \cdot (Ky)\right] \cdot R \cdot \sqrt{\frac{\rho}{G_s}}\right]}$ (Ref. 2.2.3, table 3.3-1)

$$Cy = \begin{pmatrix} 1.89 \times 10^5 \\ 2.654 \times 10^5 \\ 3.711 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

C) Vertical Z

$L := 227 \cdot ft \quad B := 242 \cdot ft$

$$R := \sqrt{\frac{B \cdot L}{\pi}} \qquad R = 132.235\,ft$$ (Ref. 2.2.3, table 3.3-3)

$$Cz := \overrightarrow{\left(0.85 \cdot Kz \cdot R \cdot \sqrt{\frac{\rho}{G_s}}\right)}$$ (Ref. 2.2.3, table 3.3-1)

$$Cz = \begin{pmatrix} 3.434 \times 10^5 \\ 4.824 \times 10^5 \\ 6.746 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

D) Rocking about X

$L := 242 \cdot ft \quad B := 203 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L^3}{3 \cdot \pi}} \qquad R = 132.181\,ft$ (Ref. 2.2.3, table 3.3-3)

$$B\psi x := 3(1 - \nu) \cdot \frac{Io_x}{8 \cdot \rho \cdot R^5} \qquad B\psi x = \begin{pmatrix} 0.058 \\ 0.058 \\ 0.058 \end{pmatrix}$$ (Ref. 2.2.3, table 3.3-1)

$$C\psi x := \overrightarrow{\left(\frac{0.3}{1 + B\psi x} \cdot (K\psi x) \cdot R \cdot \sqrt{\frac{\rho}{G_s}}\right)}$$

$$(C\psi x) = \begin{pmatrix} 1.32 \times 10^9 \\ 1.855 \times 10^9 \\ 2.593 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

E) Rocking about Y

$B := 242 \cdot ft \quad L := 234 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L^3}{3 \cdot \pi}} \quad R = 134.678\ ft$

$B\psi y := 3(1 - \nu) \cdot \frac{Io_y}{8 \cdot \rho \cdot R^5} \quad B\psi y = \begin{pmatrix} 0.05 \\ 0.05 \\ 0.05 \end{pmatrix}$ (Ref. 2.2.3, table 3.3-3)

$C\psi y := \overrightarrow{\left(\frac{0.3}{1 + B\psi y} \cdot K\psi y \cdot R \cdot \sqrt{\frac{\rho}{G_s}} \right)}$ (Ref. 2.2.3, table 3.3-1) $R = 134.678\ ft$

$C\psi y = \begin{pmatrix} 1.51 \times 10^9 \\ 2.121 \times 10^9 \\ 2.967 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$

Case 1 130' L

Case 2 130' M

Case 3 130' U

F) Torsion

$B := 227 \cdot ft \quad L := 242 \cdot ft \quad R := \sqrt[4]{\frac{B \cdot L \cdot (B^2 + L^2)}{6 \cdot \pi}} \quad R = 133.837\ ft$

$Ct := \overrightarrow{\left(\frac{\sqrt{K\psi z \cdot I_t}}{1 + 2\frac{I_t}{\rho \cdot R^5}} \right)}$ (Ref. 2.2.3, table 3.3-1)

$(Ct) = \begin{pmatrix} 1.012 \times 10^9 \\ 1.421 \times 10^9 \\ 1.988 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$

Case 1 130' L

Case 2 130' M

Case 3 130' U

6.3.2.2 Critical Damping

$Cc := 2\sqrt{k \cdot m}$ eq. 1.13, Introduction to Structural Dynamics, (Ref. 2.2.8)

Units for kx, kz, and ky is kip/ft, for kψx, kψz and kt is ft-k/rad, for mx, mz, my is kip-sec^2/ft, for mψx, mψz and mt is kip-ft-sec^2, for Ccx, Ccz, Ccy is kip-sec/ft and for Ccψx, Ccψy and Cct is ft-k-sec/rad. All k values are taken from summary of soil spring for 1E-4 page 41 and 42.

A) Horizontal X $Ccx := 2\sqrt{Kx \cdot m_x}$

$$(Ccx) = \begin{pmatrix} 2.505 \times 10^5 \\ 3.519 \times 10^5 \\ 4.921 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

B) Horizontal Y $Ccy := 2\sqrt{Ky \cdot m_y}$

$$Ccy = \begin{pmatrix} 2.584 \times 10^5 \\ 3.63 \times 10^5 \\ 5.076 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

C) Vertical Z $Ccz := 2\sqrt{Kz \cdot m_z}$

$$Ccz = \begin{pmatrix} 2.868 \times 10^5 \\ 4.028 \times 10^5 \\ 5.633 \times 10^5 \end{pmatrix} \frac{1}{ft} k \cdot sec$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

D) Rocking about X

$Cc\psi x := 2\sqrt{(K\psi x) \cdot Io_x}$

$$(Cc\psi x) = \begin{pmatrix} 2.28 \times 10^9 \\ 3.203 \times 10^9 \\ 4.479 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

E) Rocking about Y

$$Cc\psi y := 2\sqrt{K\psi y \cdot Io_y}$$

$$Cc\psi y = \begin{pmatrix} 2.351 \times 10^9 \\ 3.302 \times 10^9 \\ 4.617 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

F) Torsion

$$Cct := 2\sqrt{K\psi z \cdot I_t}$$

$$(Cct) = \begin{pmatrix} 3.242 \times 10^9 \\ 4.553 \times 10^9 \\ 6.367 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

6.2.2.3 Damping values: Cc/Cci

A) Horizontal X

$$\left(\frac{Cx}{Ccx}\right) = \begin{pmatrix} 0.709 \\ 0.709 \\ 0.709 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 70.9%
Case 3 130' U

B) Horizontal Y

$$\frac{Cy}{Ccy} = \begin{pmatrix} 0.731 \\ 0.731 \\ 0.731 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 73.1%
Case 3 130' U

C) Vertical Z

$$\frac{Cz}{Ccz} = \begin{pmatrix} 1.198 \\ 1.198 \\ 1.198 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 119.8%
Case 3 130' U

D) Rocking about X

$$\left(\frac{C\psi x}{Cc\psi x}\right) = \begin{pmatrix} 0.579 \\ 0.579 \\ 0.579 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 57.9%
Case 3 130' U

E) Rocking about Y

$$\frac{C\psi y}{Cc\psi y} = \begin{pmatrix} 0.643 \\ 0.643 \\ 0.643 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 64.3%
Case 3 130' U

F) Torsion

$$\left(\frac{Ct}{Cct}\right) = \begin{pmatrix} 0.312 \\ 0.312 \\ 0.312 \end{pmatrix}$$

Case 1 130' L
Case 2 130' M 31.2%
Case 3 130' U

7. RESULTS AND CONCLUSIONS

The following data present lower bound, median and upper bound soil springs for 130' of alluvium suitable for use in a lumped mass stick model seismic analysis of the Receipt Facility. Use of this set of soil springs is reasonable for Tier-1, seismic design for 5E–4 and 1E-4 annual exceedence frequency levels. Use of these springs is limited to the Tier-1 seismic analysis of the Receipt Facility (RF).

7.1 RESULTS FOR 5E-4 SEISMIC EVENT

7.1.1 Summary of Soil Springs for 5E-4

See Section 6.2.1 for calculation.

7.1.1.1 **Kx – Horizontal Spring in X (227') direction of foundation**
(5E-4)

$$Kx = \begin{pmatrix} 3.935\times 10^{6} \\ 7.555\times 10^{6} \\ 1.434\times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.1.2 **Kz – Vertical Spring**
(5E-4)

$$Kz = \begin{pmatrix} 5.102\times 10^{6} \\ 9.794\times 10^{6} \\ 1.858\times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.1.3 **Ky – Horizontal Spring in y (242') direction of foundation**
(5E-4)

$$Ky = \begin{pmatrix} 4.186\times 10^{6} \\ 8.037\times 10^{6} \\ 1.525\times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.1.4 **KΨX – Rocking Spring about X (203') axis of foundation**
(5E-4)

$$(K\psi x) = \begin{pmatrix} 5.881\times 10^{10} \\ 1.129\times 10^{11} \\ 2.142\times 10^{11} \end{pmatrix} \frac{ft\cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.1.5 **KΨY – Rocking Spring about Y (234') axis of foundation**
(5E-4)

$$K\psi y = \begin{pmatrix} 6.555\times 10^{10} \\ 1.258\times 10^{11} \\ 2.388\times 10^{11} \end{pmatrix} \frac{ft\cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.1.6 **KΨZ – Torsional Spring**
(5E-4)

$$K\psi z = \begin{pmatrix} 8.703\times 10^{10} \\ 1.671\times 10^{11} \\ 3.17\times 10^{11} \end{pmatrix} \frac{ft\cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2 Summary of Damping for 5E-4

See Section 6.2.2.1 and 6.2.2.2 for calculation.

7.1.2.1 **A) Horizontal X Damping Values**
(5E-4)

$$(Cx) = \begin{pmatrix} 2.147\times 10^{5} \\ 2.974\times 10^{5} \\ 4.097\times 10^{5} \end{pmatrix} \frac{k\cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2.2 **B) Horizontal Y Damping Values**
(5E-4)

$$Cy = \begin{pmatrix} 2.284\times 10^{5} \\ 3.164\times 10^{5} \\ 4.358\times 10^{5} \end{pmatrix} \frac{k\cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2.3 **C) Vertical Z Damping Values**
(5E-4)

$$Cz = \begin{pmatrix} 4.107\times 10^{5} \\ 5.69\times 10^{5} \\ 7.838\times 10^{5} \end{pmatrix} \frac{k\cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2.4 **D) Rocking about X Damping Values**
(5E-4)

$$(C\psi x) = \begin{pmatrix} 1.577\times 10^{9} \\ 2.185\times 10^{9} \\ 3.01\times 10^{9} \end{pmatrix} \frac{ft\cdot k\cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2.5 **E) Rocking about Y Damping Values**
(5E-4)

$$C\psi y = \begin{pmatrix} 1.804\times 10^{9} \\ 2.5\times 10^{9} \\ 3.443\times 10^{9} \end{pmatrix} \frac{ft\cdot k\cdot sec}{rad}$$

Case 1 30' L
Case 2 30' M
Case 3 30' U

7.1.2.6 **F) Torsion Damping Values**
(5E-4)

$$(Ct) = \begin{pmatrix} 1.237\times 10^{9} \\ 1.714\times 10^{9} \\ 2.361\times 10^{9} \end{pmatrix} \frac{ft\cdot k\cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.1.2.7 **In percentage of critical damping**
(5E-4)

Degree of Freedom	% of Critical Damping
Horizontal Translation-X	70.5%
Horizontal Translation-Y	72.7%
Vertical Translation- Z	118.4%
Rocking about- X	57.2%
Rocking about-Y	63.5%
Torsion	31.2%

The above frequency independent percent of critical damping coefficients for the six degrees of freedom are approximated soil-structure interaction damping values for the layered soil conditions at the Receipt Facility site location. Ref. 2.2.7 recommends a blanket reduction factor for translational damping values of 75%. ASCE 4-98 (Ref. 2.2.3), section 3.1.5.4 requires a maximum damping value of 20% for soil structure interaction mode shapes. For a Tier-1 response spectrum seismic analysis the percent of critical damping to be used in the seismic analysis should be limited to a maximum of 20% for Soil Structure Interaction modal shapes. Time history analysis performed to support the development of in-structure response spectra will use 75% of the computed values for translational damping and the full values for the rotational damping. Future detail design will be based on a detailed Soil Structure Interaction (SSI) analysis that will account for the frequency dependent damping values of the layered soils beneath the Receipt Facility.

7.2 RESULTS FOR 1E-4 SEISMIC EVENT

7.2.1 Summary of Soil Springs for 1E-4

See Section 6.3.1 for calculation.

7.2.1.1 **Kx – Horizontal Spring in X (227') direction of foundation**
(1E-4)

$$(Kx) = \begin{pmatrix} 2.664 \times 10^{6} \\ 5.255 \times 10^{6} \\ 1.028 \times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.1.2 **Kz – Vertical Spring**
(1E-4)

$$Kz = \begin{pmatrix} 3.491 \times 10^{6} \\ 6.886 \times 10^{6} \\ 1.347 \times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.1.3 **Ky – Horizontal Spring in Y (242') direction of foundation**
(1E-4)

$$Ky = \begin{pmatrix} 2.834 \times 10^{6} \\ 5.591 \times 10^{6} \\ 1.093 \times 10^{7} \end{pmatrix} \frac{k}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.1.4 **KΨx – Rocking Spring about X (203') axis of foundation**
(1E-4)

$$(K\psi x) = \begin{pmatrix} 4.024 \times 10^{10} \\ 7.939 \times 10^{10} \\ 1.552 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.1.5 **KΨY – Rocking Spring about Y (234') axis of foundation**
(1E-4)

$$K\psi y = \begin{pmatrix} 4.485 \times 10^{10} \\ 8.848 \times 10^{10} \\ 1.73 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.1.6 **KΨZ – Torsional Spring**
(1E-4)

$$K\psi z = \begin{pmatrix} 5.825 \times 10^{10} \\ 1.149 \times 10^{11} \\ 2.247 \times 10^{11} \end{pmatrix} \frac{ft \cdot k}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2 Summary for Damping Values for 1E-4

See Section 6.3.2.1 and 6.3.2.2 for calculation.

7.2.2.1 **A) Horizontal X Damping Values**
(1E-4)

$$(Cx) = \begin{pmatrix} 1.776 \times 10^{5} \\ 2.495 \times 10^{5} \\ 3.489 \times 10^{5} \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.2 **B) Horizontal Y Damping Values**
(1E-4)

$$Cy = \begin{pmatrix} 1.89 \times 10^{5} \\ 2.654 \times 10^{5} \\ 3.711 \times 10^{5} \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.3 **C) Vertical Z Damping Values**
(1E-4)

$$Cz = \begin{pmatrix} 3.434 \times 10^5 \\ 4.824 \times 10^5 \\ 6.746 \times 10^5 \end{pmatrix} \frac{k \cdot sec}{ft}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.4 **D) Rocking about X Damping Values**
(1E-4)

$$(C\psi x) = \begin{pmatrix} 1.32 \times 10^9 \\ 1.855 \times 10^9 \\ 2.593 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.5 **E) Rocking about Y Damping Values**
(1E-4)

$$C\psi y = \begin{pmatrix} 1.51 \times 10^9 \\ 2.121 \times 10^9 \\ 2.967 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.6 **F) Torsion Damping Values**
(1E-4)

$$(Ct) = \begin{pmatrix} 1.012 \times 10^9 \\ 1.421 \times 10^9 \\ 1.988 \times 10^9 \end{pmatrix} \frac{ft \cdot k \cdot sec}{rad}$$

Case 1 130' L
Case 2 130' M
Case 3 130' U

7.2.2.7 **In percentage of critical damping**
(1E-4)

Degree of Freedom	% of Critical Damping
Horizontal Translation-X	70.9%
Horizontal Translation-Y	73.1%
Vertical Translation- Z	119.8%
Rocking about- X	57.9%
Rocking about-Y	64.3%
Torsion	31.2%

7.2.3 Impact of FEBRUARY 2008 Strain Compatible Soil Properties

As shown on page G-16, the maximum shift in frequency due to the revised strain compatible soil properties (Ref. 2.2.5 and 2.2.10) is 0.7%. This difference will have negligible impact on the seismic analysis results.
For further discussions and results of this assessment, see Attachment G.

7.3 CONCLUSIONS

The above computed results as updated for current soil properties are reasonable compared to the inputs and are suitable for use in a Tier-1 seismic analysis of the Receipt Facility.

ATTACHMENT A -- SHEAR MODULUS and POISSON'S RATIO VALUES at 130' ALLUVIUM DEPTH FOR 5E-4 SEISMIC EVENT

From DTN MO0706SCSPS5E4.002

Weighted results of Northeast velocity profiles with 100ft Alluvium (0-100ft Alluvium, >100ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.37	0.26	868.30	1.96	0.19	613.98	4.52	0.37	1228.00	0.85	0.59	1948.40	1.14	0.42	1377.70	1.95	0.84	2755.50	0.66	0.0025	0.0038
1.22	4.00	1.83	6.00	1.80	112.32	0.39	0.27	895.18	2.83	0.19	632.99	6.52	0.39	1266.00	1.23	0.68	2243.80	1.14	0.51	1687.40	1.95	0.91	2983.70	0.66	0.0068	0.0105
1.22	4.00	3.05	10.00	1.80	112.32	0.39	0.29	949.16	3.15	0.20	671.16	7.25	0.41	1342.30	1.37	0.77	2529.20	1.14	0.59	1922.50	1.95	1.01	3327.40	0.66	0.0097	0.0149
1.22	4.00	4.27	14.00	1.80	112.32	0.39	0.33	1071.60	3.18	0.23	757.74	7.30	0.46	1515.50	1.38	0.89	2914.00	1.14	0.63	2070.60	1.95	1.25	4100.90	0.66	0.0101	0.0156
1.22	4.00	5.49	18.00	1.80	112.32	0.39	0.42	1383.40	2.96	0.30	978.21	6.81	0.60	1956.40	1.29	1.06	3464.90	1.14	0.80	2613.60	1.95	1.40	4593.40	0.66	0.0074	0.0114
2.44	8.00	7.31	24.00	1.80	112.32	0.39	0.41	1335.90	3.29	0.29	944.59	7.56	0.58	1889.20	1.43	1.08	3529.50	1.14	0.81	2648.40	1.95	1.43	4703.80	0.66	0.0100	0.0154
2.44	8.00	9.75	32.00	1.80	112.32	0.38	0.43	1399.80	3.42	0.30	989.83	7.87	0.60	1979.70	1.49	1.09	3579.50	1.14	0.83	2731.40	1.95	1.43	4690.90	0.66	0.0114	0.0176
2.44	8.00	12.19	40.00	1.80	112.32	0.36	0.45	1476.90	3.46	0.32	1044.30	7.96	0.64	2088.70	1.50	1.11	3637.40	1.14	0.84	2768.50	1.95	1.46	4779.00	0.66	0.0121	0.0186
2.44	8.00	14.63	48.00	1.80	112.32	0.36	0.50	1626.40	3.37	0.35	1150.00	7.75	0.70	2300.10	1.47	1.19	3899.30	1.14	0.93	3045.60	1.95	1.52	4992.30	0.66	0.0113	0.0173
2.44	8.00	17.07	56.00	1.80	112.32	0.34	0.55	1812.10	3.14	0.39	1281.30	7.22	0.78	2562.70	1.36	1.20	3937.30	1.14	0.94	3078.60	1.95	1.53	5035.60	0.66	0.0101	0.0155
3.05	10.00	19.81	65.00	1.80	112.32	0.34	0.59	1922.60	3.11	0.42	1379.00	7.15	0.82	2680.30	1.35	1.26	4133.60	1.14	1.03	3375.10	1.95	1.54	5062.60	0.66	0.0099	0.0152
3.05	10.00	22.86	75.00	1.80	112.32	0.34	0.61	2017.30	3.09	0.43	1426.50	7.11	0.87	2853.00	1.34	1.33	4349.90	1.14	1.08	3551.70	1.95	1.62	5327.50	0.66	0.0099	0.0152
3.05	10.00	25.91	85.00	1.80	112.32	0.33	0.67	2192.70	3.00	0.49	1610.90	6.91	0.91	2984.60	1.31	1.42	4652.90	1.14	1.16	3799.10	1.95	1.74	5698.60	0.66	0.0090	0.0139
3.05	10.00	28.95	95.00	1.80	112.32	0.34	0.66	2161.00	3.12	0.48	1569.70	7.17	0.91	2975.10	1.36	1.42	4649.00	1.14	1.16	3795.90	1.95	1.74	5693.80	0.66	0.0100	0.0153
3.05	10.00	32.00	105.00	2.20	137.28	0.30	0.81	2665.70	0.71	0.66	2176.50	1.27	1.00	3264.80	0.50	1.51	4957.20	0.50	1.23	4047.50	0.81	1.85	6071.30	0.50	0.0057	0.0088
3.05	10.00	35.05	115.00	2.20	137.28	0.30	0.81	2667.90	0.72	0.66	2178.30	1.30	1.00	3267.50	0.50	1.51	4965.90	0.50	1.24	4054.60	0.81	1.85	6082.00	0.50	0.0061	0.0094
3.05	10.00	38.10	125.00	2.20	137.28	0.30	0.82	2677.90	0.69	0.67	2186.50	1.15	1.00	3279.80	0.50	1.52	4980.60	0.50	1.24	4066.60	0.81	1.86	6100.00	0.50	0.0064	0.0099
3.05	10.00	41.15	135.00	2.20	137.28	0.30	0.84	2741.10	0.69	0.68	2238.10	1.16	1.02	3357.20	0.50	1.55	5098.80	0.50	1.27	4163.10	0.81	1.90	6244.70	0.50	0.0065	0.0100
3.05	10.00	44.19	145.00	2.20	137.28	0.30	0.85	2800.00	0.69	0.70	2286.20	1.16	1.05	3429.30	0.50	1.59	5209.10	0.50	1.30	4253.20	0.81	1.94	6379.80	0.50	0.0066	0.0101
3.05	10.00	47.24	155.00	2.20	137.28	0.30	0.86	2830.30	0.69	0.70	2310.90	1.17	1.06	3466.40	0.50	1.61	5267.50	0.50	1.31	4300.90	0.81	1.97	6451.30	0.50	0.0067	0.0104
3.05	10.00	50.29	165.00	2.20	137.28	0.30	0.87	2842.90	0.69	0.71	2321.20	1.19	1.06	3481.90	0.50	1.61	5292.60	0.50	1.32	4321.40	0.81	1.98	6482.10	0.50	0.0070	0.0107
3.05	10.00	53.34	175.00	2.20	137.28	0.30	0.86	2813.20	0.70	0.70	2297.00	1.21	1.05	3445.40	0.50	1.60	5241.90	0.50	1.30	4280.00	0.81	1.96	6420.00	0.50	0.0074	0.0114
3.05	10.00	56.39	185.00	2.20	137.28	0.30	0.85	2795.40	0.71	0.70	2282.40	1.24	1.04	3423.70	0.50	1.59	5212.50	0.50	1.30	4256.00	0.81	1.95	6384.00	0.50	0.0077	0.0119
3.05	10.00	59.43	195.00	2.20	137.28	0.30	0.87	2846.40	0.71	0.71	2324.00	1.24	1.06	3486.10	0.50	1.62	5307.50	0.50	1.32	4333.60	0.81	1.98	6500.30	0.50	0.0077	0.0119
3.81	12.50	62.86	206.25	2.20	137.28	0.30	0.87	2860.10	0.71	0.71	2334.50	1.25	1.07	3504.00	0.50	1.63	5335.40	0.50	1.33	4356.30	0.81	1.99	6534.50	0.50	0.0079	0.0122
3.81	12.50	66.67	218.75	2.20	137.28	0.30	0.88	2885.90	0.71	0.72	2356.40	1.26	1.08	3534.50	0.50	1.64	5385.20	0.50	1.34	4397.00	0.81	2.01	6595.50	0.50	0.0080	0.0124
3.81	12.50	70.48	231.25	2.20	137.28	0.30	0.89	2916.20	0.71	0.72	2370.50	1.26	1.09	3587.50	0.50	1.66	5443.10	0.50	1.35	4444.30	0.81	2.03	6666.40	0.50	0.0081	0.0125
3.81	12.50	74.29	243.75	2.20	137.28	0.30	0.90	2966.10	0.71	0.74	2414.20	1.26	1.11	3644.20	0.50	1.69	5536.30	0.50	1.38	4520.40	0.81	2.07	6780.60	0.50	0.0081	0.0124
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.92	3016.30	0.66	0.75	2462.80	1.06	1.13	3694.20	0.50	1.71	5615.30	0.50	1.40	4584.90	0.81	2.10	6877.30	0.50	0.0080	0.0123
3.81	12.50	81.91	268.75	2.20	137.28	0.30	0.92	3022.00	0.67	0.75	2467.50	1.07	1.13	3701.20	0.50	1.72	5627.40	0.50	1.40	4594.70	0.81	2.10	6892.10	0.50	0.0082	0.0126
3.81	12.50	85.72	281.25	2.20	137.28	0.30	0.94	3071.40	0.67	0.76	2507.80	1.07	1.15	3761.60	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0081	0.0125
3.81	12.50	89.53	293.75	2.20	137.28	0.30	0.94	3070.40	0.67	0.76	2507.00	1.07	1.15	3760.50	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0083	0.0128
4.57	15.00	93.72	307.50	2.20	137.28	0.30	0.96	3144.50	0.67	0.78	2567.50	1.07	1.17	3851.20	0.50	1.78	5854.10	0.50	1.46	4779.90	0.81	2.19	7169.80	0.50	0.0081	0.0125
4.57	15.00	98.29	322.50	2.20	137.28	0.30	0.97	3167.60	0.67	0.79	2586.40	1.07	1.18	3879.50	0.50	1.80	5897.50	0.50	1.47	4815.30	0.81	2.20	7222.90	0.50	0.0082	0.0126
4.57	15.00	102.86	337.50	2.20	137.28	0.30	1.00	3291.10	0.66	0.82	2687.20	1.06	1.23	4030.80	0.50	1.87	6122.20	0.50	1.52	4998.80	0.81	2.29	7498.10	0.50	0.0077	0.0119
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.02	3359.40	0.66	0.84	2742.90	1.06	1.25	4114.40	0.50	1.90	6247.10	0.50	1.55	5100.70	0.81	2.33	7651.10	0.50	0.0076	0.0117
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.05	3434.20	0.66	0.85	2804.00	1.05	1.28	4206.00	0.50	1.95	6384.20	0.50	1.59	5212.70	0.81	2.38	7819.00	0.50	0.0074	0.0114
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.06	3471.40	0.66	0.86	2834.40	1.05	1.30	4251.60	0.50	1.97	6453.30	0.50	1.61	5269.10	0.81	2.41	7903.60	0.50	0.0074	0.0113
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.06	3487.30	0.66	0.87	2847.40	1.05	1.30	4271.10	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0074	0.0114
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.06	3486.50	0.66	0.87	2846.70	1.06	1.30	4270.10	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0076	0.0116
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.06	3485.80	0.66	0.87	2846.20	1.06	1.30	4269.30	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0077	0.0118
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.06	3485.20	0.66	0.87	2845.70	1.06	1.30	4268.50	0.50	1.98	6483.90	0.50	1.61	5294.10	0.81	2.42	7941.10	0.50	0.0078	0.0120
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.09	3580.70	0.66	0.89	2923.70	1.06	1.34	4385.50	0.50	2.03	6658.70	0.50	1.66	5436.80	0.81	2.49	8155.20	0.50	0.0075	0.0115
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.10	3601.40	0.66	0.90	2940.50	1.06	1.34	4410.80	0.50	2.04	6697.30	0.50	1.67	5468.30	0.81	2.50	8202.50	0.50	0.0075	0.0116
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.11	3630.20	0.66	0.90	2964.00	1.05	1.36	4446.00	0.50	2.06	6749.70	0.50	1.68	5511.10	0.81	2.52	8266.70	0.50	0.0075	0.0115

From DTN MO0706SCSPS5E4.002

Weighted results of Northeast velocity profiles with 200ft Alluvium (0-200ft Alluvium, >200ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.37	0.26	851.78	1.84	0.18	602.30	4.13	0.37	1204.60	0.82	0.59	1922.60	1.14	0.41	1359.50	1.95	0.83	2719.00	0.66	0.0025	0.0038
1.22	4.00	1.83	6.00	1.80	112.32	0.38	0.27	888.08	2.60	0.19	627.97	5.98	0.38	1255.90	1.13	0.69	2249.50	1.14	0.51	1671.70	1.95	0.92	3027.10	0.66	0.0066	0.0102
1.22	4.00	3.05	10.00	1.80	112.32	0.39	0.29	937.47	2.94	0.20	662.89	6.77	0.40	1325.80	1.28	0.77	2519.00	1.14	0.57	1882.40	1.95	1.03	3370.80	0.66	0.0096	0.0147
1.22	4.00	4.27	14.00	1.80	112.32	0.39	0.32	1035.90	3.04	0.22	732.52	6.98	0.45	1465.00	1.32	0.87	2861.30	1.14	0.62	2035.90	1.95	1.23	4021.40	0.66	0.0105	0.0161
1.22	4.00	5.49	18.00	1.80	112.32	0.39	0.41	1340.80	2.83	0.29	948.06	6.50	0.58	1896.10	1.23	1.03	3382.00	1.14	0.77	2531.50	1.95	1.38	4518.30	0.66	0.0077	0.0118
2.44	8.00	7.31	24.00	1.80	112.32	0.40	0.39	1283.00	3.15	0.28	907.23	7.25	0.55	1814.50	1.37	1.05	3445.10	1.14	0.78	2561.50	1.95	1.41	4633.50	0.66	0.0106	0.0163
2.44	8.00	9.75	32.00	1.80	112.32	0.38	0.42	1386.00	3.19	0.30	980.06	7.34	0.60	1960.10	1.39	1.09	3569.30	1.14	0.82	2680.10	1.95	1.45	4753.50	0.66	0.0113	0.0174
2.44	8.00	12.19	40.00	1.80	112.32	0.36	0.44	1457.30	3.26	0.31	1030.50	7.50	0.63	2060.90	1.42	1.11	3627.00	1.14	0.83	2715.10	1.95	1.48	4845.10	0.66	0.0121	0.0186
2.44	8.00	14.63	48.00	1.80	112.32	0.36	0.50	1655.60	3.13	0.36	1170.70	7.19	0.71	2341.30	1.36	1.20	3928.40	1.14	0.93	3061.60	1.95	1.54	5040.60	0.66	0.0106	0.0164
2.44	8.00	17.07	56.00	1.80	112.32	0.34	0.56	1839.80	2.96	0.40	1300.90	6.82	0.79	2601.90	1.29	1.21	3966.70	1.14	0.94	3098.40	1.95	1.55	5078.30	0.66	0.0096	0.0147
3.05	10.00	19.81	65.00	1.80	112.32	0.34	0.59	1939.30	2.94	0.42	1381.90	6.76	0.83	2721.60	1.28	1.27	4153.00	1.14	1.03	3390.90	1.95	1.55	5086.40	0.66	0.0096	0.0147
3.05	10.00	22.86	75.00	1.80	112.32	0.34	0.62	2033.50	2.94	0.44	1437.90	6.75	0.88	2875.80	1.28	1.33	4359.20	1.14	1.08	3559.30	1.95	1.63	5338.90	0.66	0.0096	0.0147
3.05	10.00	25.91	85.00	1.80	112.32	0.34	0.67	2195.70	2.87	0.50	1653.80	6.60	0.89	2915.10	1.25	1.41	4632.40	1.14	1.15	3782.30	1.95	1.73	5673.50	0.66	0.0089	0.0137
3.05	10.00	28.95	95.00	1.80	112.32	0.34	0.66	2159.40	2.99	0.49	1608.20	6.87	0.88	2899.60	1.30	1.41	4623.90	1.14	1.15	3775.40	1.95	1.73	5663.10	0.66	0.0099	0.0153
3.05	10.00	32.00	105.00	1.80	112.32	0.34	0.68	2235.20	3.02	0.51	1685.50	6.95	0.90	2964.20	1.32	1.43	4705.50	1.14	1.17	3842.00	1.95	1.76	5763.00	0.66	0.0099	0.0152
3.05	10.00	35.05	115.00	1.80	112.32	0.34	0.68	2218.20	3.12	0.51	1675.20	7.16	0.90	2937.20	1.36	1.44	4711.90	1.14	1.17	3847.30	1.95	1.76	5770.90	0.66	0.0106	0.0164
3.05	10.00	38.10	125.00	1.80	112.32	0.34	0.67	2203.00	3.20	0.51	1661.30	7.35	0.89	2921.50	1.39	1.44	4723.00	1.14	1.18	3856.30	1.95	1.76	5784.50	0.66	0.0114	0.0175
3.05	10.00	41.15	135.00	1.80	112.32	0.34	0.70	2285.70	3.16	0.52	1712.50	7.27	0.93	3050.90	1.38	1.49	4884.10	1.14	1.22	3987.90	1.95	1.82	5981.80	0.66	0.0110	0.0170
3.05	10.00	44.19	145.00	1.80	112.32	0.34	0.71	2337.80	3.16	0.53	1739.90	7.27	0.96	3141.20	1.37	1.52	4994.50	1.14	1.24	4078.00	1.95	1.86	6117.00	0.66	0.0110	0.0169
3.05	10.00	47.24	155.00	1.80	112.32	0.34	0.72	2356.60	3.20	0.53	1732.40	7.37	0.98	3205.80	1.39	1.54	5060.90	1.14	1.26	4132.20	1.95	1.89	6198.30	0.66	0.0113	0.0173
3.05	10.00	50.29	165.00	1.80	112.32	0.34	0.71	2325.50	3.29	0.52	1697.50	7.56	0.97	3185.60	1.43	1.54	5039.30	1.14	1.25	4114.60	1.95	1.88	6171.90	0.66	0.0120	0.0184
3.05	10.00	53.34	175.00	1.80	112.32	0.35	0.69	2275.00	3.39	0.49	1616.80	7.78	0.98	3201.20	1.47	1.52	4995.50	1.14	1.24	4077.50	1.95	1.87	6120.20	0.66	0.0129	0.0199
3.05	10.00	56.39	185.00	1.80	112.32	0.35	0.69	2262.60	3.44	0.49	1601.90	7.91	0.97	3195.80	1.50	1.52	4999.00	1.14	1.24	4081.70	1.95	1.87	6122.50	0.66	0.0135	0.0207
3.05	10.00	59.43	195.00	1.80	112.32	0.35	0.71	2317.60	3.40	0.50	1654.70	7.83	0.99	3246.00	1.48	1.55	5094.90	1.14	1.27	4160.00	1.95	1.90	6240.00	0.66	0.0132	0.0202
3.81	12.50	62.86	206.25	2.20	137.28	0.30	0.88	2877.50	0.71	0.71	2327.20	1.20	1.08	3557.80	0.50	1.63	5363.80	0.50	1.33	4366.20	0.81	2.01	6589.30	0.50	0.0072	0.0110
3.81	12.50	66.67	218.75	2.20	137.28	0.30	0.89	2904.00	0.71	0.72	2361.60	1.21	1.09	3570.90	0.50	1.65	5415.00	0.50	1.35	4421.30	0.81	2.02	6632.00	0.50	0.0073	0.0113
3.81	12.50	70.48	231.25	2.20	137.28	0.30	0.89	2936.10	0.71	0.72	2367.10	1.22	1.11	3641.80	0.50	1.67	5477.10	0.50	1.36	4447.80	0.81	2.06	6744.60	0.50	0.0075	0.0115
3.81	12.50	74.29	243.75	2.20	137.28	0.30	0.91	2989.70	0.71	0.74	2415.70	1.22	1.13	3700.10	0.50	1.70	5578.00	0.50	1.38	4543.30	0.81	2.09	6848.40	0.50	0.0075	0.0115
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.93	3048.70	0.68	0.76	2489.20	1.09	1.14	3733.90	0.50	1.73	5664.50	0.50	1.41	4625.00	0.81	2.11	6937.60	0.50	0.0074	0.0114
3.81	12.50	81.91	268.75	2.20	137.28	0.30	0.93	3055.90	0.68	0.76	2495.10	1.09	1.14	3742.60	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0076	0.0117
3.81	12.50	85.72	281.25	2.20	137.28	0.30	0.93	3054.80	0.68	0.76	2494.20	1.10	1.14	3741.30	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0078	0.0120
3.81	12.50	89.53	293.75	2.20	137.28	0.30	0.93	3053.80	0.69	0.76	2493.40	1.10	1.14	3740.20	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0080	0.0124
4.57	15.00	93.72	307.50	2.20	137.28	0.30	0.95	3128.00	0.69	0.78	2554.00	1.10	1.17	3831.00	0.50	1.77	5815.30	0.50	1.45	4748.20	0.81	2.17	7122.30	0.50	0.0079	0.0121
4.57	15.00	98.29	322.50	2.20	137.28	0.30	0.96	3151.10	0.69	0.78	2572.90	1.10	1.18	3859.30	0.50	1.79	5858.50	0.50	1.46	4783.40	0.81	2.19	7175.20	0.50	0.0080	0.0122
4.57	15.00	102.86	337.50	2.20	137.28	0.30	1.00	3273.10	0.68	0.81	2672.50	1.09	1.22	4008.80	0.50	1.85	6081.70	0.50	1.51	4965.70	0.81	2.27	7448.50	0.50	0.0076	0.0116
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.02	3336.30	0.68	0.83	2724.10	1.09	1.25	4086.10	0.50	1.89	6196.40	0.50	1.54	5059.30	0.81	2.31	7589.00	0.50	0.0075	0.0115
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.04	3410.40	0.68	0.85	2784.60	1.08	1.27	4176.90	0.50	1.93	6332.50	0.50	1.58	5170.50	0.81	2.36	7755.70	0.50	0.0073	0.0112
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.05	3447.30	0.68	0.86	2814.70	1.08	1.29	4222.10	0.50	1.95	6400.90	0.50	1.59	5226.30	0.81	2.39	7839.50	0.50	0.0073	0.0112
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.06	3463.10	0.68	0.86	2827.60	1.08	1.29	4241.40	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0074	0.0113
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.06	3462.40	0.68	0.86	2827.00	1.09	1.29	4240.50	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0075	0.0116
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.06	3461.70	0.68	0.86	2826.40	1.09	1.29	4239.70	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0077	0.0118
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.05	3461.10	0.68	0.86	2826.00	1.09	1.29	4239.00	0.50	1.96	6431.30	0.50	1.60	5251.10	0.81	2.40	7876.70	0.50	0.0078	0.0120
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.08	3555.40	0.68	0.88	2903.00	1.09	1.33	4354.40	0.50	2.01	6604.70	0.50	1.64	5392.70	0.81	2.47	8089.10	0.50	0.0075	0.0115
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.09	3575.80	0.68	0.89	2919.60	1.09	1.33	4379.40	0.50	2.02	6643.00	0.50	1.65	5424.00	0.81	2.48	8136.00	0.50	0.0075	0.0116
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.10	3603.90	0.68	0.90	2942.50	1.09	1.35	4413.80	0.50	2.04	6695.00	0.50	1.67	5466.40	0.81	2.50	8199.70	0.50	0.0075	0.0116

Weighted results of Northeast velocity profiles with 130ft Alluvium (0-130ft Alluvium, >130ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness (ft)	Depth to Midpoint of Layer (ft)	Density (g/cm3)	Unit Weight (pcf)	Median Vs (ft/s)	Poisson's Ratio (no units)	Lower Bound Vs (ft/s)	Poisson's Ratio (no units)	Upper Bound Vs (ft/s)	Poisson's Ratio (no units)	Median Vp (ft/s)	Lower Bound Vp (ft/s)	Upper Bound Vp (ft/s)
4.00	2.00	1.80	112.32	860.04	0.37	602.30	0.37	1228.00	0.37	1935.50	1359.50	2755.50
4.00	6.00	1.80	112.32	891.63	0.39	627.97	0.38	1266.00	0.39	2246.65	1671.70	2983.70
4.00	10.00	1.80	112.32	943.32	0.39	662.89	0.39	1342.30	0.39	2524.10	1882.40	3327.40
4.00	14.00	1.80	112.32	1053.75	0.39	732.52	0.39	1515.50	0.39	2887.65	2035.90	4100.90
4.00	18.00	1.80	112.32	1362.10	0.39	948.06	0.39	1956.40	0.39	3423.45	2531.50	4593.40
8.00	24.00	1.80	112.32	1309.45	0.39	907.23	0.40	1889.20	0.39	3487.30	2561.50	4703.80
8.00	32.00	1.80	112.32	1392.90	0.38	980.06	0.38	1979.70	0.38	3574.40	2680.10	4690.90
8.00	40.00	1.80	112.32	1467.10	0.36	1030.50	0.36	2088.70	0.36	3632.20	2715.10	4779.00
8.00	48.00	1.80	112.32	1641.00	0.36	1150.00	0.36	2341.30	0.36	3913.85	3045.60	5040.60
8.00	56.00	1.80	112.32	1825.95	0.34	1281.30	0.34	2601.90	0.34	3952.00	3078.60	5078.30
10.00	65.00	1.80	112.32	1930.95	0.34	1379.00	0.34	2721.60	0.34	4143.30	3375.10	5086.40
10.00	75.00	1.80	112.32	2025.40	0.34	1426.50	0.34	2875.80	0.34	4354.55	3551.70	5338.90
10.00	85.00	1.80	112.32	2194.20	0.34	1610.90	0.33	2984.60	0.33	4642.65	3799.10	5698.60
10.00	95.00	1.80	112.32	2160.20	0.34	1569.70	0.34	2975.10	0.34	4636.45	3795.90	5693.80
10.00	105.00	1.80	112.32	2235.20	0.34	1685.50	0.34	2964.20	0.34	4705.50	3842.00	5763.00
10.00	115.00	1.80	112.32	2218.20	0.34	1675.20	0.34	2937.20	0.34	4711.90	3847.30	5770.90
10.00	125.00	1.80	112.32	2203.00	0.34	1661.30	0.34	2921.50	0.34	4723.00	3856.30	5784.50
10.00	135.00	2.20	137.28	2741.10	0.30	2238.10	0.30	3357.20	0.30	5098.80	4163.10	6244.70
10.00	145.00	2.20	137.28	2800.00	0.30	2286.20	0.30	3429.30	0.30	5209.10	4253.20	6379.80
10.00	155.00	2.20	137.28	2830.30	0.30	2310.90	0.30	3466.40	0.30	5267.50	4300.90	6451.30
10.00	165.00	2.20	137.28	2842.90	0.30	2321.20	0.30	3481.90	0.30	5292.60	4321.40	6482.10
10.00	175.00	2.20	137.28	2813.20	0.30	2297.00	0.30	3445.40	0.30	5241.90	4280.00	6420.00
10.00	185.00	2.20	137.28	2795.40	0.30	2282.40	0.30	3423.70	0.30	5212.50	4256.00	6384.00
10.00	195.00	2.20	137.28	2846.40	0.30	2324.00	0.30	3486.10	0.30	5307.50	4333.60	6500.30
12.50	206.25	2.20	137.28	2868.80	0.30	2327.20	0.30	3557.80	0.30	5349.60	4366.20	6589.30
12.50	218.75	2.20	137.28	2894.95	0.30	2356.40	0.30	3570.90	0.30	5400.10	4397.00	6632.00
12.50	231.25	2.20	137.28	2926.15	0.30	2367.10	0.30	3641.80	0.30	5460.10	4447.80	6744.60
12.50	243.75	2.20	137.28	2977.90	0.30	2414.20	0.30	3700.10	0.30	5557.15	4520.40	6848.40
12.50	256.25	2.20	137.28	3032.50	0.30	2462.80	0.30	3733.90	0.30	5639.90	4584.90	6937.60
12.50	268.75	2.20	137.28	3038.95	0.30	2467.50	0.30	3742.60	0.30	5653.40	4594.70	6955.80
12.50	281.25	2.20	137.28	3063.10	0.30	2494.20	0.30	3761.60	0.30	5699.20	4637.20	7004.30
12.50	293.75	2.20	137.28	3062.10	0.30	2493.40	0.30	3760.50	0.30	5699.20	4637.20	7004.30
15.00	307.50	2.20	137.28	3136.25	0.30	2554.00	0.30	3851.20	0.30	5834.70	4748.20	7169.80
15.00	322.50	2.20	137.28	3159.35	0.30	2572.90	0.30	3879.50	0.30	5878.00	4783.40	7222.90
15.00	337.50	2.20	137.28	3282.10	0.30	2672.50	0.30	4030.80	0.30	6101.95	4965.70	7498.10
15.00	352.50	2.20	137.28	3347.85	0.30	2724.10	0.30	4114.40	0.30	6221.75	5059.30	7651.10
15.00	367.50	2.20	137.28	3422.30	0.30	2784.60	0.30	4206.00	0.30	6358.35	5170.50	7819.00
15.00	382.50	2.20	137.28	3459.35	0.30	2814.70	0.30	4251.60	0.30	6427.10	5226.30	7903.60
15.00	397.50	2.20	137.28	3475.20	0.30	2827.60	0.30	4271.10	0.30	6457.45	5251.00	7940.90
15.00	412.50	2.20	137.28	3474.45	0.30	2827.00	0.30	4270.10	0.30	6457.45	5251.00	7940.90
15.00	427.50	2.20	137.28	3473.75	0.30	2826.40	0.30	4269.30	0.30	6457.45	5251.00	7940.90
15.00	442.50	2.20	137.28	3473.15	0.30	2826.00	0.30	4268.50	0.30	6457.60	5251.10	7941.10
15.00	457.50	2.20	137.28	3568.05	0.30	2903.00	0.30	4385.50	0.30	6631.70	5392.70	8155.20
15.00	472.50	2.20	137.28	3588.60	0.30	2919.60	0.30	4410.80	0.30	6670.15	5424.00	8202.50
15.00	487.50	2.20	137.28	3617.05	0.30	2942.50	0.30	4446.00	0.30	6722.35	5466.40	8266.70

Note: The horizontal shear-strain data, the damping values and metric equivalent data from pages A-2 and A-3 have been intentionally excluded from this spreadsheet for clarity as these items do not figure with subsequent calculation.

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION)

LOWER BOUND VALUES:
SEE PAGE A-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' LOWER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: 227 FT (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: 242 FT (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	602.3	1359.50	1266.6	0.37	1.468	3462.9	0.00826	1.000	4.0000	1.16E-03
2	4.00	6.00	112.32	628.0	1671.70	1376.8	0.38	1.539	3813.3	0.02479	1.000	4.0000	1.05E-03
3	4.00	10.00	112.32	662.9	1882.40	1534.2	0.39	1.567	4270.3	0.04132	1.000	4.0000	9.37E-04
4	4.00	14.00	112.32	732.5	2035.90	1873.5	0.39	1.573	5220.9	0.05785	1.000	4.0000	7.66E-04
5	4.00	18.00	112.32	948.1	2531.50	3138.2	0.39	1.557	8719.6	0.07438	1.000	4.0000	4.59E-04
6	8.00	24.00	112.32	907.2	2561.50	2873.7	0.40	3.164	8020.2	0.09917	1.000	8.0000	9.97E-04
7	8.00	32.00	112.32	980.1	2680.10	3353.6	0.38	3.029	9247.0	0.13223	1.000	8.0000	8.65E-04
8	8.00	40.00	112.32	1030.5	2715.10	3707.7	0.36	2.909	10112.2	0.16529	1.000	8.0000	7.91E-04
9	8.00	48.00	112.32	1150.0	3045.60	4617.4	0.36	2.856	12531.8	0.19835	1.000	8.0000	6.38E-04
10	8.00	56.00	112.32	1281.3	3078.60	5732.0	0.34	2.707	15342.8	0.23140	0.972	7.7760	5.07E-04
11	10.00	65.00	112.32	1379.0	3375.10	6639.5	0.34	3.379	17766.3	0.26860	0.930	9.3000	5.23E-04
12	10.00	75.00	112.32	1426.5	3551.70	7104.8	0.34	3.374	19004.4	0.30992	0.883	8.8300	4.65E-04
13	10.00	85.00	112.32	1610.9	3799.10	9060.3	0.33	3.348	24187.6	0.35124	0.836	8.3600	3.46E-04
14	10.00	95.00	112.32	1569.7	3795.90	8602.8	0.34	3.380	23021.8	0.39256	0.789	7.8900	3.43E-04
15	10.00	105.00	112.32	1685.5	3842.00	9918.9	0.34	3.362	26508.1	0.43388	0.748	7.4800	2.82E-04
16	10.00	115.00	112.32	1675.2	3847.30	9798.0	0.34	3.389	26236.8	0.47521	0.713	7.1300	2.72E-04
17	10.00	125.00	112.32	1661.3	3856.30	9636.1	0.34	3.411	25845.8	0.51653	0.679	6.7900	2.63E-04
18	10.00	135.00	137.28	2238.1	4163.10	21375.4	0.30	2.963	55419.7	0.55785	0.644	6.4400	1.16E-04
19	10.00	145.00	137.28	2286.2	4253.20	22304.1	0.30	2.964	57831.4	0.59917	0.610	6.1000	1.05E-04
20	10.00	155.00	137.28	2310.9	4300.90	22788.6	0.30	2.966	59096.4	0.64050	0.575	5.7500	9.73E-05
21	10.00	165.00	137.28	2321.2	4321.40	22992.2	0.30	2.968	59632.2	0.68182	0.541	5.4100	9.07E-05
22	10.00	175.00	137.28	2297.0	4280.00	22515.3	0.30	2.972	58415.1	0.72314	0.506	5.0600	8.66E-05
23	10.00	185.00	137.28	2282.4	4256.00	22230.0	0.30	2.976	57690.9	0.76446	0.472	4.7200	8.18E-05
24	10.00	195.00	137.28	2324.0	4333.60	23047.7	0.30	2.976	59813.0	0.80579	0.437	4.3700	7.31E-05
25	12.50	206.25	137.28	2327.2	4366.20	23111.3	0.30	3.718	59969.1	0.85227	0.409	5.1125	8.53E-05
26	12.50	218.75	137.28	2356.4	4397.00	23694.9	0.30	3.724	61508.6	0.90393	0.386	4.8250	7.84E-05
27	12.50	231.25	137.28	2367.1	4447.80	23910.5	0.30	3.722	62059.3	0.95558	0.364	4.5500	7.33E-05
28	12.50	243.75	137.28	2414.2	4520.40	24871.5	0.30	3.726	64569.0	1.00723	0.341	4.2625	6.60E-05
29	12.50	256.25	137.28	2462.8	4584.90	25883.0	0.30	3.711	67132.2	1.05888	0.319	3.9875	5.94E-05
30	12.50	268.75	137.28	2467.5	4594.70	25981.9	0.30	3.712	67395.4	1.11054	0.296	3.7000	5.49E-05
31	12.50	281.25	137.28	2494.2	4637.20	26547.2	0.30	3.702	68819.4	1.16219	0.274	3.4250	4.98E-05
32	12.50	293.75	137.28	2493.4	4637.20	26530.2	0.30	3.704	68783.7	1.21384	0.251	3.1375	4.56E-05
33	15.00	307.50	137.28	2554.0	4748.20	27835.4	0.30	4.442	72157.2	1.27066	0.233	3.4950	4.84E-05
34	15.00	322.50	137.28	2572.9	4783.40	28248.9	0.30	4.443	73230.8	1.33264	0.219	3.2850	4.49E-05
35	15.00	337.50	137.28	2672.5	4965.70	30478.4	0.30	4.438	78990.2	1.39463	0.206	3.0900	3.91E-05
36	15.00	352.50	137.28	2724.1	5059.30	31666.7	0.30	4.435	82057.8	1.45661	0.192	2.8800	3.51E-05
37	15.00	367.50	137.28	2784.6	5170.50	33088.9	0.30	4.433	85734.6	1.51860	0.178	2.6700	3.11E-05
38	15.00	382.50	137.28	2814.7	5226.30	33808.1	0.30	4.433	87597.4	1.58058	0.164	2.4600	2.81E-05
39	15.00	397.50	137.28	2827.6	5251.00	34118.7	0.30	4.434	88407.6	1.64256	0.150	2.2500	2.55E-05
40	15.00	412.50	137.28	2827.0	5251.00	34104.2	0.30	4.436	88377.6	1.70455	0.142	2.1300	2.41E-05
41	15.00	427.50	137.28	2826.4	5251.00	34089.7	0.30	4.437	88347.6	1.76653	0.135	2.0250	2.29E-05
42	15.00	442.50	137.28	2826.0	5251.10	34080.1	0.30	4.439	88329.4	1.82851	0.128	1.9200	2.17E-05
43	15.00	457.50	137.28	2903.0	5392.70	35962.5	0.30	4.436	93196.9	1.89050	0.122	1.8300	1.96E-05
44	15.00	472.50	137.28	2919.6	5424.00	36375.0	0.30	4.437	94268.7	1.95248	0.115	1.7250	1.83E-05
45	15.00	487.50	137.28	2942.5	5466.40	36947.8	0.30	4.437	95751.8	2.01446	0.108	1.6200	1.69E-05
Summation Σ =	495.0000							154.1953				217.7860	1.2197E-02

(1) From Soil Data on Page A-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page A-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 17855 ksf
μ = ΣμH/ΣH 0.312
G' = E/(2*(1+ μ)) =: 6807 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1396.3 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1263.0 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.312 (Lower Bound Soil Case)
Shear Modulus, G' = 6807 ksf (Lower Bound Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION)

MEDIAN VALUES:
SEE PAGE A-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' MEDIAN (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: 227 FT (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: 242 FT (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) G'=(ρ*Vs²/g*1000) [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	860.0	1935.5	2582.5	0.37	1.468	7061.0	0.00826	1.000	4.0000	5.66E-04
2	4.00	6.00	112.32	891.6	2246.7	2775.7	0.39	1.542	7690.9	0.02479	1.000	4.0000	5.20E-04
3	4.00	10.00	112.32	943.3	2524.1	3106.8	0.39	1.568	8648.7	0.04132	1.000	4.0000	4.62E-04
4	4.00	14.00	112.32	1053.8	2887.7	3876.9	0.39	1.572	10801.7	0.05785	1.000	4.0000	3.70E-04
5	4.00	18.00	112.32	1362.1	3423.5	6477.7	0.39	1.555	17993.2	0.07438	1.000	4.0000	2.22E-04
6	8.00	24.00	112.32	1309.5	3487.3	5986.7	0.39	3.159	16701.9	0.09917	1.000	8.0000	4.79E-04
7	8.00	32.00	112.32	1392.9	3574.4	6774.0	0.38	3.031	18681.2	0.13223	1.000	8.0000	4.28E-04
8	8.00	40.00	112.32	1467.1	3632.2	7514.9	0.36	2.910	20496.8	0.16529	1.000	8.0000	3.90E-04
9	8.00	48.00	112.32	1641.0	3913.9	9402.1	0.36	2.851	25505.9	0.19835	1.000	8.0000	3.14E-04
10	8.00	56.00	112.32	1826.0	3952.0	11640.8	0.34	2.702	31144.3	0.23140	0.972	7.7760	2.50E-04
11	10.00	65.00	112.32	1931.0	4143.3	13018.1	0.34	3.376	34824.8	0.26860	0.930	9.3000	2.67E-04
12	10.00	75.00	112.32	2025.4	4354.6	14322.8	0.34	3.373	38307.6	0.30992	0.883	8.8300	2.31E-04
13	10.00	85.00	112.32	2194.2	4642.7	16809.6	0.34	3.352	44887.5	0.35124	0.836	8.3600	1.86E-04
14	10.00	95.00	112.32	2160.2	4636.5	16292.7	0.34	3.386	43619.2	0.39256	0.789	7.8900	1.81E-04
15	10.00	105.00	112.32	2235.2	4705.5	17443.7	0.34	3.362	46618.0	0.43388	0.748	7.4800	1.60E-04
16	10.00	115.00	112.32	2218.2	4711.9	17179.4	0.34	3.389	46002.3	0.47521	0.713	7.1300	1.55E-04
17	10.00	125.00	112.32	2203.0	4723.0	16944.7	0.34	3.411	45448.9	0.51653	0.679	6.7900	1.49E-04
18	10.00	135.00	137.28	2741.1	5098.8	32063.1	0.30	2.963	83129.4	0.55785	0.644	6.4400	7.75E-05
19	10.00	145.00	137.28	2800.0	5209.1	33455.9	0.30	2.964	86746.4	0.59917	0.610	6.1000	7.03E-05
20	10.00	155.00	137.28	2830.3	5267.5	34183.9	0.30	2.966	88647.0	0.64050	0.575	5.7500	6.49E-05
21	10.00	165.00	137.28	2842.9	5292.6	34488.9	0.30	2.968	89449.7	0.68182	0.541	5.4100	6.05E-05
22	10.00	175.00	137.28	2813.2	5241.9	33772.1	0.30	2.972	87620.2	0.72314	0.506	5.0600	5.77E-05
23	10.00	185.00	137.28	2795.4	5212.5	33346.0	0.30	2.976	86538.9	0.76446	0.472	4.7200	5.45E-05
24	10.00	195.00	137.28	2846.4	5307.5	34573.9	0.30	2.976	89725.4	0.80579	0.437	4.3700	4.87E-05
25	12.50	206.25	137.28	2868.8	5349.6	35120.2	0.30	3.720	91144.2	0.85227	0.409	5.1125	5.61E-05
26	12.50	218.75	137.28	2895.0	5400.1	35763.4	0.30	3.722	92823.4	0.90393	0.386	4.8250	5.20E-05
27	12.50	231.25	137.28	2926.2	5460.1	36538.4	0.30	3.724	94846.0	0.95558	0.364	4.5500	4.80E-05
28	12.50	243.75	137.28	2977.9	5557.2	37842.2	0.30	3.724	98233.1	1.00723	0.341	4.2625	4.34E-05
29	12.50	256.25	137.28	3032.5	5639.9	39242.6	0.30	3.704	101743.1	1.05888	0.319	3.9875	3.92E-05
30	12.50	268.75	137.28	3039.0	5653.4	39409.7	0.30	3.706	102187.4	1.11054	0.296	3.7000	3.62E-05
31	12.50	281.25	137.28	3063.1	5699.2	40038.6	0.30	3.707	103824.0	1.16219	0.274	3.4250	3.30E-05
32	12.50	293.75	137.28	3062.1	5699.2	40012.4	0.30	3.709	103769.0	1.21384	0.251	3.1375	3.02E-05
33	15.00	307.50	137.28	3136.3	5834.7	41973.7	0.30	4.447	108837.0	1.27066	0.233	3.4950	3.21E-05
34	15.00	322.50	137.28	3159.4	5878.0	42594.3	0.30	4.448	110449.2	1.33264	0.219	3.2850	2.97E-05
35	15.00	337.50	137.28	3282.1	6102.0	45968.4	0.30	4.442	119163.1	1.39463	0.206	3.0900	2.59E-05
36	15.00	352.50	137.28	3347.9	6221.8	47828.7	0.30	4.439	123968.1	1.45661	0.192	2.8800	2.32E-05
37	15.00	367.50	137.28	3422.3	6358.4	49979.6	0.30	4.437	129527.5	1.51860	0.178	2.6700	2.06E-05
38	15.00	382.50	137.28	3459.4	6427.1	51067.6	0.30	4.437	132345.7	1.58058	0.164	2.4600	1.86E-05
39	15.00	397.50	137.28	3475.2	6457.5	51536.6	0.30	4.438	133569.5	1.64256	0.150	2.2500	1.68E-05
40	15.00	412.50	137.28	3474.5	6457.5	51514.4	0.30	4.440	133523.7	1.70455	0.142	2.1300	1.60E-05
41	15.00	427.50	137.28	3473.8	6457.5	51493.6	0.30	4.441	133480.7	1.76653	0.135	2.0250	1.52E-05
42	15.00	442.50	137.28	3473.2	6457.6	51475.8	0.30	4.443	133444.9	1.82851	0.128	1.9200	1.44E-05
43	15.00	457.50	137.28	3568.1	6631.7	54327.3	0.30	4.440	140815.3	1.89050	0.122	1.8300	1.30E-05
44	15.00	472.50	137.28	3588.6	6670.2	54954.9	0.30	4.440	142445.3	1.95248	0.115	1.7250	1.21E-05
45	15.00	487.50	137.28	3617.1	6722.4	55829.7	0.30	4.440	144708.3	2.01446	0.108	1.6200	1.12E-05
Summation Σ =	495.0000							154.2408				217.7860	6.3532E-03

(1) From Soil Data on Page A-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page A-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 34280 ksf
μ = ΣμH/ΣH 0.312
G' = E/(2*(1+ μ)) =: 13068 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1934.6 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1750.0 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.312 (Median Soil Case)
Shear Modulus, G' = 13068 ksf (Median Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION

UPPER BOUND VALUES:
SEE PAGE A-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' UPPER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNGS MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1228.00	2755.50	5265.1	0.37	1.468	14395.6	0.00826	1.000	4.0000	2.78E-04
2	4.00	6.00	112.32	1266.00	2983.70	5595.9	0.39	1.544	15511.7	0.02479	1.000	4.0000	2.58E-04
3	4.00	10.00	112.32	1342.30	3327.40	6290.8	0.39	1.568	17514.4	0.04132	1.000	4.0000	2.28E-04
4	4.00	14.00	112.32	1515.50	4100.90	8019.0	0.39	1.571	22337.9	0.05785	1.000	4.0000	1.79E-04
5	4.00	18.00	112.32	1956.40	4593.40	13363.5	0.39	1.554	37108.1	0.07438	1.000	4.0000	1.08E-04
6	8.00	24.00	112.32	1889.20	4703.80	12461.3	0.39	3.155	34752.2	0.09917	1.000	8.0000	2.30E-04
7	8.00	32.00	112.32	1979.70	4690.90	13683.7	0.38	3.033	37742.5	0.13223	1.000	8.0000	2.12E-04
8	8.00	40.00	112.32	2088.70	4779.00	15232.0	0.36	2.910	41546.6	0.16529	1.000	8.0000	1.93E-04
9	8.00	48.00	112.32	2341.30	5040.60	19139.0	0.36	2.846	51897.0	0.19835	1.000	8.0000	1.54E-04
10	8.00	56.00	112.32	2601.90	5078.30	23636.7	0.34	2.697	63209.3	0.23140	0.972	7.7760	1.23E-04
11	10.00	65.00	112.32	2721.60	5086.40	25861.6	0.34	3.372	69162.6	0.26860	0.930	9.3000	1.34E-04
12	10.00	75.00	112.32	2875.80	5338.90	28875.1	0.34	3.372	77220.7	0.30992	0.883	8.8300	1.14E-04
13	10.00	85.00	112.32	2984.60	5698.60	31101.3	0.33	3.348	83028.6	0.35124	0.836	8.3600	1.01E-04
14	10.00	95.00	112.32	2975.10	5693.80	30903.6	0.34	3.380	82700.5	0.39256	0.789	7.8900	9.54E-05
15	10.00	105.00	112.32	2964.20	5763.00	30677.6	0.34	3.362	81985.2	0.43388	0.748	7.4800	9.12E-05
16	10.00	115.00	112.32	2937.20	5770.90	30121.3	0.34	3.389	80657.5	0.47521	0.713	7.1300	8.84E-05
17	10.00	125.00	112.32	2921.50	5784.50	29800.1	0.34	3.411	79929.2	0.51653	0.679	6.7900	8.50E-05
18	10.00	135.00	137.28	3357.20	6244.70	48096.2	0.30	2.963	124698.0	0.55785	0.644	6.4400	5.16E-05
19	10.00	145.00	137.28	3429.30	6379.80	50184.2	0.30	2.964	130120.7	0.59917	0.610	6.1000	4.69E-05
20	10.00	155.00	137.28	3466.40	6451.30	51275.9	0.30	2.966	132970.8	0.64050	0.575	5.7500	4.32E-05
21	10.00	165.00	137.28	3481.90	6482.10	51735.5	0.30	2.968	134180.2	0.68182	0.541	5.4100	4.03E-05
22	10.00	175.00	137.28	3445.40	6420.00	50656.5	0.30	2.972	131426.4	0.72314	0.506	5.0600	3.85E-05
23	10.00	185.00	137.28	3423.70	6384.00	50020.5	0.30	2.976	129812.1	0.76446	0.472	4.7200	3.64E-05
24	10.00	195.00	137.28	3486.10	6500.30	51860.4	0.30	2.976	134587.1	0.80579	0.437	4.3700	3.25E-05
25	12.50	206.25	137.28	3557.80	6589.30	54015.6	0.30	3.718	140159.7	0.85227	0.409	5.1125	3.65E-05
26	12.50	218.75	137.28	3570.90	6632.00	54414.1	0.30	3.720	141211.2	0.90393	0.386	4.8250	3.42E-05
27	12.50	231.25	137.28	3641.80	6744.60	56596.3	0.30	3.722	146894.7	0.95558	0.364	4.5500	3.10E-05
28	12.50	243.75	137.28	3700.10	6848.40	58422.9	0.30	3.723	151643.7	1.00723	0.341	4.2625	2.81E-05
29	12.50	256.25	137.28	3733.90	6937.60	59495.2	0.30	3.698	154191.2	1.05888	0.319	3.9875	2.59E-05
30	12.50	268.75	137.28	3742.60	6955.80	59772.7	0.30	3.700	154928.5	1.11054	0.296	3.7000	2.39E-05
31	12.50	281.25	137.28	3761.60	7004.30	60381.2	0.30	3.712	156620.3	1.16219	0.274	3.4250	2.19E-05
32	12.50	293.75	137.28	3760.50	7004.30	60345.8	0.30	3.714	156548.0	1.21384	0.251	3.1375	2.00E-05
33	15.00	307.50	137.28	3851.20	7169.80	63291.9	0.30	4.453	164159.0	1.27066	0.233	3.4950	2.13E-05
34	15.00	322.50	137.28	3879.50	7222.90	64225.5	0.30	4.453	166585.6	1.33264	0.219	3.2850	1.97E-05
35	15.00	337.50	137.28	4030.80	7498.10	69332.8	0.30	4.447	179771.6	1.39463	0.206	3.0900	1.72E-05
36	15.00	352.50	137.28	4114.40	7651.10	72238.6	0.30	4.444	187281.4	1.45661	0.192	2.8800	1.54E-05
37	15.00	367.50	137.28	4206.00	7819.00	75490.9	0.30	4.441	195686.1	1.51860	0.178	2.6700	1.36E-05
38	15.00	382.50	137.28	4251.60	7903.60	77136.7	0.30	4.441	199949.1	1.58058	0.164	2.4600	1.23E-05
39	15.00	397.50	137.28	4271.10	7940.90	77845.9	0.30	4.442	201799.9	1.64256	0.150	2.2500	1.11E-05
40	15.00	412.50	137.28	4270.10	7940.90	77809.4	0.30	4.444	201724.1	1.70455	0.142	2.1300	1.06E-05
41	15.00	427.50	137.28	4269.30	7940.90	77780.3	0.30	4.446	201664.1	1.76653	0.135	2.0250	1.00E-05
42	15.00	442.50	137.28	4268.50	7941.10	77751.1	0.30	4.447	201604.0	1.82851	0.128	1.9200	9.52E-06
43	15.00	457.50	137.28	4385.50	8155.20	82071.9	0.30	4.443	212768.1	1.89050	0.122	1.8300	8.60E-06
44	15.00	472.50	137.28	4410.80	8202.50	83021.6	0.30	4.444	215233.4	1.95248	0.115	1.7250	8.01E-06
45	15.00	487.50	137.28	4446.00	8266.70	84351.9	0.30	4.443	218672.3	2.01446	0.108	1.6200	7.41E-06
Summation Σ =	495.0000							154.2588				217.7860	3.3480E-03

(1) From Soil Data on Page A-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion in Sect. 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page A-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 65050 ksf
μ = Σμ$_i$H /ΣH 0.312
G' = E/(2*(1+ μ)) =: 24797 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 2665.0 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 2410.6 fps (density =137.28)

USE (130' Alluvium) : **Poisson's Ratio, μ =** **0.312** **(Upper Bound Soil Case)**
Shear Modulus, G' = **24797 ksf** **(Upper Bound Soil Case)**

(5) Ratio of depth to mid-height of layer to width of building

SUMMARY OF DYNAMIC SHEAR MODULUS G' (KSF) AND POISSON'S RATIO VALUES FOR 5E-4 EVENT

130' Alluvium					
Lower Bound Soil Case		**Median Soil Case**		**Upper Bound Soil Case**	
Dynamic Shear Modulus G' (KSF)	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**
6,807	0.312	13,068	0.312	24,797	0.312
Page A-5	Page A-5	Page A-6	Page A-6	Page A-7	Page A-7

ATTACHMENT B -- SHEAR MODULUS and POISSON'S RATIO VALUES at 130' ALLUVIUM DEPTH FOR 1E-4 SEISMIC EVENT

From DTN MO0706SCSPS1E4.002

Weighted results of Northeast velocity profiles with 100ft Alluvium (0-100ft Alluvium, >100ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.38	0.23	768.22	2.79	0.17	543.21	6.42	0.33	1086.40	1.22	0.59	1948.40	1.14	0.42	1377.70	1.95	0.84	2755.50	0.66	0.0062	0.0095
1.22	4.00	1.83	6.00	1.80	112.32	0.41	0.23	751.94	4.39	0.16	531.70	10.09	0.32	1063.40	1.91	0.66	2150.00	1.14	0.49	1599.40	1.95	0.88	2890.10	0.66	0.0213	0.0328
1.22	4.00	3.05	10.00	1.80	112.32	0.42	0.24	784.89	4.85	0.17	555.00	11.16	0.34	1110.00	2.11	0.74	2413.70	1.14	0.55	1810.30	1.95	0.98	3218.30	0.66	0.0320	0.0492
1.22	4.00	4.27	14.00	1.80	112.32	0.42	0.26	857.12	4.85	0.18	606.07	11.15	0.37	1212.10	2.11	0.82	2682.20	1.14	0.58	1896.60	1.95	1.16	3793.20	0.66	0.0323	0.0497
1.22	4.00	5.49	18.00	1.80	112.32	0.41	0.34	1104.30	4.59	0.24	780.83	10.56	0.48	1561.70	2.00	1.06	3464.90	1.14	0.80	2613.60	1.95	1.40	4593.40	0.66	0.0227	0.0349
2.44	8.00	7.31	24.00	1.80	112.32	0.42	0.31	1013.50	5.14	0.22	716.69	11.82	0.44	1433.40	2.24	1.08	3529.50	1.14	0.81	2648.40	1.95	1.43	4703.80	0.66	0.0339	0.0522
2.44	8.00	9.75	32.00	1.80	112.32	0.41	0.32	1048.40	5.37	0.23	741.31	12.36	0.45	1482.60	2.34	1.09	3579.50	1.14	0.83	2731.40	1.95	1.43	4690.90	0.66	0.0396	0.0609
2.44	8.00	12.19	40.00	1.80	112.32	0.40	0.33	1092.90	5.41	0.24	772.80	12.43	0.47	1545.60	2.35	1.11	3637.40	1.14	0.84	2768.50	1.95	1.46	4779.00	0.66	0.0429	0.0660
2.44	8.00	14.63	48.00	1.80	112.32	0.39	0.37	1207.40	5.27	0.26	853.75	12.11	0.52	1707.50	2.29	1.19	3899.30	1.14	0.93	3045.60	1.95	1.52	4992.30	0.66	0.0400	0.0615
2.44	8.00	17.07	56.00	1.80	112.32	0.38	0.45	1464.80	4.98	0.32	1035.80	11.42	0.63	2071.50	2.17	1.20	3937.30	1.14	0.94	3078.60	1.95	1.53	5035.60	0.66	0.0302	0.0464
3.05	10.00	19.81	65.00	1.80	112.32	0.38	0.47	1557.00	5.02	0.34	1101.00	11.29	0.67	2202.00	2.23	1.26	4133.60	1.14	1.03	3375.10	1.95	1.54	5062.60	0.66	0.0298	0.0458
3.05	10.00	22.86	75.00	1.80	112.32	0.38	0.50	1628.90	5.02	0.35	1151.80	11.35	0.70	2303.70	2.22	1.33	4349.90	1.14	1.08	3551.70	1.95	1.62	5327.50	0.66	0.0301	0.0463
3.05	10.00	25.91	85.00	1.80	112.32	0.38	0.54	1787.50	4.89	0.39	1264.00	11.19	0.77	2527.90	2.14	1.42	4652.90	1.14	1.16	3799.10	1.95	1.74	5698.60	0.66	0.0273	0.0419
3.05	10.00	28.95	95.00	1.80	112.32	0.38	0.53	1726.30	5.12	0.37	1220.70	11.71	0.74	2441.30	2.24	1.42	4649.00	1.14	1.16	3795.90	1.95	1.74	5693.80	0.66	0.0315	0.0485
3.05	10.00	32.00	105.00	2.20	137.28	0.30	0.80	2625.10	0.83	0.65	2143.40	1.79	0.98	3215.10	0.50	1.51	4957.20	0.50	1.23	4047.50	0.81	1.85	6071.30	0.50	0.0119	0.0183
3.05	10.00	35.05	115.00	2.20	137.28	0.30	0.80	2624.10	0.84	0.65	2142.60	1.85	0.98	3213.90	0.50	1.51	4965.90	0.50	1.24	4054.60	0.81	1.85	6082.00	0.50	0.0129	0.0198
3.05	10.00	38.10	125.00	2.20	137.28	0.30	0.80	2637.40	0.80	0.66	2153.40	1.61	0.98	3230.20	0.50	1.52	4980.60	0.50	1.24	4066.60	0.81	1.86	6100.00	0.50	0.0137	0.0211
3.05	10.00	41.15	135.00	2.20	137.28	0.30	0.82	2698.60	0.80	0.67	2203.40	1.63	1.01	3305.10	0.50	1.55	5098.80	0.50	1.27	4163.20	0.81	1.90	6244.70	0.50	0.0140	0.0216
3.05	10.00	44.19	145.00	2.20	137.28	0.30	0.84	2755.40	0.80	0.69	2249.80	1.64	1.03	3374.70	0.50	1.59	5209.10	0.50	1.30	4253.20	0.81	1.94	6379.80	0.50	0.0143	0.0219
3.05	10.00	47.24	155.00	2.20	137.28	0.30	0.85	2783.90	0.81	0.69	2273.00	1.67	1.04	3409.50	0.50	1.61	5267.50	0.50	1.31	4300.90	0.81	1.97	6451.30	0.50	0.0147	0.0227
3.05	10.00	50.29	165.00	2.20	137.28	0.30	0.85	2794.40	0.81	0.70	2281.70	1.69	1.04	3422.50	0.50	1.61	5292.60	0.50	1.32	4321.40	0.81	1.98	6482.10	0.50	0.0153	0.0236
3.05	10.00	53.34	175.00	2.20	137.28	0.31	0.84	2762.10	0.83	0.69	2255.30	1.76	1.03	3382.90	0.50	1.60	5241.90	0.50	1.30	4280.00	0.81	1.96	6420.00	0.50	0.0164	0.0252
3.05	10.00	56.39	185.00	2.20	137.28	0.31	0.84	2742.20	0.84	0.68	2234.00	1.81	1.03	3366.00	0.50	1.59	5212.50	0.50	1.30	4256.00	0.81	1.95	6384.00	0.50	0.0173	0.0266
3.05	10.00	59.43	195.00	2.20	137.28	0.31	0.85	2791.70	0.85	0.69	2267.80	1.81	1.05	3436.60	0.50	1.62	5307.50	0.50	1.32	4333.60	0.81	1.98	6500.30	0.50	0.0173	0.0267
3.81	12.50	62.86	206.25	2.20	137.28	0.31	0.85	2803.60	0.85	0.69	2266.60	1.84	1.06	3467.80	0.50	1.63	5335.40	0.50	1.33	4356.30	0.81	1.99	6534.50	0.50	0.0178	0.0275
3.81	12.50	66.67	218.75	2.20	137.28	0.31	0.86	2827.80	0.86	0.70	2296.90	1.86	1.06	3481.20	0.50	1.64	5385.20	0.50	1.34	4397.00	0.81	2.01	6595.50	0.50	0.0182	0.0280
3.81	12.50	70.48	231.25	2.20	137.28	0.31	0.87	2856.40	0.87	0.70	2297.60	1.88	1.08	3551.10	0.50	1.66	5443.10	0.50	1.35	4444.30	0.81	2.03	6666.40	0.50	0.0185	0.0285
3.81	12.50	74.29	243.75	2.20	137.28	0.31	0.89	2904.80	0.87	0.71	2337.90	1.88	1.10	3609.00	0.50	1.69	5536.30	0.50	1.38	4520.40	0.81	2.07	6780.50	0.50	0.0185	0.0285
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.90	2966.80	0.81	0.74	2422.40	1.61	1.11	3633.60	0.50	1.71	5615.30	0.50	1.40	4584.90	0.81	2.10	6877.30	0.50	0.0183	0.0281
3.81	12.50	81.91	268.75	2.20	137.28	0.31	0.91	2971.20	0.82	0.74	2425.90	1.63	1.11	3638.90	0.50	1.72	5627.40	0.50	1.40	4594.80	0.81	2.10	6892.10	0.50	0.0188	0.0289
3.81	12.50	85.72	281.25	2.20	137.28	0.31	0.92	3019.70	0.82	0.75	2465.50	1.63	1.13	3698.30	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0187	0.0287
3.81	12.50	89.53	293.75	2.20	137.28	0.31	0.92	3017.40	0.83	0.75	2463.70	1.66	1.13	3695.50	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0192	0.0295
4.57	15.00	93.72	307.50	2.20	137.28	0.31	0.94	3091.60	0.82	0.77	2524.30	1.63	1.15	3786.40	0.50	1.78	5854.10	0.50	1.46	4779.90	0.81	2.19	7169.80	0.50	0.0187	0.0288
4.57	15.00	98.29	322.50	2.20	137.28	0.31	0.95	3113.70	0.82	0.77	2542.30	1.64	1.16	3813.50	0.50	1.80	5897.50	0.50	1.47	4815.30	0.81	2.20	7222.90	0.50	0.0190	0.0292
4.57	15.00	102.86	337.50	2.20	137.28	0.30	0.99	3237.80	0.80	0.81	2643.60	1.60	1.21	3965.40	0.50	1.87	6122.20	0.50	1.52	4998.80	0.81	2.29	7498.10	0.50	0.0180	0.0277
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.01	3305.70	0.80	0.82	2699.10	1.59	1.23	4048.60	0.50	1.90	6247.10	0.50	1.55	5100.70	0.81	2.33	7651.10	0.50	0.0177	0.0272
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.03	3380.40	0.79	0.84	2760.10	1.56	1.26	4140.10	0.50	1.95	6384.20	0.50	1.59	5212.70	0.81	2.38	7819.00	0.50	0.0173	0.0266
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.04	3417.10	0.79	0.85	2790.00	1.56	1.28	4185.10	0.50	1.97	6453.30	0.50	1.61	5269.10	0.81	2.41	7903.60	0.50	0.0173	0.0266
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.05	3431.90	0.80	0.85	2802.20	1.57	1.28	4203.20	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0175	0.0269
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.05	3430.10	0.80	0.85	2800.60	1.59	1.28	4201.00	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0178	0.0274
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.04	3428.40	0.81	0.85	2799.20	1.61	1.28	4198.90	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0182	0.0280
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.04	3426.80	0.81	0.85	2797.90	1.63	1.28	4196.90	0.50	1.98	6483.90	0.50	1.61	5294.10	0.81	2.42	7941.10	0.50	0.0185	0.0285
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.07	3521.90	0.81	0.88	2875.60	1.60	1.31	4313.50	0.50	2.03	6658.70	0.50	1.66	5436.80	0.81	2.49	8155.20	0.50	0.0178	0.0274
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.08	3541.90	0.81	0.88	2891.90	1.61	1.32	4337.90	0.50	2.04	6697.30	0.50	1.67	5468.30	0.81	2.50	8202.50	0.50	0.0179	0.0275
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.09	3570.70	0.80	0.89	2915.50	1.60	1.33	4373.20	0.50	2.06	6749.70	0.50	1.68	5511.10	0.81	2.52	8266.70	0.50	0.0179	0.0275

From DTN MO0706SCSPS1E4.002

Weighted results of Northeast velocity profiles with 200ft Alluvium (0-200ft Alluvium, >200ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.38	0.23	750.78	2.59	0.16	530.88	5.96	0.32	1061.80	1.13	0.59	1922.60	1.14	0.41	1359.50	1.95	0.83	2719.00	0.66	0.0061	0.0094
1.22	4.00	1.83	6.00	1.80	112.32	0.41	0.23	764.11	4.02	0.16	540.31	9.25	0.33	1080.60	1.75	0.65	2148.60	1.14	0.48	1577.60	1.95	0.89	2926.20	0.66	0.0194	0.0299
1.22	4.00	3.05	10.00	1.80	112.32	0.42	0.24	783.46	4.57	0.17	553.99	10.52	0.34	1108.00	1.99	0.73	2406.60	1.14	0.54	1776.80	1.95	0.99	3259.60	0.66	0.0308	0.0475
1.22	4.00	4.27	14.00	1.80	112.32	0.42	0.26	846.33	4.68	0.18	598.44	10.77	0.36	1196.90	2.04	0.81	2658.30	1.14	0.57	1879.70	1.95	1.15	3759.40	0.66	0.0331	0.0510
1.22	4.00	5.49	18.00	1.80	112.32	0.41	0.32	1055.00	4.43	0.23	745.99	10.19	0.45	1492.00	1.93	1.03	3382.00	1.14	0.77	2531.50	1.95	1.38	4518.30	0.66	0.0240	0.0369
2.44	8.00	7.31	24.00	1.80	112.32	0.42	0.30	986.96	4.99	0.21	697.89	11.47	0.43	1395.80	2.17	0.97	3175.50	1.14	0.69	2276.60	1.95	1.35	4429.20	0.66	0.0359	0.0553
2.44	8.00	9.75	32.00	1.80	112.32	0.41	0.32	1055.20	5.08	0.23	746.13	11.67	0.45	1492.30	2.21	1.09	3569.30	1.14	0.82	2680.10	1.95	1.45	4753.50	0.66	0.0381	0.0586
2.44	8.00	12.19	40.00	1.80	112.32	0.40	0.34	1117.00	5.20	0.24	789.85	11.95	0.48	1579.70	2.26	1.11	3627.00	1.14	0.83	2715.10	1.95	1.48	4845.10	0.66	0.0401	0.0617
2.44	8.00	14.63	48.00	1.80	112.32	0.39	0.38	1261.40	5.00	0.27	891.95	11.50	0.54	1783.90	2.18	1.20	3928.40	1.14	0.93	3061.60	1.95	1.54	5040.60	0.66	0.0358	0.0551
2.44	8.00	17.07	56.00	1.80	112.32	0.38	0.45	1479.20	4.74	0.32	1045.90	10.76	0.64	2091.80	2.09	1.21	3966.70	1.14	0.94	3098.40	1.95	1.55	5078.30	0.66	0.0290	0.0446
3.05	10.00	19.81	65.00	1.80	112.32	0.38	0.48	1570.50	4.75	0.34	1110.50	10.60	0.68	2221.00	2.13	1.27	4153.00	1.14	1.03	3390.90	1.95	1.55	5086.40	0.66	0.0286	0.0440
3.05	10.00	22.86	75.00	1.80	112.32	0.38	0.50	1644.60	4.78	0.35	1162.90	10.74	0.71	2325.80	2.13	1.33	4359.20	1.14	1.08	3559.30	1.95	1.63	5338.90	0.66	0.0289	0.0444
3.05	10.00	25.91	85.00	1.80	112.32	0.38	0.55	1801.20	4.70	0.39	1273.70	10.62	0.78	2547.30	2.08	1.41	4632.40	1.14	1.15	3782.30	1.95	1.73	5673.50	0.66	0.0263	0.0404
3.05	10.00	28.95	95.00	1.80	112.32	0.38	0.53	1735.60	4.94	0.37	1227.30	11.15	0.75	2454.60	2.19	1.41	4623.90	1.14	1.15	3775.40	1.95	1.73	5663.10	0.66	0.0306	0.0471
3.05	10.00	32.00	105.00	1.80	112.32	0.38	0.56	1838.10	5.06	0.40	1299.80	11.26	0.79	2599.50	2.27	1.43	4705.50	1.14	1.17	3842.00	1.95	1.76	5763.00	0.66	0.0292	0.0450
3.05	10.00	35.05	115.00	1.80	112.32	0.38	0.55	1801.00	5.24	0.39	1273.50	11.60	0.78	2547.00	2.37	1.44	4711.90	1.14	1.17	3847.20	1.95	1.76	5770.90	0.66	0.0324	0.0499
3.05	10.00	38.10	125.00	1.80	112.32	0.39	0.54	1761.50	5.40	0.38	1245.60	11.91	0.76	2491.10	2.45	1.44	4723.00	1.14	1.18	3856.30	1.95	1.76	5784.50	0.66	0.0358	0.0551
3.05	10.00	41.15	135.00	1.80	112.32	0.39	0.56	1826.80	5.35	0.39	1291.80	11.86	0.79	2583.60	2.41	1.49	4884.10	1.14	1.22	3987.90	1.95	1.82	5981.80	0.66	0.0350	0.0538
3.05	10.00	44.19	145.00	1.80	112.32	0.39	0.57	1867.00	5.34	0.40	1320.20	11.90	0.80	2640.30	2.40	1.52	4994.50	1.14	1.24	4078.00	1.95	1.86	6117.00	0.66	0.0350	0.0539
3.05	10.00	47.24	155.00	1.80	112.32	0.39	0.57	1870.90	5.40	0.40	1322.90	12.02	0.81	2645.90	2.43	1.54	5060.90	1.14	1.26	4132.20	1.95	1.89	6198.30	0.66	0.0364	0.0560
3.05	10.00	50.29	165.00	1.80	112.32	0.39	0.56	1823.00	5.55	0.39	1289.10	12.30	0.79	2578.10	2.50	1.54	5039.30	1.14	1.25	4114.60	1.95	1.88	6171.90	0.66	0.0398	0.0613
3.05	10.00	53.34	175.00	1.80	112.32	0.39	0.54	1756.10	5.72	0.38	1241.80	12.66	0.76	2483.50	2.58	1.52	4995.50	1.14	1.24	4077.50	1.95	1.87	6120.20	0.66	0.0444	0.0684
3.05	10.00	56.39	185.00	1.80	112.32	0.39	0.53	1730.00	5.82	0.37	1223.30	12.84	0.75	2446.60	2.64	1.52	4999.00	1.14	1.24	4081.70	1.95	1.87	6122.50	0.66	0.0473	0.0727
3.05	10.00	59.43	195.00	1.80	112.32	0.39	0.54	1784.00	5.75	0.38	1261.50	12.74	0.77	2522.90	2.60	1.55	5094.90	1.14	1.27	4160.00	1.95	1.90	6240.00	0.66	0.0457	0.0704
3.81	12.50	62.86	206.25	2.20	137.28	0.31	0.86	2826.70	0.83	0.69	2268.90	1.69	1.07	3521.50	0.50	1.63	5363.80	0.50	1.33	4366.20	0.81	2.01	6589.30	0.50	0.0154	0.0236
3.81	12.50	66.67	218.75	2.20	137.28	0.31	0.87	2850.80	0.84	0.70	2299.60	1.73	1.08	3534.00	0.50	1.65	5415.00	0.50	1.35	4421.30	0.81	2.02	6632.00	0.50	0.0159	0.0245
3.81	12.50	70.48	231.25	2.20	137.28	0.31	0.88	2880.40	0.85	0.70	2301.60	1.76	1.10	3604.70	0.50	1.67	5477.10	0.50	1.36	4447.80	0.81	2.06	6744.60	0.50	0.0164	0.0252
3.81	12.50	74.29	243.75	2.20	137.28	0.31	0.89	2931.80	0.85	0.71	2345.70	1.77	1.12	3664.40	0.50	1.70	5578.00	0.50	1.38	4543.30	0.81	2.09	6848.40	0.50	0.0165	0.0254
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.92	3006.20	0.81	0.75	2454.10	1.57	1.12	3682.40	0.50	1.73	5664.50	0.50	1.41	4625.00	0.81	2.11	6937.60	0.50	0.0163	0.0251
3.81	12.50	81.91	268.75	2.20	137.28	0.30	0.92	3011.70	0.82	0.75	2459.10	1.60	1.12	3688.60	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0169	0.0260
3.81	12.50	85.72	281.25	2.20	137.28	0.30	0.92	3009.10	0.83	0.75	2456.90	1.63	1.12	3685.40	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0175	0.0269
3.81	12.50	89.53	293.75	2.20	137.28	0.30	0.92	3006.50	0.84	0.75	2454.80	1.66	1.12	3682.20	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0181	0.0278
4.57	15.00	93.72	307.50	2.20	137.28	0.30	0.94	3080.60	0.83	0.77	2515.30	1.64	1.15	3772.90	0.50	1.77	5815.30	0.50	1.45	4748.20	0.81	2.17	7122.30	0.50	0.0177	0.0273
4.57	15.00	98.29	322.50	2.20	137.28	0.30	0.95	3102.40	0.84	0.77	2533.10	1.66	1.16	3799.60	0.50	1.79	5858.50	0.50	1.46	4783.40	0.81	2.19	7175.20	0.50	0.0181	0.0278
4.57	15.00	102.86	337.50	2.20	137.28	0.30	0.98	3224.10	0.83	0.80	2632.40	1.62	1.20	3948.70	0.50	1.85	6081.70	0.50	1.51	4965.70	0.81	2.27	7448.50	0.50	0.0172	0.0265
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.00	3287.80	0.82	0.82	2684.50	1.60	1.23	4026.70	0.50	1.89	6196.40	0.50	1.54	5059.30	0.81	2.31	7589.00	0.50	0.0170	0.0262
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.02	3361.30	0.81	0.84	2744.50	1.57	1.25	4116.70	0.50	1.93	6332.50	0.50	1.58	5170.50	0.81	2.36	7755.70	0.50	0.0167	0.0257
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.04	3397.30	0.82	0.85	2773.90	1.58	1.27	4160.90	0.50	1.95	6400.90	0.50	1.59	5226.30	0.81	2.39	7839.50	0.50	0.0168	0.0258
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.04	3411.80	0.82	0.85	2785.80	1.59	1.27	4178.60	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0171	0.0262
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.04	3409.80	0.83	0.85	2784.10	1.62	1.27	4176.20	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0175	0.0269
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.04	3407.90	0.83	0.85	2782.60	1.64	1.27	4173.90	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0179	0.0275
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.04	3406.20	0.84	0.85	2781.20	1.66	1.27	4171.70	0.50	1.96	6431.30	0.50	1.60	5251.10	0.81	2.40	7876.70	0.50	0.0182	0.0280
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.07	3499.90	0.83	0.87	2857.60	1.64	1.31	4286.50	0.50	2.01	6604.70	0.50	1.64	5392.70	0.81	2.47	8089.10	0.50	0.0176	0.0271
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.07	3519.50	0.84	0.88	2873.70	1.65	1.31	4310.50	0.50	2.02	6643.00	0.50	1.65	5424.00	0.81	2.48	8136.00	0.50	0.0177	0.0272
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.08	3547.10	0.83	0.88	2896.20	1.64	1.32	4344.30	0.50	2.04	6695.00	0.50	1.67	5466.40	0.81	2.50	8199.70	0.50	0.0177	0.0273

Weighted results of Northeast velocity profiles with 130ft Alluvium (0-130ft Alluvium, >130ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness (ft)	Depth to Midpoint of Layer (ft)	Density (g/cm^3)	Unit Weight (pcf)	Median V_s (ft/s)	Poisson's Ratio (no units)	Lower Bound V_s (ft/s)	Poisson's Ratio (no units)	Upper Bound V_s (ft/s)	Poisson's Ratio (no units)	Median V_p (ft/s)	Lower Bound V_p (ft/s)	Upper Bound V_p (ft/s)
4.00	2.00	1.80	112.32	759.50	0.38	530.88	0.38	1086.40	0.38	1935.50	1359.50	2755.50
4.00	6.00	1.80	112.32	758.03	0.41	531.70	0.41	1080.60	0.41	2149.30	1599.40	2926.20
4.00	10.00	1.80	112.32	784.18	0.42	553.99	0.42	1110.00	0.42	2410.15	1776.80	3218.30
4.00	14.00	1.80	112.32	851.73	0.42	598.44	0.42	1212.10	0.42	2670.25	1879.70	3793.20
4.00	18.00	1.80	112.32	1079.65	0.41	745.99	0.41	1561.70	0.41	3423.45	2531.50	4593.40
8.00	24.00	1.80	112.32	1000.23	0.42	697.89	0.42	1433.40	0.42	3352.50	2276.60	4703.80
8.00	32.00	1.80	112.32	1051.80	0.41	741.31	0.41	1492.30	0.41	3574.40	2731.40	4753.50
8.00	40.00	1.80	112.32	1104.95	0.40	772.80	0.40	1579.70	0.40	3632.20	2768.50	4845.10
8.00	48.00	1.80	112.32	1234.40	0.39	853.75	0.39	1783.90	0.39	3913.85	3045.60	5040.60
8.00	56.00	1.80	112.32	1472.00	0.38	1035.80	0.38	2091.80	0.38	3952.00	3078.60	5078.30
10.00	65.00	1.80	112.32	1563.75	0.38	1101.00	0.38	2221.00	0.38	4143.30	3375.10	5086.40
10.00	75.00	1.80	112.32	1636.75	0.38	1151.80	0.38	2325.80	0.38	4354.55	3551.70	5338.90
10.00	85.00	1.80	112.32	1794.35	0.38	1264.00	0.38	2547.30	0.38	4642.65	3799.10	5673.50
10.00	95.00	1.80	112.32	1730.95	0.38	1220.70	0.38	2454.60	0.38	4636.45	3795.90	5663.10
10.00	105.00	1.80	112.32	1838.10	0.38	1299.80	0.38	2599.50	0.38	4705.50	3842.00	5763.00
10.00	115.00	1.80	112.32	1801.00	0.38	1273.50	0.38	2547.00	0.38	4711.90	3847.20	5770.90
10.00	125.00	1.80	112.32	1761.50	0.39	1245.60	0.39	2491.10	0.39	4723.00	3856.30	5784.50
10.00	135.00	1.80	137.28	2698.60	0.30	2203.40	0.30	3305.10	0.30	5098.80	4163.20	6244.70
10.00	145.00	1.80	137.28	2755.40	0.30	2249.80	0.30	3374.70	0.30	5209.10	4253.20	6379.80
10.00	155.00	1.80	137.28	2783.90	0.30	2273.00	0.30	3409.50	0.30	5267.50	4300.90	6451.30
10.00	165.00	1.80	137.28	2794.40	0.30	2281.70	0.30	3422.50	0.30	5292.60	4321.40	6482.10
10.00	175.00	1.80	137.28	2762.10	0.31	2255.30	0.31	3382.90	0.31	5241.90	4280.00	6420.00
10.00	185.00	1.80	137.28	2742.20	0.31	2234.00	0.31	3366.00	0.31	5212.50	4256.00	6384.00
10.00	195.00	1.80	137.28	2791.70	0.31	2267.80	0.31	3436.60	0.31	5307.50	4333.60	6500.30
12.50	206.25	2.20	137.28	2815.15	0.31	2266.60	0.31	3521.50	0.31	5349.60	4356.30	6589.30
12.50	218.75	2.20	137.28	2839.30	0.31	2296.90	0.31	3534.00	0.31	5400.10	4397.00	6632.00
12.50	231.25	2.20	137.28	2868.40	0.31	2297.60	0.31	3604.70	0.31	5460.10	4444.30	6744.60
12.50	243.75	2.20	137.28	2918.30	0.31	2337.90	0.31	3664.40	0.31	5557.15	4520.40	6848.40
12.50	256.25	2.20	137.28	2986.50	0.30	2422.40	0.30	3682.40	0.30	5639.90	4584.90	6937.60
12.50	268.75	2.20	137.28	2991.45	0.30	2425.90	0.31	3688.60	0.30	5653.40	4594.80	6955.80
12.50	281.25	2.20	137.28	3014.40	0.30	2456.90	0.30	3698.30	0.31	5699.20	4637.20	7004.30
12.50	293.75	2.20	137.28	3011.95	0.30	2454.80	0.30	3695.50	0.31	5699.20	4637.20	7004.30
15.00	307.50	2.20	137.28	3086.10	0.30	2515.30	0.30	3786.40	0.31	5834.70	4748.20	7169.80
15.00	322.50	2.20	137.28	3108.05	0.30	2533.10	0.30	3813.50	0.31	5878.00	4783.40	7222.90
15.00	337.50	2.20	137.28	3230.95	0.30	2632.40	0.30	3965.40	0.30	6101.95	4965.70	7498.10
15.00	352.50	2.20	137.28	3296.75	0.30	2684.50	0.30	4048.60	0.30	6221.75	5059.30	7651.10
15.00	367.50	2.20	137.28	3370.85	0.30	2744.50	0.30	4140.10	0.30	6358.35	5170.50	7819.00
15.00	382.50	2.20	137.28	3407.20	0.30	2773.90	0.30	4185.10	0.30	6427.10	5226.30	7903.60
15.00	397.50	2.20	137.28	3421.85	0.30	2785.80	0.30	4203.20	0.30	6457.45	5251.10	7940.90
15.00	412.50	2.20	137.28	3419.95	0.30	2784.10	0.30	4201.00	0.30	6457.45	5251.10	7940.90
15.00	427.50	2.20	137.28	3418.15	0.30	2782.60	0.30	4198.90	0.30	6457.45	5251.10	7940.90
15.00	442.50	2.20	137.28	3416.50	0.30	2781.20	0.30	4196.90	0.30	6457.60	5251.10	7941.10
15.00	457.50	2.20	137.28	3510.90	0.30	2857.60	0.30	4313.50	0.30	6631.70	5392.70	8155.20
15.00	472.50	2.20	137.28	3530.70	0.30	2873.70	0.30	4337.90	0.30	6670.15	5424.00	8202.50
15.00	487.50	2.20	137.28	3558.90	0.30	2896.20	0.30	4373.20	0.30	6722.35	5466.40	8266.70

Note: The horizontal shear-strain data, the damping values and metric equivalent data from pages B-2 and B-3 have been intentionally excluded from this spreadsheet for clarity as these items do not figure with subsequent calculation.

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

LOWER BOUND VALUES:
SEE PAGE B-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' LOWER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: 227 FT (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: 242 FT (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) G'=(ρ*Vs²/g*1000) [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq [3]	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	530.9	1359.5	984.0	0.383	1.532	2722.0	0.00881	1.000	4.0000	1.47E-03
2	4.00	6.00	112.32	531.7	1599.4	987.1	0.409	1.637	2781.9	0.02643	1.000	4.0000	1.44E-03
3	4.00	10.00	112.32	554.0	1776.8	1071.5	0.415	1.661	3033.2	0.04405	1.000	4.0000	1.32E-03
4	4.00	14.00	112.32	598.4	1879.7	1250.4	0.417	1.667	3543.1	0.06167	1.000	4.0000	1.13E-03
5	4.00	18.00	112.32	746.0	2531.5	1943.0	0.413	1.654	5492.8	0.07930	1.000	4.0000	7.28E-04
6	8.00	24.00	112.32	697.9	2276.6	1700.5	0.421	3.366	4832.0	0.10573	1.000	8.0000	1.66E-03
7	8.00	32.00	112.32	741.3	2731.4	1918.7	0.409	3.274	5408.1	0.14097	1.000	8.0000	1.48E-03
8	8.00	40.00	112.32	772.8	2768.5	2085.2	0.399	3.189	5832.8	0.17621	1.000	8.0000	1.37E-03
9	8.00	48.00	112.32	853.8	3045.6	2544.9	0.393	3.146	7091.6	0.21145	1.000	8.0000	1.13E-03
10	8.00	56.00	112.32	1035.8	3078.6	3745.9	0.378	3.026	10325.9	0.24670	0.972	7.7744	7.53E-04
11	10.00	65.00	112.32	1101.0	3375.1	4232.3	0.379	3.792	11674.5	0.28634	0.930	9.2950	7.96E-04
12	10.00	75.00	112.32	1151.8	3551.7	4631.9	0.379	3.788	12773.0	0.33040	0.883	8.8250	6.91E-04
13	10.00	85.00	112.32	1264.0	3799.1	5578.3	0.376	3.757	15348.2	0.37445	0.836	8.3550	5.44E-04
14	10.00	95.00	112.32	1220.7	3795.9	5202.6	0.380	3.800	14359.4	0.41850	0.789	7.8850	5.49E-04
15	10.00	105.00	112.32	1299.8	3842.0	5898.7	0.380	3.805	16286.1	0.46256	0.748	7.4775	4.59E-04
16	10.00	115.00	112.32	1273.5	3847.2	5662.4	0.384	3.842	15675.9	0.50661	0.713	7.1325	4.55E-04
17	10.00	125.00	112.32	1245.6	3856.3	5417.1	0.387	3.873	15029.9	0.55066	0.679	6.7875	4.52E-04
18	10.00	135.00	137.28	2203.4	4163.2	20717.8	0.304	3.039	54026.5	0.59471	0.644	6.4425	1.19E-04
19	10.00	145.00	137.28	2249.8	4253.2	21599.5	0.304	3.041	56337.6	0.63877	0.610	6.0975	1.08E-04
20	10.00	155.00	137.28	2273.0	4300.9	22047.3	0.305	3.045	57521.4	0.68282	0.575	5.7525	1.00E-04
21	10.00	165.00	137.28	2281.7	4321.4	22216.4	0.305	3.049	57981.6	0.72687	0.541	5.4075	9.33E-05
22	10.00	175.00	137.28	2255.3	4280.0	21705.3	0.306	3.058	56685.4	0.77093	0.506	5.0625	8.93E-05
23	10.00	185.00	137.28	2234.0	4256.0	21297.2	0.307	3.065	55650.0	0.81498	0.472	4.7175	8.48E-05
24	10.00	195.00	137.28	2267.8	4333.6	21946.5	0.307	3.066	57349.8	0.85903	0.437	4.3725	7.62E-05
25	12.50	206.25	137.28	2266.6	4356.3	21923.3	0.307	3.837	57306.6	0.90859	0.409	5.1094	8.92E-05
26	12.50	218.75	137.28	2296.9	4397.0	22513.4	0.307	3.841	58862.1	0.96366	0.386	4.8281	8.20E-05
27	12.50	231.25	137.28	2297.6	4444.3	22527.1	0.307	3.844	58907.4	1.01872	0.364	4.5469	7.72E-05
28	12.50	243.75	137.28	2337.9	4520.4	23324.3	0.308	3.844	60994.4	1.07379	0.341	4.2656	6.99E-05
29	12.50	256.25	137.28	2422.4	4584.9	25040.8	0.305	3.812	65354.9	1.12885	0.319	3.9844	6.10E-05
30	12.50	268.75	137.28	2425.9	4594.8	25113.2	0.305	3.816	65560.0	1.18392	0.296	3.7031	5.65E-05
31	12.50	281.25	137.28	2456.9	4637.2	25759.1	0.304	3.796	67163.3	1.23899	0.274	3.4219	5.09E-05
32	12.50	293.75	137.28	2454.8	4637.2	25715.1	0.304	3.801	67069.1	1.29405	0.251	3.1406	4.68E-05
33	15.00	307.50	137.28	2515.3	4748.2	26998.3	0.304	4.556	70398.5	1.35463	0.233	3.4965	4.97E-05
34	15.00	322.50	137.28	2533.1	4783.4	27381.7	0.304	4.559	71408.3	1.42070	0.219	3.2895	4.61E-05
35	15.00	337.50	137.28	2632.4	4965.7	29570.6	0.303	4.551	77085.2	1.48678	0.206	3.0825	4.00E-05
36	15.00	352.50	137.28	2684.5	5059.3	30752.7	0.303	4.547	80149.5	1.55286	0.192	2.8755	3.59E-05
37	15.00	367.50	137.28	2744.5	5170.5	32142.7	0.303	4.544	83758.8	1.61894	0.178	2.6685	3.19E-05
38	15.00	382.50	137.28	2773.9	5226.3	32835.1	0.303	4.544	85565.5	1.68502	0.164	2.4615	2.88E-05
39	15.00	397.50	137.28	2785.8	5251.1	33117.4	0.303	4.548	86315.2	1.75110	0.150	2.2545	2.61E-05
40	15.00	412.50	137.28	2784.1	5251.1	33077.0	0.303	4.552	86228.4	1.81718	0.142	2.1338	2.47E-05
41	15.00	427.50	137.28	2782.6	5251.1	33041.3	0.304	4.556	86153.3	1.88326	0.135	2.0303	2.36E-05
42	15.00	442.50	137.28	2781.2	5251.1	33008.1	0.304	4.560	86083.2	1.94934	0.128	1.9268	2.24E-05
43	15.00	457.50	137.28	2857.6	5392.7	34846.5	0.304	4.555	90856.0	2.01542	0.122	1.8233	2.01E-05
44	15.00	472.50	137.28	2873.7	5424.0	35240.3	0.304	4.556	91889.0	2.08150	0.115	1.7198	1.87E-05
45	15.00	487.50	137.28	2896.2	5466.4	35794.3	0.304	4.556	93332.8	2.14758	0.108	1.6163	1.73E-05
Summation Σ =	495.0000							161.9490				217.7629	1.8007E-02

(1) From Soil Data on Page B-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page B-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 12093 ksf
μ = ΣμH/ΣH 0.327
G' = E/(2*(1+ μ)) =: 4556 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1142.3 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1033.3 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.327 (Lower Bound Soil Case)
Shear Modulus, G' = 4556 ksf (Lower Bound Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

MEDIAN VALUES:
SEE PAGE B-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' MEDIAN (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho^*Vs^2/g^*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq [3]	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	759.5	1935.5	2014.0	0.384	1.534	5572.9	0.00881	1.000	4.0000	7.18E-04
2	4.00	6.00	112.32	758.0	2149.3	2006.2	0.408	1.633	5650.3	0.02643	1.000	4.0000	7.08E-04
3	4.00	10.00	112.32	784.2	2410.2	2147.0	0.416	1.663	6079.3	0.04405	1.000	4.0000	6.58E-04
4	4.00	14.00	112.32	851.7	2670.3	2532.8	0.417	1.667	7176.2	0.06167	1.000	4.0000	5.57E-04
5	4.00	18.00	112.32	1079.7	3423.5	4069.8	0.413	1.652	11501.6	0.07930	1.000	4.0000	3.48E-04
6	8.00	24.00	112.32	1000.2	3352.5	3493.1	0.420	3.362	9921.6	0.10573	1.000	8.0000	8.06E-04
7	8.00	32.00	112.32	1051.8	3574.4	3862.5	0.409	3.272	10884.5	0.14097	1.000	8.0000	7.35E-04
8	8.00	40.00	112.32	1105.0	3632.2	4262.8	0.399	3.190	11924.6	0.17621	1.000	8.0000	6.71E-04
9	8.00	48.00	112.32	1234.4	3913.9	5320.1	0.393	3.144	14821.3	0.21145	1.000	8.0000	5.40E-04
10	8.00	56.00	112.32	1472.0	3952.0	7565.2	0.378	3.024	20850.0	0.24670	0.972	7.7744	3.73E-04
11	10.00	65.00	112.32	1563.8	4143.3	8537.7	0.379	3.790	23547.6	0.28634	0.930	9.2950	3.95E-04
12	10.00	75.00	112.32	1636.8	4354.6	9353.4	0.379	3.790	25796.2	0.33040	0.883	8.8250	3.42E-04
13	10.00	85.00	112.32	1794.4	4642.7	11241.4	0.377	3.766	30949.7	0.37445	0.836	8.3550	2.70E-04
14	10.00	95.00	112.32	1731.0	4636.5	10461.0	0.381	3.811	28896.3	0.41850	0.789	7.8850	2.73E-04
15	10.00	105.00	112.32	1838.1	4705.5	11796.3	0.380	3.805	32568.8	0.46256	0.748	7.4775	2.30E-04
16	10.00	115.00	112.32	1801.0	4711.9	11324.9	0.384	3.842	31351.8	0.50661	0.713	7.1325	2.27E-04
17	10.00	125.00	112.32	1761.5	4723.0	10833.6	0.387	3.873	30058.4	0.55066	0.679	6.7875	2.26E-04
18	10.00	135.00	137.28	2698.6	5098.8	31076.6	0.304	3.039	81039.6	0.59471	0.644	6.4425	7.95E-05
19	10.00	145.00	137.28	2755.4	5209.1	32398.5	0.304	3.041	84504.5	0.63877	0.610	6.0975	7.22E-05
20	10.00	155.00	137.28	2783.9	5267.5	33072.2	0.305	3.045	86285.4	0.68282	0.575	5.7525	6.67E-05
21	10.00	165.00	137.28	2794.4	5292.6	33322.2	0.305	3.049	86966.2	0.72687	0.541	5.4075	6.22E-05
22	10.00	175.00	137.28	2762.1	5241.9	32556.3	0.306	3.058	85024.0	0.77093	0.506	5.0625	5.95E-05
23	10.00	185.00	137.28	2742.2	5212.5	32088.9	0.307	3.065	83848.9	0.81498	0.472	4.7175	5.63E-05
24	10.00	195.00	137.28	2791.7	5307.5	33257.8	0.307	3.066	86908.0	0.85903	0.437	4.3725	5.03E-05
25	12.50	206.25	137.28	2815.2	5349.6	33818.9	0.306	3.829	88356.2	0.90859	0.409	5.1094	5.78E-05
26	12.50	218.75	137.28	2839.3	5400.1	34401.6	0.307	3.833	89903.4	0.96366	0.386	4.8281	5.37E-05
27	12.50	231.25	137.28	2868.4	5460.1	35110.4	0.307	3.837	91776.8	1.01872	0.364	4.5469	4.95E-05
28	12.50	243.75	137.28	2918.3	5557.2	36342.6	0.307	3.839	95007.2	1.07379	0.341	4.2656	4.49E-05
29	12.50	256.25	137.28	2986.5	5639.9	38061.1	0.304	3.799	99258.4	1.12885	0.319	3.9844	4.01E-05
30	12.50	268.75	137.28	2991.5	5653.4	38187.4	0.304	3.804	99614.0	1.18392	0.296	3.7031	3.72E-05
31	12.50	281.25	137.28	3014.4	5699.2	38775.6	0.304	3.806	101161.5	1.23899	0.274	3.4219	3.38E-05
32	12.50	293.75	137.28	3012.0	5699.2	38712.5	0.305	3.810	101026.2	1.29405	0.251	3.1406	3.11E-05
33	15.00	307.50	137.28	3086.1	5834.7	40642.1	0.304	4.567	106032.4	1.35463	0.233	3.4965	3.30E-05
34	15.00	322.50	137.28	3108.1	5878.0	41222.3	0.305	4.569	107558.9	1.42070	0.219	3.2895	3.06E-05
35	15.00	337.50	137.28	3231.0	6102.0	44546.8	0.304	4.560	116175.4	1.48678	0.206	3.0825	2.65E-05
36	15.00	352.50	137.28	3296.8	6221.8	46379.7	0.304	4.556	120931.9	1.55286	0.192	2.8755	2.38E-05
37	15.00	367.50	137.28	3370.9	6358.4	48488.1	0.303	4.552	126404.6	1.61894	0.178	2.6685	2.11E-05
38	15.00	382.50	137.28	3407.2	6427.1	49539.5	0.303	4.552	129146.0	1.68502	0.164	2.4615	1.91E-05
39	15.00	397.50	137.28	3421.9	6457.5	49966.4	0.304	4.555	130277.9	1.75110	0.150	2.2545	1.73E-05
40	15.00	412.50	137.28	3420.0	6457.5	49910.9	0.304	4.559	130160.2	1.81718	0.142	2.1338	1.64E-05
41	15.00	427.50	137.28	3418.2	6457.5	49858.4	0.304	4.563	130047.7	1.88326	0.135	2.0303	1.56E-05
42	15.00	442.50	137.28	3416.5	6457.6	49810.3	0.304	4.566	129946.1	1.94934	0.128	1.9268	1.48E-05
43	15.00	457.50	137.28	3510.9	6631.7	52600.9	0.304	4.561	137187.9	2.01542	0.122	1.8233	1.33E-05
44	15.00	472.50	137.28	3530.7	6670.2	53195.9	0.304	4.562	138748.1	2.08150	0.115	1.7198	1.24E-05
45	15.00	487.50	137.28	3558.9	6722.4	54049.0	0.304	4.561	140969.0	2.14758	0.108	1.6163	1.15E-05
Summation Σ =	495.0000							162.0185				217.7629	9.1264E-03

(1) From Soil Data on Page B-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page B-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 23861 ksf
μ = ΣμH/ΣH 0.327
G' = E/(2*(1+ μ)) =: 8988 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1604.5 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1451.3 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : **Poisson's Ratio, μ =** **0.327** **(Median Soil Case)**
Shear Modulus, G' = **8988 ksf** **(Median Soil Case)**

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

UPPER BOUND VALUES:
SEE PAGE B-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' UPPER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: 227 FT (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: 242 FT (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY (4) ρ (PCF)	SHEAR WAVE VELOCITY (4) Vs (FPS)	COMP. WAVE VELOCITY (4) Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) G'=(ρ*Vs²/g*1000) (2a)	POISSON'S RATIO (1) μ	μH (FT)	YOUNGS MODULUS E_i (KSF) E_i=2(1+μ)G' (2b)	Z/W (5)	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1086.4	2755.5	4120.8	0.384	1.536	11406.2	0.00881	1.000	4.0000	3.51E-04
2	4.00	6.00	112.32	1080.6	2926.2	4077.0	0.407	1.629	11474.8	0.02643	1.000	4.0000	3.49E-04
3	4.00	10.00	112.32	1110.0	3218.3	4301.8	0.416	1.665	12184.1	0.04405	1.000	4.0000	3.28E-04
4	4.00	14.00	112.32	1212.1	3793.2	5129.6	0.416	1.666	14532.0	0.06167	1.000	4.0000	2.75E-04
5	4.00	18.00	112.32	1561.7	4593.4	8515.3	0.413	1.650	24057.7	0.07930	1.000	4.0000	1.66E-04
6	8.00	24.00	112.32	1433.4	4703.8	7173.7	0.420	3.357	20367.9	0.10573	1.000	8.0000	3.93E-04
7	8.00	32.00	112.32	1492.3	4753.5	7775.3	0.409	3.269	21905.4	0.14097	1.000	8.0000	3.65E-04
8	8.00	40.00	112.32	1579.7	4845.1	8712.8	0.399	3.190	24373.7	0.17621	1.000	8.0000	3.28E-04
9	8.00	48.00	112.32	1783.9	5040.6	11110.8	0.393	3.141	30946.1	0.21145	1.000	8.0000	2.59E-04
10	8.00	56.00	112.32	2091.8	5078.3	15277.3	0.378	3.022	42096.3	0.24670	0.972	7.7744	1.85E-04
11	10.00	65.00	112.32	2221.0	5086.4	17222.8	0.379	3.789	47496.3	0.28634	0.930	9.2950	1.96E-04
12	10.00	75.00	112.32	2325.8	5338.9	18886.5	0.379	3.791	52093.8	0.33040	0.883	8.8250	1.69E-04
13	10.00	85.00	112.32	2547.3	5673.5	22655.1	0.377	3.775	62413.9	0.37445	0.836	8.3550	1.34E-04
14	10.00	95.00	112.32	2454.6	5663.1	21036.2	0.382	3.823	58155.4	0.41850	0.789	7.8850	1.36E-04
15	10.00	105.00	112.32	2599.5	5763.0	23593.1	0.380	3.805	65139.2	0.46256	0.748	7.4775	1.15E-04
16	10.00	115.00	112.32	2547.0	5770.9	22649.8	0.384	3.842	62703.6	0.50661	0.713	7.1325	1.14E-04
17	10.00	125.00	112.32	2491.1	5784.5	21666.5	0.387	3.873	60114.9	0.55066	0.679	6.7875	1.13E-04
18	10.00	135.00	137.28	3305.1	6244.7	46615.0	0.304	3.039	121559.7	0.59471	0.644	6.4425	5.30E-05
19	10.00	145.00	137.28	3374.7	6379.8	48598.9	0.304	3.041	126759.6	0.63877	0.610	6.0975	4.81E-05
20	10.00	155.00	137.28	3409.5	6451.3	49606.4	0.305	3.045	129423.1	0.68282	0.575	5.7525	4.44E-05
21	10.00	165.00	137.28	3422.5	6482.1	49985.4	0.305	3.049	130454.9	0.72687	0.541	5.4075	4.15E-05
22	10.00	175.00	137.28	3382.9	6420.0	48835.4	0.306	3.058	127538.5	0.77093	0.506	5.0625	3.97E-05
23	10.00	185.00	137.28	3366.0	6384.0	48348.7	0.307	3.065	126336.0	0.81498	0.472	4.7175	3.73E-05
24	10.00	195.00	137.28	3436.6	6500.3	50398.1	0.307	3.066	131698.3	0.85903	0.437	4.3725	3.32E-05
25	12.50	206.25	137.28	3521.5	6589.3	52919.0	0.306	3.821	138187.4	0.90859	0.409	5.1094	3.70E-05
26	12.50	218.75	137.28	3534.0	6632.0	53295.3	0.306	3.826	139216.0	0.96366	0.386	4.8281	3.47E-05
27	12.50	231.25	137.28	3604.7	6744.6	55449.1	0.306	3.831	144885.2	1.01872	0.364	4.5469	3.14E-05
28	12.50	243.75	137.28	3664.4	6848.4	57301.0	0.307	3.834	149748.1	1.07379	0.341	4.2656	2.85E-05
29	12.50	256.25	137.28	3682.4	6937.6	57865.3	0.303	3.786	150785.4	1.12885	0.319	3.9844	2.64E-05
30	12.50	268.75	137.28	3688.6	6955.8	58060.3	0.303	3.791	151336.5	1.18392	0.296	3.7031	2.45E-05
31	12.50	281.25	137.28	3698.3	7004.3	58366.1	0.305	3.815	152361.1	1.23899	0.274	3.4219	2.25E-05
32	12.50	293.75	137.28	3695.5	7004.3	58277.7	0.306	3.820	152171.3	1.29405	0.251	3.1406	2.06E-05
33	15.00	307.50	137.28	3786.4	7169.8	61180.0	0.305	4.578	159700.5	1.35463	0.233	3.4965	2.19E-05
34	15.00	322.50	137.28	3813.5	7222.9	62058.8	0.305	4.580	162010.8	1.42070	0.219	3.2895	2.03E-05
35	15.00	337.50	137.28	3965.4	7498.1	67101.2	0.305	4.568	175071.0	1.48678	0.206	3.0825	1.76E-05
36	15.00	352.50	137.28	4048.6	7651.1	69946.5	0.304	4.565	182462.4	1.55286	0.192	2.8755	1.58E-05
37	15.00	367.50	137.28	4140.1	7819.0	73143.9	0.304	4.560	190759.2	1.61894	0.178	2.6685	1.40E-05
38	15.00	382.50	137.28	4185.1	7903.6	74742.5	0.304	4.560	194924.1	1.68502	0.164	2.4615	1.26E-05
39	15.00	397.50	137.28	4203.2	7940.9	75390.4	0.304	4.562	196639.4	1.75110	0.150	2.2545	1.15E-05
40	15.00	412.50	137.28	4201.0	7940.9	75311.5	0.304	4.566	196472.8	1.81718	0.142	2.1338	1.09E-05
41	15.00	427.50	137.28	4198.9	7940.9	75236.3	0.305	4.569	196309.5	1.88326	0.135	2.0303	1.03E-05
42	15.00	442.50	137.28	4196.9	7941.1	75164.6	0.305	4.573	196157.1	1.94934	0.128	1.9268	9.82E-06
43	15.00	457.50	137.28	4313.5	8155.2	79399.1	0.304	4.566	207141.2	2.01542	0.122	1.8233	8.80E-06
44	15.00	472.50	137.28	4337.9	8202.5	80300.0	0.305	4.568	209502.6	2.08150	0.115	1.7198	8.21E-06
45	15.00	487.50	137.28	4373.2	8266.7	81612.2	0.304	4.566	212914.7	2.14758	0.108	1.6163	7.59E-06
Summation Σ =	495.0000							162.0880				217.7629	4.6665E-03

(1) From Soil Data on Page B-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page B-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 46665 ksf
μ = ΣμH /ΣH 0.327
G' = E/(2*(1+ μ)) =: 17577 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 2243.7 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 2029.5 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.327 (Upper Bound Soil Case)
Shear Modulus, G' = 17577 ksf (Upper Bound Soil Case)

SUMMARY OF DYNAMIC SHEAR MODULUS G' (KSF) AND POISSON'S RATIO VALUES FOR 1E-4 EVENT

130' Alluvium					
Lower Bound Soil Case		**Median Soil Case**		**Upper Bound Soil Case**	
Dynamic Shear Modulus G' (KSF)	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**
4,556	0.327	8,988	0.327	17,577	0.327
Page B-5	Page B-5	Page B-6	Page B-6	Page B-7	Page B-7

ATTACHMENT C -- RECEIPT FACILITY GROUND FLOOR PLAN

ATTACHMENT C Receipt Facility Ground Floor Plan

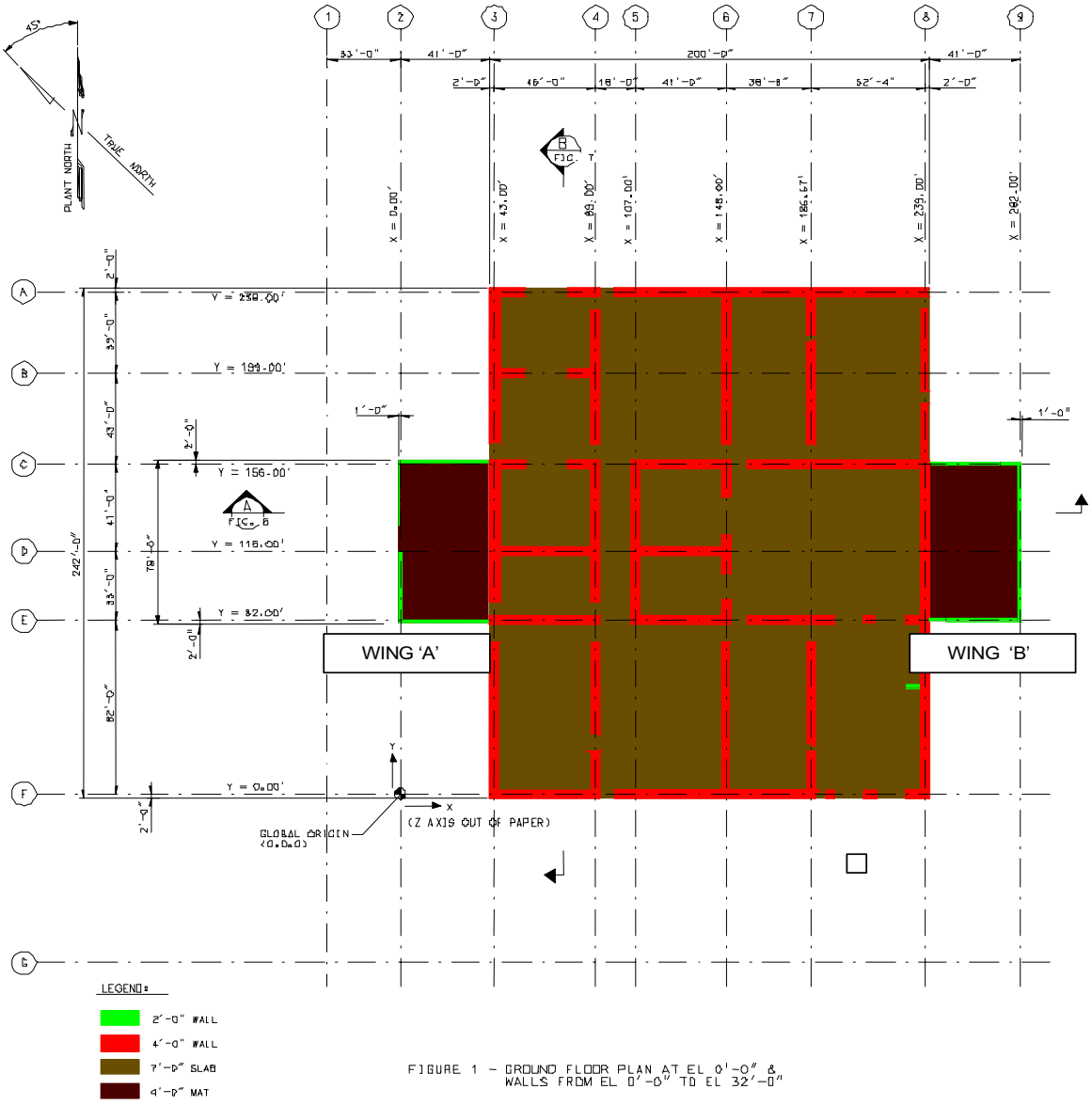


FIGURE 1 – GROUND FLOOR PLAN AT EL 0'-0" & WALLS FROM EL 0'-0" TO EL 32'-0"

For clarity see drawing: 200-DB0-RF00-00101-00A
(Ref. 2.2.11)

ATTACHMENT D -- E-MAILS ON SOIL PROPERTIES

"Ma, Thomas" tma@bechtel.com on 06/21/2007 07:46:49 AM

To: "Bisset, John R" <john_bisset@ymp.gov>
cc: "Frankert, Thomas" <thomas_frankert@ymp.gov>, "Rajagopal, Raj" <raj_rajagopal@ymp.gov>, "Jacquelyn Solowey/YM/RWDOE" <Jacquelyn_Solowey@ymp.gov>, "Ali Nikaeen/YM/RWDOE" <Ali_Nikaeen@ymp.gov>, "Walter Chang/YM/RWDOE" <Walter_Chang@ymp.gov>
Subject: RE: Soils Data for 130' Alluvium Case

LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

The following procedure looks good. However, please be aware that we are expecting revised soil profiles from URS soon.

Thomas W. Ma

50 Beale Street (50/15/A21)

San Francisco, CA 94105-1895

(415)768-4216

FAX (415)768-4692

From: Bisset, John R [mailto:john_bisset@ymp.gov]
Sent: Wednesday, June 20, 2007 6:09 PM
To: Ma, Thomas
Cc: Frankert, Thomas; Rajagopal, Raj; Jacquelyn Solowey/YM/RWDOE; Ali Nikaeen/YM/RWDOE; Walter Chang/YM/RWDOE
Subject: Soils Data for 130' Alluvium Case

Here is a summary of our recent conversations on how we should develop the soil properties for a 130' thick alluvium case for the Receipt Facility (RF); let me know by noon on Thursday if you see any problems, thanks:

1. Recently received information indicates the depth of alluvium ranges from about 127' to 141', with the 130' contour going right through the middle of the building. It was therefore decided to utilize only one set of soils values (lower, median, and upper bound cases) for 130' thick alluvium for the analysis of the RF.

2. The 130' alluvium case will be developed by using the data from the 100' and 200' cases in the following manner:

a. For the first 100’ of the alluvium the upper bound values of the shear wave velocities will be the highest value between the 100’ and 200 cases; for the lower bound case the shear wave velocities will be the lowest between the 100’ and 200’ cases.

In both cases, the compressive wave velocity will be that associated with the shear wave velocity selected to represent the 130’ alluvium case, thus if the 100’ results govern at a particular layer for the shear wave velocity than the compressive wave velocity for that layer will also come from the 100’ results.

b. For the first 100’ the median results will be the average of the 100’ and 200’ cases.

c. For the next 100’ to 130’ of alluvium values of the shear wave velocities, compressive wave velocities, and densities for all 3 sets of soils conditions (lower, upper and median) will come from the 200’ case results.

d. For the next 130’ to 200’, where we are now into tuff, values of the shear wave velocities, compressive wave velocities, and densities for all 3 sets of soils conditions (lower, upper and median) will come from the 100’ case results.

e. Below 200’ the values for the tuff will be determined from the 100’ and 200’ cases in the same manner as was done for the alluvium.

3. The resulting densities, shear wave velocities, and compressive wave velocities will then be used to calculate spring stiffness and damping values for use in the subsequent seismic analyses.

LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

This is the second email that needs to be included in the new soil springs calculation. It identifies the source of the figure that gives the alluvium thickness contours.

---------- Forwarded by John Bisset/YM/RWDOE on 07/12/2007 08:31 AM ----------

To: Farhang Ostadan <fostadan@bechtel.com>, Thomas Ma <tma@bechtel.com>, Michael Ruben/YM/RWDOE@CRWMS, John Bisset/YM/RWDOE@CRWMS, Salvador Macias/YM/RWDOE@CRWMS, Vic Sen/YM/RWDOE@CRWMS, Charles Lew/YM/RWDOE@CRWMS
cc: Thomas Frankert/YM/RWDOE@CRWMS
Subject: Fw: thickness of alluvium

LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

I would like to discuss the alluvium thickness info provided below in our meeting this afternoon. Please compare it to what you have been using.

Farhang, are you available at 2:00 pm today for a phone call with the CSA group to discuss the trial runs and path forward for the seismic analysis work?

Thanks,
Debbie

---------- Forwarded by Debra Nevergold/YM/RWDOE on 06/04/2007 08:05 AM ----------

To: Debra Nevergold/YM/RWDOE@CRWMS
cc: Richard Quittmeyer/YM/RWDOE@CRWMS, Thomas Frankert/YM/RWDOE@CRWMS, Michael Schuhen/YM/RWDOE@CRWMS, Douglas Weaver/YM/RWDOE@CRWMS, Steven Beason/YM/RWDOE@CRWMS
Subject: Re: thickness of alluvium (1)

LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

Debbie

Attached please find an updated alluvium contour map of Midway Valley. This map incorporates both Q and non-Q preliminary drilling results. By basing the thicknesses on borehole intercepts instead of borehole collar elevations I was able to develop reasonable results. Without as-built survey elevations I would rather not represent preliminary top of rock and/or bottom of alluvium contours. Should you have questions regarding this attachment please do not hesitate contact myself or Steve Beason.

Thank you, Rob

Qal thickness contour 5-31-07.pdf

To: Robert Lung/YM/RWDOE@CRWMS
cc: Richard Quittmeyer/YM/RWDOE@CRWMS, Thomas Frankert/YM/RWDOE@CRWMS, Michael Schuhen/YM/RWDOE@CRWMS, Douglas Weaver/YM/RWDOE@CRWMS
Subject: thickness of alluvium

LSN: Not Relevant - Not Privileged

User Filed as: Excl/AdminMgmt-14-4/QA:N/A

Please provide the thickness of alluvium for each of the following surface facility buildings:

060 CRCF-1
070 CRCF-2
080 CRCF-3
050 WHF
200 RF
51A IHF
26D EDGF

Please provide this input by June 1, 2007. It is required to support the seismic calculations which are scheduled to start on June 4.

Please let me know if you have any questions.

Thanks,
Debbie

---

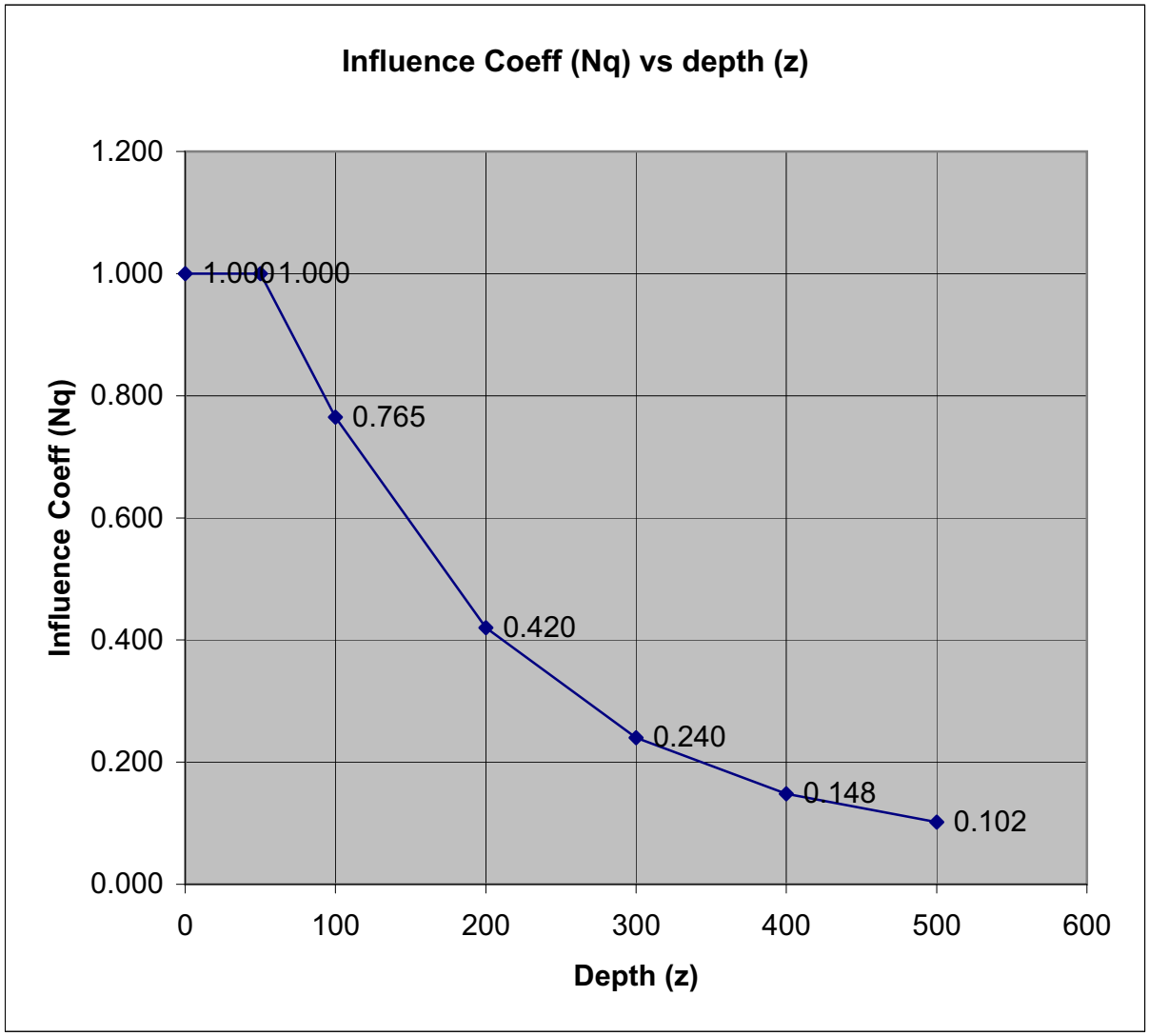
(1) -
Notes:///8825710D00772483/69760FC82C4AF1D9882571500001ADF7/B8EFB9E8D5E22B4A882572E400565CFC

ATTACHMENT E -- NEWMARK INFLUENCE CHARTS

FIGURE 2

Newmark's Influence Coefficients (Nq) vs Depth (z)

For Receipt Facility

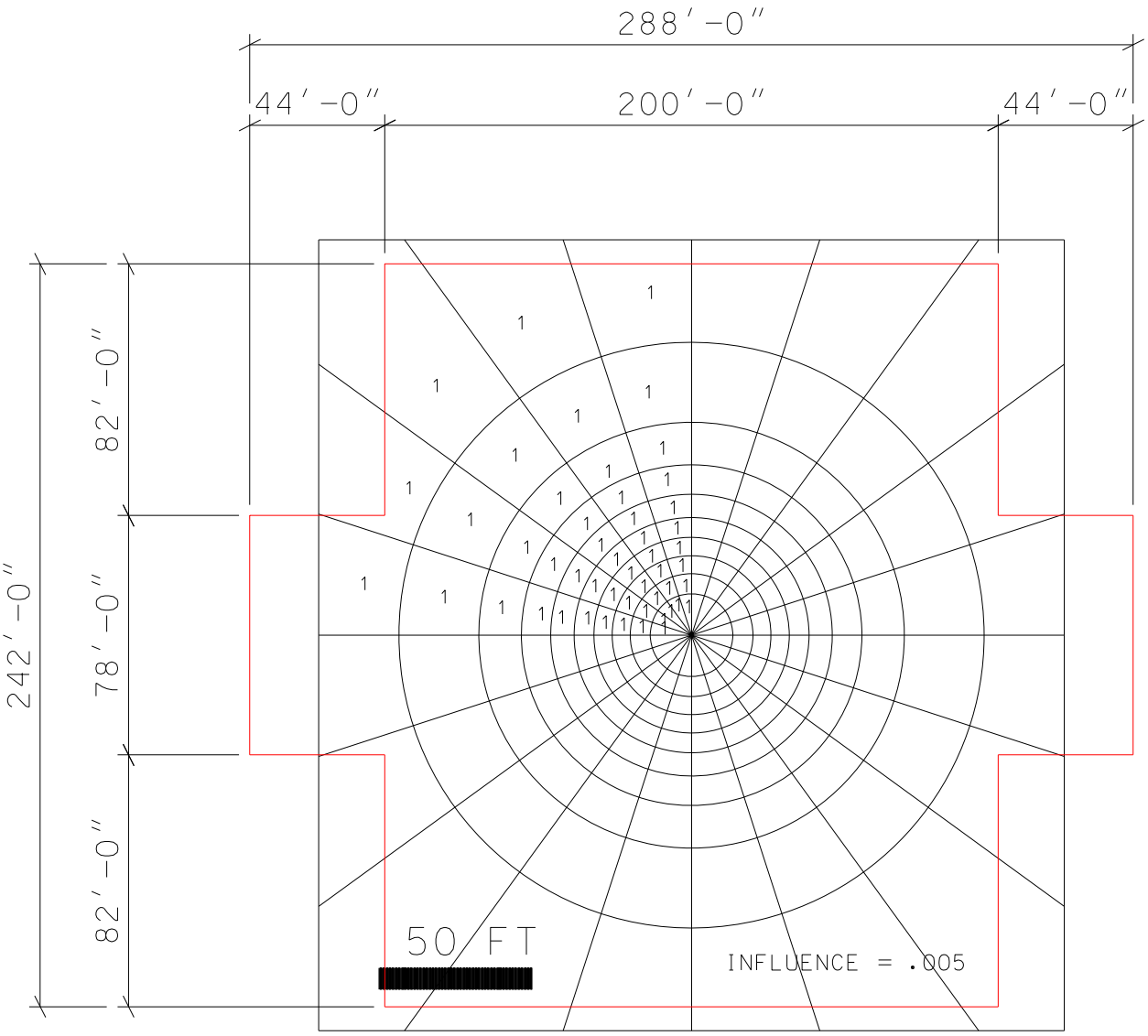


Depth (ft)	Nq [1]	Delta	Delta / depth difference [2]
0	1.000		
50	1.000	0.000	0.00000
100	0.765	0.235	0.00470
200	0.420	0.345	0.00345
300	0.240	0.180	0.00180
400	0.148	0.092	0.00092
500	0.102	0.046	0.00046

Notes: (1) Table values Nq are from Newmark Charts in the next pages.
(2) Delta / depth difference are used in calculation of interpolated Nq values and shown in Attachments A and B.

NEWMARK INFLUENCE CHART FOR VERTICAL PRESSURE

DEPTH = 50 FEET



UNITS PER QUADRANT = 50

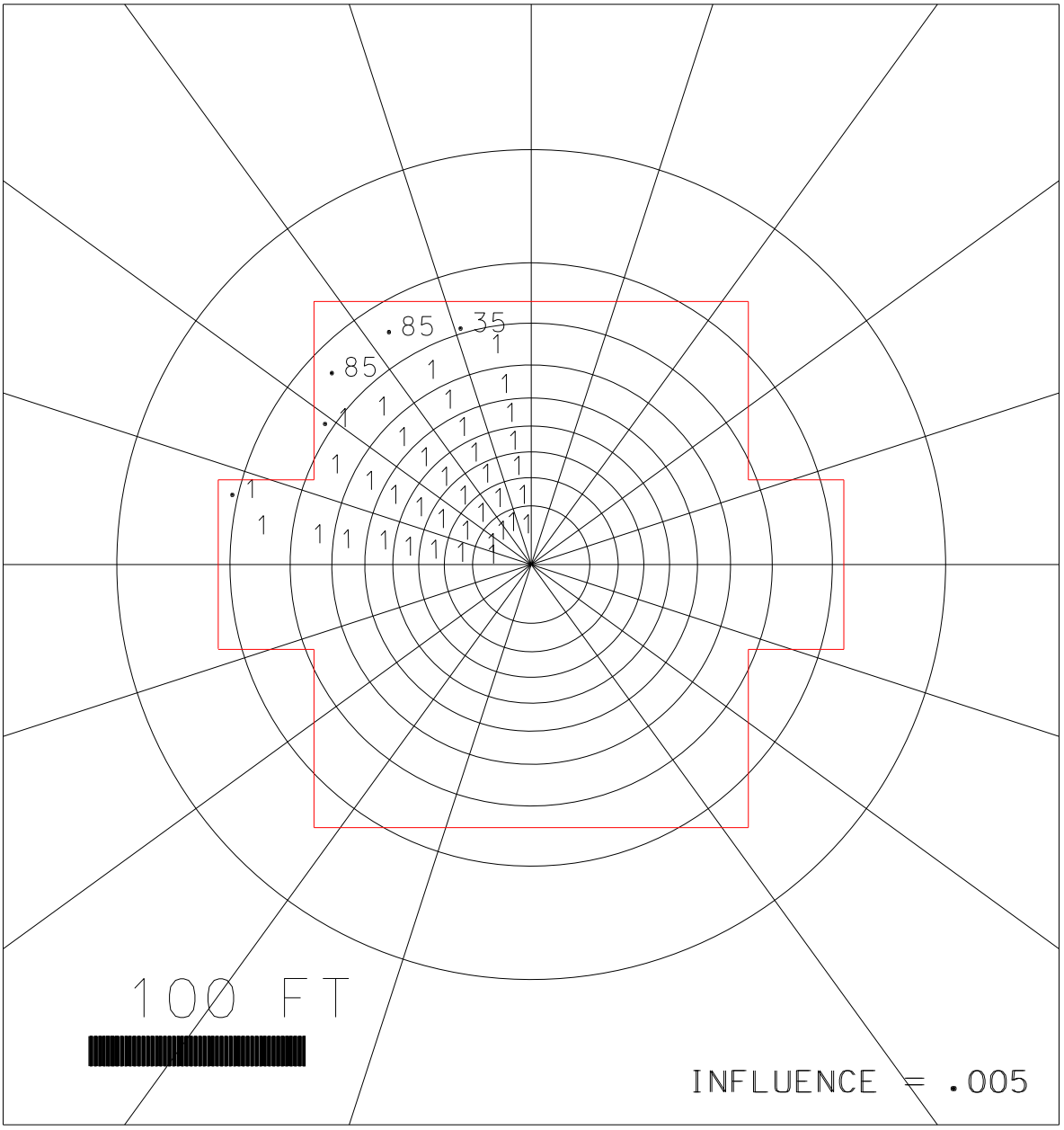
TOTAL UNITS = 50 X 4 = 200.00

Nq = INFLUENCE X TOTAL UNITS = 1.0

FOR DESCRIPTION OF THIS CHART, SEE SECT. 4.3.3 & REF 2.2.4

NEWMARK INFLUENCE FOR VERTICAL PRESSURE

DEPTH = 100 FEET



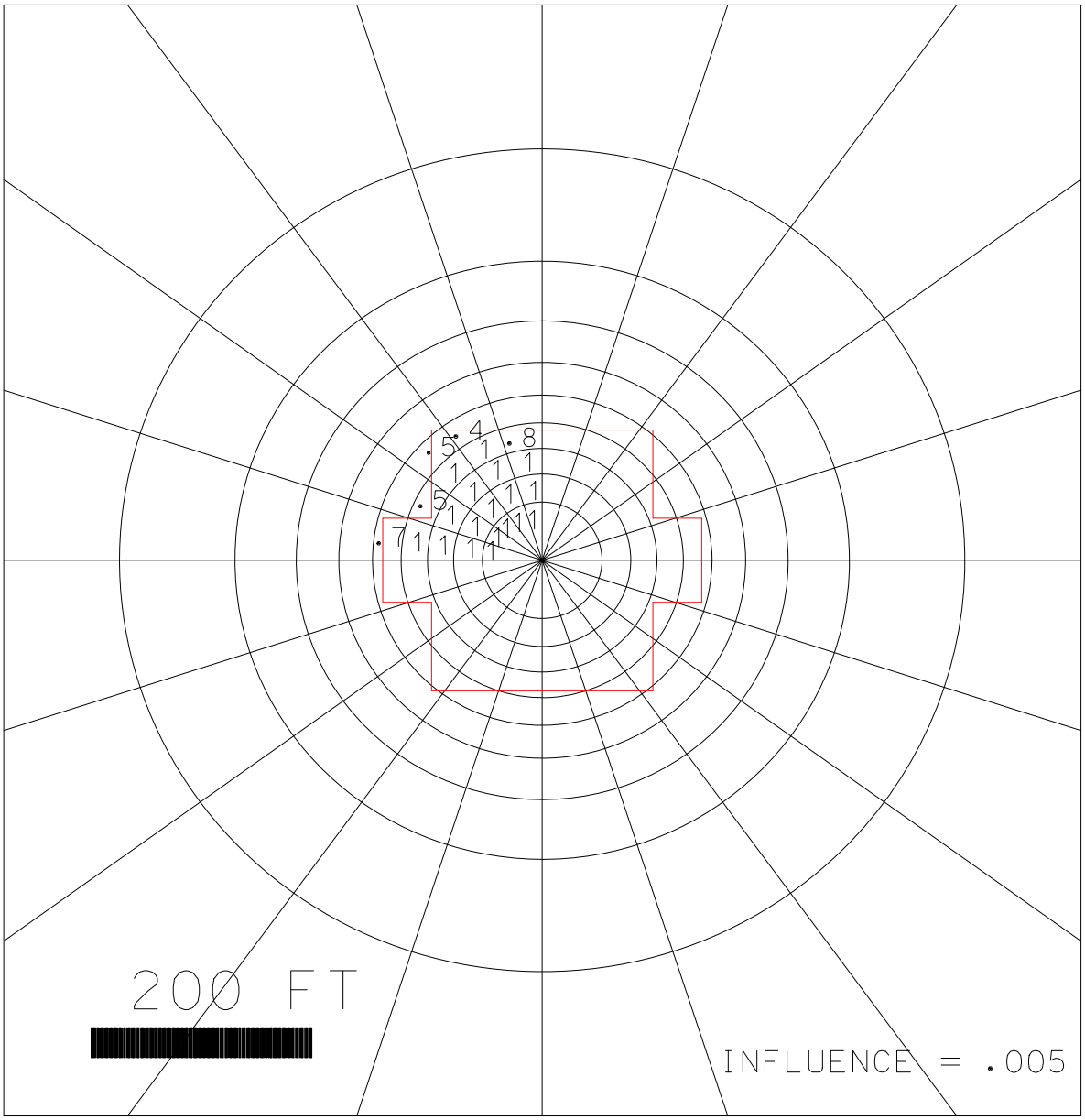
UNITS PER QUADRANT = 38.25

TOTAL UNITS = 38.25 X 4 = 153

Nq = INFLUENCE X TOTAL UNITS = .765

NEWMARK INFLUENCE CHART FOR VERTICAL PRESSURE

DEPTH = 200 FEET



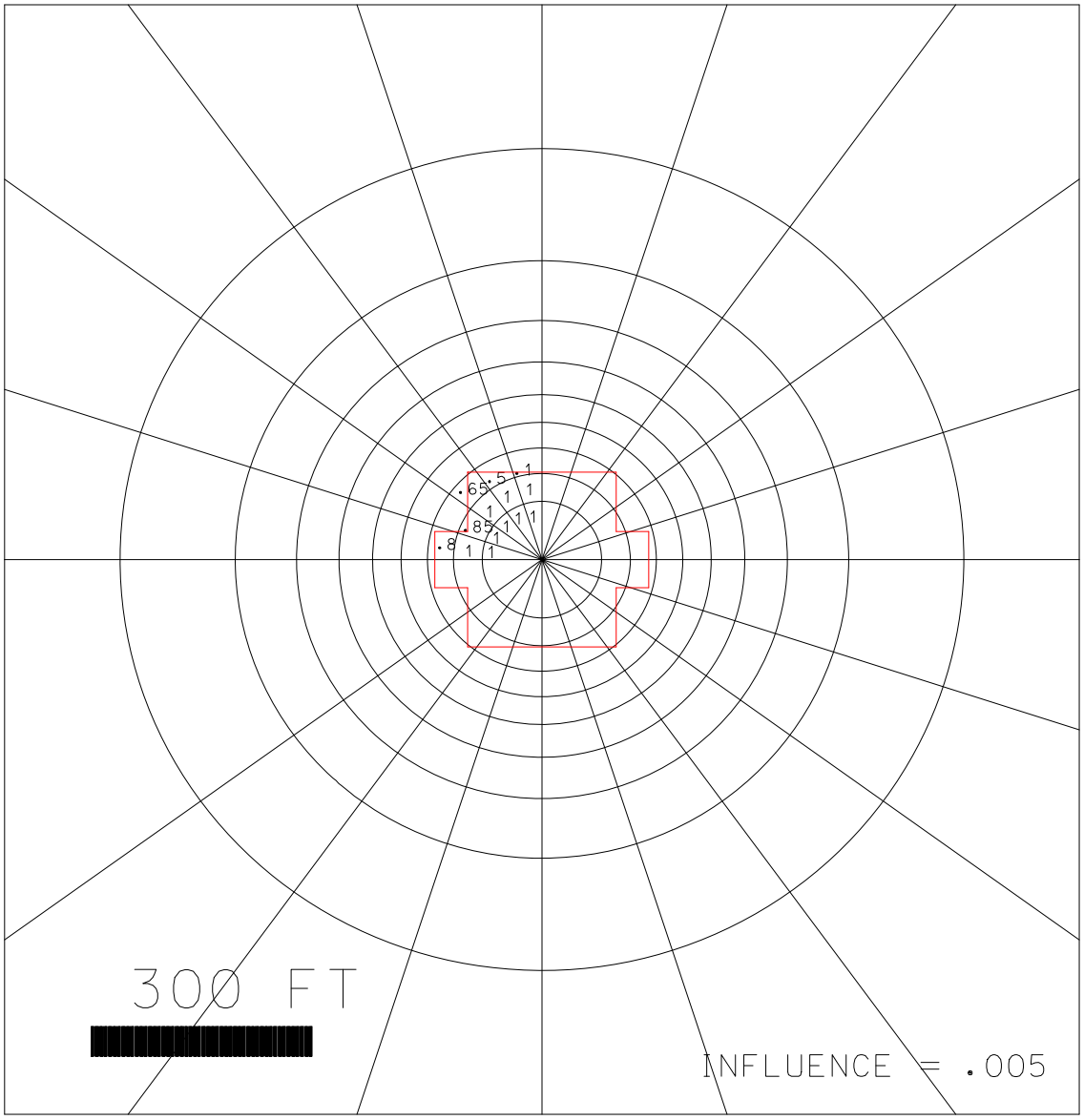
UNITS PER QUADRANT = 21

TOTAL UNITS = 21X 4 = 84

Nq = INFLUENCE X TOTAL UNITS = .42

NEWMARK INFLUENCE FOR VERTICAL PRESSURE

DEPTH = 300 FEET



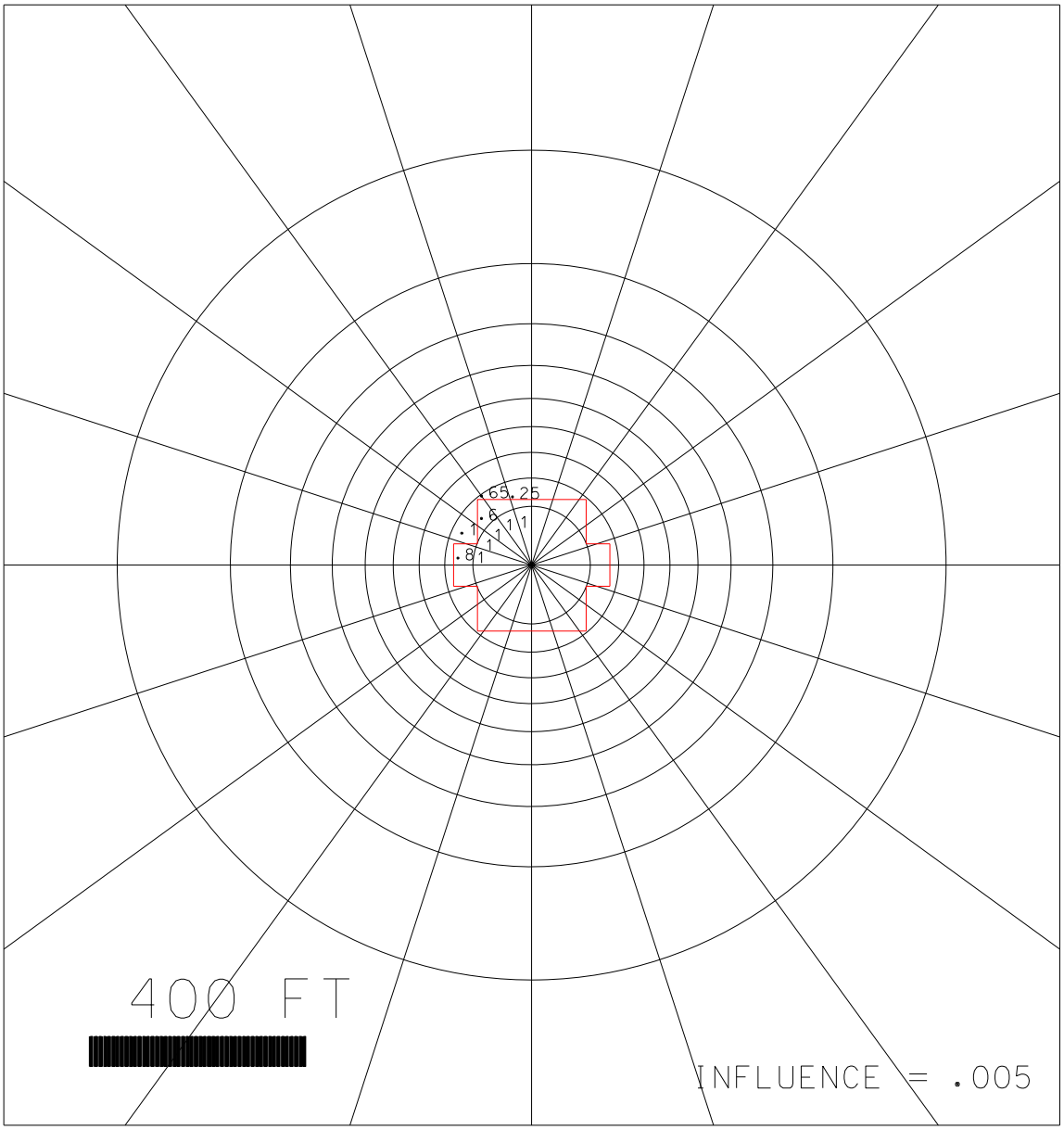
UNITS PER QUADRANT = 11.9

TOTAL UNITS = 11.9 X 4 = 47.6

Nq = INFLUENCE X TOTAL UNITS = .24

NEWMARK INFLUENCE CHART FOR VERTICAL PRESSURE

DEPTH = 400 FEET



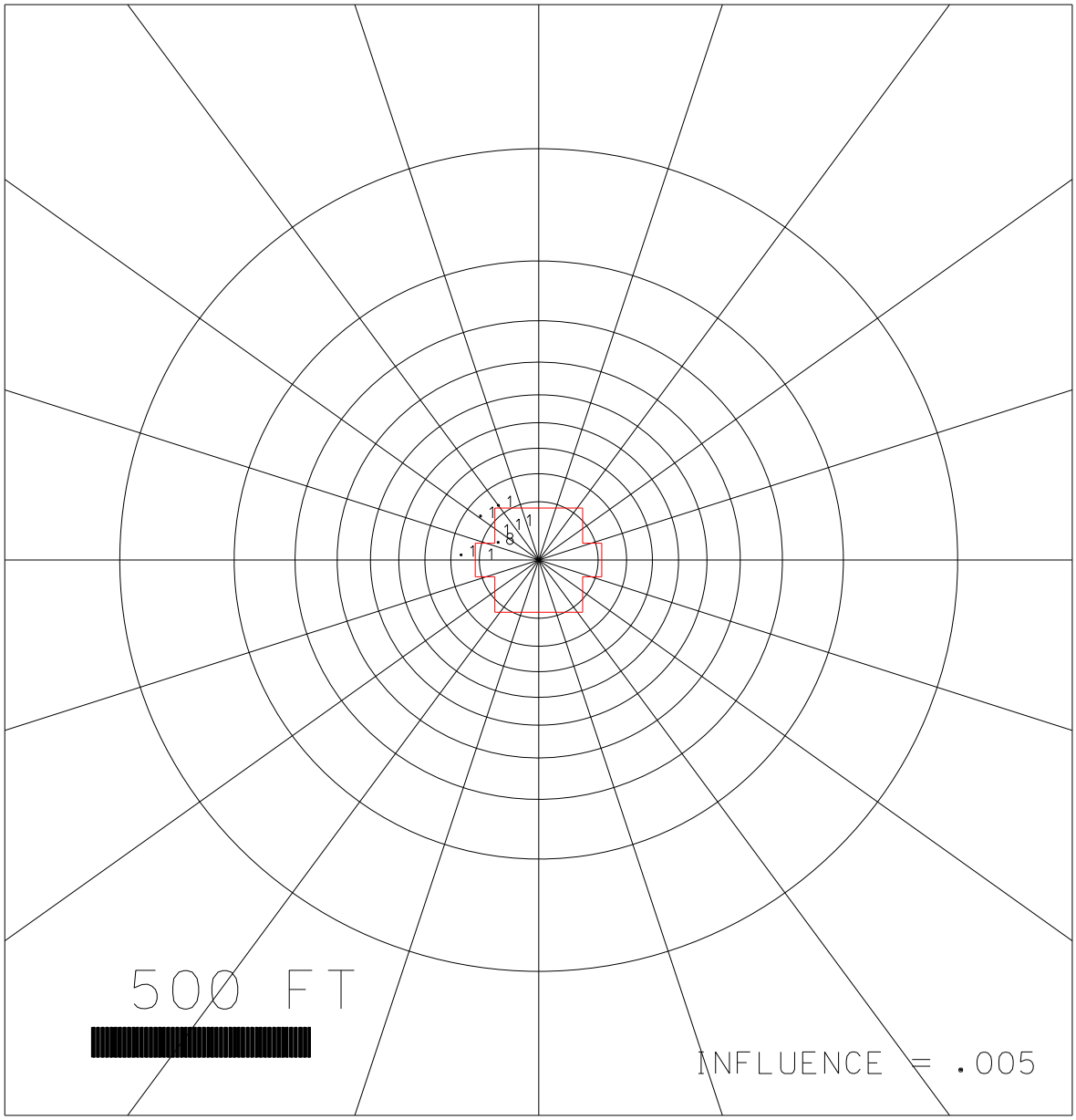
UNITS PER QUADRANT = 7.4

TOTAL UNITS = 7.4 X 4 = 29.6

Nq = INFLUENCE X TOTAL UNITS = 0.148

NEWMARK INFLUENCE CHART FOR VERTICAL PRESSURE

DEPTH = 500 FEET

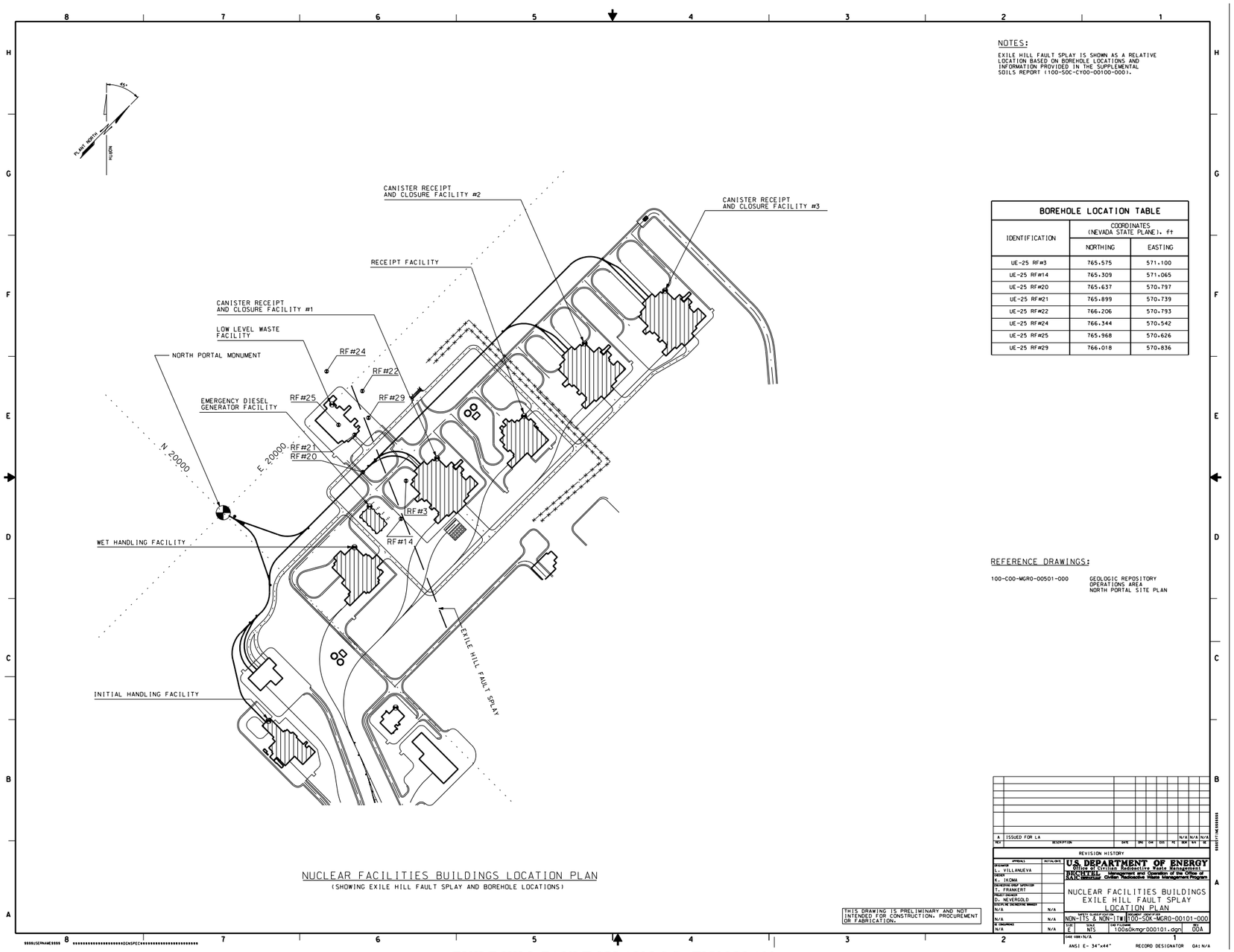


UNITS PER QUADRANT = 5.1

TOTAL UNITS = 5.1 X 4 = 20.4

Nq = INFLUENCE X TOTAL UNITS = 0.102

ATACHMENT F
EXILE HILL FAULT SPLAY LOCATION PLAN



NOTES:

EXILE HILL FAULT SPLAY IS SHOWN AS A RELATIVE LOCATION BASED ON BOREHOLE LOCATIONS AND INFORMATION PROVIDED IN THE SUPPLEMENTAL SOILS REPORT (100-SOC-CY00-00100-000).

BOREHOLE LOCATION TABLE

IDENTIFICATION	COORDINATES (NEVADA STATE PLANE), ft	
	NORTHING	EASTING
UE-25 RF#3	765,575	571,100
UE-25 RF#14	765,309	571,065
UE-25 RF#20	765,637	570,797
UE-25 RF#21	765,899	570,739
UE-25 RF#22	766,206	570,793
UE-25 RF#24	766,344	570,542
UE-25 RF#25	765,968	570,626
UE-25 RF#29	766,018	570,836

REFERENCE DRAWINGS:

100-C00-MGR0-00501-000 GEOLOGIC REPOSITORY OPERATIONS AREA NORTH PORTAL SITE PLAN

NUCLEAR FACILITIES BUILDINGS LOCATION PLAN
(SHOWING EXILE HILL FAULT SPLAY AND BOREHOLE LOCATIONS)

THIS DRAWING IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION, PROCUREMENT OR FABRICATION.

REV. A — ISSUED FOR LA — 2/8/08

U.S. DEPARTMENT OF ENERGY
Office of Civilian Radioactive Waste Management
BECHTEL SAIC COMPANY, LLC — Management and Operation of the Office of Civilian Radioactive Waste Management Program

NUCLEAR FACILITIES BUILDINGS EXILE HILL FAULT SPLAY LOCATION PLAN

NON-ITS & NON-ITWI 100-S0K-MGR0-00101-000 REV 00A

ANSI E- 34"x44" RECORD DESIGNATOR QA: N/A

EXILE HILL FAULT SPLAY LOCATION PLAN

Reference 2.2.13 (100-S0K-MGR0-00101-000-00A)

ATTACHMENT G
ASSESSMENT OF REVISED SOIL PROPERTIES

SHEAR MODULUS and POISSON'S RATIO VALUES at 130' ALLUVIUM DEPTH FOR 5E-4 AND 1E-4 SEISMIC EVENTS

The purpose of this attachment is to assess the impact on the computed foundation impedances for the revised strain compatible soil properties given in DTN's MO0801SCSPS5E4.003 (Ref. 2.2.5) and MO0801SCSPS1E4.003 (Ref. 2.2.10). Soil spring values computed in the Attachments A and B of this calculation and used in subsequent seismic analysis calculations of the RF were based on DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002 which have been superceded by the above referenced DTN's.

To assess the impact of the new strain compatible soil properties on the foundation impedance functions the composite soil column shear modulus, G's, is recomputed using the data in references 2.2.5 and 2.2.10. A comparison of the shear modulus for each of the soil cases computed using both the current data and the superceded data is made.

Soil impedances calculated in section 6 of this calculation were computed using the impedance functions given in Table 3.3-3 of ASCE 4 (Ref. 2.2.3). In reviewing the impedance functions given it is observed that both the translation and rotational spring stiffness are linear functions of the soil shear modulus, G. Thus the computed spring values will be directly proportional to the percentage increase or decrease in the computed soil shear modulus as determined in this attachment. As stated in section 6 of the calculation the soil damping values are independent of the shear modulus and thus are not impacted by the revised soil properties.

The equivalent soil shear modulus computed in this attachment uses the same procedure described in section 4.3 and carried out in section 6 using the applicable strain compatible soil properties given in Ref. 2.2.5 and 2.2.10. These shear modulus calculation are carried out in excel spreadsheets on the following pages.

Revised shear modulus values for each of the soil cases (upper bound, median, lower bound) for the 130' alluvium depth for both the 5E-4 and 1E-4 cases are shown in Tables on pages G-5 thru G-7 and G- G-14 respectively and are summerized on pages G-8 and G-15.

Comparison of these revised shear modulus values to the values computed using the superceded data are summarized in Tables G-1 and G-2 on page G-16.

Reference DTN: MO0801SCSPS5E4.003 (Ref. 2.2.5)

Weighted results of Northeast velocity profiles with 100ft Alluvium (0-100ft Alluvium, >100ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.37	0.27	870.76	2.10	0.19	615.72	4.84	0.38	1231.40	0.92	0.59	1948.40	1.14	0.42	1377.70	1.95	0.84	2755.50	0.66	0.0025	0.0038
1.22	4.00	1.83	6.00	1.80	112.32	0.39	0.28	904.37	3.01	0.19	639.48	6.91	0.39	1279.00	1.31	0.68	2243.80	1.14	0.51	1687.40	1.95	0.91	2983.70	0.66	0.0067	0.0103
1.22	4.00	3.05	10.00	1.80	112.32	0.39	0.29	963.49	3.34	0.21	681.29	7.69	0.42	1362.60	1.45	0.77	2529.20	1.14	0.59	1922.50	1.95	1.01	3327.40	0.66	0.0095	0.0146
1.22	4.00	4.27	14.00	1.80	112.32	0.39	0.33	1089.10	3.36	0.23	770.10	7.72	0.47	1540.20	1.46	0.89	2914.00	1.14	0.63	2070.60	1.95	1.25	4100.90	0.66	0.0099	0.0152
1.22	4.00	5.49	18.00	1.80	112.32	0.39	0.42	1363.90	3.17	0.29	964.43	7.28	0.59	1928.90	1.38	1.06	3464.90	1.14	0.80	2613.60	1.95	1.40	4593.40	0.66	0.0077	0.0119
2.44	8.00	7.31	24.00	1.80	112.32	0.39	0.40	1322.40	3.49	0.29	935.09	8.03	0.57	1870.20	1.52	1.08	3529.50	1.14	0.81	2648.40	1.95	1.43	4703.80	0.66	0.0104	0.0160
2.44	8.00	9.75	32.00	1.80	112.32	0.38	0.42	1388.50	3.65	0.30	981.84	8.39	0.60	1963.70	1.59	1.09	3579.50	1.14	0.83	2731.40	1.95	1.43	4690.90	0.66	0.0117	0.0180
2.44	8.00	12.19	40.00	1.80	112.32	0.36	0.45	1461.70	3.65	0.32	1033.60	8.39	0.63	2067.20	1.59	1.11	3637.40	1.14	0.84	2768.50	1.95	1.46	4779.00	0.66	0.0124	0.0191
2.44	8.00	14.63	48.00	1.80	112.32	0.36	0.49	1614.60	3.56	0.35	1141.70	8.18	0.70	2283.30	1.55	1.19	3899.30	1.14	0.93	3045.60	1.95	1.52	4992.30	0.66	0.0115	0.0178
2.44	8.00	17.07	56.00	1.80	112.32	0.34	0.55	1802.90	3.29	0.39	1274.90	7.57	0.78	2549.80	1.43	1.20	3937.30	1.14	0.94	3078.60	1.95	1.53	5035.60	0.66	0.0102	0.0158
3.05	10.00	19.81	65.00	1.80	112.32	0.34	0.58	1917.30	3.27	0.42	1384.80	7.51	0.81	2654.60	1.42	1.26	4133.60	1.14	1.03	3375.10	1.95	1.54	5062.60	0.66	0.0100	0.0154
3.05	10.00	22.86	75.00	1.80	112.32	0.34	0.61	2009.40	3.25	0.43	1420.90	7.48	0.87	2841.70	1.42	1.33	4349.90	1.14	1.08	3551.70	1.95	1.62	5327.50	0.66	0.0100	0.0154
3.05	10.00	25.91	85.00	1.80	112.32	0.34	0.66	2177.50	3.17	0.48	1576.10	7.28	0.92	3008.50	1.38	1.42	4652.90	1.14	1.16	3799.10	1.95	1.74	5698.60	0.66	0.0092	0.0142
3.05	10.00	28.95	95.00	1.80	112.32	0.34	0.65	2145.40	3.29	0.47	1534.10	7.56	0.91	3000.30	1.43	1.42	4649.00	1.14	1.16	3795.90	1.95	1.74	5693.80	0.66	0.0102	0.0156
3.05	10.00	32.00	105.00	2.20	137.28	0.30	0.81	2665.50	0.70	0.66	2176.30	1.27	0.99	3264.50	0.50	1.51	4957.20	0.50	1.23	4047.50	0.81	1.85	6071.30	0.50	0.0057	0.0088
3.05	10.00	35.05	115.00	2.20	137.28	0.30	0.81	2667.90	0.71	0.66	2178.30	1.30	1.00	3267.50	0.50	1.51	4965.90	0.50	1.24	4054.60	0.81	1.85	6082.00	0.50	0.0061	0.0094
3.05	10.00	38.10	125.00	2.20	137.28	0.30	0.82	2679.70	0.68	0.67	2188.00	1.16	1.00	3281.90	0.50	1.52	4980.60	0.50	1.24	4066.60	0.81	1.86	6100.00	0.50	0.0065	0.0100
3.05	10.00	41.15	135.00	2.20	137.28	0.30	0.84	2742.50	0.68	0.68	2239.30	1.17	1.02	3358.90	0.50	1.55	5098.80	0.50	1.27	4163.10	0.81	1.90	6244.70	0.50	0.0066	0.0101
3.05	10.00	44.19	145.00	2.20	137.28	0.30	0.85	2801.30	0.68	0.70	2287.30	1.17	1.05	3430.90	0.50	1.59	5209.10	0.50	1.30	4253.20	0.81	1.94	6379.80	0.50	0.0066	0.0102
3.05	10.00	47.24	155.00	2.20	137.28	0.30	0.86	2832.10	0.68	0.70	2312.40	1.17	1.06	3468.50	0.50	1.61	5267.50	0.50	1.31	4300.90	0.81	1.97	6451.30	0.50	0.0068	0.0104
3.05	10.00	50.29	165.00	2.20	137.28	0.30	0.87	2844.80	0.68	0.71	2322.80	1.19	1.06	3484.20	0.50	1.61	5292.60	0.50	1.32	4321.40	0.81	1.98	6482.10	0.50	0.0070	0.0108
3.05	10.00	53.34	175.00	2.20	137.28	0.30	0.86	2815.00	0.69	0.70	2298.40	1.22	1.05	3447.60	0.50	1.60	5241.90	0.50	1.30	4280.00	0.81	1.96	6420.00	0.50	0.0074	0.0114
3.05	10.00	56.39	185.00	2.20	137.28	0.30	0.85	2797.20	0.69	0.70	2283.90	1.24	1.04	3425.90	0.50	1.59	5212.50	0.50	1.30	4256.00	0.81	1.95	6384.00	0.50	0.0078	0.0120
3.05	10.00	59.43	195.00	2.20	137.28	0.30	0.87	2848.00	0.69	0.71	2325.40	1.24	1.06	3488.10	0.50	1.62	5307.50	0.50	1.32	4333.60	0.81	1.98	6500.30	0.50	0.0078	0.0120
3.81	12.50	62.86	206.25	2.20	137.28	0.30	0.87	2861.70	0.70	0.71	2336.50	1.26	1.07	3505.00	0.50	1.63	5335.40	0.50	1.33	4356.30	0.81	1.99	6534.50	0.50	0.0080	0.0122
3.81	12.50	66.67	218.75	2.20	137.28	0.30	0.88	2887.50	0.70	0.72	2357.60	1.26	1.08	3536.40	0.50	1.64	5385.20	0.50	1.34	4397.00	0.81	2.01	6595.50	0.50	0.0081	0.0124
3.81	12.50	70.48	231.25	2.20	137.28	0.30	0.89	2917.90	0.70	0.72	2372.40	1.27	1.09	3588.80	0.50	1.66	5443.10	0.50	1.35	4444.30	0.81	2.03	6666.40	0.50	0.0082	0.0126
3.81	12.50	74.29	243.75	2.20	137.28	0.30	0.90	2968.10	0.70	0.74	2416.90	1.27	1.11	3645.00	0.50	1.69	5536.30	0.50	1.38	4520.40	0.81	2.07	6780.60	0.50	0.0081	0.0125
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.92	3013.10	0.64	0.75	2460.20	1.03	1.12	3690.30	0.50	1.71	5615.30	0.50	1.40	4584.90	0.81	2.10	6877.30	0.50	0.0081	0.0125
3.81	12.50	81.91	268.75	2.20	137.28	0.30	0.92	3018.80	0.64	0.75	2464.80	1.03	1.13	3697.20	0.50	1.72	5627.40	0.50	1.40	4594.70	0.81	2.10	6892.10	0.50	0.0083	0.0127
3.81	12.50	85.72	281.25	2.20	137.28	0.30	0.94	3068.10	0.64	0.76	2505.10	1.04	1.15	3757.60	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0082	0.0126
3.81	12.50	89.53	293.75	2.20	137.28	0.30	0.93	3067.00	0.65	0.76	2504.20	1.04	1.14	3756.30	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0084	0.0129
4.57	15.00	93.72	307.50	2.20	137.28	0.30	0.96	3141.30	0.64	0.78	2564.90	1.04	1.17	3847.30	0.50	1.78	5854.10	0.50	1.46	4779.90	0.81	2.19	7169.80	0.50	0.0082	0.0126
4.57	15.00	98.29	322.50	2.20	137.28	0.30	0.96	3164.30	0.65	0.79	2583.60	1.04	1.18	3875.50	0.50	1.80	5897.50	0.50	1.47	4815.30	0.81	2.20	7222.90	0.50	0.0083	0.0127
4.57	15.00	102.86	337.50	2.20	137.28	0.30	1.00	3288.20	0.64	0.82	2684.80	1.03	1.23	4027.20	0.50	1.87	6122.20	0.50	1.52	4998.80	0.81	2.29	7498.10	0.50	0.0078	0.0120
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.02	3356.50	0.64	0.84	2740.60	1.03	1.25	4110.90	0.50	1.90	6247.10	0.50	1.55	5100.70	0.81	2.33	7651.10	0.50	0.0077	0.0118
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.05	3431.50	0.64	0.85	2801.80	1.02	1.28	4202.70	0.50	1.95	6384.20	0.50	1.59	5212.70	0.81	2.38	7819.00	0.50	0.0075	0.0115
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.06	3468.60	0.64	0.86	2832.10	1.02	1.29	4248.20	0.50	1.97	6453.30	0.50	1.61	5269.10	0.81	2.41	7903.60	0.50	0.0074	0.0115
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.06	3484.40	0.64	0.87	2845.00	1.02	1.30	4267.50	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0075	0.0116
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.06	3483.60	0.64	0.87	2844.30	1.03	1.30	4266.50	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0076	0.0118
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.06	3482.80	0.64	0.87	2843.70	1.03	1.30	4265.60	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0078	0.0120
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.06	3482.20	0.64	0.87	2843.20	1.03	1.30	4264.80	0.50	1.98	6483.90	0.50	1.61	5294.10	0.81	2.42	7941.10	0.50	0.0079	0.0121
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.09	3578.00	0.64	0.89	2921.40	1.02	1.34	4382.20	0.50	2.03	6658.70	0.50	1.66	5436.80	0.81	2.49	8155.20	0.50	0.0076	0.0117
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.10	3598.70	0.64	0.90	2938.30	1.02	1.34	4407.50	0.50	2.04	6697.30	0.50	1.67	5468.30	0.81	2.50	8202.50	0.50	0.0076	0.0117
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.11	3627.80	0.64	0.90	2962.10	1.02	1.35	4443.10	0.50	2.06	6749.70	0.50	1.68	5511.10	0.81	2.52	8266.70	0.50	0.0076	0.0116

Reference DTN: MO0801SCSPS5E4.003 (Ref. 2.2.5)

Weighted results of Northeast velocity profiles with 200ft Alluvium (0-200ft Alluvium, >200ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.37	0.26	858.61	2.13	0.19	607.13	4.90	0.37	1214.30	0.93	0.59	1922.60	1.14	0.41	1359.50	1.95	0.83	2719.00	0.66	0.0024	0.0037
1.22	4.00	1.83	6.00	1.80	112.32	0.39	0.28	904.99	2.98	0.20	639.92	6.86	0.39	1279.80	1.30	0.69	2249.50	1.14	0.51	1671.70	1.95	0.92	3027.10	0.66	0.0064	0.0099
1.22	4.00	3.05	10.00	1.80	112.32	0.39	0.29	959.05	3.34	0.21	678.15	7.69	0.41	1356.30	1.45	0.77	2519.00	1.14	0.57	1882.40	1.95	1.03	3370.80	0.66	0.0092	0.0141
1.22	4.00	4.27	14.00	1.80	112.32	0.39	0.32	1058.70	3.44	0.23	748.61	7.90	0.46	1497.20	1.49	0.87	2861.30	1.14	0.62	2035.90	1.95	1.23	4021.40	0.66	0.0101	0.0156
1.22	4.00	5.49	18.00	1.80	112.32	0.39	0.40	1313.40	3.28	0.28	928.69	7.54	0.57	1857.40	1.43	1.03	3382.00	1.14	0.77	2531.50	1.95	1.38	4518.30	0.66	0.0081	0.0125
2.44	8.00	7.31	24.00	1.80	112.32	0.40	0.39	1263.60	3.63	0.27	893.51	8.35	0.54	1787.00	1.58	1.05	3445.10	1.14	0.78	2561.50	1.95	1.41	4633.50	0.66	0.0111	0.0170
2.44	8.00	9.75	32.00	1.80	112.32	0.38	0.42	1374.20	3.69	0.30	971.68	8.47	0.59	1943.40	1.60	1.09	3569.30	1.14	0.82	2680.10	1.95	1.45	4753.50	0.66	0.0117	0.0180
2.44	8.00	12.19	40.00	1.80	112.32	0.36	0.44	1437.00	3.69	0.31	1016.10	8.49	0.62	2032.20	1.61	1.11	3627.00	1.14	0.83	2715.10	1.95	1.48	4845.10	0.66	0.0126	0.0194
2.44	8.00	14.63	48.00	1.80	112.32	0.36	0.50	1626.30	3.55	0.35	1150.00	8.16	0.70	2299.90	1.54	1.20	3928.40	1.14	0.93	3061.60	1.95	1.54	5040.60	0.66	0.0112	0.0172
2.44	8.00	17.07	56.00	1.80	112.32	0.34	0.56	1824.00	3.30	0.39	1289.70	7.60	0.79	2579.50	1.44	1.21	3966.70	1.14	0.94	3098.40	1.95	1.55	5078.30	0.66	0.0099	0.0152
3.05	10.00	19.81	65.00	1.80	112.32	0.34	0.59	1930.00	3.30	0.43	1396.00	7.58	0.81	2668.20	1.43	1.27	4153.00	1.14	1.03	3390.90	1.95	1.55	5086.40	0.66	0.0098	0.0150
3.05	10.00	22.86	75.00	1.80	112.32	0.34	0.61	2014.70	3.30	0.43	1424.60	7.58	0.87	2849.30	1.43	1.33	4359.20	1.14	1.08	3559.30	1.95	1.63	5338.90	0.66	0.0099	0.0152
3.05	10.00	25.91	85.00	1.80	112.32	0.34	0.66	2163.60	3.24	0.48	1577.40	7.46	0.90	2967.50	1.41	1.41	4632.40	1.14	1.15	3782.30	1.95	1.73	5673.50	0.66	0.0093	0.0143
3.05	10.00	28.95	95.00	1.80	112.32	0.34	0.65	2125.10	3.38	0.47	1526.60	7.77	0.90	2958.30	1.47	1.41	4623.90	1.14	1.15	3775.40	1.95	1.73	5663.10	0.66	0.0104	0.0159
3.05	10.00	32.00	105.00	1.80	112.32	0.33	0.69	2251.90	3.30	0.52	1689.80	7.58	0.91	3001.10	1.43	1.43	4705.50	1.14	1.17	3842.00	1.95	1.76	5763.00	0.66	0.0098	0.0151
3.05	10.00	35.05	115.00	1.80	112.32	0.34	0.68	2231.30	3.40	0.51	1664.10	7.82	0.91	2991.80	1.48	1.44	4711.90	1.14	1.17	3847.30	1.95	1.76	5770.90	0.66	0.0106	0.0163
3.05	10.00	38.10	125.00	1.80	112.32	0.34	0.68	2220.20	3.48	0.51	1661.30	8.01	0.90	2967.30	1.52	1.44	4723.00	1.14	1.18	3856.30	1.95	1.76	5784.50	0.66	0.0113	0.0174
3.05	10.00	41.15	135.00	1.80	112.32	0.34	0.70	2301.40	3.44	0.52	1710.00	7.91	0.94	3097.20	1.50	1.49	4884.10	1.14	1.22	3987.90	1.95	1.82	5981.80	0.66	0.0110	0.0169
3.05	10.00	44.19	145.00	1.80	112.32	0.34	0.72	2349.40	3.45	0.53	1724.30	7.92	0.98	3201.00	1.50	1.52	4994.50	1.14	1.24	4078.00	1.95	1.86	6117.00	0.66	0.0110	0.0169
3.05	10.00	47.24	155.00	1.80	112.32	0.34	0.72	2370.90	3.47	0.52	1720.90	7.98	1.00	3266.30	1.51	1.54	5060.90	1.14	1.26	4132.20	1.95	1.89	6198.30	0.66	0.0112	0.0173
3.05	10.00	50.29	165.00	1.80	112.32	0.34	0.71	2339.20	3.56	0.51	1683.50	8.18	0.99	3250.40	1.55	1.54	5039.30	1.14	1.25	4114.60	1.95	1.88	6171.90	0.66	0.0119	0.0184
3.05	10.00	53.34	175.00	1.80	112.32	0.34	0.70	2294.30	3.65	0.49	1622.30	8.39	0.99	3244.70	1.59	1.52	4995.50	1.14	1.24	4077.50	1.95	1.87	6120.20	0.66	0.0128	0.0197
3.05	10.00	56.39	185.00	1.80	112.32	0.34	0.70	2281.90	3.71	0.49	1613.60	8.52	0.98	3227.10	1.61	1.52	4999.00	1.14	1.24	4081.70	1.95	1.87	6122.50	0.66	0.0134	0.0205
3.05	10.00	59.43	195.00	1.80	112.32	0.34	0.71	2336.70	3.68	0.51	1661.20	8.45	1.00	3287.00	1.60	1.55	5094.90	1.14	1.27	4160.00	1.95	1.90	6240.00	0.66	0.0131	0.0201
3.81	12.50	62.86	206.25	2.20	137.28	0.30	0.88	2880.70	0.69	0.71	2331.30	1.22	1.08	3559.70	0.50	1.63	5363.80	0.50	1.33	4366.20	0.81	2.01	6589.30	0.50	0.0072	0.0111
3.81	12.50	66.67	218.75	2.20	137.28	0.30	0.89	2907.10	0.69	0.72	2365.00	1.23	1.09	3573.50	0.50	1.65	5415.00	0.50	1.35	4421.30	0.81	2.02	6632.00	0.50	0.0074	0.0114
3.81	12.50	70.48	231.25	2.20	137.28	0.30	0.90	2939.60	0.69	0.72	2371.20	1.24	1.11	3644.20	0.50	1.67	5477.10	0.50	1.36	4447.80	0.81	2.06	6744.60	0.50	0.0075	0.0116
3.81	12.50	74.29	243.75	2.20	137.28	0.30	0.91	2993.70	0.69	0.74	2421.40	1.24	1.13	3701.20	0.50	1.70	5578.00	0.50	1.38	4543.30	0.81	2.09	6848.40	0.50	0.0075	0.0116
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.93	3041.80	0.64	0.76	2483.60	1.02	1.14	3725.40	0.50	1.73	5664.50	0.50	1.41	4625.00	0.81	2.11	6937.60	0.50	0.0075	0.0116
3.81	12.50	81.91	268.75	2.20	137.28	0.30	0.93	3048.80	0.64	0.76	2489.30	1.03	1.14	3734.00	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0077	0.0119
3.81	12.50	85.72	281.25	2.20	137.28	0.30	0.93	3047.60	0.64	0.76	2488.40	1.03	1.14	3732.60	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0080	0.0122
3.81	12.50	89.53	293.75	2.20	137.28	0.30	0.93	3046.40	0.64	0.76	2487.40	1.03	1.14	3731.10	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0082	0.0126
4.57	15.00	93.72	307.50	2.20	137.28	0.30	0.95	3121.00	0.64	0.78	2548.30	1.03	1.17	3822.40	0.50	1.77	5815.30	0.50	1.45	4748.20	0.81	2.17	7122.30	0.50	0.0080	0.0123
4.57	15.00	98.29	322.50	2.20	137.28	0.30	0.96	3143.60	0.64	0.78	2566.80	1.04	1.17	3850.10	0.50	1.79	5858.50	0.50	1.46	4783.40	0.81	2.19	7175.20	0.50	0.0081	0.0125
4.57	15.00	102.86	337.50	2.20	137.28	0.30	1.00	3266.40	0.64	0.81	2667.00	1.03	1.22	4000.50	0.50	1.85	6081.70	0.50	1.51	4965.70	0.81	2.27	7448.50	0.50	0.0077	0.0118
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.01	3329.80	0.64	0.83	2718.70	1.02	1.24	4078.10	0.50	1.89	6196.40	0.50	1.54	5059.30	0.81	2.31	7589.00	0.50	0.0076	0.0117
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.04	3403.90	0.64	0.85	2779.30	1.02	1.27	4168.90	0.50	1.93	6332.50	0.50	1.58	5170.50	0.81	2.36	7755.70	0.50	0.0074	0.0114
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.05	3440.70	0.64	0.86	2809.30	1.02	1.28	4214.00	0.50	1.95	6400.90	0.50	1.59	5226.30	0.81	2.39	7839.50	0.50	0.0074	0.0114
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.05	3456.20	0.64	0.86	2822.00	1.02	1.29	4233.00	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0075	0.0115
4.57	15.00	125.72	412.50	2.20	137.28	0.30	1.05	3455.40	0.64	0.86	2821.30	1.02	1.29	4231.90	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0076	0.0118
4.57	15.00	130.30	427.50	2.20	137.28	0.30	1.05	3454.60	0.64	0.86	2820.70	1.03	1.29	4231.00	0.50	1.96	6431.20	0.50	1.60	5251.00	0.81	2.40	7876.60	0.50	0.0078	0.0120
4.57	15.00	134.87	442.50	2.20	137.28	0.30	1.05	3453.90	0.64	0.86	2820.10	1.03	1.29	4230.10	0.50	1.96	6431.30	0.50	1.60	5251.10	0.81	2.40	7876.70	0.50	0.0079	0.0122
4.57	15.00	139.44	457.50	2.20	137.28	0.30	1.08	3548.80	0.64	0.88	2897.60	1.02	1.32	4346.30	0.50	2.01	6604.70	0.50	1.64	5392.70	0.81	2.47	8089.10	0.50	0.0076	0.0117
4.57	15.00	144.01	472.50	2.20	137.28	0.30	1.09	3569.20	0.64	0.89	2914.20	1.02	1.33	4371.30	0.50	2.02	6643.00	0.50	1.65	5424.00	0.81	2.48	8136.00	0.50	0.0076	0.0118
4.57	15.00	148.58	487.50	2.20	137.28	0.30	1.10	3598.00	0.64	0.90	2937.80	1.02	1.34	4406.60	0.50	2.04	6695.00	0.50	1.67	5466.40	0.81	2.50	8199.70	0.50	0.0076	0.0117

Weighted results of Northeast velocity profiles with 130ft Alluvium (0-130ft Alluvium, >130ft Tuff), 5E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness (ft)	Depth to Midpoint of Layer (ft)	Density (g/cm3)	Unit Weight (pcf)	Median Vs (ft/s)	Poisson's Ratio (no units)	Lower Bound Vs (ft/s)	Poisson's Ratio (no units)	Upper Bound Vs (ft/s)	Poisson's Ratio (no units)	Median Vp (ft/s)	Lower Bound Vp (ft/s)	Upper Bound Vp (ft/s)
4.00	2.00	1.80	112.32	864.69	0.37	607.13	0.37	1231.40	0.37	1935.50	1359.50	2755.50
4.00	6.00	1.80	112.32	904.68	0.39	639.48	0.39	1279.80	0.39	2246.65	1687.40	3027.10
4.00	10.00	1.80	112.32	961.27	0.39	678.15	0.39	1362.60	0.39	2524.10	1882.40	3327.40
4.00	14.00	1.80	112.32	1073.90	0.39	748.61	0.39	1540.20	0.39	2887.65	2035.90	4100.90
4.00	18.00	1.80	112.32	1338.65	0.39	928.69	0.39	1928.90	0.39	3423.45	2531.50	4593.40
8.00	24.00	1.80	112.32	1293.00	0.40	893.51	0.40	1870.20	0.39	3487.30	2561.50	4703.80
8.00	32.00	1.80	112.32	1381.35	0.38	971.68	0.38	1963.70	0.38	3574.40	2680.10	4690.90
8.00	40.00	1.80	112.32	1449.35	0.36	1016.10	0.36	2067.20	0.36	3632.20	2715.10	4779.00
8.00	48.00	1.80	112.32	1620.45	0.36	1141.70	0.36	2299.90	0.36	3913.85	3045.60	5040.60
8.00	56.00	1.80	112.32	1813.45	0.34	1274.90	0.34	2579.50	0.34	3952.00	3078.60	5078.30
10.00	65.00	1.80	112.32	1923.65	0.34	1384.80	0.34	2668.20	0.34	4143.30	3375.10	5086.40
10.00	75.00	1.80	112.32	2012.05	0.34	1420.90	0.34	2849.30	0.34	4354.55	3551.70	5338.90
10.00	85.00	1.80	112.32	2170.55	0.34	1576.10	0.34	3008.50	0.34	4642.65	3799.10	5698.60
10.00	95.00	1.80	112.32	2135.25	0.34	1526.60	0.34	3000.30	0.34	4636.45	3775.40	5693.80
10.00	105.00	1.80	112.32	2251.90	0.33	1689.80	0.33	3001.10	0.33	4705.50	3842.00	5763.00
10.00	115.00	1.80	112.32	2231.30	0.34	1664.10	0.34	2991.80	0.34	4711.90	3847.30	5770.90
10.00	125.00	1.80	112.32	2220.20	0.34	1661.30	0.34	2967.30	0.34	4723.00	3856.30	5784.50
10.00	135.00	2.20	137.28	2742.50	0.30	2239.30	0.30	3358.90	0.30	5098.80	4163.10	6244.70
10.00	145.00	2.20	137.28	2801.30	0.30	2287.30	0.30	3430.90	0.30	5209.10	4253.20	6379.80
10.00	155.00	2.20	137.28	2832.10	0.30	2312.40	0.30	3468.50	0.30	5267.50	4300.90	6451.30
10.00	165.00	2.20	137.28	2844.80	0.30	2322.80	0.30	3484.20	0.30	5292.60	4321.40	6482.10
10.00	175.00	2.20	137.28	2815.00	0.30	2298.40	0.30	3447.60	0.30	5241.90	4280.00	6420.00
10.00	185.00	2.20	137.28	2797.20	0.30	2283.90	0.30	3425.90	0.30	5212.50	4256.00	6384.00
10.00	195.00	2.20	137.28	2848.00	0.30	2325.40	0.30	3488.10	0.30	5307.50	4333.60	6500.30
12.50	206.25	2.20	137.28	2871.20	0.30	2331.30	0.30	3559.70	0.30	5349.60	4366.20	6589.30
12.50	218.75	2.20	137.28	2897.30	0.30	2357.60	0.30	3573.50	0.30	5400.10	4397.00	6632.00
12.50	231.25	2.20	137.28	2928.75	0.30	2371.20	0.30	3644.20	0.30	5460.10	4447.80	6744.60
12.50	243.75	2.20	137.28	2980.90	0.30	2416.90	0.30	3701.20	0.30	5557.15	4520.40	6848.40
12.50	256.25	2.20	137.28	3027.45	0.30	2460.20	0.30	3725.40	0.30	5639.90	4584.90	6937.60
12.50	268.75	2.20	137.28	3033.80	0.30	2464.80	0.30	3734.00	0.30	5653.40	4594.70	6955.80
12.50	281.25	2.20	137.28	3057.85	0.30	2488.40	0.30	3757.60	0.30	5699.20	4637.20	7004.30
12.50	293.75	2.20	137.28	3056.70	0.30	2487.40	0.30	3756.30	0.30	5699.20	4637.20	7004.30
15.00	307.50	2.20	137.28	3131.15	0.30	2548.30	0.30	3847.30	0.30	5834.70	4748.20	7169.80
15.00	322.50	2.20	137.28	3153.95	0.30	2566.80	0.30	3875.50	0.30	5878.00	4783.40	7222.90
15.00	337.50	2.20	137.28	3277.30	0.30	2667.00	0.30	4027.20	0.30	6101.95	4965.70	7498.10
15.00	352.50	2.20	137.28	3343.15	0.30	2718.70	0.30	4110.90	0.30	6221.75	5059.30	7651.10
15.00	367.50	2.20	137.28	3417.70	0.30	2779.30	0.30	4202.70	0.30	6358.35	5170.50	7819.00
15.00	382.50	2.20	137.28	3454.65	0.30	2809.30	0.30	4248.20	0.30	6427.10	5226.30	7903.60
15.00	397.50	2.20	137.28	3470.30	0.30	2822.00	0.30	4267.50	0.30	6457.45	5251.00	7940.90
15.00	412.50	2.20	137.28	3469.50	0.30	2821.30	0.30	4266.50	0.30	6457.45	5251.00	7940.90
15.00	427.50	2.20	137.28	3468.70	0.30	2820.70	0.30	4265.60	0.30	6457.45	5251.00	7940.90
15.00	442.50	2.20	137.28	3468.05	0.30	2820.10	0.30	4264.80	0.30	6457.60	5251.10	7941.10
15.00	457.50	2.20	137.28	3563.40	0.30	2897.60	0.30	4382.20	0.30	6631.70	5392.70	8155.20
15.00	472.50	2.20	137.28	3583.95	0.30	2914.20	0.30	4407.50	0.30	6670.15	5424.00	8202.50
15.00	487.50	2.20	137.28	3612.90	0.30	2937.80	0.30	4443.10	0.30	6722.35	5466.40	8266.70

Note: The horizontal shear-strain data, the damping values and metric equivalent data from pages G-2 and G-3 have been intentionally excluded from this spreadsheet for clarity as these items do not figure with subsequent calculation.

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION

LOWER BOUND VALUES:
SEE PAGE G-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' LOWER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: 227 FT (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: 242 FT (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	607.13	1359.50	1287.0	0.37	1.468	3518.7	0.00826	1.000	4.0000	1.14E-03
2	4.00	6.00	112.32	639.48	1687.40	1427.8	0.38	1.539	3954.4	0.02479	1.000	4.0000	1.01E-03
3	4.00	10.00	112.32	678.15	1882.40	1605.7	0.39	1.567	4469.2	0.04132	1.000	4.0000	8.95E-04
4	4.00	14.00	112.32	748.61	2035.90	1956.7	0.39	1.573	5452.7	0.05785	1.000	4.0000	7.34E-04
5	4.00	18.00	112.32	928.69	2531.50	3011.3	0.39	1.557	8367.0	0.07438	1.000	4.0000	4.78E-04
6	8.00	24.00	112.32	893.51	2561.50	2787.4	0.40	3.164	7779.5	0.09917	1.000	8.0000	1.03E-03
7	8.00	32.00	112.32	971.68	2680.10	3296.5	0.38	3.029	9089.6	0.13223	1.000	8.0000	8.80E-04
8	8.00	40.00	112.32	1016.10	2715.10	3604.8	0.36	2.909	9831.5	0.16529	1.000	8.0000	8.14E-04
9	8.00	48.00	112.32	1141.70	3045.60	4551.0	0.36	2.856	12351.6	0.19835	1.000	8.0000	6.48E-04
10	8.00	56.00	112.32	1274.90	3078.60	5674.9	0.34	2.707	15189.9	0.23140	0.972	7.7760	5.12E-04
11	10.00	65.00	112.32	1384.80	3375.10	6695.5	0.34	3.379	17916.1	0.26860	0.930	9.3000	5.19E-04
12	10.00	75.00	112.32	1420.90	3551.70	7049.1	0.34	3.374	18855.5	0.30992	0.883	8.8300	4.68E-04
13	10.00	85.00	112.32	1576.10	3799.10	8673.1	0.33	3.348	23153.8	0.35124	0.836	8.3600	3.61E-04
14	10.00	95.00	112.32	1526.60	3775.40	8136.9	0.34	3.380	21774.9	0.39256	0.789	7.8900	3.62E-04
15	10.00	105.00	112.32	1689.80	3842.00	9969.6	0.34	3.362	26643.5	0.43388	0.748	7.4800	2.81E-04
16	10.00	115.00	112.32	1664.10	3847.30	9668.6	0.34	3.389	25890.3	0.47521	0.713	7.1300	2.75E-04
17	10.00	125.00	112.32	1661.30	3856.30	9636.1	0.34	3.411	25845.8	0.51653	0.679	6.7900	2.63E-04
18	10.00	135.00	137.28	2239.30	4163.10	21398.4	0.30	2.963	55479.1	0.55785	0.644	6.4400	1.16E-04
19	10.00	145.00	137.28	2287.30	4253.20	22325.6	0.30	2.964	57887.1	0.59917	0.610	6.1000	1.05E-04
20	10.00	155.00	137.28	2312.40	4300.90	22818.2	0.30	2.966	59173.2	0.64050	0.575	5.7500	9.72E-05
21	10.00	165.00	137.28	2322.80	4321.40	23024.0	0.30	2.968	59714.5	0.68182	0.541	5.4100	9.06E-05
22	10.00	175.00	137.28	2298.40	4280.00	22542.8	0.30	2.972	58486.3	0.72314	0.506	5.0600	8.65E-05
23	10.00	185.00	137.28	2283.90	4256.00	22259.2	0.30	2.976	57766.7	0.76446	0.472	4.7200	8.17E-05
24	10.00	195.00	137.28	2325.40	4333.60	23075.5	0.30	2.976	59885.1	0.80579	0.437	4.3700	7.30E-05
25	12.50	206.25	137.28	2331.30	4366.20	23192.8	0.30	3.718	60180.6	0.85227	0.409	5.1125	8.50E-05
26	12.50	218.75	137.28	2357.60	4397.00	23719.0	0.30	3.724	61571.2	0.90393	0.386	4.8250	7.84E-05
27	12.50	231.25	137.28	2371.20	4447.80	23993.4	0.30	3.722	62274.5	0.95558	0.364	4.5500	7.31E-05
28	12.50	243.75	137.28	2416.90	4520.40	24927.2	0.30	3.726	64713.5	1.00723	0.341	4.2625	6.59E-05
29	12.50	256.25	137.28	2460.20	4584.90	25828.4	0.30	3.711	66990.5	1.05888	0.319	3.9875	5.95E-05
30	12.50	268.75	137.28	2464.80	4594.70	25925.0	0.30	3.712	67248.0	1.11054	0.296	3.7000	5.50E-05
31	12.50	281.25	137.28	2488.40	4637.20	26423.9	0.30	3.702	68499.7	1.16219	0.274	3.4250	5.00E-05
32	12.50	293.75	137.28	2487.40	4637.20	26402.6	0.30	3.704	68453.1	1.21384	0.251	3.1375	4.58E-05
33	15.00	307.50	137.28	2548.30	4748.20	27711.3	0.30	4.442	71835.5	1.27066	0.233	3.4950	4.87E-05
34	15.00	322.50	137.28	2566.80	4783.40	28115.1	0.30	4.443	72884.0	1.33264	0.219	3.2850	4.51E-05
35	15.00	337.50	137.28	2667.00	4965.70	30353.0	0.30	4.438	78665.4	1.39463	0.206	3.0900	3.93E-05
36	15.00	352.50	137.28	2718.70	5059.30	31541.2	0.30	4.435	81732.8	1.45661	0.192	2.8800	3.52E-05
37	15.00	367.50	137.28	2779.30	5170.50	32963.0	0.30	4.433	85408.5	1.51860	0.178	2.6700	3.13E-05
38	15.00	382.50	137.28	2809.30	5226.30	33678.5	0.30	4.433	87261.6	1.58058	0.164	2.4600	2.82E-05
39	15.00	397.50	137.28	2822.00	5251.00	33983.7	0.30	4.434	88057.8	1.64256	0.150	2.2500	2.56E-05
40	15.00	412.50	137.28	2821.30	5251.00	33966.8	0.30	4.436	88021.6	1.70455	0.142	2.1300	2.42E-05
41	15.00	427.50	137.28	2820.70	5251.00	33952.4	0.30	4.437	87991.6	1.76653	0.135	2.0250	2.30E-05
42	15.00	442.50	137.28	2820.10	5251.10	33937.9	0.30	4.439	87961.0	1.82851	0.128	1.9200	2.18E-05
43	15.00	457.50	137.28	2897.60	5392.70	35828.9	0.30	4.436	92850.5	1.89050	0.122	1.8300	1.97E-05
44	15.00	472.50	137.28	2914.20	5424.00	36240.6	0.30	4.437	93920.3	1.95248	0.115	1.7250	1.84E-05
45	15.00	487.50	137.28	2937.80	5466.40	36829.9	0.30	4.437	95446.2	2.01446	0.108	1.6200	1.70E-05
Summation Σ =	495.0000							154.1953				217.7860	1.2207E-02

(1) From Soil Data on Page G-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 17841 ksf
μ = ΣμH/ΣH 0.312
G' = E/(2*(1+ μ)) =: 6802 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1395.8 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1262.5 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.312 (Lower Bound Soil Case)
Shear Modulus, G' = 6802 ksf (Lower Bound Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION)

MEDIAN VALUES:
SEE PAGE G-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' MEDIAN (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	864.69	1935.50	2610.5	0.37	1.468	7137.4	0.00826	1.000	4.0000	5.60E-04
2	4.00	6.00	112.32	904.68	2246.65	2857.6	0.39	1.542	7917.7	0.02479	1.000	4.0000	5.05E-04
3	4.00	10.00	112.32	961.27	2524.10	3226.2	0.39	1.568	8981.0	0.04132	1.000	4.0000	4.45E-04
4	4.00	14.00	112.32	1073.90	2887.65	4026.6	0.39	1.572	11218.7	0.05785	1.000	4.0000	3.57E-04
5	4.00	18.00	112.32	1338.65	3423.45	6256.6	0.39	1.555	17379.0	0.07438	1.000	4.0000	2.30E-04
6	8.00	24.00	112.32	1293.00	3487.30	5837.2	0.39	3.159	16284.9	0.09917	1.000	8.0000	4.91E-04
7	8.00	32.00	112.32	1381.35	3574.40	6662.1	0.38	3.031	18372.6	0.13223	1.000	8.0000	4.35E-04
8	8.00	40.00	112.32	1449.35	3632.20	7334.2	0.36	2.910	20003.8	0.16529	1.000	8.0000	4.00E-04
9	8.00	48.00	112.32	1620.45	3913.85	9168.1	0.36	2.851	24871.1	0.19835	1.000	8.0000	3.22E-04
10	8.00	56.00	112.32	1813.45	3952.00	11482.0	0.34	2.702	30719.4	0.23140	0.972	7.7760	2.53E-04
11	10.00	65.00	112.32	1923.65	4143.30	12919.9	0.34	3.376	34561.9	0.26860	0.930	9.3000	2.69E-04
12	10.00	75.00	112.32	2012.05	4354.55	14134.6	0.34	3.373	37804.3	0.30992	0.883	8.8300	2.34E-04
13	10.00	85.00	112.32	2170.55	4642.65	16449.2	0.34	3.352	43925.0	0.35124	0.836	8.3600	1.90E-04
14	10.00	95.00	112.32	2135.25	4636.45	15918.5	0.34	3.386	42617.5	0.39256	0.789	7.8900	1.85E-04
15	10.00	105.00	112.32	2251.90	4705.50	17705.3	0.34	3.362	47317.2	0.43388	0.748	7.4800	1.58E-04
16	10.00	115.00	112.32	2231.30	4711.90	17382.9	0.34	3.389	46547.2	0.47521	0.713	7.1300	1.53E-04
17	10.00	125.00	112.32	2220.20	4723.00	17210.4	0.34	3.411	46161.3	0.51653	0.679	6.7900	1.47E-04
18	10.00	135.00	137.28	2742.50	5098.80	32095.9	0.30	2.963	83214.4	0.55785	0.644	6.4400	7.74E-05
19	10.00	145.00	137.28	2801.30	5209.10	33486.9	0.30	2.964	86826.9	0.59917	0.610	6.1000	7.03E-05
20	10.00	155.00	137.28	2832.10	5267.50	34227.4	0.30	2.966	88759.8	0.64050	0.575	5.7500	6.48E-05
21	10.00	165.00	137.28	2844.80	5292.60	34535.0	0.30	2.968	89569.3	0.68182	0.541	5.4100	6.04E-05
22	10.00	175.00	137.28	2815.00	5241.90	33815.3	0.30	2.972	87732.4	0.72314	0.506	5.0600	5.77E-05
23	10.00	185.00	137.28	2797.20	5212.50	33389.0	0.30	2.976	86650.4	0.76446	0.472	4.7200	5.45E-05
24	10.00	195.00	137.28	2848.00	5307.50	34612.8	0.30	2.976	89826.3	0.80579	0.437	4.3700	4.86E-05
25	12.50	206.25	137.28	2871.20	5349.60	35179.0	0.30	3.720	91296.8	0.85227	0.409	5.1125	5.60E-05
26	12.50	218.75	137.28	2897.30	5400.10	35821.4	0.30	3.722	92974.2	0.90393	0.386	4.8250	5.19E-05
27	12.50	231.25	137.28	2928.75	5460.10	36603.3	0.30	3.724	95014.6	0.95558	0.364	4.5500	4.79E-05
28	12.50	243.75	137.28	2980.90	5557.15	37918.5	0.30	3.724	98431.1	1.00723	0.341	4.2625	4.33E-05
29	12.50	256.25	137.28	3027.45	5639.90	39112.0	0.30	3.704	101404.5	1.05888	0.319	3.9875	3.93E-05
30	12.50	268.75	137.28	3033.80	5653.40	39276.3	0.30	3.706	101841.4	1.11054	0.296	3.7000	3.63E-05
31	12.50	281.25	137.28	3057.85	5699.20	39901.4	0.30	3.707	103468.4	1.16219	0.274	3.4250	3.31E-05
32	12.50	293.75	137.28	3056.70	5699.20	39871.4	0.30	3.709	103403.4	1.21384	0.251	3.1375	3.03E-05
33	15.00	307.50	137.28	3131.15	5834.70	41837.3	0.30	4.447	108483.4	1.27066	0.233	3.4950	3.22E-05
34	15.00	322.50	137.28	3153.95	5878.00	42448.8	0.30	4.448	110072.0	1.33264	0.219	3.2850	2.98E-05
35	15.00	337.50	137.28	3277.30	6101.95	45834.1	0.30	4.442	118814.8	1.39463	0.206	3.0900	2.60E-05
36	15.00	352.50	137.28	3343.15	6221.75	47694.5	0.30	4.439	123620.2	1.45661	0.192	2.8800	2.33E-05
37	15.00	367.50	137.28	3417.70	6358.35	49845.3	0.30	4.437	129179.5	1.51860	0.178	2.6700	2.07E-05
38	15.00	382.50	137.28	3454.65	6427.10	50928.9	0.30	4.437	131986.3	1.58058	0.164	2.4600	1.86E-05
39	15.00	397.50	137.28	3470.30	6457.45	51391.4	0.30	4.438	133193.1	1.64256	0.150	2.2500	1.69E-05
40	15.00	412.50	137.28	3469.50	6457.45	51367.7	0.30	4.440	133143.5	1.70455	0.142	2.1300	1.60E-05
41	15.00	427.50	137.28	3468.70	6457.45	51344.0	0.30	4.441	133092.9	1.76653	0.135	2.0250	1.52E-05
42	15.00	442.50	137.28	3468.05	6457.60	51324.8	0.30	4.443	133053.3	1.82851	0.128	1.9200	1.44E-05
43	15.00	457.50	137.28	3563.40	6631.70	54185.8	0.30	4.440	140448.5	1.89050	0.122	1.8300	1.30E-05
44	15.00	472.50	137.28	3583.95	6670.15	54812.6	0.30	4.440	142076.4	1.95248	0.115	1.7250	1.21E-05
45	15.00	487.50	137.28	3612.90	6722.35	55701.7	0.30	4.440	144376.5	2.01446	0.108	1.6200	1.12E-05
Summation Σ =	495.0000							154.2408				217.7860	6.3570E-03

(1) From Soil Data on Page G-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 34259 ksf
μ = $\Sigma\mu H/\Sigma H$ 0.312
G' = E/(2*(1+ μ)) =: 13060 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1934.1 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1749.4 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.312 (Median Soil Case)
Shear Modulus, G' = 13060 ksf (Median Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 5E-4 EVENT (2000 YR. RETURN PERIOD GROUND MOTION)

UPPER BOUND VALUES:
SEE PAGE G-4 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' UPPER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNGS MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1231.40	2755.50	5294.2	0.37	1.468	14475.4	0.00826	1.000	4.0000	2.76E-04
2	4.00	6.00	112.32	1279.80	3027.10	5718.6	0.39	1.544	15851.7	0.02479	1.000	4.0000	2.52E-04
3	4.00	10.00	112.32	1362.60	3327.40	6482.5	0.39	1.568	18048.2	0.04132	1.000	4.0000	2.22E-04
4	4.00	14.00	112.32	1540.20	4100.90	8282.5	0.39	1.571	23072.0	0.05785	1.000	4.0000	1.73E-04
5	4.00	18.00	112.32	1928.90	4593.40	12990.5	0.39	1.554	36072.2	0.07438	1.000	4.0000	1.11E-04
6	8.00	24.00	112.32	1870.20	4703.80	12211.9	0.39	3.155	34056.7	0.09917	1.000	8.0000	2.35E-04
7	8.00	32.00	112.32	1963.70	4690.90	13463.4	0.38	3.033	37134.9	0.13223	1.000	8.0000	2.15E-04
8	8.00	40.00	112.32	2067.20	4779.00	14920.1	0.36	2.910	40695.7	0.16529	1.000	8.0000	1.97E-04
9	8.00	48.00	112.32	2299.90	5040.60	18468.2	0.36	2.846	50077.9	0.19835	1.000	8.0000	1.60E-04
10	8.00	56.00	112.32	2579.50	5078.30	23231.5	0.34	2.697	62125.7	0.23140	0.972	7.7760	1.25E-04
11	10.00	65.00	112.32	2668.20	5086.40	24856.7	0.34	3.372	66475.2	0.26860	0.930	9.3000	1.40E-04
12	10.00	75.00	112.32	2849.30	5338.90	28345.4	0.34	3.372	75804.1	0.30992	0.883	8.8300	1.16E-04
13	10.00	85.00	112.32	3008.50	5698.60	31601.4	0.33	3.348	84363.7	0.35124	0.836	8.3600	9.91E-05
14	10.00	95.00	112.32	3000.30	5693.80	31429.3	0.34	3.380	84107.5	0.39256	0.789	7.8900	9.38E-05
15	10.00	105.00	112.32	3001.10	5763.00	31446.1	0.34	3.362	84039.1	0.43388	0.748	7.4800	8.90E-05
16	10.00	115.00	112.32	2991.80	5770.90	31251.5	0.34	3.389	83684.1	0.47521	0.713	7.1300	8.52E-05
17	10.00	125.00	112.32	2967.30	5784.50	30741.8	0.34	3.411	82455.0	0.51653	0.679	6.7900	8.23E-05
18	10.00	135.00	137.28	3358.90	6244.70	48144.9	0.30	2.963	124824.3	0.55785	0.644	6.4400	5.16E-05
19	10.00	145.00	137.28	3430.90	6379.80	50231.1	0.30	2.964	130242.1	0.59917	0.610	6.1000	4.68E-05
20	10.00	155.00	137.28	3468.50	6451.30	51338.1	0.30	2.966	133132.0	0.64050	0.575	5.7500	4.32E-05
21	10.00	165.00	137.28	3484.20	6482.10	51803.9	0.30	2.968	134357.5	0.68182	0.541	5.4100	4.03E-05
22	10.00	175.00	137.28	3447.60	6420.00	50721.3	0.30	2.972	131594.3	0.72314	0.506	5.0600	3.85E-05
23	10.00	185.00	137.28	3425.90	6384.00	50084.8	0.30	2.976	129979.0	0.76446	0.472	4.7200	3.63E-05
24	10.00	195.00	137.28	3488.10	6500.30	51919.9	0.30	2.976	134741.6	0.80579	0.437	4.3700	3.24E-05
25	12.50	206.25	137.28	3559.70	6589.30	54073.3	0.30	3.718	140309.4	0.85227	0.409	5.1125	3.64E-05
26	12.50	218.75	137.28	3573.50	6632.00	54493.4	0.30	3.720	141416.9	0.90393	0.386	4.8250	3.41E-05
27	12.50	231.25	137.28	3644.20	6744.60	56671.0	0.30	3.722	147088.4	0.95558	0.364	4.5500	3.09E-05
28	12.50	243.75	137.28	3701.20	6848.40	58457.6	0.30	3.723	151733.8	1.00723	0.341	4.2625	2.81E-05
29	12.50	256.25	137.28	3725.40	6937.60	59224.6	0.30	3.698	153490.0	1.05888	0.319	3.9875	2.60E-05
30	12.50	268.75	137.28	3734.00	6955.80	59498.3	0.30	3.700	154217.3	1.11054	0.296	3.7000	2.40E-05
31	12.50	281.25	137.28	3757.60	7004.30	60252.8	0.30	3.712	156287.4	1.16219	0.274	3.4250	2.19E-05
32	12.50	293.75	137.28	3756.30	7004.30	60211.1	0.30	3.714	156198.5	1.21384	0.251	3.1375	2.01E-05
33	15.00	307.50	137.28	3847.30	7169.80	63163.8	0.30	4.453	163826.7	1.27066	0.233	3.4950	2.13E-05
34	15.00	322.50	137.28	3875.50	7222.90	64093.2	0.30	4.453	166242.3	1.33264	0.219	3.2850	1.98E-05
35	15.00	337.50	137.28	4027.20	7498.10	69209.0	0.30	4.447	179450.6	1.39463	0.206	3.0900	1.72E-05
36	15.00	352.50	137.28	4110.90	7651.10	72115.7	0.30	4.444	186962.9	1.45661	0.192	2.8800	1.54E-05
37	15.00	367.50	137.28	4202.70	7819.00	75372.5	0.30	4.441	195379.1	1.51860	0.178	2.6700	1.37E-05
38	15.00	382.50	137.28	4248.20	7903.60	77013.4	0.30	4.441	199629.4	1.58058	0.164	2.4600	1.23E-05
39	15.00	397.50	137.28	4267.50	7940.90	77714.7	0.30	4.442	201459.9	1.64256	0.150	2.2500	1.12E-05
40	15.00	412.50	137.28	4266.50	7940.90	77678.3	0.30	4.444	201384.1	1.70455	0.142	2.1300	1.06E-05
41	15.00	427.50	137.28	4265.60	7940.90	77645.5	0.30	4.446	201314.7	1.76653	0.135	2.0250	1.01E-05
42	15.00	442.50	137.28	4264.80	7941.10	77616.4	0.30	4.447	201254.7	1.82851	0.128	1.9200	9.54E-06
43	15.00	457.50	137.28	4382.20	8155.20	81948.4	0.30	4.443	212448.0	1.89050	0.122	1.8300	8.61E-06
44	15.00	472.50	137.28	4407.50	8202.50	82897.4	0.30	4.444	214911.5	1.95248	0.115	1.7250	8.03E-06
45	15.00	487.50	137.28	4443.10	8266.70	84241.9	0.30	4.443	218387.1	2.01446	0.108	1.6200	7.42E-06
Summation Σ =	495.0000							154.2588				217.7860	3.3480E-03

(1) From Soil Data on Page G-4
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) From Newmark Charts See Attachment E.
q_o = 1 KSF (see discussion in Sect. 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-4
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 65050 ksf
μ = $\Sigma\mu H / \Sigma H$ 0.312
G' = E/(2*(1+ μ)) =: 24797 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 2665.0 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 2410.6 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.312 (Upper Bound Soil Case)
Shear Modulus, G' = 24797 ksf (Upper Bound Soil Case)

SUMMARY OF DYNAMIC SHEAR MODULUS G' (KSF) AND POISSON'S RATIO VALUES FOR 5E-4 EVENT

130' Alluvium					
Lower Bound Soil Case		**Median Soil Case**		**Upper Bound Soil Case**	
Dynamic Shear Modulus G' (KSF)	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**
6,802	0.312	13,060	0.312	24,797	0.312
Page G-5	Page G-5	Page G-6	Page G-6	Page G-7	Page G-7

Reference DTN: MO0801SCSPS1E4.003 (Ref. 2.2.10)

Weighted results of Northeast velocity profiles with 100ft Alluvium (0-100ft Alluvium, >100ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.38	0.24	781.96	2.99	0.17	552.93	6.86	0.34	1105.90	1.30	0.59	1948.40	1.14	0.42	1377.70	1.95	0.84	2755.50	0.66	0.0060	0.0093
1.22	4.00	1.83	6.00	1.80	112.32	0.41	0.23	750.30	4.62	0.16	530.54	10.62	0.32	1061.10	2.01	0.66	2150.00	1.14	0.49	1599.40	1.95	0.88	2890.10	0.66	0.0212	0.0326
1.22	4.00	3.05	10.00	1.80	112.32	0.42	0.24	786.00	5.06	0.17	555.78	11.64	0.34	1111.60	2.20	0.74	2413.70	1.14	0.55	1810.30	1.95	0.98	3218.30	0.66	0.0330	0.0508
1.22	4.00	4.27	14.00	1.80	112.32	0.42	0.26	859.52	5.06	0.19	607.77	11.64	0.37	1215.50	2.20	0.82	2682.20	1.14	0.58	1896.60	1.95	1.16	3793.20	0.66	0.0342	0.0525
1.22	4.00	5.49	18.00	1.80	112.32	0.41	0.33	1073.60	4.81	0.23	759.12	11.07	0.46	1518.20	2.09	1.06	3464.90	1.14	0.80	2613.60	1.95	1.40	4593.40	0.66	0.0244	0.0375
2.44	8.00	7.31	24.00	1.80	112.32	0.42	0.30	996.25	5.33	0.21	704.46	12.26	0.43	1408.90	2.32	1.08	3529.50	1.14	0.81	2648.40	1.95	1.43	4703.80	0.66	0.0369	0.0567
2.44	8.00	9.75	32.00	1.80	112.32	0.41	0.31	1023.90	5.56	0.22	723.98	12.77	0.44	1448.00	2.42	1.09	3579.50	1.14	0.83	2731.40	1.95	1.43	4690.90	0.66	0.0431	0.0663
2.44	8.00	12.19	40.00	1.80	112.32	0.40	0.32	1058.00	5.55	0.23	748.11	12.75	0.46	1496.20	2.41	1.11	3637.40	1.14	0.84	2768.50	1.95	1.46	4779.00	0.66	0.0467	0.0718
2.44	8.00	14.63	48.00	1.80	112.32	0.39	0.36	1177.60	5.44	0.25	832.71	12.51	0.51	1665.40	2.37	1.19	3899.30	1.14	0.93	3045.60	1.95	1.52	4992.30	0.66	0.0424	0.0652
2.44	8.00	17.07	56.00	1.80	112.32	0.38	0.44	1446.90	5.25	0.31	1023.10	11.88	0.62	2046.20	2.32	1.20	3937.30	1.14	0.94	3078.60	1.95	1.53	5035.60	0.66	0.0312	0.0480
3.05	10.00	19.81	65.00	1.80	112.32	0.38	0.47	1543.50	5.29	0.33	1091.40	11.74	0.67	2182.80	2.39	1.26	4133.60	1.14	1.03	3375.10	1.95	1.54	5062.60	0.66	0.0305	0.0470
3.05	10.00	22.86	75.00	1.80	112.32	0.38	0.49	1606.00	5.25	0.35	1135.60	11.69	0.69	2271.30	2.36	1.33	4349.90	1.14	1.08	3551.70	1.95	1.62	5327.50	0.66	0.0312	0.0480
3.05	10.00	25.91	85.00	1.80	112.32	0.38	0.53	1747.30	5.10	0.38	1235.50	11.53	0.75	2471.00	2.26	1.42	4652.90	1.14	1.16	3799.10	1.95	1.74	5698.60	0.66	0.0288	0.0442
3.05	10.00	28.95	95.00	1.80	112.32	0.38	0.51	1688.60	5.32	0.36	1194.10	12.00	0.73	2388.10	2.36	1.42	4649.00	1.14	1.16	3795.90	1.95	1.74	5693.80	0.66	0.0332	0.0511
3.05	10.00	32.00	105.00	2.20	137.28	0.30	0.80	2624.80	0.81	0.65	2143.20	1.79	0.98	3214.80	0.50	1.51	4957.20	0.50	1.23	4047.50	0.81	1.85	6071.30	0.50	0.0120	0.0185
3.05	10.00	35.05	115.00	2.20	137.28	0.30	0.80	2624.00	0.82	0.65	2142.50	1.85	0.98	3213.80	0.50	1.51	4965.90	0.50	1.24	4054.60	0.81	1.85	6082.00	0.50	0.0130	0.0200
3.05	10.00	38.10	125.00	2.20	137.28	0.30	0.81	2641.50	0.79	0.66	2156.80	1.64	0.99	3235.20	0.50	1.52	4980.60	0.50	1.24	4066.60	0.81	1.86	6100.00	0.50	0.0138	0.0213
3.05	10.00	41.15	135.00	2.20	137.28	0.30	0.82	2702.00	0.79	0.67	2206.20	1.66	1.01	3309.20	0.50	1.55	5098.80	0.50	1.27	4163.20	0.81	1.90	6244.70	0.50	0.0141	0.0218
3.05	10.00	44.19	145.00	2.20	137.28	0.30	0.84	2758.80	0.79	0.69	2252.60	1.67	1.03	3378.80	0.50	1.59	5209.10	0.50	1.30	4253.20	0.81	1.94	6379.80	0.50	0.0144	0.0221
3.05	10.00	47.24	155.00	2.20	137.28	0.30	0.85	2787.60	0.80	0.69	2276.10	1.69	1.04	3414.10	0.50	1.61	5267.50	0.50	1.31	4300.90	0.81	1.97	6451.30	0.50	0.0149	0.0229
3.05	10.00	50.29	165.00	2.20	137.28	0.30	0.85	2798.50	0.80	0.70	2285.00	1.72	1.04	3427.50	0.50	1.61	5292.60	0.50	1.32	4321.40	0.81	1.98	6482.10	0.50	0.0155	0.0238
3.05	10.00	53.34	175.00	2.20	137.28	0.31	0.84	2766.00	0.82	0.69	2258.40	1.78	1.03	3387.60	0.50	1.60	5241.90	0.50	1.30	4280.00	0.81	1.96	6420.00	0.50	0.0166	0.0255
3.05	10.00	56.39	185.00	2.20	137.28	0.31	0.84	2746.10	0.83	0.68	2238.30	1.83	1.03	3369.20	0.50	1.59	5212.50	0.50	1.30	4256.00	0.81	1.95	6384.00	0.50	0.0175	0.0269
3.05	10.00	59.43	195.00	2.20	137.28	0.31	0.85	2795.50	0.83	0.69	2271.50	1.84	1.05	3440.30	0.50	1.62	5307.50	0.50	1.32	4333.60	0.81	1.98	6500.30	0.50	0.0175	0.0270
3.81	12.50	62.86	206.25	2.20	137.28	0.31	0.86	2807.60	0.84	0.69	2270.70	1.86	1.06	3471.50	0.50	1.63	5335.40	0.50	1.33	4356.30	0.81	1.99	6534.50	0.50	0.0180	0.0278
3.81	12.50	66.67	218.75	2.20	137.28	0.31	0.86	2831.60	0.85	0.70	2300.20	1.89	1.06	3485.80	0.50	1.64	5385.20	0.50	1.34	4397.00	0.81	2.01	6595.50	0.50	0.0184	0.0284
3.81	12.50	70.48	231.25	2.20	137.28	0.31	0.87	2860.50	0.85	0.70	2301.60	1.90	1.08	3555.20	0.50	1.66	5443.10	0.50	1.35	4444.30	0.81	2.03	6666.40	0.50	0.0187	0.0288
3.81	12.50	74.29	243.75	2.20	137.28	0.31	0.89	2909.30	0.85	0.71	2343.30	1.91	1.10	3612.00	0.50	1.69	5536.30	0.50	1.38	4520.40	0.81	2.07	6780.50	0.50	0.0187	0.0288
3.81	12.50	78.10	256.25	2.20	137.28	0.31	0.90	2958.80	0.79	0.74	2415.80	1.57	1.10	3623.70	0.50	1.71	5615.30	0.50	1.40	4584.90	0.81	2.10	6877.30	0.50	0.0187	0.0287
3.81	12.50	81.91	268.75	2.20	137.28	0.31	0.90	2963.00	0.79	0.74	2419.30	1.59	1.11	3628.90	0.50	1.72	5627.40	0.50	1.40	4594.80	0.81	2.10	6892.10	0.50	0.0191	0.0295
3.81	12.50	85.72	281.25	2.20	137.28	0.31	0.92	3011.20	0.79	0.75	2458.60	1.60	1.12	3687.90	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0190	0.0293
3.81	12.50	89.53	293.75	2.20	137.28	0.31	0.92	3008.70	0.80	0.75	2456.60	1.62	1.12	3684.90	0.50	1.74	5719.00	0.50	1.42	4669.50	0.81	2.13	7004.30	0.50	0.0196	0.0301
4.57	15.00	93.72	307.50	2.20	137.28	0.31	0.94	3083.10	0.79	0.77	2517.40	1.59	1.15	3776.10	0.50	1.78	5854.10	0.50	1.46	4779.90	0.81	2.19	7169.80	0.50	0.0191	0.0294
4.57	15.00	98.29	322.50	2.20	137.28	0.31	0.95	3104.80	0.79	0.77	2535.10	1.61	1.16	3802.60	0.50	1.80	5897.50	0.50	1.47	4815.30	0.81	2.20	7222.90	0.50	0.0194	0.0298
4.57	15.00	102.86	337.50	2.20	137.28	0.31	0.98	3229.90	0.78	0.80	2637.20	1.56	1.21	3955.80	0.50	1.87	6122.20	0.50	1.52	4998.80	0.81	2.29	7498.10	0.50	0.0183	0.0282
4.57	15.00	107.44	352.50	2.20	137.28	0.31	1.01	3297.80	0.78	0.82	2692.70	1.56	1.23	4039.00	0.50	1.90	6247.10	0.50	1.55	5100.70	0.81	2.33	7651.10	0.50	0.0180	0.0277
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.03	3372.80	0.77	0.84	2753.80	1.53	1.26	4130.80	0.50	1.95	6384.20	0.50	1.59	5212.70	0.81	2.38	7819.00	0.50	0.0176	0.0271
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.04	3409.30	0.77	0.85	2783.70	1.53	1.27	4175.60	0.50	1.97	6453.30	0.50	1.61	5269.10	0.81	2.41	7903.60	0.50	0.0176	0.0271
4.57	15.00	121.15	397.50	2.20	137.28	0.31	1.04	3424.10	0.77	0.85	2795.70	1.54	1.28	4193.60	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0178	0.0274
4.57	15.00	125.72	412.50	2.20	137.28	0.31	1.04	3422.10	0.78	0.85	2794.10	1.56	1.28	4191.20	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0182	0.0280
4.57	15.00	130.30	427.50	2.20	137.28	0.31	1.04	3420.20	0.78	0.85	2792.60	1.58	1.28	4188.90	0.50	1.98	6483.70	0.50	1.61	5293.90	0.81	2.42	7940.90	0.50	0.0186	0.0286
4.57	15.00	134.87	442.50	2.20	137.28	0.31	1.04	3418.50	0.79	0.85	2791.20	1.59	1.28	4186.70	0.50	1.98	6483.90	0.50	1.61	5294.10	0.81	2.42	7941.10	0.50	0.0189	0.0291
4.57	15.00	139.44	457.50	2.20	137.28	0.31	1.07	3514.20	0.78	0.87	2869.30	1.56	1.31	4304.00	0.50	2.03	6658.70	0.50	1.66	5436.80	0.81	2.49	8155.20	0.50	0.0182	0.0280
4.57	15.00	144.01	472.50	2.20	137.28	0.31	1.08	3534.30	0.78	0.88	2885.70	1.57	1.32	4328.60	0.50	2.04	6697.30	0.50	1.67	5468.30	0.81	2.50	8202.50	0.50	0.0183	0.0281
4.57	15.00	148.58	487.50	2.20	137.28	0.31	1.09	3563.90	0.78	0.89	2909.90	1.55	1.33	4364.90	0.50	2.06	6749.70	0.50	1.68	5511.10	0.81	2.52	8266.70	0.50	0.0182	0.0281

Reference DTN: MO0801SCSPS1E4.003 (Ref. 2.2.10)

Weighted results of Northeast velocity profiles with 200ft Alluvium (0-200ft Alluvium, >200ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness		Depth to Midpoint of Layer		Density	Unit Weight	Poisson's Ratio	Median V_s		Median Damping	Lower Bound V_s		Upper Bound Damping	Upper Bound V_s		Lower Bound Damping	Median V_p		Median Damping	Lower Bound V_p		Upper Bound Damping	Upper Bound V_p		Lower Bound Damping	Effective Horizontal Shear-Strain	Maximum Horizontal Shear-Strain
(m)	(ft)	(m)	(ft)	(g/cm^3)	(pcf)	(no units)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(km/s)	(ft/s)	(%)	(%)	(%)
1.22	4.00	0.61	2.00	1.80	112.32	0.38	0.23	767.70	2.96	0.17	542.84	6.81	0.33	1085.70	1.29	0.59	1922.60	1.14	0.41	1359.50	1.95	0.83	2719.00	0.66	0.0059	0.0090
1.22	4.00	1.83	6.00	1.80	112.32	0.41	0.24	771.66	4.48	0.17	545.64	10.31	0.33	1091.30	1.95	0.66	2177.30	1.14	0.49	1608.10	1.95	0.90	2948.00	0.66	0.0188	0.0290
1.22	4.00	3.05	10.00	1.80	112.32	0.41	0.25	807.87	5.02	0.17	571.25	11.54	0.35	1142.50	2.18	0.75	2455.90	1.14	0.56	1828.40	1.95	1.01	3298.80	0.66	0.0298	0.0459
1.22	4.00	4.27	14.00	1.80	112.32	0.42	0.26	860.43	5.06	0.19	608.41	11.64	0.37	1216.80	2.20	0.82	2698.60	1.14	0.58	1908.20	1.95	1.16	3816.40	0.66	0.0338	0.0520
1.22	4.00	5.49	18.00	1.80	112.32	0.41	0.31	1022.00	4.86	0.22	722.69	11.17	0.44	1445.40	2.11	0.95	3107.30	1.14	0.68	2216.30	1.95	1.33	4356.60	0.66	0.0261	0.0402
2.44	8.00	7.31	24.00	1.80	112.32	0.42	0.30	984.58	5.40	0.21	696.21	12.43	0.42	1392.40	2.35	0.97	3198.50	1.14	0.70	2306.80	1.95	1.35	4435.00	0.66	0.0392	0.0603
2.44	8.00	9.75	32.00	1.80	112.32	0.41	0.32	1036.40	5.49	0.22	732.81	12.62	0.45	1465.60	2.39	0.99	3242.60	1.14	0.71	2314.00	1.95	1.38	4543.80	0.66	0.0417	0.0641
2.44	8.00	12.19	40.00	1.80	112.32	0.40	0.33	1066.90	5.52	0.23	754.40	12.70	0.46	1508.80	2.40	0.99	3259.70	1.14	0.70	2305.00	1.95	1.41	4609.90	0.66	0.0452	0.0695
2.44	8.00	14.63	48.00	1.80	112.32	0.39	0.37	1217.70	5.37	0.26	861.07	12.35	0.52	1722.10	2.34	1.20	3928.40	1.14	0.93	3061.60	1.95	1.54	5040.60	0.66	0.0387	0.0595
2.44	8.00	17.07	56.00	1.80	112.32	0.38	0.45	1466.50	5.18	0.32	1037.00	11.53	0.63	2074.00	2.33	1.21	3966.70	1.14	0.94	3098.40	1.95	1.55	5078.30	0.66	0.0297	0.0456
3.05	10.00	19.81	65.00	1.80	112.32	0.38	0.48	1560.10	5.24	0.34	1103.10	11.37	0.67	2206.30	2.41	1.27	4153.00	1.14	1.03	3390.90	1.95	1.55	5086.40	0.66	0.0292	0.0449
3.05	10.00	22.86	75.00	1.80	112.32	0.38	0.49	1618.60	5.23	0.35	1144.50	11.38	0.70	2289.10	2.40	1.33	4359.20	1.14	1.08	3559.30	1.95	1.63	5338.90	0.66	0.0301	0.0463
3.05	10.00	25.91	85.00	1.80	112.32	0.38	0.53	1744.00	5.13	0.38	1233.20	11.34	0.75	2466.40	2.33	1.41	4632.40	1.14	1.15	3782.30	1.95	1.73	5673.50	0.66	0.0283	0.0435
3.05	10.00	28.95	95.00	1.80	112.32	0.38	0.51	1679.60	5.37	0.36	1187.60	11.81	0.72	2375.20	2.45	1.41	4623.90	1.14	1.15	3775.40	1.95	1.73	5663.10	0.66	0.0330	0.0508
3.05	10.00	32.00	105.00	1.80	112.32	0.37	0.57	1880.90	5.29	0.41	1330.00	11.37	0.81	2659.90	2.46	1.43	4705.50	1.14	1.17	3842.00	1.95	1.76	5763.00	0.66	0.0282	0.0433
3.05	10.00	35.05	115.00	1.80	112.32	0.38	0.56	1833.30	5.49	0.40	1296.30	11.74	0.79	2592.70	2.57	1.44	4711.90	1.14	1.17	3847.20	1.95	1.76	5770.90	0.66	0.0316	0.0486
3.05	10.00	38.10	125.00	1.80	112.32	0.38	0.55	1801.80	5.66	0.39	1274.10	12.07	0.78	2548.20	2.65	1.44	4723.00	1.14	1.18	3856.30	1.95	1.76	5784.50	0.66	0.0346	0.0532
3.05	10.00	41.15	135.00	1.80	112.32	0.38	0.57	1866.60	5.60	0.40	1319.90	12.10	0.80	2639.80	2.59	1.49	4884.10	1.14	1.22	3987.90	1.95	1.82	5981.80	0.66	0.0339	0.0521
3.05	10.00	44.19	145.00	1.80	112.32	0.38	0.58	1898.60	5.60	0.41	1342.50	12.15	0.82	2685.00	2.59	1.52	4994.50	1.14	1.24	4078.00	1.95	1.86	6117.00	0.66	0.0343	0.0528
3.05	10.00	47.24	155.00	1.80	112.32	0.38	0.58	1905.30	5.64	0.41	1347.30	12.20	0.82	2694.50	2.61	1.54	5060.90	1.14	1.26	4132.20	1.95	1.89	6198.30	0.66	0.0355	0.0546
3.05	10.00	50.29	165.00	1.80	112.32	0.38	0.57	1857.20	5.78	0.40	1313.30	12.46	0.80	2626.50	2.68	1.54	5039.30	1.14	1.25	4114.60	1.95	1.88	6171.90	0.66	0.0389	0.0598
3.05	10.00	53.34	175.00	1.80	112.32	0.39	0.55	1801.20	5.92	0.39	1273.70	12.74	0.78	2547.30	2.76	1.52	4995.50	1.14	1.24	4077.50	1.95	1.87	6120.20	0.66	0.0428	0.0659
3.05	10.00	56.39	185.00	1.80	112.32	0.39	0.54	1777.60	6.02	0.38	1257.00	12.89	0.77	2514.00	2.81	1.52	4999.00	1.14	1.24	4081.70	1.95	1.87	6122.50	0.66	0.0454	0.0698
3.05	10.00	59.43	195.00	1.80	112.32	0.39	0.56	1823.50	5.99	0.39	1289.40	12.77	0.79	2578.80	2.81	1.55	5094.90	1.14	1.27	4160.00	1.95	1.90	6240.00	0.66	0.0444	0.0683
3.81	12.50	62.86	206.25	2.20	137.28	0.30	0.86	2834.30	0.81	0.69	2278.10	1.74	1.07	3526.40	0.50	1.63	5363.80	0.50	1.33	4366.20	0.81	2.01	6589.30	0.50	0.0155	0.0238
3.81	12.50	66.67	218.75	2.20	137.28	0.31	0.87	2858.20	0.82	0.70	2307.60	1.77	1.08	3540.20	0.50	1.65	5415.00	0.50	1.35	4421.30	0.81	2.02	6632.00	0.50	0.0161	0.0247
3.81	12.50	70.48	231.25	2.20	137.28	0.31	0.88	2888.70	0.82	0.70	2311.50	1.79	1.10	3610.10	0.50	1.67	5477.10	0.50	1.36	4447.80	0.81	2.06	6744.60	0.50	0.0165	0.0255
3.81	12.50	74.29	243.75	2.20	137.28	0.31	0.90	2941.20	0.83	0.72	2358.80	1.81	1.12	3667.30	0.50	1.70	5578.00	0.50	1.38	4543.30	0.81	2.09	6848.40	0.50	0.0167	0.0256
3.81	12.50	78.10	256.25	2.20	137.28	0.30	0.91	2992.00	0.76	0.74	2427.70	1.48	1.12	3687.50	0.50	1.73	5664.50	0.50	1.41	4625.00	0.81	2.11	6937.60	0.50	0.0168	0.0258
3.81	12.50	81.91	268.75	2.20	137.28	0.31	0.91	2997.30	0.77	0.74	2439.80	1.51	1.12	3682.20	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0173	0.0266
3.81	12.50	85.72	281.25	2.20	137.28	0.31	0.91	2994.20	0.78	0.74	2435.70	1.55	1.12	3680.80	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0179	0.0276
3.81	12.50	89.53	293.75	2.20	137.28	0.31	0.91	2991.30	0.79	0.74	2431.80	1.58	1.12	3679.40	0.50	1.73	5679.40	0.50	1.41	4637.20	0.81	2.12	6955.80	0.50	0.0186	0.0285
4.57	15.00	93.72	307.50	2.20	137.28	0.31	0.93	3065.70	0.78	0.76	2503.10	1.56	1.14	3754.70	0.50	1.77	5815.30	0.50	1.45	4748.20	0.81	2.17	7122.30	0.50	0.0182	0.0280
4.57	15.00	98.29	322.50	2.20	137.28	0.31	0.94	3086.80	0.78	0.77	2520.30	1.57	1.15	3780.50	0.50	1.79	5858.50	0.50	1.46	4783.40	0.81	2.19	7175.20	0.50	0.0186	0.0286
4.57	15.00	102.86	337.50	2.20	137.28	0.31	0.98	3209.90	0.77	0.80	2620.80	1.54	1.20	3931.30	0.50	1.85	6081.70	0.50	1.51	4965.70	0.81	2.27	7448.50	0.50	0.0177	0.0272
4.57	15.00	107.44	352.50	2.20	137.28	0.30	1.00	3273.50	0.77	0.81	2672.80	1.53	1.22	4009.20	0.50	1.89	6196.40	0.50	1.54	5059.30	0.81	2.31	7589.00	0.50	0.0175	0.0269
4.57	15.00	112.01	367.50	2.20	137.28	0.30	1.02	3347.20	0.76	0.83	2733.00	1.50	1.25	4099.50	0.50	1.93	6332.50	0.50	1.58	5170.50	0.81	2.36	7755.70	0.50	0.0172	0.0264
4.57	15.00	116.58	382.50	2.20	137.28	0.30	1.03	3383.10	0.76	0.84	2762.30	1.50	1.26	4143.40	0.50	1.95	6400.90	0.50	1.59	5226.30	0.81	2.39	7839.50	0.50	0.0172	0.0265
4.57	15.00	121.15	397.50	2.20	137.28	0.30	1.04	3397.40	0.76	0.85	2774.00	1.52	1.27	4161.00	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0175	0.0269
4.57	15.00	125.72	412.50	2.20	137.28	0.31	1.03	3395.20	0.77	0.84	2772.20	1.54	1.27	4158.20	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0179	0.0276
4.57	15.00	130.30	427.50	2.20	137.28	0.31	1.03	3393.00	0.78	0.84	2770.40	1.56	1.27	4155.60	0.50	1.96	6431.20	0.50	1.60	5251.10	0.81	2.40	7876.60	0.50	0.0183	0.0282
4.57	15.00	134.87	442.50	2.20	137.28	0.31	1.03	3391.10	0.78	0.84	2768.80	1.58	1.27	4153.20	0.50	1.96	6431.30	0.50	1.60	5251.10	0.81	2.40	7876.70	0.50	0.0187	0.0288
4.57	15.00	139.44	457.50	2.20	137.28	0.31	1.06	3485.90	0.77	0.87	2846.20	1.55	1.30	4269.30	0.50	2.01	6604.70	0.50	1.64	5392.70	0.81	2.47	8089.10	0.50	0.0180	0.0277
4.57	15.00	144.01	472.50	2.20	137.28	0.31	1.07	3505.60	0.78	0.87	2862.30	1.55	1.31	4293.40	0.50	2.02	6643.00	0.50	1.65	5424.00	0.81	2.48	8136.00	0.50	0.0182	0.0279
4.57	15.00	148.58	487.50	2.20	137.28	0.31	1.08	3534.60	0.77	0.88	2886.00	1.54	1.32	4329.00	0.50	2.04	6695.00	0.50	1.67	5466.40	0.81	2.50	8199.70	0.50	0.0182	0.0279

Weighted results of Northeast velocity profiles with 130ft Alluvium (0-130ft Alluvium, >130ft Tuff), 1E-4 annual probablility of exceedance, Surface Facilities Area

Layer Thickness (ft)	Depth to Midpoint of Layer (ft)	Density (g/cm^3)	Unit Weight (pcf)	Median V_s (ft/s)	Poisson's Ratio (no units)	Lower Bound V_s (ft/s)	Poisson's Ratio (no units)	Upper Bound V_s (ft/s)	Poisson's Ratio (no units)	Median V_p (ft/s)	Lower Bound V_p (ft/s)	Upper Bound V_p (ft/s)
4.00	2.00	1.80	112.32	774.83	0.38	542.84	0.38	1105.90	0.38	1935.50	1359.50	2755.50
4.00	6.00	1.80	112.32	760.98	0.41	530.54	0.41	1091.30	0.41	2163.65	1599.40	2948.00
4.00	10.00	1.80	112.32	796.94	0.42	555.78	0.42	1142.50	0.41	2434.80	1810.30	3298.80
4.00	14.00	1.80	112.32	859.98	0.42	607.77	0.42	1216.80	0.42	2690.40	1896.60	3816.40
4.00	18.00	1.80	112.32	1047.80	0.41	722.69	0.41	1518.20	0.41	3286.10	2216.30	4593.40
8.00	24.00	1.80	112.32	990.42	0.42	696.21	0.42	1408.90	0.42	3364.00	2306.80	4703.80
8.00	32.00	1.80	112.32	1030.15	0.41	723.98	0.41	1465.60	0.41	3411.05	2731.40	4543.80
8.00	40.00	1.80	112.32	1062.45	0.40	748.11	0.40	1508.80	0.40	3448.55	2768.50	4609.90
8.00	48.00	1.80	112.32	1197.65	0.39	832.71	0.39	1722.10	0.39	3913.85	3045.60	5040.60
8.00	56.00	1.80	112.32	1456.70	0.38	1023.10	0.38	2074.00	0.38	3952.00	3078.60	5078.30
10.00	65.00	1.80	112.32	1551.80	0.38	1091.40	0.38	2206.30	0.38	4143.30	3375.10	5086.40
10.00	75.00	1.80	112.32	1612.30	0.38	1135.60	0.38	2289.10	0.38	4354.55	3551.70	5338.90
10.00	85.00	1.80	112.32	1745.65	0.38	1233.20	0.38	2471.00	0.38	4642.65	3782.30	5698.60
10.00	95.00	1.80	112.32	1684.10	0.38	1187.60	0.38	2388.10	0.38	4636.45	3775.40	5693.80
10.00	105.00	1.80	112.32	1880.90	0.37	1330.00	0.37	2659.90	0.37	4705.50	3842.00	5763.00
10.00	115.00	1.80	112.32	1833.30	0.38	1296.30	0.38	2592.70	0.38	4711.90	3847.20	5770.90
10.00	125.00	1.80	112.32	1801.80	0.38	1274.10	0.38	2548.20	0.38	4723.00	3856.30	5784.50
10.00	135.00	2.20	137.28	2702.00	0.30	2206.20	0.30	3309.20	0.30	5098.80	4163.20	6244.70
10.00	145.00	2.20	137.28	2758.80	0.30	2252.60	0.30	3378.80	0.30	5209.10	4253.20	6379.80
10.00	155.00	2.20	137.28	2787.60	0.30	2276.10	0.30	3414.10	0.30	5267.50	4300.90	6451.30
10.00	165.00	2.20	137.28	2798.50	0.30	2285.00	0.30	3427.50	0.30	5292.60	4321.40	6482.10
10.00	175.00	2.20	137.28	2766.00	0.31	2258.40	0.31	3387.60	0.31	5241.90	4280.00	6420.00
10.00	185.00	2.20	137.28	2746.10	0.31	2238.30	0.31	3369.20	0.31	5212.50	4256.00	6384.00
10.00	195.00	2.20	137.28	2795.50	0.31	2271.50	0.31	3440.30	0.31	5307.50	4333.60	6500.30
12.50	206.25	2.20	137.28	2820.95	0.31	2270.70	0.31	3526.40	0.30	5349.60	4356.30	6589.30
12.50	218.75	2.20	137.28	2844.90	0.31	2300.20	0.31	3540.20	0.31	5400.10	4397.00	6632.00
12.50	231.25	2.20	137.28	2874.60	0.31	2301.60	0.31	3610.10	0.31	5460.10	4444.30	6744.60
12.50	243.75	2.20	137.28	2925.25	0.31	2343.30	0.31	3667.30	0.31	5557.15	4520.40	6848.40
12.50	256.25	2.20	137.28	2975.40	0.31	2415.80	0.31	3687.50	0.30	5639.90	4584.90	6937.60
12.50	268.75	2.20	137.28	2980.15	0.31	2419.30	0.31	3682.20	0.31	5653.40	4594.80	6955.80
12.50	281.25	2.20	137.28	3002.70	0.31	2435.70	0.31	3687.90	0.31	5699.20	4637.20	7004.30
12.50	293.75	2.20	137.28	3000.00	0.31	2431.80	0.31	3684.90	0.31	5699.20	4637.20	7004.30
15.00	307.50	2.20	137.28	3074.40	0.31	2503.10	0.31	3776.10	0.31	5834.70	4748.20	7169.80
15.00	322.50	2.20	137.28	3095.80	0.31	2520.30	0.31	3802.60	0.31	5878.00	4783.40	7222.90
15.00	337.50	2.20	137.28	3219.90	0.31	2620.80	0.31	3955.80	0.31	6101.95	4965.70	7498.10
15.00	352.50	2.20	137.28	3285.65	0.31	2672.80	0.30	4039.00	0.31	6221.75	5059.30	7651.10
15.00	367.50	2.20	137.28	3360.00	0.30	2733.00	0.30	4130.80	0.30	6358.35	5170.50	7819.00
15.00	382.50	2.20	137.28	3396.20	0.30	2762.30	0.30	4175.60	0.30	6427.10	5226.30	7903.60
15.00	397.50	2.20	137.28	3410.75	0.31	2774.00	0.30	4193.60	0.31	6457.45	5251.10	7940.90
15.00	412.50	2.20	137.28	3408.65	0.31	2772.20	0.31	4191.20	0.31	6457.45	5251.10	7940.90
15.00	427.50	2.20	137.28	3406.60	0.31	2770.40	0.31	4188.90	0.31	6457.45	5251.10	7940.90
15.00	442.50	2.20	137.28	3404.80	0.31	2768.80	0.31	4186.70	0.31	6457.60	5251.10	7941.10
15.00	457.50	2.20	137.28	3500.05	0.31	2846.20	0.31	4304.00	0.31	6631.70	5392.70	8155.20
15.00	472.50	2.20	137.28	3519.95	0.31	2862.30	0.31	4328.60	0.31	6670.15	5424.00	8202.50
15.00	487.50	2.20	137.28	3549.25	0.31	2886.00	0.31	4364.90	0.31	6722.35	5466.40	8266.70

Note: The horizontal shear-strain data, the damping values and metric equivalent data from pages G-9 and G-10 have been intentionally excluded from this spreadsheet for clarity as these items do not figure with subsequent calculation.

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

LOWER BOUND VALUES:
SEE PAGE G-11 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' LOWER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY (4) ρ (PCF)	SHEAR WAVE VELOCITY (4) Vs (FPS)	COMP. WAVE VELOCITY (4) Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) G'=(ρ*Vs²/g*1000) (2a)	POISSON'S RATIO (1) μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ (2b)	Z/W (5)	INFLUENCE COEFFICIENT Nq (3)	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	542.8	1359.5	1028.8	0.384	1.534	2846.9	0.00881	1.000	4.0000	1.41E-03
2	4.00	6.00	112.32	530.5	1599.4	982.7	0.410	1.639	2770.8	0.02643	1.000	4.0000	1.44E-03
3	4.00	10.00	112.32	555.8	1810.3	1078.5	0.416	1.665	3055.0	0.04405	1.000	4.0000	1.31E-03
4	4.00	14.00	112.32	607.8	1896.6	1289.7	0.417	1.666	3653.7	0.06167	1.000	4.0000	1.09E-03
5	4.00	18.00	112.32	722.7	2216.3	1823.5	0.413	1.650	5151.8	0.07930	1.000	4.0000	7.76E-04
6	8.00	24.00	112.32	696.2	2306.8	1692.3	0.419	3.356	4804.4	0.10573	1.000	8.0000	1.67E-03
7	8.00	32.00	112.32	724.0	2731.4	1830.0	0.409	3.272	5157.0	0.14097	1.000	8.0000	1.55E-03
8	8.00	40.00	112.32	748.1	2768.5	1954.1	0.398	3.183	5463.1	0.17621	1.000	8.0000	1.46E-03
9	8.00	48.00	112.32	832.7	3045.6	2421.0	0.393	3.141	6743.0	0.21145	1.000	8.0000	1.19E-03
10	8.00	56.00	112.32	1023.1	3078.6	3654.6	0.379	3.029	10076.5	0.24670	0.972	7.7744	7.72E-04
11	10.00	65.00	112.32	1091.4	3375.1	4158.9	0.379	3.795	11473.9	0.28634	0.930	9.2950	8.10E-04
12	10.00	75.00	112.32	1135.6	3551.7	4502.5	0.379	3.787	12415.6	0.33040	0.883	8.8250	7.11E-04
13	10.00	85.00	112.32	1233.2	3782.3	5309.7	0.376	3.760	14612.7	0.37445	0.836	8.3550	5.72E-04
14	10.00	95.00	112.32	1187.6	3775.4	4924.3	0.380	3.805	13595.8	0.41850	0.789	7.8850	5.80E-04
15	10.00	105.00	112.32	1330.0	3842.0	6176.0	0.374	3.739	16970.7	0.46256	0.748	7.4775	4.41E-04
16	10.00	115.00	112.32	1296.3	3847.2	5867.0	0.377	3.774	16162.6	0.50661	0.713	7.1325	4.41E-04
17	10.00	125.00	112.32	1274.1	3856.3	5667.8	0.381	3.805	15648.9	0.55066	0.679	6.7875	4.34E-04
18	10.00	135.00	137.28	2206.2	4163.2	20770.5	0.303	3.034	54143.2	0.59471	0.644	6.4425	1.19E-04
19	10.00	145.00	137.28	2252.6	4253.2	21653.3	0.304	3.036	56455.8	0.63877	0.610	6.0975	1.08E-04
20	10.00	155.00	137.28	2276.1	4300.9	22107.5	0.304	3.040	57655.8	0.68282	0.575	5.7525	9.98E-05
21	10.00	165.00	137.28	2285.0	4321.4	22280.7	0.304	3.044	58125.9	0.72687	0.541	5.4075	9.30E-05
22	10.00	175.00	137.28	2258.4	4280.0	21765.0	0.305	3.053	56818.7	0.77093	0.506	5.0625	8.91E-05
23	10.00	185.00	137.28	2238.3	4256.0	21379.3	0.306	3.060	55842.2	0.81498	0.472	4.7175	8.45E-05
24	10.00	195.00	137.28	2271.5	4333.6	22018.2	0.306	3.061	57515.0	0.85903	0.437	4.3725	7.60E-05
25	12.50	206.25	137.28	2270.7	4356.3	22002.7	0.306	3.831	57491.7	0.90859	0.409	5.1094	8.89E-05
26	12.50	218.75	137.28	2300.2	4397.0	22578.1	0.307	3.835	59009.2	0.96366	0.386	4.8281	8.18E-05
27	12.50	231.25	137.28	2301.6	4444.3	22605.6	0.307	3.837	59090.1	1.01872	0.364	4.5469	7.69E-05
28	12.50	243.75	137.28	2343.3	4520.4	23432.1	0.307	3.837	61250.7	1.07379	0.341	4.2656	6.96E-05
29	12.50	256.25	137.28	2415.8	4584.9	24904.5	0.306	3.826	65054.6	1.12885	0.319	3.9844	6.12E-05
30	12.50	268.75	137.28	2419.3	4594.8	24976.7	0.306	3.830	65259.2	1.18392	0.296	3.7031	5.67E-05
31	12.50	281.25	137.28	2435.7	4637.2	25316.5	0.306	3.822	66112.5	1.23899	0.274	3.4219	5.18E-05
32	12.50	293.75	137.28	2431.8	4637.2	25235.5	0.306	3.827	65923.2	1.29405	0.251	3.1406	4.76E-05
33	15.00	307.50	137.28	2503.1	4748.2	26737.0	0.306	4.587	69827.9	1.35463	0.233	3.4965	5.01E-05
34	15.00	322.50	137.28	2520.3	4783.4	27105.7	0.306	4.591	70802.8	1.42070	0.219	3.2895	4.65E-05
35	15.00	337.50	137.28	2620.8	4965.7	29310.6	0.305	4.579	76516.9	1.48678	0.206	3.0825	4.03E-05
36	15.00	352.50	137.28	2672.8	5059.3	30485.2	0.305	4.575	79565.2	1.55286	0.192	2.8755	3.61E-05
37	15.00	367.50	137.28	2733.0	5170.5	31873.9	0.305	4.571	83173.1	1.61894	0.178	2.6685	3.21E-05
38	15.00	382.50	137.28	2762.3	5226.3	32561.0	0.305	4.571	84968.6	1.68502	0.164	2.4615	2.90E-05
39	15.00	397.50	137.28	2774.0	5251.1	32837.4	0.305	4.574	85703.1	1.75110	0.150	2.2545	2.63E-05
40	15.00	412.50	137.28	2772.2	5251.1	32794.8	0.305	4.579	85611.5	1.81718	0.142	2.1338	2.49E-05
41	15.00	427.50	137.28	2770.4	5251.1	32752.3	0.306	4.583	85518.8	1.88326	0.135	2.0303	2.37E-05
42	15.00	442.50	137.28	2768.8	5251.1	32714.4	0.306	4.587	85438.3	1.94934	0.128	1.9268	2.26E-05
43	15.00	457.50	137.28	2846.2	5392.7	34569.0	0.305	4.580	90248.0	2.01542	0.122	1.8233	2.02E-05
44	15.00	472.50	137.28	2862.3	5424.0	34961.2	0.305	4.581	91278.1	2.08150	0.115	1.7198	1.88E-05
45	15.00	487.50	137.28	2886.0	5466.4	35542.6	0.305	4.580	92790.3	2.14758	0.108	1.6163	1.74E-05
Summation Σ =	495.0000							162.1121				217.7629	1.8248E-02

(1) From Soil Data on Page G-11
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-11
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 11933 ksf
μ = ΣμH/ΣH 0.327
G' = E/(2*(1+ μ)) =: 4495 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1134.6 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1026.3 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.327 (Lower Bound Soil Case)
Shear Modulus, G' = 4495 ksf (Lower Bound Soil Case)

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

MEDIAN VALUES:
SEE PAGE G-11 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' MEDIAN (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq [3]	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	774.8	1935.5	2096.1	0.384	1.536	5802.0	0.00881	1.000	4.0000	6.89E-04
2	4.00	6.00	112.32	761.0	2163.7	2021.9	0.409	1.634	5695.9	0.02643	1.000	4.0000	7.02E-04
3	4.00	10.00	112.32	796.9	2434.8	2217.4	0.416	1.662	6277.8	0.04405	1.000	4.0000	6.37E-04
4	4.00	14.00	112.32	860.0	2690.4	2582.1	0.416	1.665	7313.3	0.06167	1.000	4.0000	5.47E-04
5	4.00	18.00	112.32	1047.8	3286.1	3833.2	0.413	1.650	10829.3	0.07930	1.000	4.0000	3.69E-04
6	8.00	24.00	112.32	990.4	3364.0	3424.8	0.419	3.355	9722.4	0.10573	1.000	8.0000	8.23E-04
7	8.00	32.00	112.32	1030.2	3411.1	3705.2	0.408	3.266	10435.7	0.14097	1.000	8.0000	7.67E-04
8	8.00	40.00	112.32	1062.5	3448.6	3941.2	0.397	3.178	11014.0	0.17621	1.000	8.0000	7.26E-04
9	8.00	48.00	112.32	1197.7	3913.9	5008.0	0.392	3.134	13939.8	0.21145	1.000	8.0000	5.74E-04
10	8.00	56.00	112.32	1456.7	3952.0	7408.8	0.378	3.023	20415.9	0.24670	0.972	7.7744	3.81E-04
11	10.00	65.00	112.32	1551.8	4143.3	8407.7	0.379	3.788	23184.9	0.28634	0.930	9.2950	4.01E-04
12	10.00	75.00	112.32	1612.3	4354.6	9076.1	0.378	3.784	25020.7	0.33040	0.883	8.8250	3.53E-04
13	10.00	85.00	112.32	1745.7	4642.7	10639.5	0.376	3.758	29275.4	0.37445	0.836	8.3550	2.85E-04
14	10.00	95.00	112.32	1684.1	4636.5	9902.4	0.380	3.801	27332.2	0.41850	0.789	7.8850	2.88E-04
15	10.00	105.00	112.32	1880.9	4705.5	12352.0	0.374	3.739	33941.3	0.46256	0.748	7.4775	2.20E-04
16	10.00	115.00	112.32	1833.3	4711.9	11734.7	0.377	3.774	32327.1	0.50661	0.713	7.1325	2.21E-04
17	10.00	125.00	112.32	1801.8	4723.0	11334.9	0.381	3.805	31296.0	0.55066	0.679	6.7875	2.17E-04
18	10.00	135.00	137.28	2702.0	5098.8	31154.9	0.303	3.034	81212.8	0.59471	0.644	6.4425	7.93E-05
19	10.00	145.00	137.28	2758.8	5209.1	32478.6	0.304	3.036	84680.0	0.63877	0.610	6.0975	7.20E-05
20	10.00	155.00	137.28	2787.6	5267.5	33160.2	0.304	3.040	86481.1	0.68282	0.575	5.7525	6.65E-05
21	10.00	165.00	137.28	2798.5	5292.6	33420.0	0.304	3.044	87186.2	0.72687	0.541	5.4075	6.20E-05
22	10.00	175.00	137.28	2766.0	5241.9	32648.3	0.305	3.053	85230.3	0.77093	0.506	5.0625	5.94E-05
23	10.00	185.00	137.28	2746.1	5212.5	32180.2	0.306	3.060	84054.1	0.81498	0.472	4.7175	5.61E-05
24	10.00	195.00	137.28	2795.5	5307.5	33348.4	0.306	3.061	87111.4	0.85903	0.437	4.3725	5.02E-05
25	12.50	206.25	137.28	2821.0	5349.6	33958.4	0.306	3.820	88670.1	0.90859	0.409	5.1094	5.76E-05
26	12.50	218.75	137.28	2844.9	5400.1	34537.4	0.306	3.825	90209.0	0.96366	0.386	4.8281	5.35E-05
27	12.50	231.25	137.28	2874.6	5460.1	35262.3	0.306	3.828	92120.7	1.01872	0.364	4.5469	4.94E-05
28	12.50	243.75	137.28	2925.3	5557.2	36515.9	0.306	3.828	95398.2	1.07379	0.341	4.2656	4.47E-05
29	12.50	256.25	137.28	2975.4	5639.9	37778.7	0.305	3.819	98639.0	1.12885	0.319	3.9844	4.04E-05
30	12.50	268.75	137.28	2980.2	5653.4	37899.4	0.306	3.823	98980.8	1.18392	0.296	3.7031	3.74E-05
31	12.50	281.25	137.28	3002.7	5699.2	38475.1	0.306	3.825	100499.7	1.23899	0.274	3.4219	3.40E-05
32	12.50	293.75	137.28	3000.0	5699.2	38406.0	0.306	3.830	100349.8	1.29405	0.251	3.1406	3.13E-05
33	15.00	307.50	137.28	3074.4	5834.7	40334.5	0.306	4.591	105359.0	1.35463	0.233	3.4965	3.32E-05
34	15.00	322.50	137.28	3095.8	5878.0	40898.0	0.306	4.594	106846.4	1.42070	0.219	3.2895	3.08E-05
35	15.00	337.50	137.28	3219.9	6102.0	44242.6	0.305	4.581	115509.6	1.48678	0.206	3.0825	2.67E-05
36	15.00	352.50	137.28	3285.7	6221.8	46067.9	0.305	4.577	120249.8	1.55286	0.192	2.8755	2.39E-05
37	15.00	367.50	137.28	3360.0	6358.4	48176.4	0.305	4.572	125724.1	1.61894	0.178	2.6685	2.12E-05
38	15.00	382.50	137.28	3396.2	6427.1	49220.1	0.305	4.573	128448.8	1.68502	0.164	2.4615	1.92E-05
39	15.00	397.50	137.28	3410.8	6457.5	49642.8	0.305	4.575	129570.1	1.75110	0.150	2.2545	1.74E-05
40	15.00	412.50	137.28	3408.7	6457.5	49581.7	0.305	4.580	129438.4	1.81718	0.142	2.1338	1.65E-05
41	15.00	427.50	137.28	3406.6	6457.5	49522.0	0.306	4.584	129309.0	1.88326	0.135	2.0303	1.57E-05
42	15.00	442.50	137.28	3404.8	6457.6	49469.7	0.306	4.587	129198.1	1.94934	0.128	1.9268	1.49E-05
43	15.00	457.50	137.28	3500.1	6631.7	52276.3	0.305	4.580	136475.6	2.01542	0.122	1.8233	1.34E-05
44	15.00	472.50	137.28	3520.0	6670.2	52872.4	0.305	4.581	138039.8	2.08150	0.115	1.7198	1.25E-05
45	15.00	487.50	137.28	3549.3	6722.4	53756.3	0.305	4.580	140337.3	2.14758	0.108	1.6163	1.15E-05
Summation Σ =	495.0000							162.0318				217.7629	9.2517E-03

(1) From Soil Data on Page G-11
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-11
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 23538 ksf
μ = ΣμH/ΣH 0.327
G' = E/(2*(1+ μ)) =: 8866 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 1593.6 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 1441.4 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : **Poisson's Ratio, μ =** **0.327** **(Median Soil Case)**
Shear Modulus, G' = **8866 ksf** **(Median Soil Case)**

CALCULATION OF EQUIVALENT SHEAR MODULUS: 1E-4 EVENT (10000 YR. RETURN PERIOD GROUND MOTION)

UPPER BOUND VALUES:
SEE PAGE G-11 FOR STRAIN COMPATIBLE SOIL PROPERTIES

USING 130' UPPER BOUND (Soil Property) VALUES:

LENGTH OF BUILDING (L) =: **227** **FT** (Page 15 of this Calculation)
WIDTH OF BUILDING (B) =: **242** **FT** (Page 15 of this Calculation)

Note: Depth = 0.0 is at soil surface

LAYER NO.	LAYER THICKNESS H (FT)	DEPTH (Z) TO MID-HEIGHT OF LAYER (FT)	DENSITY [4] ρ (PCF)	SHEAR WAVE VELOCITY [4] Vs (FPS)	COMP. WAVE VELOCITY [4] Vp (FPS)	DYNAMIC SHEAR MODULUS G' (KSF) $G'=(\rho*Vs^2/g*1000)$ [2a]	POISSON'S RATIO [1] μ	μH (FT)	YOUNGS MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [2b]	Z/W [5]	INFLUENCE COEFFICIENT Nq [3]	Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1105.9	2755.5	4270.1	0.384	1.538	11823.3	0.00881	1.000	4.0000	3.38E-04
2	4.00	6.00	112.32	1091.3	2948.0	4158.1	0.407	1.630	11704.3	0.02643	1.000	4.0000	3.42E-04
3	4.00	10.00	112.32	1142.5	3298.8	4557.4	0.415	1.659	12895.3	0.04405	1.000	4.0000	3.10E-04
4	4.00	14.00	112.32	1216.8	3816.4	5169.5	0.416	1.663	14637.4	0.06167	1.000	4.0000	2.73E-04
5	4.00	18.00	112.32	1518.2	4593.4	8047.6	0.413	1.650	22734.7	0.07930	1.000	4.0000	1.76E-04
6	8.00	24.00	112.32	1408.9	4703.8	6930.5	0.419	3.354	19673.1	0.10573	1.000	8.0000	4.07E-04
7	8.00	32.00	112.32	1465.6	4543.8	7499.6	0.408	3.260	21111.9	0.14097	1.000	8.0000	3.79E-04
8	8.00	40.00	112.32	1508.8	4609.9	7948.2	0.397	3.174	22202.9	0.17621	1.000	8.0000	3.60E-04
9	8.00	48.00	112.32	1722.1	5040.6	10354.3	0.391	3.127	28803.3	0.21145	1.000	8.0000	2.78E-04
10	8.00	56.00	112.32	2074.0	5078.3	15018.4	0.377	3.016	41361.9	0.24670	0.972	7.7744	1.88E-04
11	10.00	65.00	112.32	2206.3	5086.4	16995.5	0.378	3.781	46844.1	0.28634	0.930	9.2950	1.98E-04
12	10.00	75.00	112.32	2289.1	5338.9	18295.1	0.378	3.781	50423.2	0.33040	0.883	8.8250	1.75E-04
13	10.00	85.00	112.32	2471.0	5698.6	21318.2	0.376	3.756	58648.6	0.37445	0.836	8.3550	1.42E-04
14	10.00	95.00	112.32	2388.1	5693.8	19911.8	0.380	3.797	54943.9	0.41850	0.789	7.8850	1.44E-04
15	10.00	105.00	112.32	2659.9	5763.0	24702.3	0.374	3.739	67877.9	0.46256	0.748	7.4775	1.10E-04
16	10.00	115.00	112.32	2592.7	5770.9	23469.9	0.377	3.774	64655.3	0.50661	0.713	7.1325	1.10E-04
17	10.00	125.00	112.32	2548.2	5784.5	22671.1	0.381	3.805	62595.4	0.55066	0.679	6.7875	1.08E-04
18	10.00	135.00	137.28	3309.2	6244.7	46730.7	0.303	3.034	121814.8	0.59471	0.644	6.4425	5.29E-05
19	10.00	145.00	137.28	3378.8	6379.8	48717.1	0.304	3.036	127018.1	0.63877	0.610	6.0975	4.80E-05
20	10.00	155.00	137.28	3414.1	6451.3	49740.3	0.304	3.040	129721.8	0.68282	0.575	5.7525	4.43E-05
21	10.00	165.00	137.28	3427.5	6482.1	50131.6	0.304	3.044	130783.2	0.72687	0.541	5.4075	4.13E-05
22	10.00	175.00	137.28	3387.6	6420.0	48971.2	0.305	3.053	127842.2	0.77093	0.506	5.0625	3.96E-05
23	10.00	185.00	137.28	3369.2	6384.0	48440.6	0.306	3.060	126526.0	0.81498	0.472	4.7175	3.73E-05
24	10.00	195.00	137.28	3440.3	6500.3	50506.7	0.306	3.061	131931.5	0.85903	0.437	4.3725	3.31E-05
25	12.50	206.25	137.28	3526.4	6589.3	53066.4	0.305	3.808	138468.2	0.90859	0.409	5.1094	3.69E-05
26	12.50	218.75	137.28	3540.2	6632.0	53482.5	0.305	3.814	139604.3	0.96366	0.386	4.8281	3.46E-05
27	12.50	231.25	137.28	3610.1	6744.6	55615.3	0.305	3.818	145207.2	1.01872	0.364	4.5469	3.13E-05
28	12.50	243.75	137.28	3667.3	6848.4	57391.7	0.306	3.819	149853.2	1.07379	0.341	4.2656	2.85E-05
29	12.50	256.25	137.28	3687.5	6937.6	58025.7	0.305	3.811	151434.3	1.12885	0.319	3.9844	2.63E-05
30	12.50	268.75	137.28	3682.2	6955.8	57859.0	0.305	3.816	151043.2	1.18392	0.296	3.7031	2.45E-05
31	12.50	281.25	137.28	3687.9	7004.3	58038.3	0.306	3.829	151636.6	1.23899	0.274	3.4219	2.26E-05
32	12.50	293.75	137.28	3684.9	7004.3	57943.9	0.307	3.834	151431.7	1.29405	0.251	3.1406	2.07E-05
33	15.00	307.50	137.28	3776.1	7169.8	60847.6	0.306	4.595	158970.3	1.35463	0.233	3.4965	2.20E-05
34	15.00	322.50	137.28	3802.6	7222.9	61704.6	0.306	4.597	161229.2	1.42070	0.219	3.2895	2.04E-05
35	15.00	337.50	137.28	3955.8	7498.1	66776.7	0.306	4.583	174359.3	1.48678	0.206	3.0825	1.77E-05
36	15.00	352.50	137.28	4039.0	7651.1	69615.2	0.305	4.579	181736.0	1.55286	0.192	2.8755	1.58E-05
37	15.00	367.50	137.28	4130.8	7819.0	72815.6	0.305	4.574	190040.0	1.61894	0.178	2.6685	1.40E-05
38	15.00	382.50	137.28	4175.6	7903.6	74403.6	0.305	4.574	194181.5	1.68502	0.164	2.4615	1.27E-05
39	15.00	397.50	137.28	4193.6	7940.9	75046.5	0.305	4.576	195884.8	1.75110	0.150	2.2545	1.15E-05
40	15.00	412.50	137.28	4191.2	7940.9	74960.6	0.305	4.580	195699.6	1.81718	0.142	2.1338	1.09E-05
41	15.00	427.50	137.28	4188.9	7940.9	74878.3	0.306	4.584	195522.3	1.88326	0.135	2.0303	1.04E-05
42	15.00	442.50	137.28	4186.7	7941.1	74799.7	0.306	4.588	195352.9	1.94934	0.128	1.9268	9.86E-06
43	15.00	457.50	137.28	4304.0	8155.2	79049.8	0.305	4.580	206372.1	2.01542	0.122	1.8233	8.83E-06
44	15.00	472.50	137.28	4328.6	8202.5	79956.0	0.305	4.581	208747.6	2.08150	0.115	1.7198	8.24E-06
45	15.00	487.50	137.28	4364.9	8266.7	81302.7	0.305	4.579	212245.5	2.14758	0.108	1.6163	7.62E-06
Summation Σ =	495.0000							161.9515				217.7629	4.7314E-03

(1) From Soil Data on Page G-11
(2a) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Eq. (20-15)
(2b) Ref. 2.2.4, Bowles Foundation Analysis and Design, 5th Ed. Page 121
(3) Nq values by Newmark Charts see Attachment E
q_o = 1 KSF (see discussion in Sect 4.3.3 on Page 11 of this calculation)

(4) Shear Wave Velocity and density values are from Page G-11
E = SUM[(Nq*H) /SUM(Nq*H/E_i)] =: 46025 ksf
μ = Σμ$_i$H /ΣH 0.327
G' = E/(2*(1+ μ)) =: 17340 ksf
Vs = SQRT(32.17*1000*G'/ρ) =: 2228.5 fps (density =112.32)
Vs = SQRT(32.17*1000*G'/ρ) =: 2015.8 fps (density =137.28)

(5) Ratio of depth to mid-height of layer to width of building

USE (130' Alluvium) : Poisson's Ratio, μ = 0.327 (Upper Bound Soil Case)
Shear Modulus, G' = 17340 ksf (Upper Bound Soil Case)

SUMMARY OF DYNAMIC SHEAR MODULUS G' (KSF) AND POISSON'S RATIO VALUES FOR 1E-4 EVENT

130' Alluvium					
Lower Bound Soil Case		**Median Soil Case**		**Upper Bound Soil Case**	
Dynamic Shear Modulus G' (KSF)	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**	**Dynamic Shear Modulus G' (KSF)**	**Poisson's Ratio, μ**
4,495	0.327	8,866	0.327	17,340	0.327
Page G-12	Page G-12	Page G-13	Page G-13	Page G-14	Page G-15

TABLE G-1 SHEAR MODULUS COMPARISON: 5E-4

	130' SHEAR MODULUS G' (KSF)		
STRAIN COMPATIBLE SOIL DATA	**LOWER BOUND**	**MEDIAN**	**UPPER BOUND**
MO0706SCSPS5E4.002	6807	13068	24797
MO0801SCSPS5E4.003	6802	13060	24797
% CHANGE	0.07	0.06	0.00

TABLE G-2 SHEAR MODULUS COMPARISON: 1E-4

	130' SHEAR MODULUS G' (KSF)		
STRAIN COMPATIBLE SOIL DATA	**LOWER BOUND**	**MEDIAN**	**UPPER BOUND**
MO0706SCSPS1E4.002	4556	8988	17577
MO0801SCSPS1E4.003	4495	8866	17340
% CHANGE	1.34	1.36	1.35

% CHANGE = [(New Value - Old Value)/Old Value] X 100

As seen in Tables G-1 and G-2 the maximum % change in G and thus the corresponding % change in spring stiffness values from the qualified data compared to the superceded data used in the soil spring calculations is 1.36%, maximum . The effect of this change in soil stiffness on the seismic analysis results is even less since frequency of a system a function of stiffness and mass given by: $f = \sqrt{k/m}$ .Thus a 1.36% change (maximum in Table G-2) in stiffness will result in a $\sqrt{1.0136} = 1.007$ that is 0.7% shift in frequency. Given the broad band nature of the YMP input ground spectra (Ref. 2.2.14) the effect of this 0.7% change in frequency will have a negligible impact on the computed seismic analysis results. The existing seismic analysis results based on the soil springs computed using the superceded data contained in MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002 are adequate for use in the preliminary design of the Receipt Facility (RF).