BSC

Design Calculation or Analysis Cover Sheet

Complete only applicable items.

1. QA: QA
2. Page 1

3. System	4. Document Identifier
Canister Receipt and Closure Facility	060-SYC-CR00-00700-000-00C

5. Title
CRCF Soil Springs – 2007 Strain Compatible Soil Properties

6. Group
Civil/Structural/Architectural

7. Document Status Designation
☐ Preliminary ☒ Committed ☐ Confirmed ☐ Cancelled/Superseded

8. Notes/Comments

Rev. A and B of this calculation were based on strain compatible soil properties given in Data Tracking Numbers (DTN's) MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002. These DTN's were un-qualified and were subsequently superceded by DTNS MO0801SCSPS5E4.003 and MO0801SCSPS5E4.003. Rev. C of this calculation in Attachment B evaluates the new DTN's and assesses the impact on the computed impedance functions.

Attachments	Total Number of Pages
ATTACHMENT A - EXILE HILL FAULT SPLAY LOCATION PLAN	1
ATTACHMENT B - ASSESSMENT OF REVISED SOIL PROPERTIES	15

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	58	58	J. Char 8/14/2007	A. Dutt 8/14/2007	M. Denlinger 8/14/2007	R. Rajagopal 8/14/2007
00B	Added reference 2.2.11, 2.2.12 and Attachment A, revised pages 3 & 25, and sections 2.1, 2.2, 2.4, 4.2, 4.3.1, and 5. Deleted section 2.1.3.	59	A-1	A. Joshi	S. Kothari	M. Denlinger	R. Rajagopal
00C	Added Attachment B, revised pages 3, 6, thru 9, 11 thru 24, 26 thru 29 and added section 7.1.6. See notes above.	74	B-15	H. Ko [signature] 2/29/2008	K C Hsu T. FRANKERT FOR K.C.H. Thomas Frankert 2/29/08	M. Denlinger T. FRANKERT FOR M.D. Thomas Frankert 2/29/08	R. Rajagopal [signature] 2/29/08

DISCLAIMER

CONTENT

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

kip	1000 pound force
ksf	kips per square foot
ASCE	American Society of Civil Engineers
BDBGM	beyond design basis ground motion
BSC	Bechtel SAIC Company
CRCF	Canister Receipt and Closure Facility
DBGM	design basis ground motion
DIRS	Document Input Reference System
ITS	important to safety
LLC	limited liability company
ORD	Office of Repository Development'
PC	personal computer
QA	quality assurance
SAIC	Science Applications International Corporation
SSC's	structures, systems, and components
SASSI	System for Analysis of Soil-Structure Interaction
SSI	Soil-Structure Interaction
TAD	transportation aging and disposal
TIC	Technical Information Center
YMP	Yucca Mountain Project

1. PURPOSE

The purpose of this calculation is to compute foundation impedance functions (Soil Springs and Damping values) for 2,000 and 10,000 year return periods (Annual Exceedance Frequency of 5E-4 and 1E-4) seismic events (Ref. 2.2.1, section 4.2.11.2.1) for 100' and 200' alluvium soil cases for use in a seismic analysis of the Canister Receipt and Closure Facility (CRCF). The basis of design for the CRCF is defined in the 000-3DR-MGR0-00300-000-000, *Basis of Design for the TAD Canister–Based Repository Design Concept* (Ref. 2.2.2).

For the Tier-1 seismic analysis of the CRCF, a lumped mass multiple 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 and Damping values for use in the seismic analysis for 100' and 200' alluvium soil cases.

Soil spring values computed in the body of this calculation are based on DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002 which have been superceded by DTN's given in Refs. 2.2.9 and 2.2.10 respectively. An assessment of the impact of the superceded data is provided in attachment B

2. REFERENCES

2.1 PROJECT PROCEDURES/DIRECTIVES

2.1.1 BSC 2007. *Calculations and Analyses.* EG-PRO-3DP-G04B-00037, Rev.010, ICN : 0
Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071018.0001.

2.1.2 BSC 2007. *Software Management.* IT-PRO-0011 Rev.007, ICN: 0.
Las Vegas, Nevada, Bechtel SAIC Company. ACC: DOC.20070905.0007.

2.2 DESIGN INPUTS

2.2.1 BSC 2007. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000 Rev. 007.
Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071016.0005.

2.2.2 BSC 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.

2.2.3 ASCE 4-98. 2000.
Seismic Analysis of Safety-Related Nuclear Structures and Commentary.
Reston, Virginia: American Society of Civil Engineers.
TIC: 253158. **[ISBN 0-7844-0433-X]**

2.2.4 BSC 2006. *Canister Receipt and Closure Facility (CRCF) Soil Springs.* 060-SYC-CR00-00300-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061129.001

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

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

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

2.2.11 SNL (Sandia National Laboratories) 2007. *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 00. Las Vegas, NV: Sandia National Laboratories. **[DIRS 183779]**

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

2.2.13 BSC 2007. *Seismic Analysis and Design Approach Document.* 000-30R-MGR0-02000-000 Revision 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 calculation CRCF Seismic Analysis – 2007 Seismic Input Ground Motions, and CRCF Tier-1 In-Structure Response Spectra.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

None

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* (Ref. 2.1.1). Section 4.1.2 of the *Basis of Design for the TAD Canister–Based Repository Design Concept* (Ref. 2.2.2) classifies the CRCF structure as Important To Safety (ITS). Therefore, the approved version of this calculation is designated as QA: QA.

4.2 USE OF SOFTWARE

Word 2003 & Excel 2003, which are part of the Microsoft Office 2003 Professional suite of programs, were used in preparation of the calculation. Excel 2003 was used in section 6 to calculate Shear Modulus by inputting soil properties. Inputs for Excel are located in section 4.3.1 and outputs are found in section 6. Microsoft Office 2003, as used in the calculation is classified as Level 2 software usage as defined in IT-PRO-0011, *Software Management* (Ref. 2.1.2). Microsoft Office 2003 is also listed on the LEVEL 2 USAGE Controlled Software Report (SW Tracking Number 610236-2003-00).

Mathcad 13 was utilized to perform the mathematical computations to calculate soil springs and soil damping values. All Mathcad input values and equations are stated in the calculation section 6. Inputs for Mathcad are located in section 6.1.1 and outputs are found in section 6. Checking of the Mathcad template was done by using a hand calculator to check the operations being performed by Mathcad.

Mathcad 2003, as used in the calculation is classified as Level 2 software usage as defined in IT-PRO-0011, *Software Management* (Ref. 2.1.2). Mathcad version 13 is listed on the LEVEL 2 USAGE Controlled Software Report (SW Tracking Number 611161-13-00).

The software was executed on a PC system running Microsoft Windows XP operating system.

4.3 DESIGN APPROACH

4.3.1 Soil Springs

The soil impedance functions computed in section 6 and summarized in sections 7.1.1 through 7.1.5 are based on data contained in DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002 which have been superceded by DTN's MO0801SCSPS5E4.003 (Ref. 2.2.9) and MO0801SCSPS1E4.003 (Ref. 2.2.10). The impact of the superceding data, given in Ref's 2.2.9 and 2.2.10 on the computed impedance functions is assessed in Attachment B of this calculation. Results of this assessment are discussed in section 7.1.6.

The CRCF is a surface structure, which rests on a layered alluvial material with varying properties. The CRCF structures are located on the Northeast side (with respect to the true North) of the Exile Hill Fault Splay, see Attachment A. The alluvium depth varies from 100' to 200', see Fig. 6.2-4, Alluvium Thickness Contour Map of Midway Valley, Nevada, and Table 6.2.2, Borehole Locations and Alluvium Depth for Boreholes used in Figure 6.2-4, Ref. 2.2.11. Use soil properties for Northeast-100ft & 200ft data sets from DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002. (See discussion in above paragraph regarding the use of these DTN's which have been superceded)

For the purpose 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 a set of frequency independent soils springs, damping coefficients and corresponding percent of critical damping will be computed in accordance with ASCE 4-98 (Ref. 2.2.3) Section 3.3.4.2.

Frequency independent soil springs and corresponding percent of critical 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 Poisson's Ratio. Damping values are computed using ASCE 4-98 (Ref. 2.2.3) Table 3.3-1. Computation of the dynamic shear modulus follows the procedure recommended in Hadjian, A.H. and Ellison, B., 1985 "Equivalent Properties for Layered Media." *Soil Dynamics and Earthquake Engineering* (Ref. 2.2.7) and is summarized below :

The excel spreadsheets in Section 6.1.1 show that the shear wave velocity varies with depth under the surface facilities located on the Yucca Mountain Project North Portal pad.

Since the dynamic shear modulus is a function of the shear wave velocity it also varies with depth. An equivalent shear modulus needs to be computed for use in determining the frequency independent soil springs. A method for evaluating the effect of layered soil properties is discussed in a paper by Hadjian, A.H. and Ellison, B., 1985 "Equivalent Properties for Layered Media.", *Soil Dynamics and Earthquake Engineering* (Ref. 2.2.7). The method derived in this paper is appropriate for computing soil springs in layered media for use in soil structure interaction problems. The method discussed in the paper is summarized below:

Note: For ease of understanding Ref. 2.2.7 Equation 1(a) is redefined as follows:

The relative vertical layer displacements are given by: (Ref. 2.2.6, Page 76, eq. 3)

$\Delta_1 = (P * H_1)/ (A_1 * E_1) = (Nq_1 * H_1)/ E_1$ (ft)

$\Delta_2 = (P * H_2)/ (A_2 * E_2) = (Nq_2 * H_2)/ E_2$ (ft)

$\Delta_n = (P * H_n)/ (A_n * E_n) = (Nq_n * H_n)/ E_n$ (ft)

Where P = Dead Weight of Building (kip) H_n = Thickness of soil layer, n (ft)

A_n= Effective area at layer, n (ft^2) E_n = Modulus of Elasticity for soil layer, n (ksf)

Nq_n = Boussinesq coefficient from Newmark's influence diagrams (Ref. 2.2.5)

Δ_i (i =1…n) = Vertical displacement in layer i (ft)

Thus the total displacement is: $\Delta = (Nq_1 * H_1)/ E_1 + (Nq_2 * H_2)/ E_2 + \ldots (Nq_n * H_n)/E_n$ (Eq. 1)

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

$$\Delta = (Nq_1 * H_1)/ E + (Nq_2 * H_2)/ E + \ldots (Nq_n * H_n)/ E \quad \text{(ft)}$$

or $\Delta = \{(Nq_1 * H_1) + (Nq_2 * H_2) + \ldots (Nq_n * H_n)\} / E$ (ft) (Eq. 2)

For the displacements to be equal the equivalent modulus of elasticity may be computed by equating Eq. 1 and Eq. 2, which yields:

$$E = \{(Nq_1 * H_1) + (Nq_2 * H_2) + \ldots (Nq_n * H_n)\} / \{(Nq_1 * H_1)/ E_1 + (Nq_2 * H_2)/ E_2 + \ldots (Nq_n * H_n)/ E_n\}$$

Which may be rewritten as : $$E = \frac{\sum_{i=1}^{n}(Nq_i * H_i)}{\sum_{i=1}^{n}(Nq_{i*}H_i / E_i)} \text{ (ksf)} \qquad \text{(Eq. 3)}$$

Once E has been determined an equivalent dynamic shear modulus can be computed as G = E / 2*(1 + μ) (ksf) where μ is the average Poisson's Ratio for the soil at the 100' and 200' alluvium cases.

Process

1. Divide the soil media into layers and determine the representative shear wave velocity for each layer. The soil has been divided into 45 layers for both the 100' and 200' alluvium cases. The shear wave velocity for each layer was taken from references 2.2.9 and 2.2.10, Northeast-100ft & 200ft data sets.

2. Compile a table of shear wave velocities and densities for each layer based on strain compatible soil properties using data given in DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002 for the Northeast-100ft & 200ft data sets.

3. Compute dynamic shear modulus, G', for each layer based on the shear wave velocities for each layer using Eq. 20-15 from Bowles Foundation Analysis and Design, 5th Edition (Ref. 2.2.5).

4. Compute soil modulus E' for each layer based on Poisson's Ratio at each individual soil layer (DTN's MO0706SCSPS5E4.002 and MO0706SCSPS1E4.002, Northeast-100ft & 200ft data sets), and the G' value for each soil layer computed in step 3.

5. Use the Newmark's influence coefficient (Nq) from 060-SYC-CR00-00300-000-00A, *Canister Receipt and Closure Facility (CRCF) Soil Springs* (Ref. 2.2.4) Figure 3.

6. Compute an equivalent E for the entire depth to 495' using equation 3 previously shown.

7. Using the equivalent E from step 6 compute an equivalent shear modulus, G.

8. Compute soil spring values using ASCE 4-98 Section 3.3.4.2 (Ref. 2.2.3) and the equivalent shear modulus values computed in step 7.

4.3.2 Soil Damping Values

Equivalent damping coefficients are calculated for six degrees of freedom from Equations presented in Table 3.3-1 of ASCE 4-98 (Ref. 2.2.3). These equations utilize an equivalent radius of circular basemat calculated per equations in Table 3.3-3 of ASCE 4-98 (Ref. 2.2.3).

The Critical Damping values are calculated for each degree of freedom from equation 1.13, from Biggs, J.M. 1964 *Introduction to Structural Dynamics* (Ref. 2.2.8). The mass properties are from Ref. 2.2.4, Section 6.1.3.1. Soil stiffness values (Soil Springs) computed in 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 for soil damping.

Ref. 2.2.7, page 204 recommends limiting the translational damping coefficients to 75% of the computed value. This 75% limit accounts for the fact that layering has an adverse effect on radiation damping for the translational degrees of freedom. In addition to the theoretical damping values, 75% of the theoretical damping values are also computed for use in a direct integration time history analysis where damping coefficients are assigned to the soil elements.

5. LIST OF ATTACHMENTS

	Number of Pages
ATTACHMENT A - EXILE HILL FAULT SPLAY LOCATION PLAN	1
ATTACHMENT B - ASSESSMENT OF REVISED SOIL PROPERTIES.	15

6. BODY OF CALCULATION

6.1 SOIL SPRINGS AND DAMPING FOR 5E-4 AND 1E-4 SEISMIC EVENTS

6.1.1 Equivalent Dynamic Shear Modulus

The following spreadsheets are utilized to determine the equivalent dynamic shear modulus G for the lower bound, median and upper bound soil profiles for both the 100' depth of alluvium and 200' depth of alluvium conditions for 5E-4 and 1E-4 seismic events based on the methodology discussed in Section 4.3.

The Newmark's influence coefficients for each soil layer were read from Figure 3 of the *Canister Receipt and Closure Facility (CRCF) Soil Springs* (Ref. 2.2.4).

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 1

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	$E_i=2(1+\mu)G'$ (3)	Z/W		Nq*H	$Nq*H/E_i$
1	4.00	2.00	112.32	613.98	1377.70	1316.2	0.37	1.468	3598.7	0.008	1	4.00	1.11E-03
2	4.00	6.00	112.32	632.99	1687.40	1398.9	0.39	1.544	3877.8	0.023	1	4.00	1.03E-03
3	4.00	10.00	112.32	671.16	1922.50	1572.7	0.39	1.568	4378.7	0.038	1	4.00	9.14E-04
4	4.00	14.00	112.32	757.74	2070.60	2004.7	0.39	1.571	5584.3	0.053	1	4.00	7.16E-04
5	4.00	18.00	112.32	978.21	2613.60	3341.0	0.39	1.554	9277.2	0.069	1	4.00	4.31E-04
6	8.00	24.00	112.32	944.59	2648.40	3115.2	0.39	3.155	8687.9	0.092	1	8.00	9.21E-04
7	8.00	32.00	112.32	989.83	2731.40	3420.8	0.38	3.033	9435.2	0.122	1	8.00	8.48E-04
8	8.00	40.00	112.32	1044.30	2768.50	3807.6	0.36	2.910	10385.7	0.153	1	8.00	7.70E-04
9	8.00	48.00	112.32	1150.00	3045.60	4617.4	0.36	2.856	12531.8	0.183	1	8.00	6.38E-04
10	8.00	56.00	112.32	1281.30	3078.60	5732.0	0.34	2.707	15342.8	0.214	0.98	7.84	5.11E-04
11	10.00	65.00	112.32	1379.00	3375.10	6639.5	0.34	3.379	17766.3	0.248	0.96	9.60	5.40E-04
12	10.00	75.00	112.32	1426.50	3551.70	7104.8	0.34	3.374	19004.4	0.286	0.93	9.30	4.89E-04
13	10.00	85.00	112.32	1610.90	3799.10	9060.3	0.33	3.348	24187.6	0.324	0.90	9.00	3.72E-04
14	10.00	95.00	112.32	1569.70	3795.90	8602.8	0.34	3.380	23021.8	0.363	0.88	8.80	3.82E-04
15	10.00	105.00	137.28	2176.50	4047.50	20215.0	0.30	2.962	52404.1	0.401	0.85	8.50	1.62E-04
16	10.00	115.00	137.28	2178.30	4054.60	20248.4	0.30	2.966	52509.9	0.439	0.81	8.10	1.54E-04
17	10.00	125.00	137.28	2186.50	4066.60	20401.2	0.30	2.963	52891.3	0.477	0.78	7.80	1.47E-04
18	10.00	135.00	137.28	2238.10	4163.10	21375.4	0.30	2.963	55419.7	0.515	0.75	7.50	1.35E-04
19	10.00	145.00	137.28	2286.20	4253.20	22304.1	0.30	2.964	57831.4	0.553	0.72	7.20	1.24E-04
20	10.00	155.00	137.28	2310.90	4300.90	22788.6	0.30	2.966	59096.4	0.592	0.68	6.80	1.15E-04
21	10.00	165.00	137.28	2321.20	4321.40	22992.2	0.30	2.968	59632.2	0.630	0.65	6.50	1.09E-04
22	10.00	175.00	137.28	2297.00	4280.00	22515.3	0.30	2.972	58415.1	0.668	0.62	6.20	1.06E-04
23	10.00	185.00	137.28	2282.40	4256.00	22230.0	0.30	2.976	57690.9	0.706	0.59	5.90	1.02E-04
24	10.00	195.00	137.28	2324.00	4333.60	23047.7	0.30	2.976	59813.0	0.744	0.56	5.60	9.36E-05
25	12.50	206.25	137.28	2334.50	4356.30	23256.5	0.30	3.723	60365.0	0.787	0.53	6.63	1.10E-04
26	12.50	218.75	137.28	2356.40	4397.00	23694.9	0.30	3.724	61508.6	0.835	0.51	6.38	1.04E-04
27	12.50	231.25	137.28	2370.50	4444.30	23979.3	0.30	3.726	62252.6	0.883	0.49	6.13	9.84E-05
28	12.50	243.75	137.28	2414.20	4520.40	24871.5	0.30	3.726	64569.0	0.930	0.47	5.88	9.10E-05
29	12.50	256.25	137.28	2462.80	4584.90	25883.0	0.30	3.711	67132.2	0.978	0.45	5.63	8.38E-05
30	12.50	268.75	137.28	2467.50	4594.70	25981.9	0.30	3.712	67395.4	1.026	0.42	5.25	7.79E-05
31	12.50	281.25	137.28	2507.80	4669.50	26837.5	0.30	3.712	69612.7	1.073	0.40	5.00	7.18E-05
32	12.50	293.75	137.28	2507.00	4669.50	26820.4	0.30	3.714	69576.9	1.121	0.38	4.75	6.83E-05
33	15.00	307.50	137.28	2567.50	4779.90	28130.5	0.30	4.453	72961.5	1.174	0.36	5.40	7.40E-05
34	15.00	322.50	137.28	2586.40	4815.30	28546.2	0.30	4.453	74041.9	1.231	0.35	5.25	7.09E-05
35	15.00	337.50	137.28	2687.20	4998.80	30814.6	0.30	4.447	79898.5	1.288	0.33	4.95	6.20E-05
36	15.00	352.50	137.28	2742.90	5100.70	32105.3	0.30	4.444	83234.2	1.345	0.32	4.80	5.77E-05
37	15.00	367.50	137.28	2804.00	5212.70	33551.5	0.30	4.441	86971.6	1.403	0.30	4.50	5.17E-05
38	15.00	382.50	137.28	2834.40	5269.10	34283.0	0.30	4.441	88866.3	1.460	0.29	4.35	4.89E-05
39	15.00	397.50	137.28	2847.40	5293.90	34598.2	0.30	4.442	89688.8	1.517	0.28	4.20	4.68E-05
40	15.00	412.50	137.28	2846.70	5293.90	34581.2	0.30	4.444	89653.1	1.574	0.25	3.75	4.18E-05
41	15.00	427.50	137.28	2846.20	5293.90	34569.0	0.30	4.446	89628.5	1.632	0.24	3.60	4.02E-05
42	15.00	442.50	137.28	2845.70	5294.10	34556.9	0.30	4.447	89603.9	1.689	0.22	3.30	3.68E-05
43	15.00	457.50	137.28	2923.70	5436.80	36477.2	0.30	4.443	94565.8	1.746	0.20	3.00	3.17E-05
44	15.00	472.50	137.28	2940.50	5468.30	36897.6	0.30	4.444	95657.1	1.803	0.19	2.85	2.98E-05
45	15.00	487.50	137.28	2964.00	5511.10	37489.8	0.30	4.443	97187.7	1.861	0.17	2.55	2.62E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.309	Σ= 153.06			Σ=	264.77	1.22E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear & Compression Wave Velocities values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 21614 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 8255 ksf

Vel = SQRT(32.17*1000*G/p) 1537.6 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p) 1390.8 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 8255 ksf : 5E-4 Event : 100' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 2

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	868.30	1948.40	2632.4	0.37	1.468	7197.4	0.008	1	4.00	5.56E-04
2	4.00	6.00	112.32	895.18	2243.80	2797.9	0.39	1.544	7755.6	0.023	1	4.00	5.16E-04
3	4.00	10.00	112.32	949.16	2529.20	3145.5	0.39	1.568	8757.4	0.038	1	4.00	4.57E-04
4	4.00	14.00	112.32	1071.60	2914.00	4009.3	0.39	1.571	11168.5	0.053	1	4.00	3.58E-04
5	4.00	18.00	112.32	1383.40	3464.90	6681.9	0.39	1.554	18554.5	0.069	1	4.00	2.16E-04
6	8.00	24.00	112.32	1335.90	3529.50	6230.9	0.39	3.155	17377.0	0.092	1	8.00	4.60E-04
7	8.00	32.00	112.32	1399.80	3579.50	6841.3	0.38	3.033	18869.6	0.122	1	8.00	4.24E-04
8	8.00	40.00	112.32	1476.90	3637.40	7615.7	0.36	2.910	20772.4	0.153	1	8.00	3.85E-04
9	8.00	48.00	112.32	1626.40	3899.30	9235.5	0.36	2.856	25065.4	0.183	1	8.00	3.19E-04
10	8.00	56.00	112.32	1812.10	3937.30	11464.9	0.34	2.707	30687.9	0.214	0.98	7.84	2.55E-04
11	10.00	65.00	112.32	1922.60	4133.60	12905.8	0.34	3.379	34534.0	0.248	0.96	9.60	2.78E-04
12	10.00	75.00	112.32	2017.30	4349.90	14208.5	0.34	3.374	38005.9	0.286	0.93	9.30	2.45E-04
13	10.00	85.00	112.32	2192.70	4652.90	16786.7	0.33	3.348	44814.0	0.324	0.90	9.00	2.01E-04
14	10.00	95.00	112.32	2161.00	4649.00	16304.8	0.34	3.380	43633.0	0.363	0.88	8.80	2.02E-04
15	10.00	105.00	137.28	2665.70	4957.20	30323.5	0.30	2.962	78608.7	0.401	0.85	8.50	1.08E-04
16	10.00	115.00	137.28	2667.90	4965.90	30373.5	0.30	2.966	78767.1	0.439	0.81	8.10	1.03E-04
17	10.00	125.00	137.28	2677.90	4980.60	30601.7	0.30	2.963	79336.6	0.477	0.78	7.80	9.83E-05
18	10.00	135.00	137.28	2741.10	5098.80	32063.1	0.30	2.963	83129.4	0.515	0.75	7.50	9.02E-05
19	10.00	145.00	137.28	2800.00	5209.10	33455.9	0.30	2.964	86746.4	0.553	0.72	7.20	8.30E-05
20	10.00	155.00	137.28	2830.30	5267.50	34183.9	0.30	2.966	88647.0	0.592	0.68	6.80	7.67E-05
21	10.00	165.00	137.28	2842.90	5292.60	34488.9	0.30	2.968	89449.7	0.630	0.65	6.50	7.27E-05
22	10.00	175.00	137.28	2813.20	5241.90	33772.1	0.30	2.972	87620.2	0.668	0.62	6.20	7.08E-05
23	10.00	185.00	137.28	2795.40	5212.50	33346.0	0.30	2.976	86538.9	0.706	0.59	5.90	6.82E-05
24	10.00	195.00	137.28	2846.40	5307.50	34573.9	0.30	2.976	89725.4	0.744	0.56	5.60	6.24E-05
25	12.50	206.25	137.28	2860.10	5335.40	34907.5	0.30	3.723	90606.6	0.787	0.53	6.63	7.31E-05
26	12.50	218.75	137.28	2885.90	5385.20	35540.1	0.30	3.724	92257.1	0.835	0.51	6.38	6.91E-05
27	12.50	231.25	137.28	2916.20	5443.10	36290.3	0.30	3.726	94213.3	0.883	0.49	6.13	6.50E-05
28	12.50	243.75	137.28	2966.10	5536.30	37542.9	0.30	3.726	97465.1	0.930	0.47	5.88	6.03E-05
29	12.50	256.25	137.28	3016.30	5615.30	38824.4	0.30	3.711	100698.2	0.978	0.45	5.63	5.59E-05
30	12.50	268.75	137.28	3022.00	5627.40	38971.3	0.30	3.712	101089.3	1.026	0.42	5.25	5.19E-05
31	12.50	281.25	137.28	3071.40	5719.00	40255.8	0.30	3.712	104418.0	1.073	0.40	5.00	4.79E-05
32	12.50	293.75	137.28	3070.40	5719.00	40229.6	0.30	3.714	104362.9	1.121	0.38	4.75	4.55E-05
33	15.00	307.50	137.28	3144.50	5854.10	42194.8	0.30	4.453	109439.9	1.174	0.36	5.40	4.93E-05
34	15.00	322.50	137.28	3167.60	5897.50	42817.1	0.30	4.453	111057.2	1.231	0.35	5.25	4.73E-05
35	15.00	337.50	137.28	3291.10	6122.20	46220.9	0.30	4.447	119845.2	1.288	0.33	4.95	4.13E-05
36	15.00	352.50	137.28	3359.40	6247.10	48159.2	0.30	4.444	124854.8	1.345	0.32	4.80	3.84E-05
37	15.00	367.50	137.28	3434.20	6384.20	50327.7	0.30	4.441	130458.5	1.403	0.30	4.50	3.45E-05
38	15.00	382.50	137.28	3471.40	6453.30	51424.0	0.30	4.441	133298.1	1.460	0.29	4.35	3.26E-05
39	15.00	397.50	137.28	3487.30	6483.70	51896.1	0.30	4.442	134530.3	1.517	0.28	4.20	3.12E-05
40	15.00	412.50	137.28	3486.50	6483.70	51872.3	0.30	4.444	134481.0	1.574	0.25	3.75	2.79E-05
41	15.00	427.50	137.28	3485.80	6483.70	51851.5	0.30	4.446	134437.4	1.632	0.24	3.60	2.68E-05
42	15.00	442.50	137.28	3485.20	6483.90	51833.6	0.30	4.447	134401.5	1.689	0.22	3.30	2.46E-05
43	15.00	457.50	137.28	3580.70	6658.70	54713.2	0.30	4.443	141841.8	1.746	0.20	3.00	2.12E-05
44	15.00	472.50	137.28	3601.40	6697.30	55347.6	0.30	4.444	143488.7	1.803	0.19	2.85	1.99E-05
45	15.00	487.50	137.28	3630.20	6749.70	56236.4	0.30	4.443	145786.1	1.861	0.17	2.55	1.75E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.309	Σ= 153.06			Σ=	264.77	6.59E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 40203 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 15354 ksf
Vel = SQRT(32.17*1000*G/p) 2097.0 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p) 1896.8 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 15354 ksf : 5E-4 Event : 100' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 3

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS [1] H (FT)	DEPTH TO MIDPOINT [1] Z (FT) Depth = 0' is at soil surface.	DENSITY [1] Den (PCF)	SHEAR WAVE VELOCITY [1] Vs (FT/S)	COMPR. WAVE VELOCITY [1] Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO [2] μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' [3]	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT [4] Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	1228.00	2755.50	5265.1	0.37	1.468	14395.6	0.008	1	4.00	2.78E-04
2	4.00	6.00	112.32	1266.00	2983.70	5595.9	0.39	1.544	15511.7	0.023	1	4.00	2.58E-04
3	4.00	10.00	112.32	1342.30	3327.40	6290.8	0.39	1.568	17514.4	0.038	1	4.00	2.28E-04
4	4.00	14.00	112.32	1515.50	4100.90	8019.0	0.39	1.571	22337.9	0.053	1	4.00	1.79E-04
5	4.00	18.00	112.32	1956.40	4593.40	13363.5	0.39	1.554	37108.1	0.069	1	4.00	1.08E-04
6	8.00	24.00	112.32	1889.20	4703.80	12461.3	0.39	3.155	34752.2	0.092	1	8.00	2.30E-04
7	8.00	32.00	112.32	1979.70	4690.90	13683.7	0.38	3.033	37742.5	0.122	1	8.00	2.12E-04
8	8.00	40.00	112.32	2088.70	4779.00	15232.0	0.36	2.910	41546.6	0.153	1	8.00	1.93E-04
9	8.00	48.00	112.32	2300.10	4992.30	18471.4	0.36	2.856	50131.7	0.183	1	8.00	1.60E-04
10	8.00	56.00	112.32	2562.70	5035.60	22929.9	0.34	2.707	61375.9	0.214	0.98	7.84	1.28E-04
11	10.00	65.00	112.32	2680.30	5062.60	25082.6	0.34	3.379	67117.6	0.248	0.96	9.60	1.43E-04
12	10.00	75.00	112.32	2853.00	5327.50	28419.1	0.34	3.374	76017.6	0.286	0.93	9.30	1.22E-04
13	10.00	85.00	112.32	2984.60	5698.60	31101.3	0.33	3.348	83028.6	0.324	0.90	9.00	1.08E-04
14	10.00	95.00	112.32	2975.10	5693.80	30903.6	0.34	3.380	82700.5	0.363	0.88	8.80	1.06E-04
15	10.00	105.00	137.28	3264.80	6071.30	45485.1	0.30	2.962	117912.9	0.401	0.85	8.50	7.21E-05
16	10.00	115.00	137.28	3267.50	6082.00	45560.4	0.30	2.966	118150.8	0.439	0.81	8.10	6.86E-05
17	10.00	125.00	137.28	3279.80	6100.00	45904.0	0.30	2.963	119009.0	0.477	0.78	7.80	6.55E-05
18	10.00	135.00	137.28	3357.20	6244.70	48096.2	0.30	2.963	124698.0	0.515	0.75	7.50	6.01E-05
19	10.00	145.00	137.28	3429.30	6379.80	50184.2	0.30	2.964	130120.7	0.553	0.72	7.20	5.53E-05
20	10.00	155.00	137.28	3466.40	6451.30	51275.9	0.30	2.966	132970.8	0.592	0.68	6.80	5.11E-05
21	10.00	165.00	137.28	3481.90	6482.10	51735.5	0.30	2.968	134180.2	0.630	0.65	6.50	4.84E-05
22	10.00	175.00	137.28	3445.40	6420.00	50656.5	0.30	2.972	131426.4	0.668	0.62	6.20	4.72E-05
23	10.00	185.00	137.28	3423.70	6384.00	50020.5	0.30	2.976	129812.1	0.706	0.59	5.90	4.55E-05
24	10.00	195.00	137.28	3486.10	6500.30	51860.4	0.30	2.976	134587.1	0.744	0.56	5.60	4.16E-05
25	12.50	206.25	137.28	3504.00	6534.50	52394.3	0.30	3.723	135995.8	0.787	0.53	6.63	4.87E-05
26	12.50	218.75	137.28	3534.50	6595.50	53310.4	0.30	3.724	138386.4	0.835	0.51	6.38	4.61E-05
27	12.50	231.25	137.28	3587.50	6666.40	54921.2	0.30	3.726	142580.9	0.883	0.49	6.13	4.30E-05
28	12.50	243.75	137.28	3644.20	6780.60	56671.0	0.30	3.726	147123.5	0.930	0.47	5.88	3.99E-05
29	12.50	256.25	137.28	3694.20	6877.30	58236.7	0.30	3.711	151047.5	0.978	0.45	5.63	3.72E-05
30	12.50	268.75	137.28	3701.20	6892.10	58457.6	0.30	3.712	151635.6	1.026	0.42	5.25	3.46E-05
31	12.50	281.25	137.28	3761.60	7004.30	60381.2	0.30	3.712	156620.3	1.073	0.40	5.00	3.19E-05
32	12.50	293.75	137.28	3760.50	7004.30	60345.8	0.30	3.714	156548.0	1.121	0.38	4.75	3.03E-05
33	15.00	307.50	137.28	3851.20	7169.80	63291.9	0.30	4.453	164159.0	1.174	0.36	5.40	3.29E-05
34	15.00	322.50	137.28	3879.50	7222.90	64225.5	0.30	4.453	166585.6	1.231	0.35	5.25	3.15E-05
35	15.00	337.50	137.28	4030.80	7498.10	69332.8	0.30	4.447	179771.6	1.288	0.33	4.95	2.75E-05
36	15.00	352.50	137.28	4114.40	7651.10	72238.6	0.30	4.444	187281.4	1.345	0.32	4.80	2.56E-05
37	15.00	367.50	137.28	4206.00	7819.00	75490.9	0.30	4.441	195686.1	1.403	0.30	4.50	2.30E-05
38	15.00	382.50	137.28	4251.60	7903.60	77136.7	0.30	4.441	199949.1	1.460	0.29	4.35	2.18E-05
39	15.00	397.50	137.28	4271.10	7940.90	77845.9	0.30	4.442	201799.9	1.517	0.28	4.20	2.08E-05
40	15.00	412.50	137.28	4270.10	7940.90	77809.4	0.30	4.444	201724.1	1.574	0.25	3.75	1.86E-05
41	15.00	427.50	137.28	4269.30	7940.90	77780.3	0.30	4.446	201664.1	1.632	0.24	3.60	1.79E-05
42	15.00	442.50	137.28	4268.50	7941.10	77751.1	0.30	4.447	201604.0	1.689	0.22	3.30	1.64E-05
43	15.00	457.50	137.28	4385.50	8155.20	82071.9	0.30	4.443	212768.1	1.746	0.20	3.00	1.41E-05
44	15.00	472.50	137.28	4410.80	8202.50	83021.6	0.30	4.444	215233.4	1.803	0.19	2.85	1.32E-05
45	15.00	487.50	137.28	4446.00	8266.70	84351.9	0.30	4.443	218672.3	1.861	0.17	2.55	1.17E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.309	Σ= 153.06			Σ=	264.77	3.60E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 73640 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 28124 ksf

Vel = SQRT(32.17*1000*G/p) 2838.1 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p) 2567.2 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 28124 ksf : 5E-4 Event : 100' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 4

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	$E_i=2(1+\mu)G'$ (3)	Z/W		Nq*H	$Nq*H/E_i$
1	4.00	2.00	112.32	602.30	1359.50	1266.6	0.37	1.468	3462.9	0.008	1	4.00	1.16E-03
2	4.00	6.00	112.32	627.97	1671.70	1376.8	0.38	1.539	3813.3	0.023	1	4.00	1.05E-03
3	4.00	10.00	112.32	662.89	1882.40	1534.2	0.39	1.567	4270.3	0.038	1	4.00	9.37E-04
4	4.00	14.00	112.32	732.52	2035.90	1873.5	0.39	1.573	5220.9	0.053	1	4.00	7.66E-04
5	4.00	18.00	112.32	948.06	2531.50	3138.2	0.39	1.557	8719.6	0.069	1	4.00	4.59E-04
6	8.00	24.00	112.32	907.23	2561.50	2873.7	0.40	3.164	8020.2	0.092	1	8.00	9.97E-04
7	8.00	32.00	112.32	980.06	2680.10	3353.6	0.38	3.029	9247.0	0.122	1	8.00	8.65E-04
8	8.00	40.00	112.32	1030.50	2715.10	3707.7	0.36	2.909	10112.2	0.153	1	8.00	7.91E-04
9	8.00	48.00	112.32	1170.70	3061.60	4785.2	0.36	2.846	12975.4	0.183	1	8.00	6.17E-04
10	8.00	56.00	112.32	1300.90	3098.40	5908.7	0.34	2.697	15801.1	0.214	0.98	7.84	4.96E-04
11	10.00	65.00	112.32	1381.90	3390.90	6667.4	0.34	3.372	17831.0	0.248	0.96	9.60	5.38E-04
12	10.00	75.00	112.32	1437.90	3559.30	7218.8	0.34	3.372	19305.2	0.286	0.93	9.30	4.82E-04
13	10.00	85.00	112.32	1653.80	3782.30	9549.3	0.34	3.355	25506.8	0.324	0.90	9.00	3.53E-04
14	10.00	95.00	112.32	1608.20	3775.40	9030.0	0.34	3.392	24185.5	0.363	0.88	8.80	3.64E-04
15	10.00	105.00	112.32	1685.50	3842.00	9918.9	0.34	3.362	26508.1	0.401	0.85	8.50	3.21E-04
16	10.00	115.00	112.32	1675.20	3847.30	9798.0	0.34	3.389	26236.8	0.439	0.81	8.10	3.09E-04
17	10.00	125.00	112.32	1661.30	3856.30	9636.1	0.34	3.411	25845.8	0.477	0.78	7.80	3.02E-04
18	10.00	135.00	112.32	1712.50	3987.90	10239.2	0.34	3.400	27441.7	0.515	0.75	7.50	2.73E-04
19	10.00	145.00	112.32	1739.90	4078.00	10569.5	0.34	3.400	28327.1	0.553	0.72	7.20	2.54E-04
20	10.00	155.00	112.32	1732.40	4132.20	10478.6	0.34	3.413	28109.6	0.592	0.68	6.80	2.42E-04
21	10.00	165.00	112.32	1697.50	4114.60	10060.6	0.34	3.435	27032.9	0.630	0.65	6.50	2.40E-04
22	10.00	175.00	112.32	1616.80	4077.50	9126.8	0.35	3.461	24570.4	0.668	0.62	6.20	2.52E-04
23	10.00	185.00	112.32	1601.90	4081.70	8959.4	0.35	3.475	24144.9	0.706	0.59	5.90	2.44E-04
24	10.00	195.00	112.32	1654.70	4160.00	9559.7	0.35	3.468	25749.8	0.744	0.56	5.60	2.17E-04
25	12.50	206.25	137.28	2327.20	4366.20	23111.3	0.30	3.718	59969.1	0.787	0.53	6.63	1.10E-04
26	12.50	218.75	137.28	2361.60	4421.30	23799.6	0.30	3.720	61762.7	0.835	0.51	6.38	1.03E-04
27	12.50	231.25	137.28	2367.10	4447.80	23910.5	0.30	3.722	62059.3	0.883	0.49	6.13	9.87E-05
28	12.50	243.75	137.28	2415.70	4543.30	24902.5	0.30	3.723	64637.3	0.930	0.47	5.88	9.09E-05
29	12.50	256.25	137.28	2489.20	4625.00	26440.9	0.30	3.698	68525.8	0.978	0.45	5.63	8.21E-05
30	12.50	268.75	137.28	2495.10	4637.20	26566.4	0.30	3.700	68859.0	1.026	0.42	5.25	7.62E-05
31	12.50	281.25	137.28	2494.20	4637.20	26547.2	0.30	3.702	68819.4	1.073	0.40	5.00	7.27E-05
32	12.50	293.75	137.28	2493.40	4637.20	26530.2	0.30	3.704	68783.7	1.121	0.38	4.75	6.91E-05
33	15.00	307.50	137.28	2554.00	4748.20	27835.4	0.30	4.442	72157.2	1.174	0.36	5.40	7.48E-05
34	15.00	322.50	137.28	2572.90	4783.40	28248.9	0.30	4.443	73230.8	1.231	0.35	5.25	7.17E-05
35	15.00	337.50	137.28	2672.50	4965.70	30478.4	0.30	4.438	78990.2	1.288	0.33	4.95	6.27E-05
36	15.00	352.50	137.28	2724.10	5059.30	31666.7	0.30	4.435	82057.8	1.345	0.32	4.80	5.85E-05
37	15.00	367.50	137.28	2784.60	5170.50	33088.9	0.30	4.433	85734.6	1.403	0.30	4.50	5.25E-05
38	15.00	382.50	137.28	2814.70	5226.30	33808.1	0.30	4.433	87597.4	1.460	0.29	4.35	4.97E-05
39	15.00	397.50	137.28	2827.60	5251.00	34118.7	0.30	4.434	88407.6	1.517	0.28	4.20	4.75E-05
40	15.00	412.50	137.28	2827.00	5251.00	34104.2	0.30	4.436	88377.6	1.574	0.25	3.75	4.24E-05
41	15.00	427.50	137.28	2826.40	5251.00	34089.7	0.30	4.437	88347.6	1.632	0.24	3.60	4.07E-05
42	15.00	442.50	137.28	2826.00	5251.10	34080.1	0.30	4.439	88329.4	1.689	0.22	3.30	3.74E-05
43	15.00	457.50	137.28	2903.00	5392.70	35962.5	0.30	4.436	93196.9	1.746	0.20	3.00	3.22E-05
44	15.00	472.50	137.28	2919.60	5424.00	36375.0	0.30	4.437	94268.7	1.803	0.19	2.85	3.02E-05
45	15.00	487.50	137.28	2942.50	5466.40	36947.8	0.30	4.437	95751.8	1.861	0.17	2.55	2.66E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.318	Σ= 157.42			Σ=	264.77	1.39E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ = 19111 ksf

Equivalent Shear Modulus $G = E/(2*(1+\text{Average } \mu))$ = 7250 ksf

Vel = SQRT(32.17*1000*G/p 1441.0 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p 1303.4 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 7250 ksf : 5E-4 Event : 200' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 5

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS [(1)] H (FT)	DEPTH TO MIDPOINT [(1)] Z (FT) Depth = 0' is at soil surface.	DENSITY [(1)] Den (PCF)	SHEAR WAVE VELOCITY [(1)] Vs (FT/S)	COMPR. WAVE VELOCITY [(1)] Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO [(2)] μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ [(3)]	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT [(4)] Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus $Nq*H/E_i$
1	4.00	2.00	112.32	851.78	1922.60	2533.2	0.37	1.468	6925.9	0.008	1	4.00	5.78E-04
2	4.00	6.00	112.32	888.08	2249.50	2753.7	0.38	1.539	7626.6	0.023	1	4.00	5.24E-04
3	4.00	10.00	112.32	937.47	2519.00	3068.5	0.39	1.567	8540.6	0.038	1	4.00	4.68E-04
4	4.00	14.00	112.32	1035.90	2861.30	3746.6	0.39	1.573	10440.9	0.053	1	4.00	3.83E-04
5	4.00	18.00	112.32	1340.80	3382.00	6276.7	0.39	1.557	17440.3	0.069	1	4.00	2.29E-04
6	8.00	24.00	112.32	1283.00	3445.10	5747.2	0.40	3.164	16040.0	0.092	1	8.00	4.99E-04
7	8.00	32.00	112.32	1386.00	3569.30	6707.1	0.38	3.029	18493.7	0.122	1	8.00	4.33E-04
8	8.00	40.00	112.32	1457.30	3627.00	7414.9	0.36	2.909	20223.0	0.153	1	8.00	3.96E-04
9	8.00	48.00	112.32	1655.60	3928.40	9570.1	0.36	2.846	25950.1	0.183	1	8.00	3.08E-04
10	8.00	56.00	112.32	1839.80	3966.70	11818.1	0.34	2.697	31603.9	0.214	0.98	7.84	2.48E-04
11	10.00	65.00	112.32	1939.30	4153.00	13130.9	0.34	3.372	35116.6	0.248	0.96	9.60	2.73E-04
12	10.00	75.00	112.32	2033.50	4359.20	14437.6	0.34	3.372	38610.4	0.286	0.93	9.30	2.41E-04
13	10.00	85.00	112.32	2195.70	4632.40	16832.6	0.34	3.355	44961.0	0.324	0.90	9.00	2.00E-04
14	10.00	95.00	112.32	2159.40	4623.90	16280.7	0.34	3.392	43605.5	0.363	0.88	8.80	2.02E-04
15	10.00	105.00	112.32	2235.20	4705.50	17443.7	0.34	3.362	46618.0	0.401	0.85	8.50	1.82E-04
16	10.00	115.00	112.32	2218.20	4711.90	17179.4	0.34	3.389	46002.3	0.439	0.81	8.10	1.76E-04
17	10.00	125.00	112.32	2203.00	4723.00	16944.7	0.34	3.411	45448.9	0.477	0.78	7.80	1.72E-04
18	10.00	135.00	112.32	2285.70	4884.10	18240.8	0.34	3.400	48886.5	0.515	0.75	7.50	1.53E-04
19	10.00	145.00	112.32	2337.80	4994.50	19081.9	0.34	3.400	51140.9	0.553	0.72	7.20	1.41E-04
20	10.00	155.00	112.32	2356.60	5060.90	19390.0	0.34	3.413	52015.2	0.592	0.68	6.80	1.31E-04
21	10.00	165.00	112.32	2325.50	5039.30	18881.6	0.34	3.435	50734.9	0.630	0.65	6.50	1.28E-04
22	10.00	175.00	112.32	2275.00	4995.50	18070.4	0.35	3.461	48647.8	0.668	0.62	6.20	1.27E-04
23	10.00	185.00	112.32	2262.60	4999.00	17874.0	0.35	3.475	48169.3	0.706	0.59	5.90	1.22E-04
24	10.00	195.00	112.32	2317.60	5094.90	18753.5	0.35	3.468	50514.1	0.744	0.56	5.60	1.11E-04
25	12.50	206.25	137.28	2877.50	5363.80	35333.5	0.30	3.718	91683.4	0.787	0.53	6.63	7.23E-05
26	12.50	218.75	137.28	2904.00	5415.00	35987.3	0.30	3.720	93391.4	0.835	0.51	6.38	6.83E-05
27	12.50	231.25	137.28	2936.10	5477.10	36787.3	0.30	3.722	95480.7	0.883	0.49	6.13	6.41E-05
28	12.50	243.75	137.28	2989.70	5578.00	38142.7	0.30	3.723	99004.0	0.930	0.47	5.88	5.93E-05
29	12.50	256.25	137.28	3048.70	5664.50	39663.0	0.30	3.698	102793.0	0.978	0.45	5.63	5.47E-05
30	12.50	268.75	137.28	3055.90	5679.40	39850.6	0.30	3.700	103291.1	1.026	0.42	5.25	5.08E-05
31	12.50	281.25	137.28	3054.80	5679.40	39821.9	0.30	3.702	103231.9	1.073	0.40	5.00	4.84E-05
32	12.50	293.75	137.28	3053.80	5679.40	39795.8	0.30	3.704	103177.0	1.121	0.38	4.75	4.60E-05
33	15.00	307.50	137.28	3128.00	5815.30	41753.2	0.30	4.442	108236.0	1.174	0.36	5.40	4.99E-05
34	15.00	322.50	137.28	3151.10	5858.50	42372.2	0.30	4.443	109843.0	1.231	0.35	5.25	4.78E-05
35	15.00	337.50	137.28	3273.10	6081.70	45716.7	0.30	4.438	118483.0	1.288	0.33	4.95	4.18E-05
36	15.00	352.50	137.28	3336.30	6196.40	47499.2	0.30	4.435	123084.7	1.345	0.32	4.80	3.90E-05
37	15.00	367.50	137.28	3410.40	6332.50	49632.6	0.30	4.433	128600.0	1.403	0.30	4.50	3.50E-05
38	15.00	382.50	137.28	3447.30	6400.90	50712.4	0.30	4.433	131396.9	1.460	0.29	4.35	3.31E-05
39	15.00	397.50	137.28	3463.10	6431.20	51178.3	0.30	4.434	132612.3	1.517	0.28	4.20	3.17E-05
40	15.00	412.50	137.28	3462.40	6431.20	51157.7	0.30	4.436	132570.0	1.574	0.25	3.75	2.83E-05
41	15.00	427.50	137.28	3461.70	6431.20	51137.0	0.30	4.437	132527.6	1.632	0.24	3.60	2.72E-05
42	15.00	442.50	137.28	3461.10	6431.30	51119.3	0.30	4.439	132491.9	1.689	0.22	3.30	2.49E-05
43	15.00	457.50	137.28	3555.40	6604.70	53942.8	0.30	4.436	139792.7	1.746	0.20	3.00	2.15E-05
44	15.00	472.50	137.28	3575.80	6643.00	54563.6	0.30	4.437	141405.8	1.803	0.19	2.85	2.02E-05
45	15.00	487.50	137.28	3603.90	6695.00	55424.5	0.30	4.437	143634.8	1.861	0.17	2.55	1.78E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.318	Σ= 157.42			Σ=	264.77	7.31E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ = 36228 ksf

Equivalent Shear Modulus $G = E/(2*(1+\text{Average } \mu))$ = 13744 ksf

Vel = SQRT(32.17*1000*G/p) 1984.0 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p) 1794.6 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 13744 ksf : 5E-4 Event : 200' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 6

See DTN MO0706SCSPS5E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO $H*\mu$	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus $Nq*H/E_i$
1	4.00	2.00	112.32	1204.60	2719.00	5066.3	0.37	1.468	13851.8	0.008	1	4.00	2.89E-04
2	4.00	6.00	112.32	1255.90	3027.10	5507.0	0.38	1.539	15252.3	0.023	1	4.00	2.62E-04
3	4.00	10.00	112.32	1325.80	3370.80	6137.1	0.39	1.567	17081.7	0.038	1	4.00	2.34E-04
4	4.00	14.00	112.32	1465.00	4021.40	7493.4	0.39	1.573	20882.3	0.053	1	4.00	1.92E-04
5	4.00	18.00	112.32	1896.10	4518.30	12552.5	0.39	1.557	34877.7	0.069	1	4.00	1.15E-04
6	8.00	24.00	112.32	1814.50	4633.50	11495.3	0.40	3.164	32082.2	0.092	1	8.00	2.49E-04
7	8.00	32.00	112.32	1960.10	4753.50	13414.1	0.38	3.029	36987.3	0.122	1	8.00	2.16E-04
8	8.00	40.00	112.32	2060.90	4845.10	14829.3	0.36	2.909	40444.8	0.153	1	8.00	1.98E-04
9	8.00	48.00	112.32	2341.30	5040.60	19139.0	0.36	2.846	51897.0	0.183	1	8.00	1.54E-04
10	8.00	56.00	112.32	2601.90	5078.30	23636.7	0.34	2.697	63209.3	0.214	0.98	7.84	1.24E-04
11	10.00	65.00	112.32	2721.60	5086.40	25861.6	0.34	3.372	69162.6	0.248	0.96	9.60	1.39E-04
12	10.00	75.00	112.32	2875.80	5338.90	28875.1	0.34	3.372	77220.7	0.286	0.93	9.30	1.20E-04
13	10.00	85.00	112.32	2915.10	5673.50	29669.7	0.34	3.355	79249.5	0.324	0.90	9.00	1.14E-04
14	10.00	95.00	112.32	2899.60	5663.10	29355.0	0.34	3.392	78623.3	0.363	0.88	8.80	1.12E-04
15	10.00	105.00	112.32	2964.20	5763.00	30677.6	0.34	3.362	81985.2	0.401	0.85	8.50	1.04E-04
16	10.00	115.00	112.32	2937.20	5770.90	30121.3	0.34	3.389	80657.5	0.439	0.81	8.10	1.00E-04
17	10.00	125.00	112.32	2921.50	5784.50	29800.1	0.34	3.411	79929.2	0.477	0.78	7.80	9.76E-05
18	10.00	135.00	112.32	3050.90	5981.80	32498.4	0.34	3.400	87097.7	0.515	0.75	7.50	8.61E-05
19	10.00	145.00	112.32	3141.20	6117.00	34450.6	0.34	3.400	92330.5	0.553	0.72	7.20	7.80E-05
20	10.00	155.00	112.32	3205.80	6198.30	35882.2	0.34	3.413	96256.8	0.592	0.68	6.80	7.06E-05
21	10.00	165.00	112.32	3185.60	6171.90	35431.4	0.34	3.435	95204.2	0.630	0.65	6.50	6.83E-05
22	10.00	175.00	112.32	3201.20	6120.20	35779.3	0.35	3.461	96322.1	0.668	0.62	6.20	6.44E-05
23	10.00	185.00	112.32	3195.80	6122.50	35658.7	0.35	3.475	96098.0	0.706	0.59	5.90	6.14E-05
24	10.00	195.00	112.32	3246.00	6240.00	36787.7	0.35	3.468	99090.7	0.744	0.56	5.60	5.65E-05
25	12.50	206.25	137.28	3557.80	6589.30	54015.6	0.30	3.718	140159.7	0.787	0.53	6.63	4.73E-05
26	12.50	218.75	137.28	3570.90	6632.00	54414.1	0.30	3.720	141211.2	0.835	0.51	6.38	4.51E-05
27	12.50	231.25	137.28	3641.80	6744.60	56596.3	0.30	3.722	146894.7	0.883	0.49	6.13	4.17E-05
28	12.50	243.75	137.28	3700.10	6848.40	58422.9	0.30	3.723	151643.7	0.930	0.47	5.88	3.87E-05
29	12.50	256.25	137.28	3733.90	6937.60	59495.2	0.30	3.698	154191.2	0.978	0.45	5.63	3.65E-05
30	12.50	268.75	137.28	3742.60	6955.80	59772.7	0.30	3.700	154928.5	1.026	0.42	5.25	3.39E-05
31	12.50	281.25	137.28	3741.30	6955.80	59731.2	0.30	3.702	154843.6	1.073	0.40	5.00	3.23E-05
32	12.50	293.75	137.28	3740.20	6955.80	59696.1	0.30	3.704	154771.7	1.121	0.38	4.75	3.07E-05
33	15.00	307.50	137.28	3831.00	7122.30	62629.7	0.30	4.442	162353.8	1.174	0.36	5.40	3.33E-05
34	15.00	322.50	137.28	3859.30	7175.20	63558.4	0.30	4.443	164765.1	1.231	0.35	5.25	3.19E-05
35	15.00	337.50	137.28	4008.80	7448.50	68578.0	0.30	4.438	177732.3	1.288	0.33	4.95	2.79E-05
36	15.00	352.50	137.28	4086.10	7589.00	71248.2	0.30	4.435	184625.6	1.345	0.32	4.80	2.60E-05
37	15.00	367.50	137.28	4176.90	7755.70	74449.9	0.30	4.433	192902.8	1.403	0.30	4.50	2.33E-05
38	15.00	382.50	137.28	4222.10	7839.50	76070.0	0.30	4.433	197098.8	1.460	0.29	4.35	2.21E-05
39	15.00	397.50	137.28	4241.40	7876.60	76767.0	0.30	4.434	198917.2	1.517	0.28	4.20	2.11E-05
40	15.00	412.50	137.28	4240.50	7876.60	76734.4	0.30	4.436	198849.6	1.574	0.25	3.75	1.89E-05
41	15.00	427.50	137.28	4239.70	7876.60	76705.5	0.30	4.437	198791.5	1.632	0.24	3.60	1.81E-05
42	15.00	442.50	137.28	4239.00	7876.70	76680.2	0.30	4.439	198741.2	1.689	0.22	3.30	1.66E-05
43	15.00	457.50	137.28	4354.40	8089.10	80912.0	0.30	4.436	209683.4	1.746	0.20	3.00	1.43E-05
44	15.00	472.50	137.28	4379.40	8136.00	81843.7	0.30	4.437	212104.6	1.803	0.19	2.85	1.34E-05
45	15.00	487.50	137.28	4413.80	8199.70	83134.5	0.30	4.437	215446.5	1.861	0.17	2.55	1.18E-05
Σ=	495.00					Average μ = SUM $(H*\mu)$/SUM H	0.318	Σ= 157.42			Σ=	264.77	3.89E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS5E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS5E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) 68070 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 25823 ksf

Vel = SQRT(32.17*1000*G/ 2719.6 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/ 2459.9 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 25823 ksf : 5E-4 Event : 200' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 7

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		$H^*\mu$	$E_i=2(1+\mu)G'$ (3)	Z/W		Nq*H	Nq^*H/E_i
1	4.00	2.00	112.32	543.21	1377.70	1030.2	0.38	1.536	2851.7	0.008	1	4.00	1.40E-03
2	4.00	6.00	112.32	531.70	1599.40	987.1	0.41	1.637	2781.9	0.023	1	4.00	1.44E-03
3	4.00	10.00	112.32	555.00	1810.30	1075.5	0.42	1.665	3046.0	0.038	1	4.00	1.31E-03
4	4.00	14.00	112.32	606.07	1896.60	1282.5	0.42	1.666	3633.2	0.053	1	4.00	1.10E-03
5	4.00	18.00	112.32	780.83	2613.60	2128.7	0.41	1.650	6014.1	0.069	1	4.00	6.65E-04
6	8.00	24.00	112.32	716.69	2648.40	1793.4	0.42	3.357	5091.8	0.092	1	8.00	1.57E-03
7	8.00	32.00	112.32	741.31	2731.40	1918.7	0.41	3.274	5408.1	0.122	1	8.00	1.48E-03
8	8.00	40.00	112.32	772.80	2768.50	2085.2	0.40	3.189	5832.8	0.153	1	8.00	1.37E-03
9	8.00	48.00	112.32	853.75	3045.60	2544.9	0.39	3.146	7091.6	0.183	1	8.00	1.13E-03
10	8.00	56.00	112.32	1035.80	3078.60	3745.9	0.38	3.026	10325.9	0.214	0.98	7.84	7.59E-04
11	10.00	65.00	112.32	1101.00	3375.10	4232.3	0.38	3.792	11674.5	0.248	0.96	9.60	8.22E-04
12	10.00	75.00	112.32	1151.80	3551.70	4631.9	0.38	3.788	12773.0	0.286	0.93	9.30	7.28E-04
13	10.00	85.00	112.32	1264.00	3799.10	5578.3	0.38	3.757	15348.2	0.324	0.90	9.00	5.86E-04
14	10.00	95.00	112.32	1220.70	3795.90	5202.6	0.38	3.800	14359.4	0.363	0.88	8.80	6.13E-04
15	10.00	105.00	137.28	2143.40	4047.50	19604.8	0.30	3.035	51109.0	0.401	0.85	8.50	1.66E-04
16	10.00	115.00	137.28	2142.60	4054.60	19590.2	0.30	3.044	51106.9	0.439	0.81	8.10	1.58E-04
17	10.00	125.00	137.28	2153.40	4066.60	19788.2	0.30	3.037	51593.7	0.477	0.78	7.80	1.51E-04
18	10.00	135.00	137.28	2203.40	4163.20	20717.8	0.30	3.039	54026.5	0.515	0.75	7.50	1.39E-04
19	10.00	145.00	137.28	2249.80	4253.20	21599.5	0.30	3.041	56337.6	0.553	0.72	7.20	1.28E-04
20	10.00	155.00	137.28	2273.00	4300.90	22047.3	0.30	3.045	57521.4	0.592	0.68	6.80	1.18E-04
21	10.00	165.00	137.28	2281.70	4321.40	22216.4	0.30	3.049	57981.6	0.630	0.65	6.50	1.12E-04
22	10.00	175.00	137.28	2255.30	4280.00	21705.3	0.31	3.058	56685.4	0.668	0.62	6.20	1.09E-04
23	10.00	185.00	137.28	2234.00	4256.00	21297.2	0.31	3.065	55650.0	0.706	0.59	5.90	1.06E-04
24	10.00	195.00	137.28	2267.80	4333.60	21946.5	0.31	3.066	57349.8	0.744	0.56	5.60	9.76E-05
25	12.50	206.25	137.28	2266.60	4356.30	21923.3	0.31	3.837	57306.6	0.787	0.53	6.63	1.16E-04
26	12.50	218.75	137.28	2296.90	4397.00	22513.4	0.31	3.841	58862.1	0.835	0.51	6.38	1.08E-04
27	12.50	231.25	137.28	2297.60	4444.30	22527.1	0.31	3.844	58907.4	0.883	0.49	6.13	1.04E-04
28	12.50	243.75	137.28	2337.90	4520.40	23324.3	0.31	3.844	60994.4	0.930	0.47	5.88	9.63E-05
29	12.50	256.25	137.28	2422.40	4584.90	25040.8	0.30	3.812	65354.9	0.978	0.45	5.63	8.61E-05
30	12.50	268.75	137.28	2425.90	4594.80	25113.2	0.31	3.816	65560.0	1.026	0.42	5.25	8.01E-05
31	12.50	281.25	137.28	2465.50	4669.50	25939.8	0.31	3.815	67714.2	1.073	0.40	5.00	7.38E-05
32	12.50	293.75	137.28	2463.70	4669.50	25901.9	0.31	3.820	67633.5	1.121	0.38	4.75	7.02E-05
33	15.00	307.50	137.28	2524.30	4779.90	27191.8	0.31	4.578	70979.9	1.174	0.36	5.40	7.61E-05
34	15.00	322.50	137.28	2542.30	4815.30	27581.0	0.31	4.580	72002.9	1.231	0.35	5.25	7.29E-05
35	15.00	337.50	137.28	2643.60	4998.80	29822.8	0.30	4.568	77809.3	1.288	0.33	4.95	6.36E-05
36	15.00	352.50	137.28	2699.10	5100.70	31088.1	0.30	4.565	81096.4	1.345	0.32	4.80	5.92E-05
37	15.00	367.50	137.28	2760.10	5212.70	32509.2	0.30	4.560	84783.9	1.403	0.30	4.50	5.31E-05
38	15.00	382.50	137.28	2790.00	5269.10	33217.3	0.30	4.560	86628.8	1.460	0.29	4.35	5.02E-05
39	15.00	397.50	137.28	2802.20	5293.90	33508.5	0.30	4.562	87399.4	1.517	0.28	4.20	4.81E-05
40	15.00	412.50	137.28	2800.60	5293.90	33470.2	0.30	4.566	87317.1	1.574	0.25	3.75	4.29E-05
41	15.00	427.50	137.28	2799.20	5293.90	33436.8	0.30	4.569	87244.5	1.632	0.24	3.60	4.13E-05
42	15.00	442.50	137.28	2797.90	5294.10	33405.7	0.30	4.573	87178.9	1.689	0.22	3.30	3.79E-05
43	15.00	457.50	137.28	2875.60	5436.80	35286.9	0.30	4.566	92058.5	1.746	0.20	3.00	3.26E-05
44	15.00	472.50	137.28	2891.90	5468.30	35688.0	0.30	4.568	93110.1	1.803	0.19	2.85	3.06E-05
45	15.00	487.50	137.28	2915.50	5511.10	36272.9	0.30	4.566	94630.9	1.861	0.17	2.55	2.69E-05
Σ=	495.00					Average μ = SUM ($H^*\mu$)/SUM H	0.323	Σ= 159.77			Σ=	264.77	1.76E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq^*H)/sum(Nq^*H/E_i)$ = 15014 ksf

Equivalent Shear Modulus $G = E/(2^*(1+\text{Average } \mu))$ = 5675 ksf

Vel = SQRT(32.17*1000*G/p 1274.9 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p 1153.2 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 5675 ksf : 1E-4 Event : 100' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 8

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	768.22	1948.40	2060.5	0.38	1.536	5703.4	0.008	1	4.00	7.01E-04
2	4.00	6.00	112.32	751.94	2150.00	1974.1	0.41	1.637	5563.8	0.023	1	4.00	7.19E-04
3	4.00	10.00	112.32	784.89	2413.70	2150.9	0.42	1.665	6092.1	0.038	1	4.00	6.57E-04
4	4.00	14.00	112.32	857.12	2682.20	2565.0	0.42	1.666	7266.6	0.053	1	4.00	5.50E-04
5	4.00	18.00	112.32	1104.30	3464.90	4257.8	0.41	1.650	12029.1	0.069	1	4.00	3.33E-04
6	8.00	24.00	112.32	1013.50	3529.50	3586.4	0.42	3.357	10182.6	0.092	1	8.00	7.86E-04
7	8.00	32.00	112.32	1048.40	3579.50	3837.6	0.41	3.274	10816.7	0.122	1	8.00	7.40E-04
8	8.00	40.00	112.32	1092.90	3637.40	4170.3	0.40	3.189	11665.5	0.153	1	8.00	6.86E-04
9	8.00	48.00	112.32	1207.40	3899.30	5089.9	0.39	3.146	14183.6	0.183	1	8.00	5.64E-04
10	8.00	56.00	112.32	1464.80	3937.30	7491.4	0.38	3.026	20650.6	0.214	0.98	7.84	3.80E-04
11	10.00	65.00	112.32	1557.00	4133.60	8464.1	0.38	3.792	23347.5	0.248	0.96	9.60	4.11E-04
12	10.00	75.00	112.32	1628.90	4349.90	9263.9	0.38	3.788	25546.4	0.286	0.93	9.30	3.64E-04
13	10.00	85.00	112.32	1787.50	4652.90	11155.7	0.38	3.757	30694.1	0.324	0.90	9.00	2.93E-04
14	10.00	95.00	112.32	1726.30	4649.00	10404.9	0.38	3.800	28717.8	0.363	0.88	8.80	3.06E-04
15	10.00	105.00	137.28	2625.10	4957.20	29406.8	0.30	3.035	76662.4	0.401	0.85	8.50	1.11E-04
16	10.00	115.00	137.28	2624.10	4965.90	29384.4	0.30	3.044	76658.0	0.439	0.81	8.10	1.06E-04
17	10.00	125.00	137.28	2637.40	4980.60	29683.0	0.30	3.037	77392.6	0.477	0.78	7.80	1.01E-04
18	10.00	135.00	137.28	2698.60	5098.80	31076.6	0.30	3.039	81039.6	0.515	0.75	7.50	9.25E-05
19	10.00	145.00	137.28	2755.40	5209.10	32398.5	0.30	3.041	84504.5	0.553	0.72	7.20	8.52E-05
20	10.00	155.00	137.28	2783.90	5267.50	33072.2	0.30	3.045	86285.4	0.592	0.68	6.80	7.88E-05
21	10.00	165.00	137.28	2794.40	5292.60	33322.2	0.30	3.049	86966.2	0.630	0.65	6.50	7.47E-05
22	10.00	175.00	137.28	2762.10	5241.90	32556.3	0.31	3.058	85024.0	0.668	0.62	6.20	7.29E-05
23	10.00	185.00	137.28	2742.20	5212.50	32088.9	0.31	3.065	83848.9	0.706	0.59	5.90	7.04E-05
24	10.00	195.00	137.28	2791.70	5307.50	33257.8	0.31	3.066	86908.0	0.744	0.56	5.60	6.44E-05
25	12.50	206.25	137.28	2803.60	5335.40	33542.0	0.31	3.837	87677.3	0.787	0.53	6.63	7.56E-05
26	12.50	218.75	137.28	2827.80	5385.20	34123.5	0.31	3.841	89217.3	0.835	0.51	6.38	7.15E-05
27	12.50	231.25	137.28	2856.40	5443.10	34817.2	0.31	3.844	91045.7	0.883	0.49	6.13	6.73E-05
28	12.50	243.75	137.28	2904.80	5536.30	36007.1	0.31	3.844	94160.8	0.930	0.47	5.88	6.24E-05
29	12.50	256.25	137.28	2966.80	5615.30	37560.6	0.30	3.812	98031.0	0.978	0.45	5.63	5.74E-05
30	12.50	268.75	137.28	2971.20	5627.40	37672.1	0.31	3.816	98346.1	1.026	0.42	5.25	5.34E-05
31	12.50	281.25	137.28	3019.70	5719.00	38912.0	0.31	3.815	101577.5	1.073	0.40	5.00	4.92E-05
32	12.50	293.75	137.28	3017.40	5719.00	38852.8	0.31	3.820	101450.0	1.121	0.38	4.75	4.68E-05
33	15.00	307.50	137.28	3091.60	5854.10	40787.1	0.31	4.578	106468.2	1.174	0.36	5.40	5.07E-05
34	15.00	322.50	137.28	3113.70	5897.50	41372.3	0.31	4.580	108006.5	1.231	0.35	5.25	4.86E-05
35	15.00	337.50	137.28	3237.80	6122.20	44735.9	0.30	4.568	116718.7	1.288	0.33	4.95	4.24E-05
36	15.00	352.50	137.28	3305.70	6247.10	46631.9	0.30	4.565	121644.0	1.345	0.32	4.80	3.95E-05
37	15.00	367.50	137.28	3380.40	6384.20	48763.2	0.30	4.560	127174.5	1.403	0.30	4.50	3.54E-05
38	15.00	382.50	137.28	3417.10	6453.30	49827.8	0.30	4.560	129947.9	1.460	0.29	4.35	3.35E-05
39	15.00	397.50	137.28	3431.90	6483.70	50260.3	0.30	4.562	131093.1	1.517	0.28	4.20	3.20E-05
40	15.00	412.50	137.28	3430.10	6483.70	50207.6	0.30	4.566	130981.7	1.574	0.25	3.75	2.86E-05
41	15.00	427.50	137.28	3428.40	6483.70	50157.9	0.30	4.569	130873.9	1.632	0.24	3.60	2.75E-05
42	15.00	442.50	137.28	3426.80	6483.90	50111.1	0.30	4.573	130774.9	1.689	0.22	3.30	2.52E-05
43	15.00	457.50	137.28	3521.90	6658.70	52931.0	0.30	4.566	138089.6	1.746	0.20	3.00	2.17E-05
44	15.00	472.50	137.28	3541.90	6697.30	53533.9	0.30	4.568	139669.9	1.803	0.19	2.85	2.04E-05
45	15.00	487.50	137.28	3570.70	6749.70	54408.0	0.30	4.566	141942.9	1.861	0.17	2.55	1.80E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.323	Σ= 159.77			Σ=	264.77	9.25E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 28614 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 10816 ksf
Vel = SQRT(32.17*1000*G/p 1760.1 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p 1592.1 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 10816 ksf : 1E-4 Event : 100' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 9

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO $H*\mu$	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus $Nq*H/E_i$
1	4.00	2.00	112.32	1086.40	2755.50	4120.8	0.38	1.536	11406.2	0.008	1	4.00	3.51E-04
2	4.00	6.00	112.32	1063.40	2890.10	3948.2	0.41	1.637	11127.5	0.023	1	4.00	3.59E-04
3	4.00	10.00	112.32	1110.00	3218.30	4301.8	0.42	1.665	12184.1	0.038	1	4.00	3.28E-04
4	4.00	14.00	112.32	1212.10	3793.20	5129.6	0.42	1.666	14532.0	0.053	1	4.00	2.75E-04
5	4.00	18.00	112.32	1561.70	4593.40	8515.3	0.41	1.650	24057.7	0.069	1	4.00	1.66E-04
6	8.00	24.00	112.32	1433.40	4703.80	7173.7	0.42	3.357	20367.9	0.092	1	8.00	3.93E-04
7	8.00	32.00	112.32	1482.60	4690.90	7674.6	0.41	3.274	21631.7	0.122	1	8.00	3.70E-04
8	8.00	40.00	112.32	1545.60	4779.00	8340.7	0.40	3.189	23331.2	0.153	1	8.00	3.43E-04
9	8.00	48.00	112.32	1707.50	4992.30	10179.5	0.39	3.146	28366.5	0.183	1	8.00	2.82E-04
10	8.00	56.00	112.32	2071.50	5035.60	14982.2	0.38	3.026	41299.7	0.214	0.98	7.84	1.90E-04
11	10.00	65.00	112.32	2202.00	5062.60	16929.4	0.38	3.792	46698.0	0.248	0.96	9.60	2.06E-04
12	10.00	75.00	112.32	2303.70	5327.50	18529.3	0.38	3.788	51096.6	0.286	0.93	9.30	1.82E-04
13	10.00	85.00	112.32	2527.90	5698.60	22311.3	0.38	3.757	61387.9	0.324	0.90	9.00	1.47E-04
14	10.00	95.00	112.32	2441.30	5693.80	20808.9	0.38	3.800	57432.9	0.363	0.88	8.80	1.53E-04
15	10.00	105.00	137.28	3215.10	6071.30	44110.8	0.30	3.035	114995.2	0.401	0.85	8.50	7.39E-05
16	10.00	115.00	137.28	3213.90	6082.00	44077.9	0.30	3.044	114990.4	0.439	0.81	8.10	7.04E-05
17	10.00	125.00	137.28	3230.20	6100.00	44526.1	0.30	3.037	116093.0	0.477	0.78	7.80	6.72E-05
18	10.00	135.00	137.28	3305.10	6244.70	46615.0	0.30	3.039	121559.7	0.515	0.75	7.50	6.17E-05
19	10.00	145.00	137.28	3374.70	6379.80	48598.9	0.30	3.041	126759.6	0.553	0.72	7.20	5.68E-05
20	10.00	155.00	137.28	3409.50	6451.30	49606.4	0.30	3.045	129423.1	0.592	0.68	6.80	5.25E-05
21	10.00	165.00	137.28	3422.50	6482.10	49985.4	0.30	3.049	130454.9	0.630	0.65	6.50	4.98E-05
22	10.00	175.00	137.28	3382.90	6420.00	48835.4	0.31	3.058	127538.5	0.668	0.62	6.20	4.86E-05
23	10.00	185.00	137.28	3366.00	6384.00	48348.7	0.31	3.065	126336.0	0.706	0.59	5.90	4.67E-05
24	10.00	195.00	137.28	3436.60	6500.30	50398.1	0.31	3.066	131698.3	0.744	0.56	5.60	4.25E-05
25	12.50	206.25	137.28	3467.80	6534.50	51317.4	0.31	3.837	134141.5	0.787	0.53	6.63	4.94E-05
26	12.50	218.75	137.28	3481.20	6595.50	51714.7	0.31	3.841	135210.2	0.835	0.51	6.38	4.71E-05
27	12.50	231.25	137.28	3551.10	6666.40	53812.4	0.31	3.844	140717.2	0.883	0.49	6.13	4.35E-05
28	12.50	243.75	137.28	3609.00	6780.50	55581.5	0.31	3.844	145348.9	0.930	0.47	5.88	4.04E-05
29	12.50	256.25	137.28	3633.60	6877.30	56341.8	0.30	3.812	147048.6	0.978	0.45	5.63	3.83E-05
30	12.50	268.75	137.28	3638.90	6892.10	56506.2	0.31	3.816	147514.1	1.026	0.42	5.25	3.56E-05
31	12.50	281.25	137.28	3698.30	7004.30	58366.1	0.31	3.815	152361.1	1.073	0.40	5.00	3.28E-05
32	12.50	293.75	137.28	3695.50	7004.30	58277.7	0.31	3.820	152171.3	1.121	0.38	4.75	3.12E-05
33	15.00	307.50	137.28	3786.40	7169.80	61180.0	0.31	4.578	159700.5	1.174	0.36	5.40	3.38E-05
34	15.00	322.50	137.28	3813.50	7222.90	62058.8	0.31	4.580	162010.8	1.231	0.35	5.25	3.24E-05
35	15.00	337.50	137.28	3965.40	7498.10	67101.2	0.30	4.568	175071.0	1.288	0.33	4.95	2.83E-05
36	15.00	352.50	137.28	4048.60	7651.10	69946.5	0.30	4.565	182462.4	1.345	0.32	4.80	2.63E-05
37	15.00	367.50	137.28	4140.10	7819.00	73143.9	0.30	4.560	190759.2	1.403	0.30	4.50	2.36E-05
38	15.00	382.50	137.28	4185.10	7903.60	74742.5	0.30	4.560	194924.1	1.460	0.29	4.35	2.23E-05
39	15.00	397.50	137.28	4203.20	7940.90	75390.4	0.30	4.562	196639.4	1.517	0.28	4.20	2.14E-05
40	15.00	412.50	137.28	4201.00	7940.90	75311.5	0.30	4.566	196472.8	1.574	0.25	3.75	1.91E-05
41	15.00	427.50	137.28	4198.90	7940.90	75236.3	0.30	4.569	196309.5	1.632	0.24	3.60	1.83E-05
42	15.00	442.50	137.28	4196.90	7941.10	75164.6	0.30	4.573	196157.1	1.689	0.22	3.30	1.68E-05
43	15.00	457.50	137.28	4313.50	8155.20	79399.1	0.30	4.566	207141.2	1.746	0.20	3.00	1.45E-05
44	15.00	472.50	137.28	4337.90	8202.50	80300.0	0.30	4.568	209502.6	1.803	0.19	2.85	1.36E-05
45	15.00	487.50	137.28	4373.20	8266.70	81612.2	0.30	4.566	212914.7	1.861	0.17	2.55	1.20E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.323	Σ= 159.77			Σ=	264.77	4.92E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ = 53861 ksf

Equivalent Shear Modulus $G = E/(2*(1+Average\ \mu)$ = 20359 ksf

Vel = SQRT(32.17*1000*G/p 2414.8 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p 2184.2 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 20359 ksf : 1E-4 Event : 100' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 10

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	530.88	1359.50	984.0	0.38	1.532	2722.0	0.008	1	4.00	1.47E-03
2	4.00	6.00	112.32	540.31	1577.60	1019.3	0.41	1.629	2868.8	0.023	1	4.00	1.39E-03
3	4.00	10.00	112.32	553.99	1776.80	1071.5	0.42	1.661	3033.2	0.038	1	4.00	1.32E-03
4	4.00	14.00	112.32	598.44	1879.70	1250.4	0.42	1.667	3543.1	0.053	1	4.00	1.13E-03
5	4.00	18.00	112.32	745.99	2531.50	1943.0	0.41	1.654	5492.8	0.069	1	4.00	7.28E-04
6	8.00	24.00	112.32	697.89	2276.60	1700.5	0.42	3.366	4832.0	0.092	1	8.00	1.66E-03
7	8.00	32.00	112.32	746.13	2680.10	1943.7	0.41	3.269	5476.1	0.122	1	8.00	1.46E-03
8	8.00	40.00	112.32	789.85	2715.10	2178.2	0.40	3.190	6093.4	0.153	1	8.00	1.31E-03
9	8.00	48.00	112.32	891.95	3061.60	2777.7	0.39	3.141	7736.5	0.183	1	8.00	1.03E-03
10	8.00	56.00	112.32	1045.90	3098.40	3819.3	0.38	3.022	10524.1	0.214	0.98	7.84	7.45E-04
11	10.00	65.00	112.32	1110.50	3390.90	4305.7	0.38	3.789	11874.1	0.248	0.96	9.60	8.08E-04
12	10.00	75.00	112.32	1162.90	3559.30	4721.6	0.38	3.791	13023.4	0.286	0.93	9.30	7.14E-04
13	10.00	85.00	112.32	1273.70	3782.30	5664.2	0.38	3.775	15604.7	0.324	0.90	9.00	5.77E-04
14	10.00	95.00	112.32	1227.30	3775.40	5259.1	0.38	3.823	14538.9	0.363	0.88	8.80	6.05E-04
15	10.00	105.00	112.32	1299.80	3842.00	5898.7	0.38	3.805	16286.1	0.401	0.85	8.50	5.22E-04
16	10.00	115.00	112.32	1273.50	3847.20	5662.4	0.38	3.842	15675.9	0.439	0.81	8.10	5.17E-04
17	10.00	125.00	112.32	1245.60	3856.30	5417.1	0.39	3.873	15029.9	0.477	0.78	7.80	5.19E-04
18	10.00	135.00	112.32	1291.80	3987.90	5826.4	0.39	3.860	16150.5	0.515	0.75	7.50	4.64E-04
19	10.00	145.00	112.32	1320.20	4078.00	6085.3	0.39	3.860	16869.0	0.553	0.72	7.20	4.27E-04
20	10.00	155.00	112.32	1322.90	4132.20	6110.3	0.39	3.871	16951.0	0.592	0.68	6.80	4.01E-04
21	10.00	165.00	112.32	1289.10	4114.60	5802.0	0.39	3.898	16127.8	0.630	0.65	6.50	4.03E-04
22	10.00	175.00	112.32	1241.80	4077.50	5384.1	0.39	3.927	14997.2	0.668	0.62	6.20	4.13E-04
23	10.00	185.00	112.32	1223.30	4081.70	5224.8	0.39	3.945	14572.5	0.706	0.59	5.90	4.05E-04
24	10.00	195.00	112.32	1261.50	4160.00	5556.2	0.39	3.939	15489.3	0.744	0.56	5.60	3.62E-04
25	12.50	206.25	137.28	2268.90	4366.20	21967.8	0.31	3.821	57364.6	0.787	0.53	6.63	1.15E-04
26	12.50	218.75	137.28	2299.60	4421.30	22566.3	0.31	3.826	58946.8	0.835	0.51	6.38	1.08E-04
27	12.50	231.25	137.28	2301.60	4447.80	22605.6	0.31	3.831	59067.1	0.883	0.49	6.13	1.04E-04
28	12.50	243.75	137.28	2345.70	4543.30	23480.2	0.31	3.834	61362.1	0.930	0.47	5.88	9.57E-05
29	12.50	256.25	137.28	2454.10	4625.00	25700.4	0.30	3.786	66970.2	0.978	0.45	5.63	8.40E-05
30	12.50	268.75	137.28	2459.10	4637.20	25805.3	0.30	3.791	67262.5	1.026	0.42	5.25	7.81E-05
31	12.50	281.25	137.28	2456.90	4637.20	25759.1	0.30	3.796	67163.3	1.073	0.40	5.00	7.44E-05
32	12.50	293.75	137.28	2454.80	4637.20	25715.1	0.30	3.801	67069.1	1.121	0.38	4.75	7.08E-05
33	15.00	307.50	137.28	2515.30	4748.20	26998.3	0.30	4.556	70398.5	1.174	0.36	5.40	7.67E-05
34	15.00	322.50	137.28	2533.10	4783.40	27381.7	0.30	4.559	71408.3	1.231	0.35	5.25	7.35E-05
35	15.00	337.50	137.28	2632.40	4965.70	29570.6	0.30	4.551	77085.2	1.288	0.33	4.95	6.42E-05
36	15.00	352.50	137.28	2684.50	5059.30	30752.7	0.30	4.547	80149.5	1.345	0.32	4.80	5.99E-05
37	15.00	367.50	137.28	2744.50	5170.50	32142.7	0.30	4.544	83758.8	1.403	0.30	4.50	5.37E-05
38	15.00	382.50	137.28	2773.90	5226.30	32835.1	0.30	4.544	85565.5	1.460	0.29	4.35	5.08E-05
39	15.00	397.50	137.28	2785.80	5251.10	33117.4	0.30	4.548	86315.2	1.517	0.28	4.20	4.87E-05
40	15.00	412.50	137.28	2784.10	5251.10	33077.0	0.30	4.552	86228.4	1.574	0.25	3.75	4.35E-05
41	15.00	427.50	137.28	2782.60	5251.10	33041.3	0.30	4.556	86153.3	1.632	0.24	3.60	4.18E-05
42	15.00	442.50	137.28	2781.20	5251.10	33008.1	0.30	4.560	86083.2	1.689	0.22	3.30	3.83E-05
43	15.00	457.50	137.28	2857.60	5392.70	34846.5	0.30	4.555	90856.0	1.746	0.20	3.00	3.30E-05
44	15.00	472.50	137.28	2873.70	5424.00	35240.3	0.30	4.556	91889.0	1.803	0.19	2.85	3.10E-05
45	15.00	487.50	137.28	2896.20	5466.40	35794.3	0.30	4.556	93332.8	1.861	0.17	2.55	2.73E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.339	Σ= 167.80			Σ=	264.77	2.08E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus	E=sum(Nq*H)/sum(Nq*H/E_i) =	12755 ksf
Equivalent Shear Modulus	G = E/(2*(1+Average μ) =	4763 ksf
	Vel = SQRT(32.17*1000*G/p	1168.0 fps (density =112.32 pcf)
	Vel = SQRT(32.17*1000*G/p	1056.5 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 4763 ksf : 1E-4 Event : 200' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 11

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	750.78	1922.60	1968.0	0.38	1.532	5444.0	0.008	1	4.00	7.35E-04
2	4.00	6.00	112.32	764.11	2148.60	2038.5	0.41	1.629	5737.5	0.023	1	4.00	6.97E-04
3	4.00	10.00	112.32	783.46	2406.60	2143.1	0.42	1.661	6066.5	0.038	1	4.00	6.59E-04
4	4.00	14.00	112.32	846.33	2658.30	2500.8	0.42	1.667	7086.3	0.053	1	4.00	5.64E-04
5	4.00	18.00	112.32	1055.00	3382.00	3886.1	0.41	1.654	10985.8	0.069	1	4.00	3.64E-04
6	8.00	24.00	112.32	986.96	3175.50	3401.0	0.42	3.366	9664.0	0.092	1	8.00	8.28E-04
7	8.00	32.00	112.32	1055.20	3569.30	3887.5	0.41	3.269	10952.4	0.122	1	8.00	7.30E-04
8	8.00	40.00	112.32	1117.00	3627.00	4356.2	0.40	3.190	12186.5	0.153	1	8.00	6.56E-04
9	8.00	48.00	112.32	1261.40	3928.40	5555.4	0.39	3.141	15472.9	0.183	1	8.00	5.17E-04
10	8.00	56.00	112.32	1479.20	3966.70	7639.4	0.38	3.022	21050.2	0.214	0.98	7.84	3.72E-04
11	10.00	65.00	112.32	1570.50	4153.00	8611.6	0.38	3.789	23748.6	0.248	0.96	9.60	4.04E-04
12	10.00	75.00	112.32	1644.60	4359.20	9443.4	0.38	3.791	26047.2	0.286	0.93	9.30	3.57E-04
13	10.00	85.00	112.32	1801.20	4632.40	11327.4	0.38	3.775	31206.5	0.324	0.90	9.00	2.88E-04
14	10.00	95.00	112.32	1735.60	4623.90	10517.3	0.38	3.823	29075.6	0.363	0.88	8.80	3.03E-04
15	10.00	105.00	112.32	1838.10	4705.50	11796.3	0.38	3.805	32568.8	0.401	0.85	8.50	2.61E-04
16	10.00	115.00	112.32	1801.00	4711.90	11324.9	0.38	3.842	31351.8	0.439	0.81	8.10	2.58E-04
17	10.00	125.00	112.32	1761.50	4723.00	10833.6	0.39	3.873	30058.4	0.477	0.78	7.80	2.59E-04
18	10.00	135.00	112.32	1826.80	4884.10	11651.7	0.39	3.860	32298.2	0.515	0.75	7.50	2.32E-04
19	10.00	145.00	112.32	1867.00	4994.50	12170.1	0.39	3.860	33736.3	0.553	0.72	7.20	2.13E-04
20	10.00	155.00	112.32	1870.90	5060.90	12221.0	0.39	3.871	33903.3	0.592	0.68	6.80	2.01E-04
21	10.00	165.00	112.32	1823.00	5039.30	11603.2	0.39	3.898	32253.3	0.630	0.65	6.50	2.02E-04
22	10.00	175.00	112.32	1756.10	4995.50	10767.2	0.39	3.927	29991.9	0.668	0.62	6.20	2.07E-04
23	10.00	185.00	112.32	1730.00	4999.00	10449.6	0.39	3.945	29144.7	0.706	0.59	5.90	2.02E-04
24	10.00	195.00	112.32	1784.00	5094.90	11112.1	0.39	3.939	30977.6	0.744	0.56	5.60	1.81E-04
25	12.50	206.25	137.28	2826.70	5363.80	34097.0	0.31	3.821	89037.4	0.787	0.53	6.63	7.44E-05
26	12.50	218.75	137.28	2850.80	5415.00	34680.8	0.31	3.826	90591.9	0.835	0.51	6.38	7.04E-05
27	12.50	231.25	137.28	2880.40	5477.10	35404.8	0.31	3.831	92510.5	0.883	0.49	6.13	6.62E-05
28	12.50	243.75	137.28	2931.80	5578.00	36679.6	0.31	3.834	95857.1	0.930	0.47	5.88	6.13E-05
29	12.50	256.25	137.28	3006.20	5664.50	38564.9	0.30	3.786	100492.4	0.978	0.45	5.63	5.60E-05
30	12.50	268.75	137.28	3011.70	5679.40	38706.1	0.30	3.791	100889.0	1.026	0.42	5.25	5.20E-05
31	12.50	281.25	137.28	3009.10	5679.40	38639.3	0.30	3.796	100746.6	1.073	0.40	5.00	4.96E-05
32	12.50	293.75	137.28	3006.50	5679.40	38572.6	0.30	3.801	100603.4	1.121	0.38	4.75	4.72E-05
33	15.00	307.50	137.28	3080.60	5815.30	40497.4	0.30	4.556	105597.7	1.174	0.36	5.40	5.11E-05
34	15.00	322.50	137.28	3102.40	5858.50	41072.6	0.30	4.559	107112.3	1.231	0.35	5.25	4.90E-05
35	15.00	337.50	137.28	3224.10	6081.70	44358.1	0.30	4.551	115633.7	1.288	0.33	4.95	4.28E-05
36	15.00	352.50	137.28	3287.80	6196.40	46128.3	0.30	4.547	120222.2	1.345	0.32	4.80	3.99E-05
37	15.00	367.50	137.28	3361.30	6332.50	48213.7	0.30	4.544	125637.3	1.403	0.30	4.50	3.58E-05
38	15.00	382.50	137.28	3397.30	6400.90	49252.0	0.30	4.544	128346.8	1.460	0.29	4.35	3.39E-05
39	15.00	397.50	137.28	3411.80	6431.20	49673.3	0.30	4.548	129465.6	1.517	0.28	4.20	3.24E-05
40	15.00	412.50	137.28	3409.80	6431.20	49615.1	0.30	4.552	129341.6	1.574	0.25	3.75	2.90E-05
41	15.00	427.50	137.28	3407.90	6431.20	49559.8	0.30	4.556	129224.3	1.632	0.24	3.60	2.79E-05
42	15.00	442.50	137.28	3406.20	6431.30	49510.4	0.30	4.560	129120.2	1.689	0.22	3.30	2.56E-05
43	15.00	457.50	137.28	3499.90	6604.70	52271.8	0.30	4.555	136289.3	1.746	0.20	3.00	2.20E-05
44	15.00	472.50	137.28	3519.50	6643.00	52858.9	0.30	4.556	137829.6	1.803	0.19	2.85	2.07E-05
45	15.00	487.50	137.28	3547.10	6695.00	53691.2	0.30	4.556	139998.7	1.861	0.17	2.55	1.82E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.339	Σ= 167.80			Σ=	264.77	1.06E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 24982 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 9329 ksf
Vel = SQRT(32.17*1000*G/p 1634.6 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p 1478.5 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 9329 ksf : 1E-4 Event : 200' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 12

See DTN MO0706SCSPS1E4.002 - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

CRCF Soil Springs - 2007 Strain Compatible Soil Properties

LAYER	LAYER THICKNESS [1] H (FT)	DEPTH TO MIDPOINT [1] Z (FT) Depth = 0' is at soil surface.	DENSITY [1] Den (PCF)	SHEAR WAVE VELOCITY [1] Vs (FT/S)	COMPR. WAVE VELOCITY [1] Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO [2] μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' [3]	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT [4] Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	1061.80	2719.00	3936.3	0.38	1.532	10888.8	0.008	1	4.00	3.67E-04
2	4.00	6.00	112.32	1080.60	2926.20	4077.0	0.41	1.629	11474.8	0.023	1	4.00	3.49E-04
3	4.00	10.00	112.32	1108.00	3259.60	4286.3	0.42	1.661	12133.4	0.038	1	4.00	3.30E-04
4	4.00	14.00	112.32	1196.90	3759.40	5001.7	0.42	1.667	14172.8	0.053	1	4.00	2.82E-04
5	4.00	18.00	112.32	1492.00	4518.30	7772.2	0.41	1.654	21971.7	0.069	1	4.00	1.82E-04
6	8.00	24.00	112.32	1395.80	4429.20	6802.2	0.42	3.366	19328.7	0.092	1	8.00	4.14E-04
7	8.00	32.00	112.32	1492.30	4753.50	7775.3	0.41	3.269	21905.4	0.122	1	8.00	3.65E-04
8	8.00	40.00	112.32	1579.70	4845.10	8712.8	0.40	3.190	24373.7	0.153	1	8.00	3.28E-04
9	8.00	48.00	112.32	1783.90	5040.60	11110.8	0.39	3.141	30946.1	0.183	1	8.00	2.59E-04
10	8.00	56.00	112.32	2091.80	5078.30	15277.3	0.38	3.022	42096.3	0.214	0.98	7.84	1.86E-04
11	10.00	65.00	112.32	2221.00	5086.40	17222.8	0.38	3.789	47496.3	0.248	0.96	9.60	2.02E-04
12	10.00	75.00	112.32	2325.80	5338.90	18886.5	0.38	3.791	52093.8	0.286	0.93	9.30	1.79E-04
13	10.00	85.00	112.32	2547.30	5673.50	22655.1	0.38	3.775	62413.9	0.324	0.90	9.00	1.44E-04
14	10.00	95.00	112.32	2454.60	5663.10	21036.2	0.38	3.823	58155.4	0.363	0.88	8.80	1.51E-04
15	10.00	105.00	112.32	2599.50	5763.00	23593.1	0.38	3.805	65139.2	0.401	0.85	8.50	1.30E-04
16	10.00	115.00	112.32	2547.00	5770.90	22649.8	0.38	3.842	62703.6	0.439	0.81	8.10	1.29E-04
17	10.00	125.00	112.32	2491.10	5784.50	21666.5	0.39	3.873	60114.9	0.477	0.78	7.80	1.30E-04
18	10.00	135.00	112.32	2583.60	5981.80	23305.4	0.39	3.860	64602.1	0.515	0.75	7.50	1.16E-04
19	10.00	145.00	112.32	2640.30	6117.00	24339.6	0.39	3.860	67470.7	0.553	0.72	7.20	1.07E-04
20	10.00	155.00	112.32	2645.90	6198.30	24442.9	0.39	3.871	67809.0	0.592	0.68	6.80	1.00E-04
21	10.00	165.00	112.32	2578.10	6171.90	23206.3	0.39	3.898	64506.0	0.630	0.65	6.50	1.01E-04
22	10.00	175.00	112.32	2483.50	6120.20	21534.5	0.39	3.927	59983.9	0.668	0.62	6.20	1.03E-04
23	10.00	185.00	112.32	2446.60	6122.50	20899.3	0.39	3.945	58289.9	0.706	0.59	5.90	1.01E-04
24	10.00	195.00	112.32	2522.90	6240.00	22223.2	0.39	3.939	61952.4	0.744	0.56	5.60	9.04E-05
25	12.50	206.25	137.28	3521.50	6589.30	52919.0	0.31	3.821	138187.4	0.787	0.53	6.63	4.79E-05
26	12.50	218.75	137.28	3534.00	6632.00	53295.3	0.31	3.826	139216.0	0.835	0.51	6.38	4.58E-05
27	12.50	231.25	137.28	3604.70	6744.60	55449.1	0.31	3.831	144885.2	0.883	0.49	6.13	4.23E-05
28	12.50	243.75	137.28	3664.40	6848.40	57301.0	0.31	3.834	149748.1	0.930	0.47	5.88	3.92E-05
29	12.50	256.25	137.28	3682.40	6937.60	57865.3	0.30	3.786	150785.4	0.978	0.45	5.63	3.73E-05
30	12.50	268.75	137.28	3688.60	6955.80	58060.3	0.30	3.791	151336.5	1.026	0.42	5.25	3.47E-05
31	12.50	281.25	137.28	3685.40	6955.80	57959.6	0.30	3.796	151121.6	1.073	0.40	5.00	3.31E-05
32	12.50	293.75	137.28	3682.20	6955.80	57859.0	0.30	3.801	150905.5	1.121	0.38	4.75	3.15E-05
33	15.00	307.50	137.28	3772.90	7122.30	60744.5	0.30	4.556	158392.4	1.174	0.36	5.40	3.41E-05
34	15.00	322.50	137.28	3799.60	7175.20	61607.3	0.30	4.559	160664.4	1.231	0.35	5.25	3.27E-05
35	15.00	337.50	137.28	3948.70	7448.50	66537.2	0.30	4.551	173450.5	1.288	0.33	4.95	2.85E-05
36	15.00	352.50	137.28	4026.70	7589.00	69191.8	0.30	4.547	180331.9	1.345	0.32	4.80	2.66E-05
37	15.00	367.50	137.28	4116.70	7755.70	72319.4	0.30	4.544	188452.7	1.403	0.30	4.50	2.39E-05
38	15.00	382.50	137.28	4160.90	7839.50	73880.7	0.30	4.544	192527.1	1.460	0.29	4.35	2.26E-05
39	15.00	397.50	137.28	4178.60	7876.60	74510.6	0.30	4.548	194199.8	1.517	0.28	4.20	2.16E-05
40	15.00	412.50	137.28	4176.20	7876.60	74425.0	0.30	4.552	194018.5	1.574	0.25	3.75	1.93E-05
41	15.00	427.50	137.28	4173.90	7876.60	74343.0	0.30	4.556	193845.0	1.632	0.24	3.60	1.86E-05
42	15.00	442.50	137.28	4171.70	7876.70	74264.7	0.30	4.560	193677.8	1.689	0.22	3.30	1.70E-05
43	15.00	457.50	137.28	4286.50	8089.10	78408.3	0.30	4.555	204435.4	1.746	0.20	3.00	1.47E-05
44	15.00	472.50	137.28	4310.50	8136.00	79288.7	0.30	4.556	206745.4	1.803	0.19	2.85	1.38E-05
45	15.00	487.50	137.28	4344.30	8199.70	80537.1	0.30	4.556	209998.8	1.861	0.17	2.55	1.21E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.339	Σ= 167.80			Σ=	264.77	5.44E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0706SCSPS1E4.002.
(2) Poisson's Ratio at each soil layer are from DTN MO0706SCSPS1E4.002.
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus	E=sum(Nq*H)/sum(Nq*H/E_i)	48637 ksf
Equivalent Shear Modulus	G = E/(2*(1+Average μ) =	18162 ksf
	Vel = SQRT(32.17*1000*G/ρ	2280.7 fps (density =112.32 pcf)
	Vel = SQRT(32.17*1000*G/ρ	2063.0 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 18162 ksf : 1E-4 Event : 200' Alluvium : Upper Bound Shear Wave Velocity.

Summary of Equivalent Dynamic Shear Modulus

For values of equivalent dynamic shear modulus, see section 6.1.1.

SUMMARY OF EQUIVALENT DYNAMIC SHEAR MODULUS G_s (KSF) FOR 5E-4 SEISMIC EVENT

100' Alluvium			200' Alluvium		
Lower Bound	Median	Upper Bound	Lower Bound	Median	Upper Bound
CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
8255 KSF	15354 KSF	28124 KSF	7250 KSF	13744 KSF	25823 KSF
(Page 13)	(Page 14)	(Page 15)	(Page 16)	(Page 17)	(Page 18)

SUMMARY OF EQUIVALENT DYNAMIC SHEAR MODULUS G_s (KSF) FOR 1E-4 SEISMIC EVENT

100' Alluvium			200' Alluvium		
Lower Bound	Median	Upper Bound	Lower Bound	Median	Upper Bound
CASE 7	CASE 8	CASE 9	CASE 10	CASE 11	CASE 12
5675 KSF	10816 KSF	20359 KSF	4763 KSF	9329 KSF	18162 KSF
(Page 19)	(Page 20)	(Page 21)	(Page 22)	(Page 23)	(Page 24)

Figure 1

Shear Wave Velocity for 100' Alluvium over tuff, 5E-4 (DBGM-2) event
(Taken from DTN MO0706SCSPS5E4.002, Northeast-100ft data set)

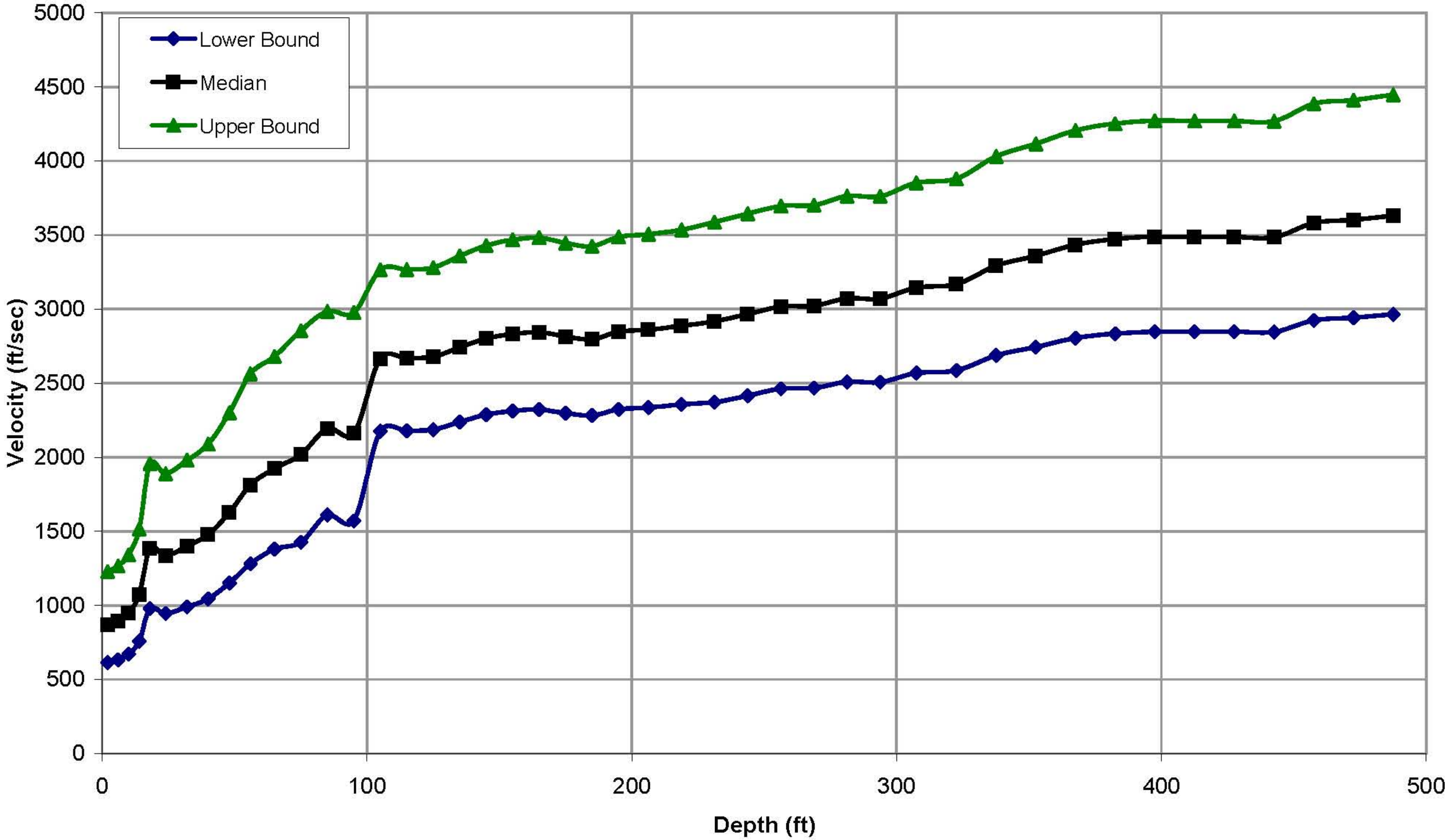


Figure 2
Shear Wave Velocity for 200' Alluvium over tuff. 5E-4 (DBGM-2) event
(Taken from DTN MO0706SCSPS5E4.002, Northeast-200ft data set)

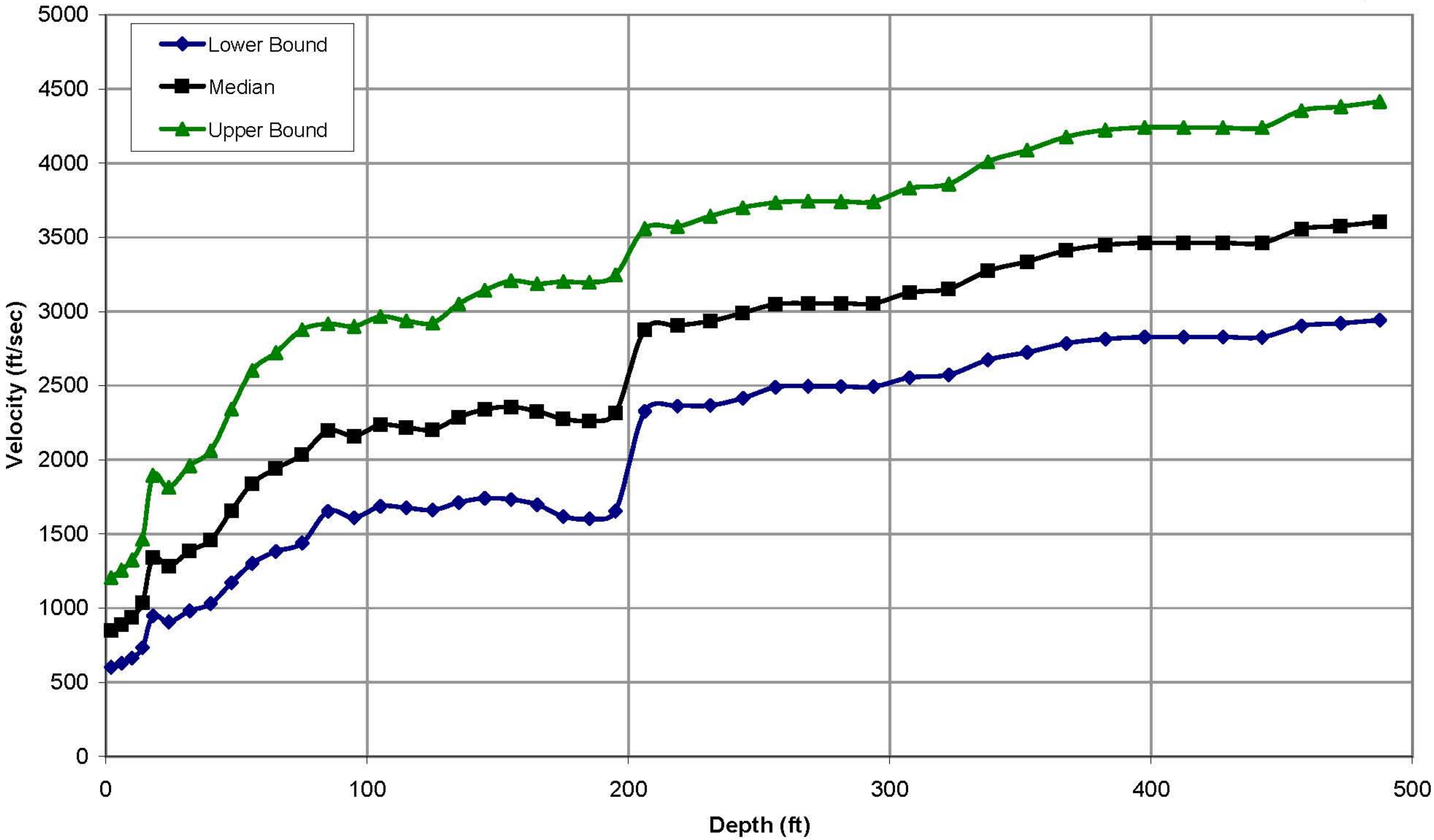


Figure 3
Shear Wave Velocity for 100' Alluvium over tuff, 1E-4 (BDBGM) event
(Taken from DTN MO0706SCSPS1E4.002, Northeast-100ft data set)

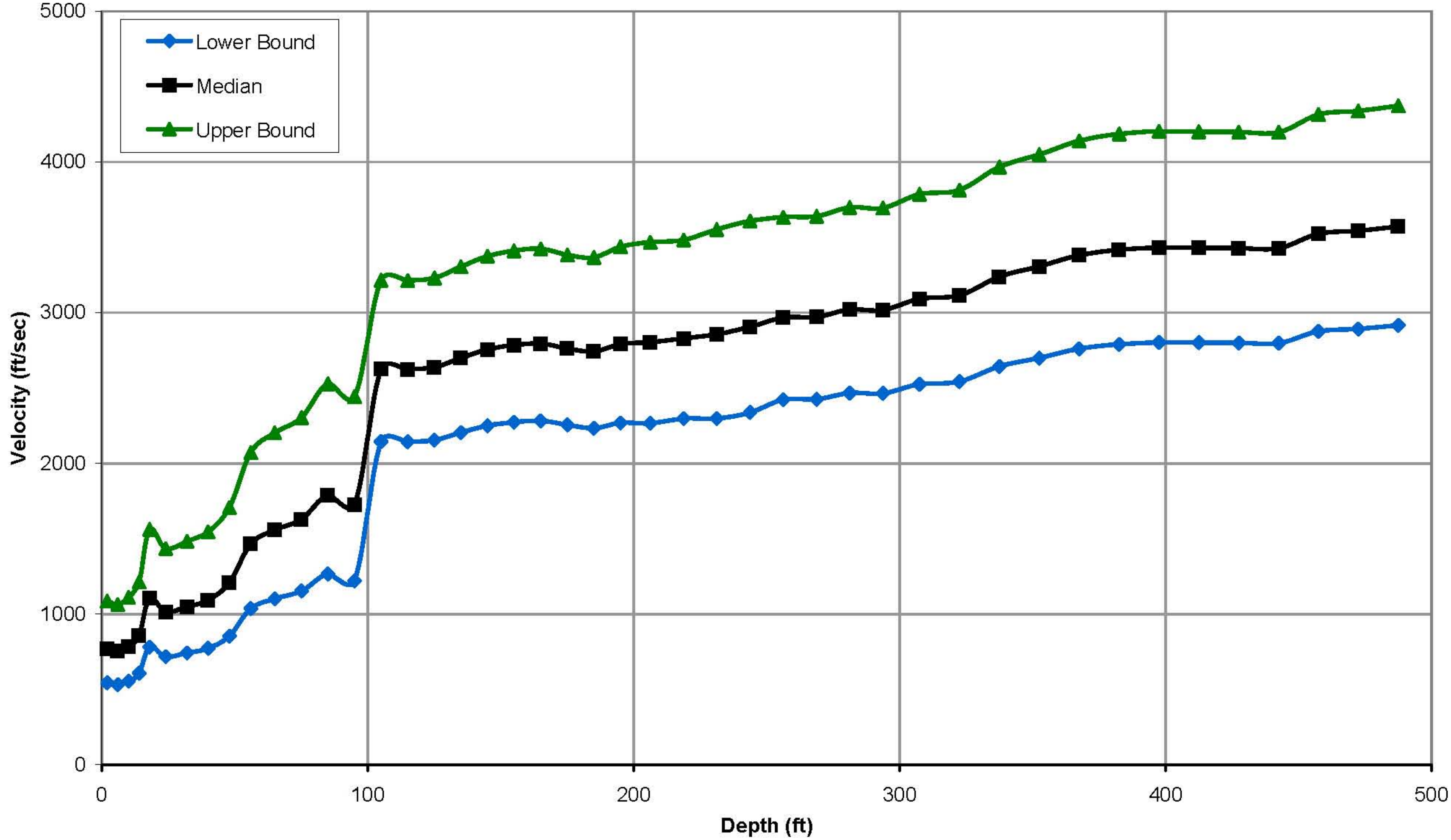
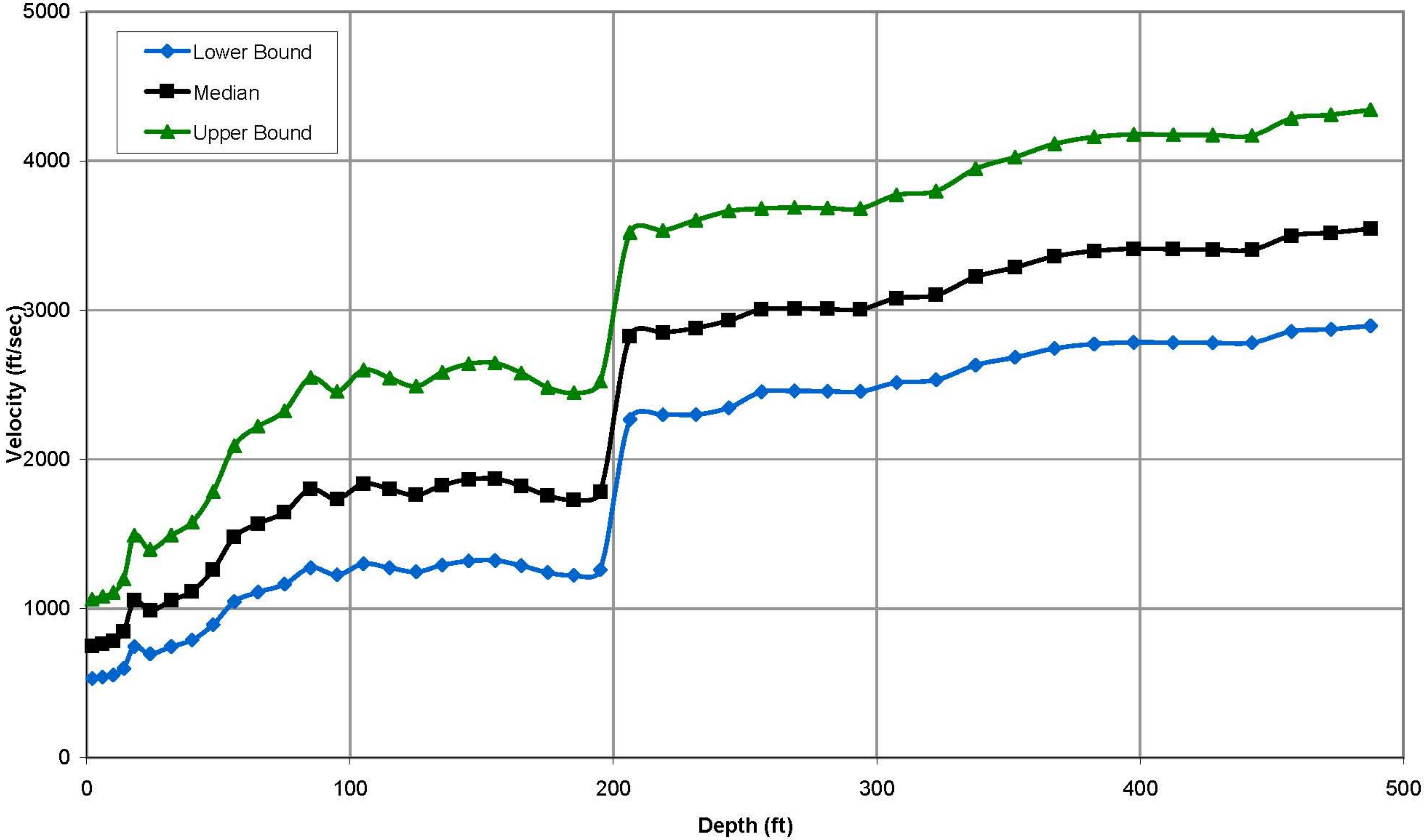


Figure 4
Shear Wave Velocity for 200' Alluvium over tuff, 1E-4 (BDBGM) event
(Taken from DTN MO0706SCSPS1E4.002, Northeast-200ft data set)



6.1.2 SOIL SPRINGS FOR 5E-4 SEISMIC EVENT

The following calculations determine translational and rotational springs (Kx,Ky,Kz, $K_{\psi}x$,$K_{\psi}y$ and $K_{\psi}z$) as per ASCE 4-98 (Ref. 2.2.3) section 3.3 methodology. These results are tabulated in sections 7.1.1 and 7.1.2.

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

6.1.2.1 Soil Properties

The soil springs will be calculated for Lower Bound, Median and Upper Bound cases for 100' and 200' depth of alluvium for 5E-4 seismic event as follows.

Case 1 : Lower Bound : 100' Depth of Alluvium : 5E-4 Seismic Event

Case 2 : Median : 100' Depth of Alluvium : 5E-4 Seismic Event

Case 3 : Upper Bound : 100' Depth of Alluvium : 5E-4 Seismic Event

Case 4 : Lower Bound : 200' Depth of Alluvium : 5E-4 Seismic Event

Case 5 : Median : 200' Depth of Alluvium : 5E-4 Seismic Event

Case 6 : Upper Bound : 200' Depth of Alluvium : 5E-4 Seismic Event

Shear Modulus : See section 6.1.1.

$$G_{s1} := \begin{pmatrix} 8255 \\ 15354 \\ 28124 \\ 7250 \\ 13744 \\ 25823 \end{pmatrix} ksf$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

Poisson's Ratio : See section 6.1.1

$$\mu := \begin{pmatrix} 0.309 \\ 0.309 \\ 0.309 \\ 0.318 \\ 0.318 \\ 0.318 \end{pmatrix}$$

average Poisson's ratio for 100' and 200' alluvium depths

6.1.2.2 Horizontal X : Soil Springs

For Seismic loads in the x-direction (365' building dimension) :

$L_x := 365 \cdot ft$ Length of base mat in direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$B_x := 262 \cdot ft$ Width of base mat perpendicular to direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_x}{B_x} = 1.39$$

From ASCE 4-98 (Ref. 2.2.3) Figure 3.3-3

for L.x / B.x = 1.4 : $\beta x1 := 0.95$ $\beta z1 := 2.2$

$$Kx1 := 2 \cdot \overrightarrow{\left[(1+\mu) \cdot G_{s1}\right]} \cdot \beta x1 \cdot \sqrt{B_x \cdot L_x}$$ (Ref. 2.2.3 Table 3.3-3)

$$Kx1 = \begin{pmatrix} 6.349 \times 10^6 \\ 1.181 \times 10^7 \\ 2.163 \times 10^7 \\ 5.614 \times 10^6 \\ 1.064 \times 10^7 \\ 2.000 \times 10^7 \end{pmatrix} \frac{kip}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.2.3 Vertical Y : Soil Springs

$L_y := L_x$ $L_y = 365\,ft$ $B_y := B_x$ $B_y = 262\,ft$ (Ref. 2.2.4, Section 6.1.2.1)

$$Ky1 := \frac{G_{s1}}{1-\mu} \cdot \beta z1 \cdot \sqrt{B_y \cdot L_y}$$ (Ref. 2.2.3 Table 3.3-3)

$$Ky1 = \begin{pmatrix} 8.128 \times 10^6 \\ 1.512 \times 10^7 \\ 2.769 \times 10^7 \\ 7.232 \times 10^6 \\ 1.371 \times 10^7 \\ 2.576 \times 10^7 \end{pmatrix} \frac{kip}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.2.4 Horizontal Z : Soil Springs

For Seismic loads in the z-direction (262' for length) :

$L_z := 262 \cdot ft$ Length of base mat in direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$B_z := 365 \cdot ft$ Width of base mat perpendicular to direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_z}{B_z} = 0.72$$

From Ref. 2.2.3 figure 3.3-3

for $L_z / B_z = 0.7$: $\beta x2 := 1.0$

$$Kz1 := 2 \cdot \overrightarrow{\left[(1 + \mu) \cdot G_{s1}\right]} \cdot \beta x2 \cdot \sqrt{B_z \cdot L_z}$$ (Ref. 2.2.3 Table 3.3-3)

$$Kz1 = \begin{pmatrix} 6.683 \times 10^{6} \\ 1.243 \times 10^{7} \\ 2.277 \times 10^{7} \\ 5.910 \times 10^{6} \\ 1.120 \times 10^{7} \\ 2.105 \times 10^{7} \end{pmatrix} \frac{kip}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.2.5 Rocking about X : Soil Springs

For Rocking about X use 336' x 262'. $L_{rx} := 262 \cdot ft$ $B_{rx} := 336 \cdot ft$ (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_{rx}}{B_{rx}} = 0.78$$

$\beta\psi 1 := 0.53$ (Ref. 2.2.3 figure 3.3-3)

$$K\psi x1 := \frac{G_{s1}}{1 - \mu} \cdot \beta\psi 1 \cdot B_{rx} \cdot L_{rx}^{\,2}$$ (Ref. 2.2.3 Table 3.3-3)

$$K\psi x1 = \begin{pmatrix} 1.460 \times 10^{11} \\ 2.716 \times 10^{11} \\ 4.975 \times 10^{11} \\ 1.299 \times 10^{11} \\ 2.463 \times 10^{11} \\ 4.628 \times 10^{11} \end{pmatrix} \frac{ft \cdot kip}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.2.6 Torsion : Soil Springs

$L_t := 365 \cdot ft$ $B_t := 262 \cdot ft$ (Ref. 2.2.4, Section 6.1.2.1)

$$R_t := \left[\frac{(B_t \cdot L_t) \cdot (B_t^2 + L_t^2)}{6 \cdot \pi}\right]^{.25}$$ (Ref. 2.2.3, Table 3.3-3)

$R_t = 178.9\ ft$

$$K\psi y1 := \frac{16 \cdot G_{s1} \cdot R_t^3}{3}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$K\psi y1 = \begin{pmatrix} 2.521 \times 10^{11} \\ 4.688 \times 10^{11} \\ 8.587 \times 10^{11} \\ 2.214 \times 10^{11} \\ 4.196 \times 10^{11} \\ 7.885 \times 10^{11} \end{pmatrix} \frac{ft \cdot kip}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.2.7 Rocking about Z : Soil Springs

For Rocking about Z use 370' x 262'.

$L_{rz} := 370 \cdot ft$ $B_{rz} := 262 \cdot ft$ (Ref. 2.2.4, Section 6.1.2.1)

$\frac{L_{rz}}{B_{rz}} = 1.41$ $\beta\psi2 := 0.56$ (Ref. 2.2.3 figure 3.3-3)

$$K\psi z1 := \frac{G_{s1}}{1-\mu} \cdot \beta\psi2 \cdot B_{rz} \cdot L_{rz}^2$$ (Ref. 2.2.3 Table 3.3-3)

$$K\psi z1 = \begin{pmatrix} 2.400 \times 10^{11} \\ 4.463 \times 10^{11} \\ 8.175 \times 10^{11} \\ 2.135 \times 10^{11} \\ 4.048 \times 10^{11} \\ 7.605 \times 10^{11} \end{pmatrix} \frac{ft \cdot kip}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.3 SOIL DAMPING FOR 5E-4 SEISMIC EVENT

Legend :

G_s = shear modulus of foundation medium (Calculated in section 6.1.1)
R = Equivalent radius of circular base mat
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 base mat
Io_x (mψx), Io_z(mψz) = total mass moment of inertia of structure and base mat about rocking axis at base

k_x, kψz, kψx, kz, ky, kt = equivalent spring constants (note kt=kψy shown in sections 7.1.1 and 7.1.2)
Cx, Cψx, Cz, Ct, Cψz,Cy = equivalent damping coefficients
Cc = critical damping value
βψ = constants that are functions of the base mat dimensional ratio, L/B

Damping Cases :

The equivalent soil damping coefficient and critical damping values will be calculated for Lower Bound, Median and Upper Bound cases for 100' and 200' depth of alluvium for 5E-4 seismic event.

See section 6.1.2.1 for definitions of cases 1 to 6.

Units :

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

Results :

Results are presented in tabular form in section 7.1.5.

6.1.3.1 Equivalent Damping Coefficients

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

See section 6.1.3.1 of *Canister Receipt and Closure Facility (CRCF) Soil Springs (Ref. 2.2.4)* for mass and mass moment of inertia.

$m_x := 9759 \cdot \frac{kip \cdot sec^2}{ft}$ Horizontal X

$m_y := 9759 \cdot \frac{kip \cdot sec^2}{ft}$ Vertical Y

$m_z := 9759 \cdot \frac{kip \cdot sec^2}{ft}$ Horizontal Z

$Io_x := 6.56 \cdot 10^7 \cdot kip \cdot ft \cdot sec^2$ Rocking about X

$I_t := 13.47 \cdot 10^7 \cdot kip \cdot ft \cdot sec^2$ Torsion

$Io_z := 10.35 \cdot 10^7 \cdot kip \cdot ft \cdot sec^2$ Rocking about Z

A) Horizontal X : Equiv Damping Co-eff : Seismic load in the X-direction (365' building dimension)

$L_x = 365\,ft$ $B_x = 262\,ft$ See section 6.1.2.2.

$R_x := \sqrt{\frac{B_x \cdot L_x}{\pi}}$ $R_x = 174.5\,ft$ (Ref. 2.2.3, Table 3.3-3)

$\gamma := 0.11232 \cdot \frac{kip}{ft^3}$ (Ref. 2.2.9) use lower bound value to get conservative damping value

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

$Cx1 := \overrightarrow{\left(0.576 \cdot Kx1 \cdot R_x \cdot \sqrt{\frac{\rho}{G_{s1}}}\right)}$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cx1 = \begin{pmatrix} 4.149 \times 10^5 \\ 5.659 \times 10^5 \\ 7.659 \times 10^5 \\ 3.915 \times 10^5 \\ 5.391 \times 10^5 \\ 7.389 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft} \quad \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix} \quad Cx1 \cdot (0.75) = \begin{pmatrix} 3.112 \times 10^5 \\ 4.244 \times 10^5 \\ 5.744 \times 10^5 \\ 2.936 \times 10^5 \\ 4.043 \times 10^5 \\ 5.542 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

B) Vertical Y : Equiv Damping Co-eff : Seismic load in the Y-direction

$L_y = 365\,ft$ $B_y = 262\,ft$ See section 6.1.2.3.

$R_y := \sqrt{\frac{B_y \cdot L_y}{\pi}}$ $R_y = 174.5\,ft$ (Ref. 2.2.3, Table 3.3-3)

$Cy1 := \overrightarrow{\left(0.85 \cdot Ky1 \cdot R_y \cdot \sqrt{\frac{\rho}{G_{s1}}}\right)}$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cy1 = \begin{pmatrix} 7.838 \times 10^5 \\ 1.069 \times 10^6 \\ 1.447 \times 10^6 \\ 7.443 \times 10^5 \\ 1.025 \times 10^6 \\ 1.405 \times 10^6 \end{pmatrix} \frac{kip \cdot sec}{ft} \quad \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix} \quad Cy1 \cdot (0.75) = \begin{pmatrix} 5.879 \times 10^5 \\ 8.017 \times 10^5 \\ 1.085 \times 10^6 \\ 5.582 \times 10^5 \\ 7.685 \times 10^5 \\ 1.053 \times 10^6 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

C) Horizontal Z: Equiv Damping Co-eff : Seismic load in the Z-direction (262' building dimension)

$R_z := R_x$ $R_z = 174.5\ \text{ft}$ R is same as Horizontal X.

$$Cz1 := \overrightarrow{\left[[0.576(Kz1)]\cdot R_z\cdot\sqrt{\frac{\rho}{G_{s1}}}\right]}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cz1 = \begin{pmatrix} 4.368\times10^5 \\ 5.957\times10^5 \\ 8.062\times10^5 \\ 4.121\times10^5 \\ 5.674\times10^5 \\ 7.778\times10^5 \end{pmatrix}\frac{\text{kip}\cdot\text{sec}}{\text{ft}} \qquad Cz1\cdot(0.75) = \begin{pmatrix} 3.276\times10^5 \\ 4.467\times10^5 \\ 6.046\times10^5 \\ 3.091\times10^5 \\ 4.256\times10^5 \\ 5.833\times10^5 \end{pmatrix}\frac{\text{kip}\cdot\text{sec}}{\text{ft}}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

D) Rocking about X: Equiv Damping Co-eff

$L_{rx} = 262\ \text{ft}$ $B_{rx} = 336\ \text{ft}$ See section 6.1.2.5.

$$R_{rx} := \sqrt[4]{\frac{B_{rx}\cdot L_{rx}^3}{3\cdot\pi}}$$ $R_{rx} = 159.1\ \text{ft}$ (Ref. 2.2.3, Table 3.3-3)

$$B\psi x := 3(1-\mu)\cdot\frac{Io_x}{8\cdot\rho\cdot R_{rx}^5} \qquad B\psi x = \begin{pmatrix} 0.048 \\ 0.048 \\ 0.048 \\ 0.047 \\ 0.047 \\ 0.047 \end{pmatrix}$$ (Ref. 2.2.3, Table 3.3-1)

$$C\psi x1 := \overrightarrow{\left(\frac{0.3}{1+B\psi x}\cdot K\psi x1\cdot R_{rx}\cdot\sqrt{\frac{\rho}{G_{s1}}}\right)}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$C\psi x1 = \begin{pmatrix} 4.327\times10^9 \\ 5.901\times10^9 \\ 7.987\times10^9 \\ 4.111\times10^9 \\ 5.660\times10^9 \\ 7.759\times10^9 \end{pmatrix}\frac{\text{ft}\cdot\text{kip}\cdot\text{sec}}{\text{rad}}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

E) Torsion : Equiv Damping Co-eff

$R_t = 178.9\,ft$ See section 6.1.2.6.

$$Ct1 := \overrightarrow{\left(\frac{\sqrt{K\psi y1 \cdot I_t}}{1 + 2\dfrac{I_t}{\rho \cdot R_t^{\,5}}} \right)}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$Ct1 = \begin{pmatrix} 4.100 \times 10^{9} \\ 5.591 \times 10^{9} \\ 7.567 \times 10^{9} \\ 3.842 \times 10^{9} \\ 5.290 \times 10^{9} \\ 7.251 \times 10^{9} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

F) Rocking about Z: Equiv Damping Co-eff

$L_{rz} = 370\,ft$ $B_{rz} = 262\,ft$ See section 6.1.2.7.

$$R_{rz} := \sqrt[4]{\frac{B_{rz} \cdot L_{rz}^{\,3}}{3 \cdot \pi}}$$ $R_{rz} = 194\,ft$ (Ref. 2.2.3, Table 3.3-3)

$$B\psi z := 3(1 - \mu) \cdot \frac{Io_z}{8 \cdot \rho \cdot R_{rz}^{\,5}}$$

$$B\psi z = \begin{pmatrix} 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \end{pmatrix}$$ (Ref. 2.2.3, Table 3.3-1)

$$C\psi z1 := \overrightarrow{\left(\frac{0.3}{1 + B\psi z} \cdot K\psi z1 \cdot R_{rz} \cdot \sqrt{\frac{\rho}{G_{s1}}} \right)}$$ (Ref. 2.2.3, Table 3.3-1)

$$C\psi z1 = \begin{pmatrix} 8.820 \times 10^{9} \\ 1.203 \times 10^{10} \\ 1.628 \times 10^{10} \\ 8.378 \times 10^{9} \\ 1.153 \times 10^{10} \\ 1.581 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.3.2 Critical Damping

$Cc1 := 2\sqrt{K \cdot m}$ Eq. 1.13, Introduction to Structural Dynamics, Ref. 2.2.8

Units for Kx, Ky, and Kz is kip/ft, for Kψx, Kψy and Kψz is ft-k/rad, for mx, my, mz is kip-sec²/ft, for mψx, mψz and mt is kip-ft-sec², for Ccx, Ccz, Ccy is kip-sec/ft and for Ccψx, Ccψz and Cct is ft-k-sec/rad. All k values are taken from sections 6.1.2.2 to 6.1.2.7.

A) Horizontal X : Critical Damping

$Ccx1 := 2\sqrt{Kx1 \cdot m_x}$

$$Ccx1 = \begin{pmatrix} 4.978 \times 10^5 \\ 6.790 \times 10^5 \\ 9.189 \times 10^5 \\ 4.681 \times 10^5 \\ 6.446 \times 10^5 \\ 8.835 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

B) Vertical Y : Critical Damping

$Ccy1 := 2\sqrt{Ky1 \cdot m_y}$

$$Ccy1 = \begin{pmatrix} 5.633 \times 10^5 \\ 7.682 \times 10^5 \\ 1.040 \times 10^6 \\ 5.313 \times 10^5 \\ 7.316 \times 10^5 \\ 1.003 \times 10^6 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

C) Horizontal Z : Critical Damping

$Ccz1 := 2\sqrt{Kz1 \cdot m_z}$

$$Ccz1 = \begin{pmatrix} 5.108 \times 10^5 \\ 6.966 \times 10^5 \\ 9.428 \times 10^5 \\ 4.803 \times 10^5 \\ 6.613 \times 10^5 \\ 9.065 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

D) Rocking about X : Critical Damping

$$Cc\psi x1 := 2\sqrt{K\psi x1 \cdot Io_x}$$

$$Cc\psi x1 = \begin{pmatrix} 6.190 \times 10^{9} \\ 8.442 \times 10^{9} \\ 1.143 \times 10^{10} \\ 5.839 \times 10^{9} \\ 8.040 \times 10^{9} \\ 1.102 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

E) Torsion : Critical Damping

$$Cct1 := 2\sqrt{K\psi y1 \cdot I_t}$$

$$Cct1 = \begin{pmatrix} 1.165 \times 10^{10} \\ 1.589 \times 10^{10} \\ 2.151 \times 10^{10} \\ 1.092 \times 10^{10} \\ 1.504 \times 10^{10} \\ 2.061 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

F) Rocking about Z : Critical Damping

$$Cc\psi z1 := 2\sqrt{K\psi z1 \cdot Io_z}$$

$$Cc\psi z1 = \begin{pmatrix} 9.967 \times 10^{9} \\ 1.359 \times 10^{10} \\ 1.840 \times 10^{10} \\ 9.402 \times 10^{9} \\ 1.295 \times 10^{10} \\ 1.774 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

6.1.3.3 % of Critical Damping : Cc / Cci

Note : Equivalent Damping (Cc) and Critical Damping (Cci) are from sections 6.1.3.1 and 6.1.3.2 respectively.

A) Horizontal X : % of Critical Damping

$$\frac{Cx1}{Ccx1} = \begin{pmatrix} 0.833 \\ 0.833 \\ 0.833 \\ 0.836 \\ 0.836 \\ 0.836 \end{pmatrix} \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix}$$

83.3 % at 100' alluvium depth

83.6 % at 200' alluvium depth

B) Vertical Y : % of Critical Damping

$$\frac{Cy1}{Ccy1} = \begin{pmatrix} 1.392 \\ 1.392 \\ 1.392 \\ 1.401 \\ 1.401 \\ 1.401 \end{pmatrix} \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix}$$

139.2 % at 100' alluvium depth

140.1 % at 200' alluvium depth

C) Horizontal Z : % of Critical Damping

$$\frac{Cz1}{Ccz1} = \begin{pmatrix} 0.855 \\ 0.855 \\ 0.855 \\ 0.858 \\ 0.858 \\ 0.858 \end{pmatrix} \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix}$$

85.5 % at 100' alluvium depth

85.8 % at 200' alluvium depth

D) Rocking about X : % of Critical Damping

$$\frac{C\psi x1}{Cc\psi x1} = \begin{pmatrix} 0.699 \\ 0.699 \\ 0.699 \\ 0.704 \\ 0.704 \\ 0.704 \end{pmatrix} \begin{matrix} \text{Case 1} \\ \text{Case 2} \\ \text{Case 3} \\ \text{Case 4} \\ \text{Case 5} \\ \text{Case 6} \end{matrix}$$

69.9 % at 100' alluvium depth

70.4 % at 200' alluvium depth

E) Torsion : % of Critical Damping

$$\frac{Ct1}{Cct1} = \begin{pmatrix} 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \end{pmatrix}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

35.2 % at 100' alluvium depth

35.2 % at 200' alluvium depth

F) Rocking about Z : % of Critical Damping

$$\frac{C\psi z1}{Cc\psi z1} = \begin{pmatrix} 0.885 \\ 0.885 \\ 0.885 \\ 0.891 \\ 0.891 \\ 0.891 \end{pmatrix}$$

Case 1
Case 2
Case 3
Case 4
Case 5
Case 6

88.5 % at 100' alluvium depth

89.1 % at 200' alluvium depth

The calculated damping values for 5E-4 seismic event for all cases within each 100' & 200' alluvium depth are the same. Therefore, damping values are independent of the Shear Modulus and Shear Wave Velocities for the soil. The minimum % of critical damping values for the 5E-4 seismic event is tabulated in section 7.1.5.

6.1.4 SOIL SPRINGS FOR 1E-4 SEISMIC EVENT

The following calculations determine translational and rotational springs (Kx,Ky,Kz, $K\psi x$,$K\psi y$ and $K\psi z$) per ASCE 4-98 (Ref. 2.2.3) section 3.3 methodology. These results are tabulated in sections 7.1.3 and 7.1.4.

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

6.1.4.1 Soil Properties

The soil springs will be calculated for Lower Bound, Median and Upper Bound cases for 100' and 200' depth of alluvium for 1E-4 seismic event as follows.

Case 7 : Lower Bound : 100' Depth of Alluvium : 1E-4 Seismic Event

Case 8 : Median : 100 Depth of Alluvium : 1E-4 Seismic Event

Case 9 : Upper Bound : 100' Depth of Alluvium : 1E-4 Seismic Event

Case 10 : Lower Bound : 200' Depth of Alluvium : 1E-4 Seismic Event

Case 11 : Median : 200' Depth of Alluvium : 1E-4 Seismic Event

Case 12 : Upper Bound : 200' Depth of Alluvium : 1E-4 Seismic Event

<u>Shear Modulus</u> : See section 6.1.1.

$$G_{s2} := \begin{pmatrix} 5675 \\ 10816 \\ 20359 \\ 4763 \\ 9329 \\ 18162 \end{pmatrix} \text{ksf}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

<u>Poisson's Ratio</u> : See section 6.1.1.

$$\mu := \begin{pmatrix} 0.323 \\ 0.323 \\ 0.323 \\ 0.339 \\ 0.339 \\ 0.339 \end{pmatrix}$$

average Poisson's ratio for 100' and 200' alluvium depths

6.1.4.2 Horizontal X : Soil Springs

For Seismic loads in the x-direction (365' building dimension) :

$L_x = 365\ ft$ — Length of base mat in direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$B_x = 262\ ft$ — Width of base mat perpendicular to direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_x}{B_x} = 1.39$$

From ASCE 4-98 (Ref. 2.2.3) figure 3.3-3

for L.x / B.x = 1.4 : $\beta x1 = 0.95$ $\beta z1 = 2.20$

$$Kx2 := 2\cdot\overrightarrow{\left[(1+\mu)\cdot G_{s2}\right]}\cdot\beta x1\cdot\sqrt{B_x\cdot L_x}$$ (Ref. 2.2.3 Table 3.3-3)

$$Kx2 = \begin{pmatrix} 4.411\times10^{6} \\ 8.408\times10^{6} \\ 1.583\times10^{7} \\ 3.747\times10^{6} \\ 7.339\times10^{6} \\ 1.429\times10^{7} \end{pmatrix}\frac{kip}{ft}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.4.3 Vertical Y : Soil Springs

$L_y = 365\ ft$ $B_y = 262\ ft$ (Ref. 2.2.4, Section 6.1.2.1)

$$Ky2 := \frac{G_{s2}}{1-\mu}\cdot\beta z1\cdot\sqrt{B_y\cdot L_y}$$ (Ref. 2.2.3 Table 3.3-3)

$$Ky2 = \begin{pmatrix} 5.703\times10^{6} \\ 1.087\times10^{7} \\ 2.046\times10^{7} \\ 4.902\times10^{6} \\ 9.602\times10^{6} \\ 1.869\times10^{7} \end{pmatrix}\frac{kip}{ft}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.4.4 Horizontal Z : Soil Springs

For Seismic loads in the z-direction (262' for length) :

$L_z = 262\ \text{ft}$ — Length of base mat in direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$B_z = 365\ \text{ft}$ — Width of base mat perpendicular to direction of seismic motion (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_z}{B_z} = 0.72$$

From Ref. 2.2.3 figure 3.3-3

for $L_z / B_z = 0.7$: $\beta x2 = 1.00$

$$Kz2 := 2\cdot\overrightarrow{\left[(1+\mu)\cdot G_{s2}\right]}\cdot\beta x2\cdot\sqrt{B_z\cdot L_z}$$ (Ref. 2.2.3 Table 3.3-3)

$$Kz2 = \begin{pmatrix} 4.644\times10^{6} \\ 8.850\times10^{6} \\ 1.666\times10^{7} \\ 3.944\times10^{6} \\ 7.726\times10^{6} \\ 1.504\times10^{7} \end{pmatrix}\frac{\text{kip}}{\text{ft}}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.4.5 Rocking about X : Soil Springs

For Rocking about X use 336' x 262'. $L_{rx} = 262\ \text{ft}$ $B_{rx} = 336\ \text{ft}$ (Ref. 2.2.4, Section 6.1.2.1)

$$\frac{L_{rx}}{B_{rx}} = 0.78$$

$\beta\psi1 = 0.53$ (Ref. 2.2.3 figure 3.3-3)

$$K\psi x2 := \frac{G_{s2}}{1-\mu}\cdot\beta\psi1\cdot B_{rx}\cdot L_{rx}^{2}$$ (Ref. 2.2.3 Table 3.3-3)

$$K\psi x2 = \begin{pmatrix} 1.025\times10^{11} \\ 1.953\times10^{11} \\ 3.676\times10^{11} \\ 8.808\times10^{10} \\ 1.725\times10^{11} \\ 3.359\times10^{11} \end{pmatrix}\frac{\text{ft}\cdot\text{kip}}{\text{rad}}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.4.6 Torsion : Soil Springs

$L_t = 365\ ft$ $B_t = 262\ ft$ (Ref. 2.2.4, Section 6.1.2.1)

$$R_{t2} := \left[\frac{(B_t \cdot L_t)\cdot(B_t^2 + L_t^2)}{6\cdot\pi}\right]^{.25}$$ (Ref. 2.2.3, Table 3.3-3)

$R_{t2} = 178.9\ ft$

$$K\psi y2 := \frac{16\cdot G_{s2}\cdot R_{t2}^3}{3}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$K\psi y2 = \begin{pmatrix} 1.733\times10^{11} \\ 3.302\times10^{11} \\ 6.216\times10^{11} \\ 1.454\times10^{11} \\ 2.848\times10^{11} \\ 5.545\times10^{11} \end{pmatrix}\frac{ft\cdot kip}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.4.7 Rocking about Z : Soil Springs

For Rocking about Z use 370' x 262'.

$L_{rz} = 370\ ft$ $B_{rz} = 262\ ft$ (Ref. 2.2.4, Section 6.1.2.1)

$\frac{L_{rz}}{B_{rz}} = 1.41$ $\beta\psi2 = 0.56$ (Ref. 2.2.3 figure 3.3-3)

$$K\psi z2 := \frac{G_{s2}}{1-\mu}\cdot\beta\psi2\cdot B_{rz}\cdot L_{rz}^2$$ (Ref. 2.2.3 Table 3.3-3)

$$K\psi z2 = \begin{pmatrix} 1.684\times10^{11} \\ 3.209\times10^{11} \\ 6.040\times10^{11} \\ 1.447\times10^{11} \\ 2.835\times10^{11} \\ 5.519\times10^{11} \end{pmatrix}\frac{ft\cdot kip}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.5 SOIL DAMPING FOR 1E-4 SEISMIC EVENT

Legend :

G_s = shear modulus of foundation medium (Calculated in section 6.1.1.)
R = Equivalent radius of circular base mat
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 base mat
Io_x (mψx) , Io_z(mψz) = total mass moment of inertia of structure and base mat about rocking axis at base

k_x, kψz, kψx, kz, ky, kt = equivalent spring constants (note kt=kψy shown in sections 7.1.3 and 7.1.4)
Cx, Cψx, Cz, Ct, Cψz,Cy = equivalent damping coefficients
Cc = critical damping value
$\beta\psi$ = constants that are functions of the base mat dimensional ratio, L/B

Damping Cases :

The equivalent soil damping coefficient and critical damping values will be calculated for Lower Bound, Median and Upper Bound cases for 100' and 200' depth of alluvium for 1E-4 seismic event.

See section 6.1.4.1 for definitions of cases 7 to 12.

Units :

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

Results :

Results are presented in tabular form in section 7.1.5.

6.1.5.1 Equivalent Damping Coefficients

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

See section 6.1.3.1 of *Canister Receipt and Closure Facility (CRCF) Soil Springs (Ref. 2.2.4)* for mass and mass moment of inertia.

$m_x = 9759 \, \frac{kip \cdot sec^2}{ft}$ Horizontal X

$m_y = 9759 \, \frac{kip \cdot sec^2}{ft}$ Vertical Y

$m_z = 9759 \, \frac{kip \cdot sec^2}{ft}$ Horizontal Z

$Io_x = 6.56 \times 10^7 \, kip \cdot ft \cdot sec^2$ Rocking about X

$I_t = 1.347 \times 10^8 \, kip \cdot ft \cdot sec^2$ Torsion

$Io_z = 1.035 \times 10^8 \, kip \cdot ft \cdot sec^2$ Rocking about Z

A) Horizontal X : Equiv Damping Co-eff : Seismic load in the X-direction (365' building dimension)

$R_x = 174.5\,ft$ See section 6.1.3.1.

$\rho = 3.491 \times 10^{-3}\,\frac{kip \cdot sec^2}{ft^4}$ See section 6.1.3.1.

$Cx2 := \overrightarrow{\left(0.576 \cdot Kx2 \cdot R_x \cdot \sqrt{\frac{\rho}{G_{s2}}}\right)}$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cx2 = \begin{pmatrix} 3.477 \times 10^5 \\ 4.800 \times 10^5 \\ 6.586 \times 10^5 \\ 3.224 \times 10^5 \\ 4.512 \times 10^5 \\ 6.296 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft} \qquad \begin{matrix} \text{Case 7} \\ \text{Case 8} \\ \text{Case 9} \\ \text{Case 10} \\ \text{Case 11} \\ \text{Case 12} \end{matrix} \qquad Cx2 \cdot (0.75) = \begin{pmatrix} 2.608 \times 10^5 \\ 3.6 \times 10^5 \\ 4.939 \times 10^5 \\ 2.418 \times 10^5 \\ 3.384 \times 10^5 \\ 4.722 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

B) Vertical Y : Equiv Damping Co-eff : Seismic load in the Y-direction

$R_y = 174.5\,ft$ See section 6.1.3.1.

$Cy2 := \overrightarrow{\left(0.85 \cdot Ky2 \cdot R_y \cdot \sqrt{\frac{\rho}{G_{s2}}}\right)}$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cy2 = \begin{pmatrix} 6.633 \times 10^5 \\ 9.158 \times 10^5 \\ 1.256 \times 10^6 \\ 6.224 \times 10^5 \\ 8.711 \times 10^5 \\ 1.215 \times 10^6 \end{pmatrix} \frac{kip \cdot sec}{ft} \qquad \begin{matrix} \text{Case 7} \\ \text{Case 8} \\ \text{Case 9} \\ \text{Case 10} \\ \text{Case 11} \\ \text{Case 12} \end{matrix} \qquad Cy2 \cdot (0.75) = \begin{pmatrix} 4.975 \times 10^5 \\ 6.868 \times 10^5 \\ 9.423 \times 10^5 \\ 4.668 \times 10^5 \\ 6.533 \times 10^5 \\ 9.115 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

C) Horizontal Z: Equiv Damping Co-eff : Seismic load in the Z-direction (262' building dimension)

$R_z = 174.5\ \text{ft}$ See section 6.1.3.1.

$$Cz2 := \overrightarrow{\left[[0.576(Kz2)]\cdot R_z\cdot\sqrt{\frac{\rho}{G_{s2}}}\right]}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

75% of damped values

$$Cz2 = \begin{pmatrix} 3.660\times10^5 \\ 5.053\times10^5 \\ 6.932\times10^5 \\ 3.394\times10^5 \\ 4.749\times10^5 \\ 6.627\times10^5 \end{pmatrix}\frac{\text{kip}\cdot\text{sec}}{\text{ft}}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

$$Cz2\cdot(0.75) = \begin{pmatrix} 2.745\times10^5 \\ 3.79\times10^5 \\ 5.199\times10^5 \\ 2.545\times10^5 \\ 3.562\times10^5 \\ 4.97\times10^5 \end{pmatrix}\frac{\text{kip}\cdot\text{sec}}{\text{ft}}$$

D) Rocking about X : Equiv Damping Co-eff

$R_{rx} = 159.1\ \text{ft}$ See section 6.1.3.1.

$$B\psi x = \begin{pmatrix} 0.048 \\ 0.048 \\ 0.048 \\ 0.047 \\ 0.047 \\ 0.047 \end{pmatrix}$$ See section 6.1.3.1.

$$C\psi x2 := \overrightarrow{\left(\frac{0.3}{1+B\psi x}\cdot K\psi x2\cdot R_{rx}\cdot\sqrt{\frac{\rho}{G_{s2}}}\right)}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$C\psi x2 = \begin{pmatrix} 3.662\times10^9 \\ 5.055\times10^9 \\ 6.936\times10^9 \\ 3.438\times10^9 \\ 4.812\times10^9 \\ 6.713\times10^9 \end{pmatrix}\frac{\text{ft}\cdot\text{kip}\cdot\text{sec}}{\text{rad}}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

E) Torsion : Equiv Damping Co-eff

$R_t = 178.9\ ft$ See section 6.1.2.6.

$$Ct2 := \overrightarrow{\left(\frac{\sqrt{K\psi y2 \cdot I_t}}{1 + 2\dfrac{I_t}{\rho \cdot R_t^5}} \right)}$$ (Ref. 2.2.3 Tables 3.3-3 and 3.3-1)

$$Ct2 = \begin{pmatrix} 3.399 \times 10^9 \\ 4.693 \times 10^9 \\ 6.439 \times 10^9 \\ 3.114 \times 10^9 \\ 4.358 \times 10^9 \\ 6.081 \times 10^9 \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

F) Rocking about Z : Equiv Damping Co-eff

$$B\psi z = \begin{pmatrix} 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \\ 0.028 \end{pmatrix}$$

See section 6.1.3.1.

$$C\psi z2 := \overrightarrow{\left(\frac{0.3}{1 + B\psi z} \cdot K\psi z2 \cdot R_{rz} \cdot \sqrt{\frac{\rho}{G_{s2}}} \right)}$$ (Ref. 2.2.3, Table 3.3-1)

$$C\psi z2 = \begin{pmatrix} 7.464 \times 10^9 \\ 1.030 \times 10^{10} \\ 1.414 \times 10^{10} \\ 7.006 \times 10^9 \\ 9.805 \times 10^9 \\ 1.368 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.5.2 Critical Damping

$Cc2 := 2\sqrt{K \cdot m}$ Eq. 1.13, Introduction to Structural Dynamics, Ref. 2.2.8

Units for Kx, Ky, and Kz is kip/ft, for Kψx, Kψy and Kψz is ft-k/rad, for mx, my, mz is kip-sec²/ft, for mψx, mψz and mt is kip-ft-sec², for Ccx, Ccz, Ccy is kip-sec/ft and for Ccψx, Ccψz and Cct is ft-k-sec/rad. All k values are taken from sections 6.1.4.2 to 6.1.4.7.

A) Horizontal X : Critical Damping

$Ccx2 := 2\sqrt{Kx2 \cdot m_x}$

$$Ccx2 = \begin{pmatrix} 4.150 \times 10^5 \\ 5.729 \times 10^5 \\ 7.860 \times 10^5 \\ 3.825 \times 10^5 \\ 5.353 \times 10^5 \\ 7.468 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

B) Vertical Y : Critical Damping

$Ccy2 := 2\sqrt{Ky2 \cdot m_y}$

$$Ccy2 = \begin{pmatrix} 4.718 \times 10^5 \\ 6.514 \times 10^5 \\ 8.937 \times 10^5 \\ 4.375 \times 10^5 \\ 6.122 \times 10^5 \\ 8.542 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

C) Horizontal Z : Critical Damping

$Ccz2 := 2\sqrt{Kz2 \cdot m_z}$

$$Ccz2 = \begin{pmatrix} 4.258 \times 10^5 \\ 5.878 \times 10^5 \\ 8.064 \times 10^5 \\ 3.924 \times 10^5 \\ 5.492 \times 10^5 \\ 7.662 \times 10^5 \end{pmatrix} \frac{kip \cdot sec}{ft}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

D) Rocking about X : Critical Damping

$$Cc\psi x2 := 2\sqrt{K\psi x2 \cdot Io_x}$$

$$Cc\psi x2 = \begin{pmatrix} 5.185 \times 10^{9} \\ 7.159 \times 10^{9} \\ 9.821 \times 10^{9} \\ 4.808 \times 10^{9} \\ 6.728 \times 10^{9} \\ 9.388 \times 10^{9} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

E) Torsion : Critical Damping

$$Cct2 := 2\sqrt{K\psi y2 \cdot I_t}$$

$$Cct2 = \begin{pmatrix} 9.662 \times 10^{9} \\ 1.334 \times 10^{10} \\ 1.830 \times 10^{10} \\ 8.852 \times 10^{9} \\ 1.239 \times 10^{10} \\ 1.729 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

F) Rocking about Z : Critical Damping

$$Cc\psi z2 := 2\sqrt{K\psi z2 \cdot Io_z}$$

$$Cc\psi z2 = \begin{pmatrix} 8.349 \times 10^{9} \\ 1.153 \times 10^{10} \\ 1.581 \times 10^{10} \\ 7.741 \times 10^{9} \\ 1.083 \times 10^{10} \\ 1.512 \times 10^{10} \end{pmatrix} \frac{ft \cdot kip \cdot sec}{rad}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

6.1.5.3 % of Critical Damping : Cc / Cci

Note : Equivalent Damping (Cc) and Critical Damping (Cci) are from sections 6.1.5.1 and 6.1.5.2 respectively.

A) Horizontal X : % of Critical Damping

$$\frac{Cx2}{Ccx2} = \begin{pmatrix} 0.838 \\ 0.838 \\ 0.838 \\ 0.843 \\ 0.843 \\ 0.843 \end{pmatrix}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

83.8 % at 100' alluvium depth

84.3 % at 200' alluvium depth

B) Vertical Y : % of Critical Damping

$$\frac{Cy2}{Ccy2} = \begin{pmatrix} 1.406 \\ 1.406 \\ 1.406 \\ 1.423 \\ 1.423 \\ 1.423 \end{pmatrix}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

140.6 % at 100' alluvium depth

142.3 % at 200' alluvium depth

C) Horizontal Z : % of Critical Damping

$$\frac{Cz2}{Ccz2} = \begin{pmatrix} 0.860 \\ 0.860 \\ 0.860 \\ 0.865 \\ 0.865 \\ 0.865 \end{pmatrix}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

86.0 % at 100' alluvium depth

86.5 % at 200' alluvium depth

D) Rocking about X : % of Critical Damping

$$\frac{C\psi x2}{Cc\psi x2} = \begin{pmatrix} 0.706 \\ 0.706 \\ 0.706 \\ 0.715 \\ 0.715 \\ 0.715 \end{pmatrix}$$

Case 7
Case 8
Case 9
Case 10
Case 11
Case 12

70.6 % at 100' alluvium depth

71.5 % at 200' alluvium depth

E) Torsion : % of Critical Damping

$$\frac{Ct2}{Cct2} = \begin{pmatrix} 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \\ 0.352 \end{pmatrix} \begin{matrix} \text{Case 7} \\ \text{Case 8} \\ \text{Case 9} \\ \text{Case 10} \\ \text{Case 11} \\ \text{Case 12} \end{matrix}$$

35.2 % at 100' alluvium depth

35.2 % at 200' alluvium depth

F) Rocking about Z : % of Critical Damping

$$\frac{C\psi z2}{Cc\psi z2} = \begin{pmatrix} 0.894 \\ 0.894 \\ 0.894 \\ 0.905 \\ 0.905 \\ 0.905 \end{pmatrix} \begin{matrix} \text{Case 7} \\ \text{Case 8} \\ \text{Case 9} \\ \text{Case 10} \\ \text{Case 11} \\ \text{Case 12} \end{matrix}$$

89.4 % at 100' alluvium depth

90.5 % at 200' alluvium depth

The calculated damping values for 1E-4 seismic event for all cases within each 100' & 200' alluvium depth are the same. Therefore, damping values are independent of the Shear Modulus and Shear Wave Velocities for the soil. The minimum % of critical damping values for the 1E-4 event is tabulated in section 7.1.5.

7. RESULTS AND CONCLUSIONS

7.1 RESULTS

Tables in this section present lower bound, median and upper bound soil springs for 100' and 200' of alluvium and damping suitable for use in a lumped mass stick model seismic analysis of the CRCF.

7.1.1 Soil Springs for 100' Alluvium : 5E-4 Event

Table 7.1.1 Soil Springs 100' Alluvium : 5E-4 Event

Values are taken from Sections 6.1.2.2 to 6.1.2.7.

Soil Spring	Lower Bound	Median	Upper Bound
KX – Horizontal Spring in x (365') direction of foundation	6.35×10^6 kips/ft	11.81×10^6 kips/ft	21.63×10^6 kips/ft
KY – Vertical Spring	8.13×10^6 kips/ft	15.12×10^6 kips/ft	27.69×10^6 kips/ft
KZ – Horizontal Spring in z (262') direction of foundation	6.68×10^6 kips/ft	12.43×10^6 kips/ft	22.77×10^6 kips/ft
KΨX –Rocking Spring about x (365') axis of foundation	14.60×10^{10} ft-kips/rad	27.16×10^{10} ft-kips/rad	49.75×10^{10} ft-kips/rad
KΨY – Torsional Spring	25.21×10^{10} ft-kips/rad	46.88×10^{10} ft-kips/rad	85.87×10^{10} ft-kips/rad
KΨZ – Rocking Spring about z (262') axis of foundation	24.00×10^{10} ft-kips/rad	44.63×10^{10} ft-kips/rad	81.75×10^{10} ft-kips/rad

7.1.2 Soil Springs for 200' Alluvium : 5E-4 Event

Table 7.1.2 Soil Springs 200' Alluvium : 5E-4 Event

Values are taken from Sections 6.1.2.2 to 6.1.2.7.

Soil Spring	Lower Bound	Median	Upper Bound
KX – Horizontal Spring in x (365') direction of foundation	5.61×10^{6} kips/ft	10.64×10^{6} kips/ft	20.00×10^{6} kips/ft
KY – Vertical Spring	7.23×10^{6} kips/ft	13.71×10^{6} kips/ft	25.76×10^{6} kips/ft
KZ – Horizontal Spring in z (262') direction of foundation	5.91×10^{6} kips/ft	11.20×10^{6} kips/ft	21.05×10^{6} kips/ft
KΨX –Rocking Spring about x (365') axis of foundation	12.99×10^{10} ft-kips/rad	24.63×10^{10} ft-kips/rad	46.28×10^{10} ft-kips/rad
KΨY – Torsional Spring	22.14×10^{10} ft-kips/rad	41.96×10^{10} ft-kips/rad	78.85×10^{10} ft-kips/rad
KΨZ – Rocking Spring about z (262') axis of foundation	21.35×10^{10} ft-kips/rad	40.48×10^{10} ft-kips/rad	76.05×10^{10} ft-kips/rad

7.1.3 Soil Springs for 100' Alluvium : 1E-4 Event

Table 7.1.3 Soil Springs 100' Alluvium : 1E-4 Event

Values are taken from Sections 6.1.4.2 to 6.1.4.7.

Soil Spring	Lower Bound	Median	Upper Bound
KX – Horizontal Spring in x (365') direction of foundation	4.41×10^{6} kips/ft	8.41×10^{6} kips/ft	15.83×10^{6} kips/ft
KY – Vertical Spring	5.70×10^{6} kips/ft	10.87×10^{6} kips/ft	20.46×10^{6} kips/ft
KZ – Horizontal Spring in z (262') direction of foundation	4.64×10^{6} kips/ft	8.85×10^{6} kips/ft	16.66×10^{6} kips/ft
KΨX –Rocking Spring about x (365') axis of foundation	10.25×10^{10} ft-kips/rad	19.53×10^{10} ft-kips/rad	36.76×10^{10} ft-kips/rad
KΨY – Torsional Spring	17.33×10^{10} ft-kips/rad	33.02×10^{10} ft-kips/rad	62.16×10^{10} ft-kips/rad
KΨZ – Rocking Spring about z (262') axis of foundation	16.84×10^{10} ft-kips/rad	32.09×10^{10} ft-kips/rad	60.40×10^{10} ft-kips/rad

7.1.4 Soil Springs for 200' Alluvium : 1E-4 Event

Table 7.1.4 Soil Springs 200' Alluvium : 1E-4 Event

Values are taken from Sections 6.1.4.2 to 6.1.4.7.

Soil Spring	Lower Bound	Median	Upper Bound
KX – Horizontal Spring in x (365') direction of foundation	3.75×10^{6} kips/ft	7.34×10^{6} kips/ft	14.29×10^{6} kips/ft
KY – Vertical Spring	4.90×10^{6} kips/ft	9.60×10^{6} kips/ft	18.69×10^{6} kips/ft
KZ – Horizontal Spring in z (262') direction of foundation	3.94×10^{6} kips/ft	7.73×10^{6} kips/ft	15.04×10^{6} kips/ft
KΨX –Rocking Spring about x (365') axis of foundation	8.81×10^{10} ft-kips/rad	17.25×10^{10} ft-kips/rad	33.59×10^{10} ft-kips/rad
KΨY – Torsional Spring	14.54×10^{10} ft-kips/rad	28.48×10^{10} ft-kips/rad	55.45×10^{10} ft-kips/rad
KΨZ – Rocking Spring about z (262') axis of foundation	14.47×10^{10} ft-kips/rad	28.35×10^{10} ft-kips/rad	55.19×10^{10} ft-kips/rad

7.1.5 Summary of Damping Values

As seen in Sections 6.1.3.3 and 6.1.5.3 of this calculation the percent of critical damping is independent of the shear wave velocity. Thus for the Tier –1 seismic analysis of the CRCF the % of critical damping to be used in the analysis is summarized below for 5E-4 and 1E-4 events.

Table 7.1.5 Summary of Damping Values

Minimum values are taken from Sections 6.1.3.3 and 6.1.5.3.

Degree of Freedom	Minimum % of Critical Damping
Horizontal Translation-X	83.3 %
Vertical Translation-Y	139.2 %
Horizontal Translation- Z	85.5 %
Rocking about- X	69.9 %
Torsion	35.2 %
Rocking about-Z	88.5 %

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 CRCF site location. Ref. 2.2.7, page 204 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 structural analysis the percent of critical damping to be used in the seismic analysis should be limited to 75% of the computed values or a maximum of 20% for Soil Structure Interaction mode shapes. 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 CRCF.

7.1.6 Revised Strain Compatible Soil Properties

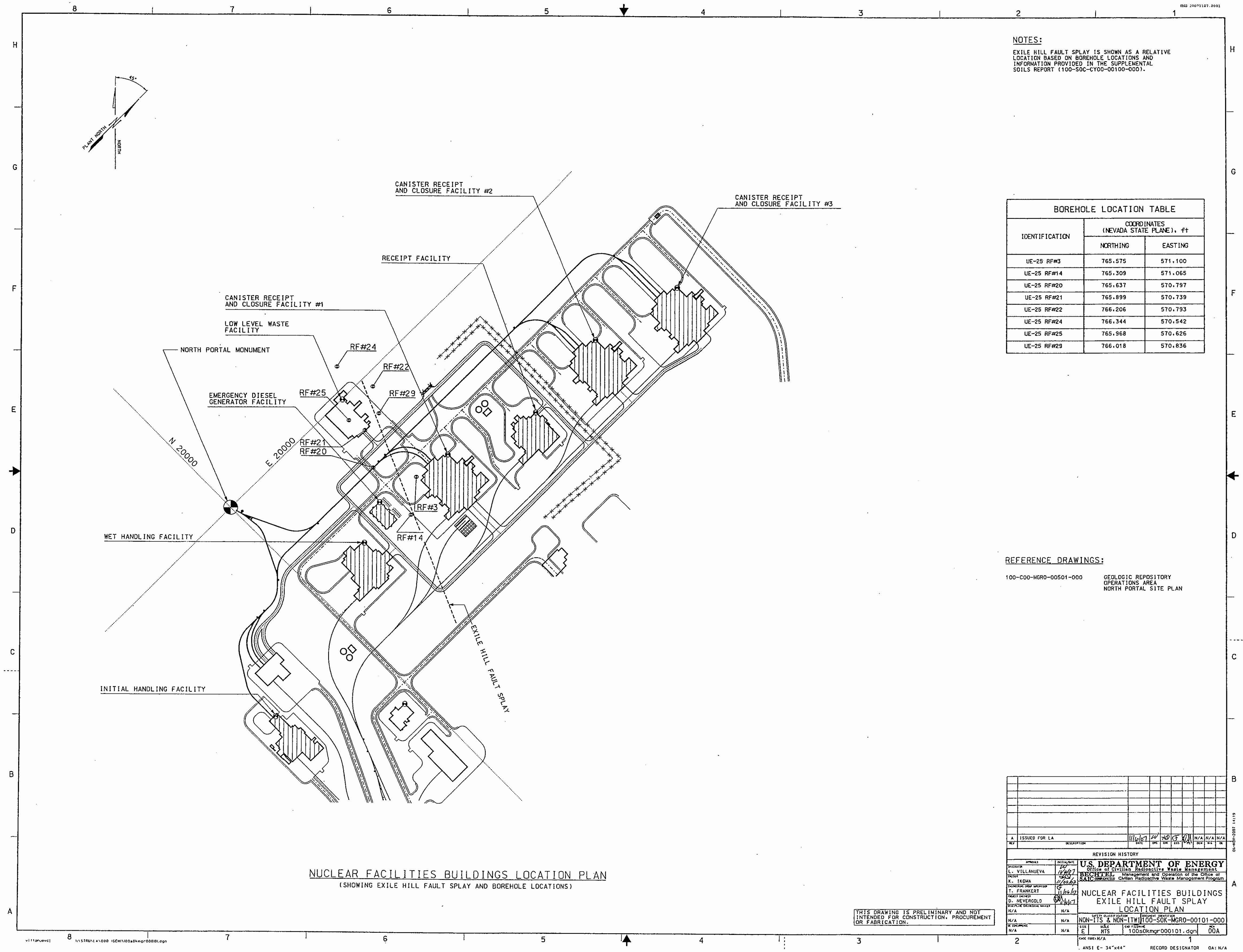
From ATTACHMENT B page B-15, the max. percentage change of Shear Modulus “G” is 2.1 %. The Equivalent Damping Coefficient is a linear function of the square root of “G” (Ref. 2.2.3, Table 3.3.1 & 3.3.3) and the impact to the Critical Damping due to this change is insignificant. Therefore this revised soil properties have no impact to this calculation.

7.2 CONCLUSIONS

The above computed results for soil springs and damping are reasonable compared to the inputs and are suitable for use in a Tier-1 seismic analysis of the CRCF.

As the design matures soil structure interaction effects will be included in the analysis by modeling the soil properties in SASSI (System for Analysis of Soil Structure Interaction).

ATTACHMENT A : EXILE HILL FAULT SPLAY LOCATION PLAN (From reference 2.2.12)



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

ATTACHMENT B: ASSESSMENT OF REVISED SOIL PROPERTIES

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. 2.2.9) and MO0801SCSPS1E4.003 (Ref. 2.2.10). Soil spring values computed in the body of this calculation and used in subsequent seismic analysis calculations of the CRCF 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 2.2.9 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 4-98 (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 approach described in section 4.3 and carried out in section 6 using the applicable strain compatible soil properties given in Refs. 2.2.9 and 2.2.10. These shear modulus calculations 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) and each of the alluvium depths (100' and 200') for both the 5E-4 and 1E-4 cases are summarized in Tables B-1 and B-2.

Comparison of these revised shear modulus values to the values computed using the superceded data are summarized in Tables B-3 and B-4.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 1

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		$H*\mu$	$E_i=2(1+\mu)G'$ (3)	Z/W		Nq*H	$Nq*H/E_i$
1	4.00	2.00	112.32	615.72	1377.70	1323.6	0.37	1.469	3619.5	0.008	1	4.00	1.11E-03
2	4.00	6.00	112.32	639.48	1687.40	1427.8	0.39	1.545	3958.2	0.023	1	4.00	1.01E-03
3	4.00	10.00	112.32	681.29	1922.50	1620.6	0.39	1.568	4512.0	0.038	1	4.00	8.87E-04
4	4.00	14.00	112.32	770.10	2070.60	2070.6	0.39	1.572	5768.5	0.053	1	4.00	6.93E-04
5	4.00	18.00	112.32	964.43	2613.60	3247.5	0.39	1.555	9019.9	0.069	1	4.00	4.43E-04
6	8.00	24.00	112.32	935.09	2648.40	3052.9	0.39	3.156	8514.6	0.092	1	8.00	9.40E-04
7	8.00	32.00	112.32	981.84	2731.40	3365.8	0.38	3.035	9285.8	0.122	1	8.00	8.62E-04
8	8.00	40.00	112.32	1033.60	2768.50	3730.0	0.36	2.911	10174.2	0.153	1	8.00	7.86E-04
9	8.00	48.00	112.32	1141.70	3045.60	4551.0	0.36	2.858	12353.8	0.183	1	8.00	6.48E-04
10	8.00	56.00	112.32	1274.90	3078.60	5674.9	0.34	2.712	15196.8	0.214	0.98	7.84	5.16E-04
11	10.00	65.00	112.32	1384.80	3375.10	6695.5	0.34	3.385	17923.3	0.248	0.96	9.60	5.36E-04
12	10.00	75.00	112.32	1420.90	3551.70	7049.1	0.34	3.379	18862.4	0.286	0.93	9.30	4.93E-04
13	10.00	85.00	112.32	1576.10	3799.10	8673.1	0.34	3.351	23159.4	0.324	0.90	9.00	3.89E-04
14	10.00	95.00	112.32	1534.10	3795.90	8217.0	0.34	3.383	21993.3	0.363	0.88	8.80	4.00E-04
15	10.00	105.00	137.28	2176.30	4047.50	20211.3	0.30	2.962	52395.7	0.401	0.85	8.50	1.62E-04
16	10.00	115.00	137.28	2178.30	4054.60	20248.4	0.30	2.967	52510.3	0.439	0.81	8.10	1.54E-04
17	10.00	125.00	137.28	2188.00	4066.60	20429.2	0.30	2.960	52951.6	0.477	0.78	7.80	1.47E-04
18	10.00	135.00	137.28	2239.30	4163.10	21398.4	0.30	2.961	55468.4	0.515	0.75	7.50	1.35E-04
19	10.00	145.00	137.28	2287.30	4253.20	22325.6	0.30	2.962	57876.3	0.553	0.72	7.20	1.24E-04
20	10.00	155.00	137.28	2312.40	4300.90	22818.2	0.30	2.963	59159.5	0.592	0.68	6.80	1.15E-04
21	10.00	165.00	137.28	2322.80	4321.40	23024.0	0.30	2.965	59699.7	0.630	0.65	6.50	1.09E-04
22	10.00	175.00	137.28	2298.40	4280.00	22542.8	0.30	2.969	58472.4	0.668	0.62	6.20	1.06E-04
23	10.00	185.00	137.28	2283.90	4256.00	22259.2	0.30	2.973	57752.5	0.706	0.59	5.90	1.02E-04
24	10.00	195.00	137.28	2325.40	4333.60	23075.5	0.30	2.973	59872.2	0.744	0.56	5.60	9.35E-05
25	12.50	206.25	137.28	2336.50	4356.30	23296.3	0.30	3.719	60454.9	0.787	0.53	6.63	1.10E-04
26	12.50	218.75	137.28	2357.60	4397.00	23719.0	0.30	3.721	61558.9	0.835	0.51	6.38	1.04E-04
27	12.50	231.25	137.28	2372.40	4444.30	24017.7	0.30	3.722	62339.0	0.883	0.49	6.13	9.83E-05
28	12.50	243.75	137.28	2416.90	4520.40	24927.2	0.30	3.722	64697.6	0.930	0.47	5.88	9.08E-05
29	12.50	256.25	137.28	2460.20	4584.90	25828.4	0.30	3.717	67017.4	0.978	0.45	5.63	8.39E-05
30	12.50	268.75	137.28	2464.80	4594.70	25925.0	0.30	3.719	67275.5	1.026	0.42	5.25	7.80E-05
31	12.50	281.25	137.28	2505.10	4669.50	26779.7	0.30	3.718	69491.3	1.073	0.40	5.00	7.20E-05
32	12.50	293.75	137.28	2504.20	4669.50	26760.5	0.30	3.720	69450.5	1.121	0.38	4.75	6.84E-05
33	15.00	307.50	137.28	2564.90	4779.90	28073.5	0.30	4.460	72842.4	1.174	0.36	5.40	7.41E-05
34	15.00	322.50	137.28	2583.60	4815.30	28484.4	0.30	4.461	73911.3	1.231	0.35	5.25	7.10E-05
35	15.00	337.50	137.28	2684.80	4998.80	30759.6	0.30	4.453	79782.9	1.288	0.33	4.95	6.20E-05
36	15.00	352.50	137.28	2740.60	5100.70	32051.4	0.30	4.450	83121.6	1.345	0.32	4.80	5.77E-05
37	15.00	367.50	137.28	2801.80	5212.70	33498.9	0.30	4.447	86862.0	1.403	0.30	4.50	5.18E-05
38	15.00	382.50	137.28	2832.10	5269.10	34227.4	0.30	4.447	88750.9	1.460	0.29	4.35	4.90E-05
39	15.00	397.50	137.28	2845.00	5293.90	34539.9	0.30	4.449	89567.4	1.517	0.28	4.20	4.69E-05
40	15.00	412.50	137.28	2844.30	5293.90	34522.9	0.30	4.451	89531.6	1.574	0.25	3.75	4.19E-05
41	15.00	427.50	137.28	2843.70	5293.90	34508.3	0.30	4.452	89500.8	1.632	0.24	3.60	4.02E-05
42	15.00	442.50	137.28	2843.20	5294.10	34496.2	0.30	4.454	89476.9	1.689	0.22	3.30	3.69E-05
43	15.00	457.50	137.28	2921.40	5436.80	36419.9	0.30	4.449	94444.7	1.746	0.20	3.00	3.18E-05
44	15.00	472.50	137.28	2938.30	5468.30	36842.4	0.30	4.449	95542.0	1.803	0.19	2.85	2.98E-05
45	15.00	487.50	137.28	2962.10	5511.10	37441.7	0.30	4.448	97088.6	1.861	0.17	2.55	2.63E-05
Σ=	495.00					Average μ = SUM ($H*\mu$)/SUM H	0.309	Σ= 153.16			Σ=	264.77	1.23E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear & Compression Wave Velocities values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ = 21560 ksf
Equivalent Shear Modulus $G = E/(2*(1+\text{Average } \mu))$ = 8233 ksf
Vel = SQRT(32.17*1000*G/p) 1535.6 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p) 1389.0 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 8233 ksf : 5E-4 Event : 100' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 2

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	870.76	1948.40	2647.3	0.37	1.469	7239.1	0.008	1	4.00	5.53E-04
2	4.00	6.00	112.32	904.37	2243.80	2855.6	0.39	1.545	7916.6	0.023	1	4.00	5.05E-04
3	4.00	10.00	112.32	963.49	2529.20	3241.2	0.39	1.568	9024.0	0.038	1	4.00	4.43E-04
4	4.00	14.00	112.32	1089.10	2914.00	4141.3	0.39	1.572	11537.2	0.053	1	4.00	3.47E-04
5	4.00	18.00	112.32	1363.90	3464.90	6494.9	0.39	1.555	18039.5	0.069	1	4.00	2.22E-04
6	8.00	24.00	112.32	1322.40	3529.50	6105.6	0.39	3.156	17028.8	0.092	1	8.00	4.70E-04
7	8.00	32.00	112.32	1388.50	3579.50	6731.3	0.38	3.035	18570.7	0.122	1	8.00	4.31E-04
8	8.00	40.00	112.32	1461.70	3637.40	7459.7	0.36	2.911	20347.6	0.153	1	8.00	3.93E-04
9	8.00	48.00	112.32	1614.60	3899.30	9102.0	0.36	2.858	24707.3	0.183	1	8.00	3.24E-04
10	8.00	56.00	112.32	1802.90	3937.30	11348.8	0.34	2.712	30390.9	0.214	0.98	7.84	2.58E-04
11	10.00	65.00	112.32	1917.30	4133.60	12834.7	0.34	3.385	34357.8	0.248	0.96	9.60	2.79E-04
12	10.00	75.00	112.32	2009.40	4349.90	14097.4	0.34	3.379	37722.7	0.286	0.93	9.30	2.47E-04
13	10.00	85.00	112.32	2177.50	4652.90	16554.7	0.34	3.351	44205.5	0.324	0.90	9.00	2.04E-04
14	10.00	95.00	112.32	2145.40	4649.00	16070.2	0.34	3.383	43013.0	0.363	0.88	8.80	2.05E-04
15	10.00	105.00	137.28	2665.50	4957.20	30318.9	0.30	2.962	78598.7	0.401	0.85	8.50	1.08E-04
16	10.00	115.00	137.28	2667.90	4965.90	30373.5	0.30	2.967	78767.7	0.439	0.81	8.10	1.03E-04
17	10.00	125.00	137.28	2679.70	4980.60	30642.8	0.30	2.960	79424.9	0.477	0.78	7.80	9.82E-05
18	10.00	135.00	137.28	2742.50	5098.80	32095.9	0.30	2.961	83198.3	0.515	0.75	7.50	9.01E-05
19	10.00	145.00	137.28	2801.30	5209.10	33486.9	0.30	2.962	86810.9	0.553	0.72	7.20	8.29E-05
20	10.00	155.00	137.28	2832.10	5267.50	34227.4	0.30	2.963	88739.2	0.592	0.68	6.80	7.66E-05
21	10.00	165.00	137.28	2844.80	5292.60	34535.0	0.30	2.965	89547.2	0.630	0.65	6.50	7.26E-05
22	10.00	175.00	137.28	2815.00	5241.90	33815.3	0.30	2.969	87711.4	0.668	0.62	6.20	7.07E-05
23	10.00	185.00	137.28	2797.20	5212.50	33389.0	0.30	2.973	86629.1	0.706	0.59	5.90	6.81E-05
24	10.00	195.00	137.28	2848.00	5307.50	34612.8	0.30	2.973	89806.9	0.744	0.56	5.60	6.24E-05
25	12.50	206.25	137.28	2861.70	5335.40	34946.6	0.30	3.719	90687.7	0.787	0.53	6.63	7.31E-05
26	12.50	218.75	137.28	2887.50	5385.20	35579.5	0.30	3.721	92341.0	0.835	0.51	6.38	6.90E-05
27	12.50	231.25	137.28	2917.90	5443.10	36332.6	0.30	3.722	94302.8	0.883	0.49	6.13	6.50E-05
28	12.50	243.75	137.28	2968.10	5536.30	37593.5	0.30	3.722	97572.5	0.930	0.47	5.88	6.02E-05
29	12.50	256.25	137.28	3013.10	5615.30	38742.1	0.30	3.717	100524.9	0.978	0.45	5.63	5.60E-05
30	12.50	268.75	137.28	3018.80	5627.40	38888.8	0.30	3.719	100916.5	1.026	0.42	5.25	5.20E-05
31	12.50	281.25	137.28	3068.10	5719.00	40169.4	0.30	3.718	104236.4	1.073	0.40	5.00	4.80E-05
32	12.50	293.75	137.28	3067.00	5719.00	40140.6	0.30	3.720	104175.3	1.121	0.38	4.75	4.56E-05
33	15.00	307.50	137.28	3141.30	5854.10	42109.0	0.30	4.460	109260.3	1.174	0.36	5.40	4.94E-05
34	15.00	322.50	137.28	3164.30	5897.50	42727.9	0.30	4.461	110870.3	1.231	0.35	5.25	4.74E-05
35	15.00	337.50	137.28	3288.20	6122.20	46139.5	0.30	4.453	119674.7	1.288	0.33	4.95	4.14E-05
36	15.00	352.50	137.28	3356.50	6247.10	48076.1	0.30	4.450	124679.7	1.345	0.32	4.80	3.85E-05
37	15.00	367.50	137.28	3431.50	6384.20	50248.6	0.30	4.447	130293.7	1.403	0.30	4.50	3.45E-05
38	15.00	382.50	137.28	3468.60	6453.30	51341.0	0.30	4.447	133126.3	1.460	0.29	4.35	3.27E-05
39	15.00	397.50	137.28	3484.40	6483.70	51809.8	0.30	4.449	134351.2	1.517	0.28	4.20	3.13E-05
40	15.00	412.50	137.28	3483.60	6483.70	51786.0	0.30	4.451	134301.9	1.574	0.25	3.75	2.79E-05
41	15.00	427.50	137.28	3482.80	6483.70	51762.3	0.30	4.452	134250.6	1.632	0.24	3.60	2.68E-05
42	15.00	442.50	137.28	3482.20	6483.90	51744.4	0.30	4.454	134215.7	1.689	0.22	3.30	2.46E-05
43	15.00	457.50	137.28	3578.00	6658.70	54630.7	0.30	4.449	141669.5	1.746	0.20	3.00	2.12E-05
44	15.00	472.50	137.28	3598.70	6697.30	55264.7	0.30	4.449	143315.6	1.803	0.19	2.85	1.99E-05
45	15.00	487.50	137.28	3627.80	6749.70	56162.0	0.30	4.448	145631.5	1.861	0.17	2.55	1.75E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.309	Σ= 153.16			Σ=	264.77	6.59E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 40155 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 15333 ksf

Vel = SQRT(32.17*1000*G/p) 2095.6 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p) 1895.6 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 15333 ksf : 5E-4 Event : 100' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 100' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 3

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		$H*\mu$	$E_i=2(1+\mu)G'$ (3)	Z/W		Nq*H	$Nq*H/E_i$
1	4.00	2.00	112.32	1231.40	2755.50	5294.2	0.37	1.469	14477.2	0.008	1	4.00	2.76E-04
2	4.00	6.00	112.32	1279.00	2983.70	5711.5	0.39	1.545	15833.9	0.023	1	4.00	2.53E-04
3	4.00	10.00	112.32	1362.60	3327.40	6482.5	0.39	1.568	18048.5	0.038	1	4.00	2.22E-04
4	4.00	14.00	112.32	1540.20	4100.90	8282.5	0.39	1.572	23073.8	0.053	1	4.00	1.73E-04
5	4.00	18.00	112.32	1928.90	4593.40	12990.5	0.39	1.555	36081.1	0.069	1	4.00	1.11E-04
6	8.00	24.00	112.32	1870.20	4703.80	12211.9	0.39	3.156	34059.1	0.092	1	8.00	2.35E-04
7	8.00	32.00	112.32	1963.70	4690.90	13463.4	0.38	3.035	37143.8	0.122	1	8.00	2.15E-04
8	8.00	40.00	112.32	2067.20	4779.00	14920.1	0.36	2.911	40696.9	0.153	1	8.00	1.97E-04
9	8.00	48.00	112.32	2283.30	4992.30	18202.5	0.36	2.858	49410.8	0.183	1	8.00	1.62E-04
10	8.00	56.00	112.32	2549.80	5035.60	22699.6	0.34	2.712	60787.3	0.214	0.98	7.84	1.29E-04
11	10.00	65.00	112.32	2654.60	5062.60	24603.9	0.34	3.385	65863.2	0.248	0.96	9.60	1.46E-04
12	10.00	75.00	112.32	2841.70	5327.50	28194.4	0.34	3.379	75444.2	0.286	0.93	9.30	1.23E-04
13	10.00	85.00	112.32	3008.50	5698.60	31601.4	0.34	3.351	84383.9	0.324	0.90	9.00	1.07E-04
14	10.00	95.00	112.32	3000.30	5693.80	31429.3	0.34	3.383	84122.5	0.363	0.88	8.80	1.05E-04
15	10.00	105.00	137.28	3264.50	6071.30	45476.8	0.30	2.962	117894.0	0.401	0.85	8.50	7.21E-05
16	10.00	115.00	137.28	3267.50	6082.00	45560.4	0.30	2.967	118151.8	0.439	0.81	8.10	6.86E-05
17	10.00	125.00	137.28	3281.90	6100.00	45962.8	0.30	2.960	119133.9	0.477	0.78	7.80	6.55E-05
18	10.00	135.00	137.28	3358.90	6244.70	48144.9	0.30	2.961	124800.3	0.515	0.75	7.50	6.01E-05
19	10.00	145.00	137.28	3430.90	6379.80	50231.1	0.30	2.962	130218.0	0.553	0.72	7.20	5.53E-05
20	10.00	155.00	137.28	3468.50	6451.30	51338.1	0.30	2.963	133101.2	0.592	0.68	6.80	5.11E-05
21	10.00	165.00	137.28	3484.20	6482.10	51803.9	0.30	2.965	134324.4	0.630	0.65	6.50	4.84E-05
22	10.00	175.00	137.28	3447.60	6420.00	50721.3	0.30	2.969	131562.8	0.668	0.62	6.20	4.71E-05
23	10.00	185.00	137.28	3425.90	6384.00	50084.8	0.30	2.973	129946.9	0.706	0.59	5.90	4.54E-05
24	10.00	195.00	137.28	3488.10	6500.30	51919.9	0.30	2.973	134712.5	0.744	0.56	5.60	4.16E-05
25	12.50	206.25	137.28	3505.00	6534.50	52424.3	0.30	3.719	136043.0	0.787	0.53	6.63	4.87E-05
26	12.50	218.75	137.28	3536.40	6595.50	53367.8	0.30	3.721	138507.5	0.835	0.51	6.38	4.60E-05
27	12.50	231.25	137.28	3588.80	6666.40	54961.0	0.30	3.722	142653.5	0.883	0.49	6.13	4.29E-05
28	12.50	243.75	137.28	3645.00	6780.60	56695.9	0.30	3.722	147151.8	0.930	0.47	5.88	3.99E-05
29	12.50	256.25	137.28	3690.30	6877.30	58113.8	0.30	3.717	150789.1	0.978	0.45	5.63	3.73E-05
30	12.50	268.75	137.28	3697.20	6892.10	58331.4	0.30	3.719	151369.9	1.026	0.42	5.25	3.47E-05
31	12.50	281.25	137.28	3757.60	7004.30	60252.8	0.30	3.718	156351.2	1.073	0.40	5.00	3.20E-05
32	12.50	293.75	137.28	3756.30	7004.30	60211.1	0.30	3.720	156263.5	1.121	0.38	4.75	3.04E-05
33	15.00	307.50	137.28	3847.30	7169.80	63163.8	0.30	4.460	163891.1	1.174	0.36	5.40	3.29E-05
34	15.00	322.50	137.28	3875.50	7222.90	64093.2	0.30	4.461	166308.9	1.231	0.35	5.25	3.16E-05
35	15.00	337.50	137.28	4027.20	7498.10	69209.0	0.30	4.453	179511.5	1.288	0.33	4.95	2.76E-05
36	15.00	352.50	137.28	4110.90	7651.10	72115.7	0.30	4.450	187023.5	1.345	0.32	4.80	2.57E-05
37	15.00	367.50	137.28	4202.70	7819.00	75372.5	0.30	4.447	195439.4	1.403	0.30	4.50	2.30E-05
38	15.00	382.50	137.28	4248.20	7903.60	77013.4	0.30	4.447	199694.1	1.460	0.29	4.35	2.18E-05
39	15.00	397.50	137.28	4267.50	7940.90	77714.7	0.30	4.449	201526.7	1.517	0.28	4.20	2.08E-05
40	15.00	412.50	137.28	4266.50	7940.90	77678.3	0.30	4.451	201450.9	1.574	0.25	3.75	1.86E-05
41	15.00	427.50	137.28	4265.60	7940.90	77645.5	0.30	4.452	201381.4	1.632	0.24	3.60	1.79E-05
42	15.00	442.50	137.28	4264.80	7941.10	77616.4	0.30	4.454	201323.0	1.689	0.22	3.30	1.64E-05
43	15.00	457.50	137.28	4382.20	8155.20	81948.4	0.30	4.449	212510.3	1.746	0.20	3.00	1.41E-05
44	15.00	472.50	137.28	4407.50	8202.50	82897.4	0.30	4.449	214974.5	1.803	0.19	2.85	1.33E-05
45	15.00	487.50	137.28	4443.10	8266.70	84241.9	0.30	4.448	218444.4	1.861	0.17	2.55	1.17E-05
Σ=	495.00					Average μ = SUM $(H*\mu)$/SUM H	0.309	Σ= 153.16			Σ=	264.77	3.60E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ = 73645 ksf

Equivalent Shear Modulus $G = E/(2*(1+Average\ \mu))$ = 28121 ksf

Vel = SQRT(32.17*1000*G/p) 2838.0 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p) 2567.1 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 28121 ksf : 5E-4 Event : 100' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 4

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	E_i=2(1+μ)G' (3)	Z/W		Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	607.13	1359.50	1287.0	0.37	1.469	3519.1	0.008	1	4.00	1.14E-03
2	4.00	6.00	112.32	639.92	1671.70	1429.7	0.39	1.541	3960.9	0.023	1	4.00	1.01E-03
3	4.00	10.00	112.32	678.15	1882.40	1605.7	0.39	1.566	4468.4	0.038	1	4.00	8.95E-04
4	4.00	14.00	112.32	748.61	2035.90	1956.7	0.39	1.573	5452.6	0.053	1	4.00	7.34E-04
5	4.00	18.00	112.32	928.69	2531.50	3011.3	0.39	1.559	8370.1	0.069	1	4.00	4.78E-04
6	8.00	24.00	112.32	893.51	2561.50	2787.4	0.40	3.167	7781.6	0.092	1	8.00	1.03E-03
7	8.00	32.00	112.32	971.68	2680.10	3296.5	0.38	3.035	9094.3	0.122	1	8.00	8.80E-04
8	8.00	40.00	112.32	1016.10	2715.10	3604.8	0.36	2.912	9834.2	0.153	1	8.00	8.13E-04
9	8.00	48.00	112.32	1150.00	3061.60	4617.4	0.36	2.852	12527.5	0.183	1	8.00	6.39E-04
10	8.00	56.00	112.32	1289.70	3098.40	5807.4	0.34	2.707	15545.1	0.214	0.98	7.84	5.04E-04
11	10.00	65.00	112.32	1396.00	3390.90	6804.2	0.34	3.383	18212.7	0.248	0.96	9.60	5.27E-04
12	10.00	75.00	112.32	1424.60	3559.30	7085.8	0.34	3.383	18965.4	0.286	0.93	9.30	4.90E-04
13	10.00	85.00	112.32	1577.40	3782.30	8687.4	0.34	3.364	23219.7	0.324	0.90	9.00	3.88E-04
14	10.00	95.00	112.32	1526.60	3775.40	8136.9	0.34	3.399	21805.6	0.363	0.88	8.80	4.04E-04
15	10.00	105.00	112.32	1689.80	3842.00	9969.6	0.33	3.330	26579.1	0.401	0.85	8.50	3.20E-04
16	10.00	115.00	112.32	1664.10	3847.30	9668.6	0.34	3.355	25825.5	0.439	0.81	8.10	3.14E-04
17	10.00	125.00	112.32	1661.30	3856.30	9636.1	0.34	3.376	25778.9	0.477	0.78	7.80	3.03E-04
18	10.00	135.00	112.32	1710.00	3987.90	10209.4	0.34	3.370	27299.6	0.515	0.75	7.50	2.75E-04
19	10.00	145.00	112.32	1724.30	4078.00	10380.8	0.34	3.370	27758.9	0.553	0.72	7.20	2.59E-04
20	10.00	155.00	112.32	1720.90	4132.20	10339.9	0.34	3.376	27661.2	0.592	0.68	6.80	2.46E-04
21	10.00	165.00	112.32	1683.50	4114.60	9895.4	0.34	3.397	26513.9	0.630	0.65	6.50	2.45E-04
22	10.00	175.00	112.32	1622.30	4077.50	9189.0	0.34	3.421	24664.2	0.668	0.62	6.20	2.51E-04
23	10.00	185.00	112.32	1613.60	4081.70	9090.7	0.34	3.434	24424.7	0.706	0.59	5.90	2.42E-04
24	10.00	195.00	112.32	1661.20	4160.00	9635.0	0.34	3.428	25875.8	0.744	0.56	5.60	2.16E-04
25	12.50	206.25	137.28	2331.30	4366.20	23192.8	0.30	3.711	60156.0	0.787	0.53	6.63	1.10E-04
26	12.50	218.75	137.28	2365.00	4421.30	23868.1	0.30	3.714	61917.8	0.835	0.51	6.38	1.03E-04
27	12.50	231.25	137.28	2371.20	4447.80	23993.4	0.30	3.715	62249.1	0.883	0.49	6.13	9.84E-05
28	12.50	243.75	137.28	2421.40	4543.30	25020.1	0.30	3.715	64911.7	0.930	0.47	5.88	9.05E-05
29	12.50	256.25	137.28	2483.60	4625.00	26322.0	0.30	3.712	68277.3	0.978	0.45	5.63	8.24E-05
30	12.50	268.75	137.28	2489.30	4637.20	26443.0	0.30	3.714	68599.5	1.026	0.42	5.25	7.65E-05
31	12.50	281.25	137.28	2488.40	4637.20	26423.9	0.30	3.717	68561.0	1.073	0.40	5.00	7.29E-05
32	12.50	293.75	137.28	2487.40	4637.20	26402.6	0.30	3.719	68515.9	1.121	0.38	4.75	6.93E-05
33	15.00	307.50	137.28	2548.30	4748.20	27711.3	0.30	4.459	71898.1	1.174	0.36	5.40	7.51E-05
34	15.00	322.50	137.28	2566.80	4783.40	28115.1	0.30	4.460	72950.4	1.231	0.35	5.25	7.20E-05
35	15.00	337.50	137.28	2667.00	4965.70	30353.0	0.30	4.453	78727.9	1.288	0.33	4.95	6.29E-05
36	15.00	352.50	137.28	2718.70	5059.30	31541.2	0.30	4.450	81795.3	1.345	0.32	4.80	5.87E-05
37	15.00	367.50	137.28	2779.30	5170.50	32963.0	0.30	4.447	85471.8	1.403	0.30	4.50	5.26E-05
38	15.00	382.50	137.28	2809.30	5226.30	33678.5	0.30	4.447	87326.9	1.460	0.29	4.35	4.98E-05
39	15.00	397.50	137.28	2822.00	5251.00	33983.7	0.30	4.449	88125.1	1.517	0.28	4.20	4.77E-05
40	15.00	412.50	137.28	2821.30	5251.00	33966.8	0.30	4.451	88090.2	1.574	0.25	3.75	4.26E-05
41	15.00	427.50	137.28	2820.70	5251.00	33952.4	0.30	4.452	88060.9	1.632	0.24	3.60	4.09E-05
42	15.00	442.50	137.28	2820.10	5251.10	33937.9	0.30	4.454	88030.9	1.689	0.22	3.30	3.75E-05
43	15.00	457.50	137.28	2897.60	5392.70	35828.9	0.30	4.450	92915.7	1.746	0.20	3.00	3.23E-05
44	15.00	472.50	137.28	2914.20	5424.00	36240.6	0.30	4.450	93985.5	1.803	0.19	2.85	3.03E-05
45	15.00	487.50	137.28	2937.80	5466.40	36829.9	0.30	4.449	95508.1	1.861	0.17	2.55	2.67E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.318	Σ= 157.36			Σ=	264.77	1.39E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus	E=sum(Nq*H)/sum(Nq*H/E_i) =	19009 ksf
Equivalent Shear Modulus	G = E/(2*(1+Average μ) =	7212 ksf
	Vel = SQRT(32.17*1000*G/p	1437.2 fps (density =112.32 pcf)
	Vel = SQRT(32.17*1000*G/p	1300.0 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 7212 ksf : 5E-4 Event : 200' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 5

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	858.61	1922.60	2573.9	0.37	1.469	7038.2	0.008	1	4.00	5.68E-04
2	4.00	6.00	112.32	904.99	2249.50	2859.5	0.39	1.541	7921.9	0.023	1	4.00	5.05E-04
3	4.00	10.00	112.32	959.05	2519.00	3211.4	0.39	1.566	8936.9	0.038	1	4.00	4.48E-04
4	4.00	14.00	112.32	1058.70	2861.30	3913.4	0.39	1.573	10905.4	0.053	1	4.00	3.67E-04
5	4.00	18.00	112.32	1313.40	3382.00	6022.8	0.39	1.559	16741.0	0.069	1	4.00	2.39E-04
6	8.00	24.00	112.32	1263.60	3445.10	5574.7	0.40	3.167	15562.9	0.092	1	8.00	5.14E-04
7	8.00	32.00	112.32	1374.20	3569.30	6593.3	0.38	3.035	18189.6	0.122	1	8.00	4.40E-04
8	8.00	40.00	112.32	1437.00	3627.00	7209.7	0.36	2.912	19668.9	0.153	1	8.00	4.07E-04
9	8.00	48.00	112.32	1626.30	3928.40	9234.4	0.36	2.852	25053.6	0.183	1	8.00	3.19E-04
10	8.00	56.00	112.32	1824.00	3966.70	11616.0	0.34	2.707	31093.2	0.214	0.98	7.84	2.52E-04
11	10.00	65.00	112.32	1930.00	4153.00	13005.3	0.34	3.383	34811.0	0.248	0.96	9.60	2.76E-04
12	10.00	75.00	112.32	2014.70	4359.20	14171.9	0.34	3.383	37931.3	0.286	0.93	9.30	2.45E-04
13	10.00	85.00	112.32	2163.60	4632.40	16344.1	0.34	3.364	43684.4	0.324	0.90	9.00	2.06E-04
14	10.00	95.00	112.32	2125.10	4623.90	15767.6	0.34	3.399	42254.9	0.363	0.88	8.80	2.08E-04
15	10.00	105.00	112.32	2251.90	4705.50	17705.3	0.33	3.330	47202.8	0.401	0.85	8.50	1.80E-04
16	10.00	115.00	112.32	2231.30	4711.90	17382.9	0.34	3.355	46430.7	0.439	0.81	8.10	1.74E-04
17	10.00	125.00	112.32	2220.20	4723.00	17210.4	0.34	3.376	46041.9	0.477	0.78	7.80	1.69E-04
18	10.00	135.00	112.32	2301.40	4884.10	18492.3	0.34	3.370	49448.0	0.515	0.75	7.50	1.52E-04
19	10.00	145.00	112.32	2349.40	4994.50	19271.7	0.34	3.370	51533.7	0.553	0.72	7.20	1.40E-04
20	10.00	155.00	112.32	2370.90	5060.90	19626.0	0.34	3.376	52503.2	0.592	0.68	6.80	1.30E-04
21	10.00	165.00	112.32	2339.20	5039.30	19104.7	0.34	3.397	51189.6	0.630	0.65	6.50	1.27E-04
22	10.00	175.00	112.32	2294.30	4995.50	18378.3	0.34	3.421	49329.3	0.668	0.62	6.20	1.26E-04
23	10.00	185.00	112.32	2281.90	4999.00	18180.2	0.34	3.434	48846.3	0.706	0.59	5.90	1.21E-04
24	10.00	195.00	112.32	2336.70	5094.90	19063.9	0.34	3.428	51198.4	0.744	0.56	5.60	1.09E-04
25	12.50	206.25	137.28	2880.70	5363.80	35412.1	0.30	3.711	91849.9	0.787	0.53	6.63	7.21E-05
26	12.50	218.75	137.28	2907.10	5415.00	36064.2	0.30	3.714	93556.3	0.835	0.51	6.38	6.81E-05
27	12.50	231.25	137.28	2939.60	5477.10	36875.1	0.30	3.715	95669.4	0.883	0.49	6.13	6.40E-05
28	12.50	243.75	137.28	2993.70	5578.00	38244.8	0.30	3.715	99221.6	0.930	0.47	5.88	5.92E-05
29	12.50	256.25	137.28	3041.80	5664.50	39483.7	0.30	3.712	102417.5	0.978	0.45	5.63	5.49E-05
30	12.50	268.75	137.28	3048.80	5679.40	39665.6	0.30	3.714	102902.1	1.026	0.42	5.25	5.10E-05
31	12.50	281.25	137.28	3047.60	5679.40	39634.4	0.30	3.717	102837.8	1.073	0.40	5.00	4.86E-05
32	12.50	293.75	137.28	3046.40	5679.40	39603.2	0.30	3.719	102771.8	1.121	0.38	4.75	4.62E-05
33	15.00	307.50	137.28	3121.00	5815.30	41566.5	0.30	4.459	107846.0	1.174	0.36	5.40	5.01E-05
34	15.00	322.50	137.28	3143.60	5858.50	42170.7	0.30	4.460	109420.3	1.231	0.35	5.25	4.80E-05
35	15.00	337.50	137.28	3266.40	6081.70	45529.7	0.30	4.453	118092.2	1.288	0.33	4.95	4.19E-05
36	15.00	352.50	137.28	3329.80	6196.40	47314.3	0.30	4.450	122699.3	1.345	0.32	4.80	3.91E-05
37	15.00	367.50	137.28	3403.90	6332.50	49443.6	0.30	4.447	128205.2	1.403	0.30	4.50	3.51E-05
38	15.00	382.50	137.28	3440.70	6400.90	50518.4	0.30	4.447	130992.3	1.460	0.29	4.35	3.32E-05
39	15.00	397.50	137.28	3456.20	6431.20	50974.6	0.30	4.449	132185.3	1.517	0.28	4.20	3.18E-05
40	15.00	412.50	137.28	3455.40	6431.20	50951.0	0.30	4.451	132137.4	1.574	0.25	3.75	2.84E-05
41	15.00	427.50	137.28	3454.60	6431.20	50927.4	0.30	4.452	132088.4	1.632	0.24	3.60	2.73E-05
42	15.00	442.50	137.28	3453.90	6431.30	50906.8	0.30	4.454	132046.1	1.689	0.22	3.30	2.50E-05
43	15.00	457.50	137.28	3548.80	6604.70	53742.7	0.30	4.450	139371.9	1.746	0.20	3.00	2.15E-05
44	15.00	472.50	137.28	3569.20	6643.00	54362.3	0.30	4.450	140982.2	1.803	0.19	2.85	2.02E-05
45	15.00	487.50	137.28	3598.00	6695.00	55243.2	0.30	4.449	143257.7	1.861	0.17	2.55	1.78E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.318	Σ= 157.36				Σ= 264.77	7.31E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 36244 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 13751 ksf
Vel = SQRT(32.17*1000*G/p) 1984.5 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p) 1795.1 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 13751 ksf : 5E-4 Event : 200' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 5E-4 EVENT : 200' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 6

See Ref. DTN MO0801SCSPS5E4.003 (Ref. 2.2.9) - Strain Compatible Soil Properties for the Surface Facilities Area at 5E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	E_i=2(1+μ)G' (3)	Z/W		Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1214.30	2719.00	5148.2	0.37	1.469	14077.4	0.008	1	4.00	2.84E-04
2	4.00	6.00	112.32	1279.80	3027.10	5718.6	0.39	1.541	15842.5	0.023	1	4.00	2.52E-04
3	4.00	10.00	112.32	1356.30	3370.80	6422.7	0.39	1.566	17873.7	0.038	1	4.00	2.24E-04
4	4.00	14.00	112.32	1497.20	4021.40	7826.5	0.39	1.573	21810.0	0.053	1	4.00	1.83E-04
5	4.00	18.00	112.32	1857.40	4518.30	12045.3	0.39	1.559	33481.1	0.069	1	4.00	1.19E-04
6	8.00	24.00	112.32	1787.00	4633.50	11149.5	0.40	3.167	31125.8	0.092	1	8.00	2.57E-04
7	8.00	32.00	112.32	1943.40	4753.50	13186.5	0.38	3.035	36378.7	0.122	1	8.00	2.20E-04
8	8.00	40.00	112.32	2032.20	4845.10	14419.1	0.36	2.912	39336.8	0.153	1	8.00	2.03E-04
9	8.00	48.00	112.32	2299.90	5040.60	18468.2	0.36	2.852	50105.6	0.183	1	8.00	1.60E-04
10	8.00	56.00	112.32	2579.50	5078.30	23231.5	0.34	2.707	62185.1	0.214	0.98	7.84	1.26E-04
11	10.00	65.00	112.32	2668.20	5086.40	24856.7	0.34	3.383	66533.3	0.248	0.96	9.60	1.44E-04
12	10.00	75.00	112.32	2849.30	5338.90	28345.4	0.34	3.383	75867.0	0.286	0.93	9.30	1.23E-04
13	10.00	85.00	112.32	2967.50	5673.50	30745.9	0.34	3.364	82177.7	0.324	0.90	9.00	1.10E-04
14	10.00	95.00	112.32	2958.30	5663.10	30555.6	0.34	3.399	81884.7	0.363	0.88	8.80	1.07E-04
15	10.00	105.00	112.32	3001.10	5763.00	31446.1	0.33	3.330	83836.0	0.401	0.85	8.50	1.01E-04
16	10.00	115.00	112.32	2991.80	5770.90	31251.5	0.34	3.355	83474.7	0.439	0.81	8.10	9.70E-05
17	10.00	125.00	112.32	2967.30	5784.50	30741.8	0.34	3.376	82241.6	0.477	0.78	7.80	9.48E-05
18	10.00	135.00	112.32	3097.20	5981.80	33492.3	0.34	3.370	89557.7	0.515	0.75	7.50	8.37E-05
19	10.00	145.00	112.32	3201.00	6117.00	35774.8	0.34	3.370	95664.0	0.553	0.72	7.20	7.53E-05
20	10.00	155.00	112.32	3266.30	6198.30	37249.3	0.34	3.376	99648.6	0.592	0.68	6.80	6.82E-05
21	10.00	165.00	112.32	3250.40	6171.90	36887.5	0.34	3.397	98837.2	0.630	0.65	6.50	6.58E-05
22	10.00	175.00	112.32	3244.70	6120.20	36758.3	0.34	3.421	98662.9	0.668	0.62	6.20	6.28E-05
23	10.00	185.00	112.32	3227.10	6122.50	36360.6	0.34	3.434	97692.9	0.706	0.59	5.90	6.04E-05
24	10.00	195.00	112.32	3287.00	6240.00	37722.9	0.34	3.428	101309.5	0.744	0.56	5.60	5.53E-05
25	12.50	206.25	137.28	3559.70	6589.30	54073.3	0.30	3.711	140252.1	0.787	0.53	6.63	4.72E-05
26	12.50	218.75	137.28	3573.50	6632.00	54493.4	0.30	3.714	141364.6	0.835	0.51	6.38	4.51E-05
27	12.50	231.25	137.28	3644.20	6744.60	56671.0	0.30	3.715	147028.3	0.883	0.49	6.13	4.17E-05
28	12.50	243.75	137.28	3701.20	6848.40	58457.6	0.30	3.715	151661.3	0.930	0.47	5.88	3.87E-05
29	12.50	256.25	137.28	3725.40	6937.60	59224.6	0.30	3.712	153623.8	0.978	0.45	5.63	3.66E-05
30	12.50	268.75	137.28	3734.00	6955.80	59498.3	0.30	3.714	154353.0	1.026	0.42	5.25	3.40E-05
31	12.50	281.25	137.28	3732.60	6955.80	59453.7	0.30	3.717	154262.2	1.073	0.40	5.00	3.24E-05
32	12.50	293.75	137.28	3731.10	6955.80	59406.0	0.30	3.719	154160.8	1.121	0.38	4.75	3.08E-05
33	15.00	307.50	137.28	3822.40	7122.30	62348.9	0.30	4.459	161766.6	1.174	0.36	5.40	3.34E-05
34	15.00	322.50	137.28	3850.10	7175.20	63255.8	0.30	4.460	164129.8	1.231	0.35	5.25	3.20E-05
35	15.00	337.50	137.28	4000.50	7448.50	68294.3	0.30	4.453	177137.8	1.288	0.33	4.95	2.79E-05
36	15.00	352.50	137.28	4078.10	7589.00	70969.5	0.30	4.450	184043.9	1.345	0.32	4.80	2.61E-05
37	15.00	367.50	137.28	4168.90	7755.70	74165.0	0.30	4.447	192307.0	1.403	0.30	4.50	2.34E-05
38	15.00	382.50	137.28	4214.00	7839.50	75778.4	0.30	4.447	196490.3	1.460	0.29	4.35	2.21E-05
39	15.00	397.50	137.28	4233.00	7876.60	76463.2	0.30	4.449	198281.4	1.517	0.28	4.20	2.12E-05
40	15.00	412.50	137.28	4231.90	7876.60	76423.5	0.30	4.451	198198.3	1.574	0.25	3.75	1.89E-05
41	15.00	427.50	137.28	4231.00	7876.60	76391.0	0.30	4.452	198132.3	1.632	0.24	3.60	1.82E-05
42	15.00	442.50	137.28	4230.10	7876.70	76358.5	0.30	4.454	198064.8	1.689	0.22	3.30	1.67E-05
43	15.00	457.50	137.28	4346.30	8089.10	80611.2	0.30	4.450	209050.7	1.746	0.20	3.00	1.44E-05
44	15.00	472.50	137.28	4371.30	8136.00	81541.3	0.30	4.450	211467.5	1.803	0.19	2.85	1.35E-05
45	15.00	487.50	137.28	4406.60	8199.70	82863.5	0.30	4.449	214883.4	1.861	0.17	2.55	1.19E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.318	Σ= 157.36			Σ=	264.77	3.86E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS5E4.003 (Ref. 2.2.9).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) 68519 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 25996 ksf

Vel = SQRT(32.17*1000*G/ 2728.6 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/ 2468.2 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 25996 ksf : 5E-4 Event : 200' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 7

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) $E_i=2(1+\mu)G'$ (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	552.93	1377.70	1067.4	0.38	1.538	2955.6	0.008	1	4.00	1.35E-03
2	4.00	6.00	112.32	530.54	1599.40	982.7	0.41	1.639	2770.8	0.023	1	4.00	1.44E-03
3	4.00	10.00	112.32	555.78	1810.30	1078.5	0.42	1.665	3055.0	0.038	1	4.00	1.31E-03
4	4.00	14.00	112.32	607.77	1896.60	1289.7	0.42	1.666	3653.7	0.053	1	4.00	1.09E-03
5	4.00	18.00	112.32	759.12	2613.60	2012.0	0.41	1.650	5684.0	0.069	1	4.00	7.04E-04
6	8.00	24.00	112.32	704.46	2648.40	1732.7	0.42	3.354	4918.4	0.092	1	8.00	1.63E-03
7	8.00	32.00	112.32	723.98	2731.40	1830.0	0.41	3.272	5157.0	0.122	1	8.00	1.55E-03
8	8.00	40.00	112.32	748.11	2768.50	1954.1	0.40	3.183	5463.1	0.153	1	8.00	1.46E-03
9	8.00	48.00	112.32	832.71	3045.60	2421.0	0.39	3.141	6743.0	0.183	1	8.00	1.19E-03
10	8.00	56.00	112.32	1023.10	3078.60	3654.6	0.38	3.029	10076.5	0.214	0.98	7.84	7.78E-04
11	10.00	65.00	112.32	1091.40	3375.10	4158.9	0.38	3.795	11473.9	0.248	0.96	9.60	8.37E-04
12	10.00	75.00	112.32	1135.60	3551.70	4502.5	0.38	3.787	12415.6	0.286	0.93	9.30	7.49E-04
13	10.00	85.00	112.32	1235.50	3799.10	5329.6	0.38	3.756	14662.2	0.324	0.90	9.00	6.14E-04
14	10.00	95.00	112.32	1194.10	3795.90	4978.4	0.38	3.797	13737.1	0.363	0.88	8.80	6.41E-04
15	10.00	105.00	137.28	2143.20	4047.50	19601.2	0.30	3.035	51101.8	0.401	0.85	8.50	1.66E-04
16	10.00	115.00	137.28	2142.50	4054.60	19588.4	0.30	3.045	51105.2	0.439	0.81	8.10	1.58E-04
17	10.00	125.00	137.28	2156.80	4066.60	19850.7	0.30	3.030	51732.5	0.477	0.78	7.80	1.51E-04
18	10.00	135.00	137.28	2206.20	4163.20	20770.5	0.30	3.034	54143.2	0.515	0.75	7.50	1.39E-04
19	10.00	145.00	137.28	2252.60	4253.20	21653.3	0.30	3.036	56455.8	0.553	0.72	7.20	1.28E-04
20	10.00	155.00	137.28	2276.10	4300.90	22107.5	0.30	3.040	57655.8	0.592	0.68	6.80	1.18E-04
21	10.00	165.00	137.28	2285.00	4321.40	22280.7	0.30	3.044	58125.9	0.630	0.65	6.50	1.12E-04
22	10.00	175.00	137.28	2258.40	4280.00	21765.0	0.31	3.053	56818.7	0.668	0.62	6.20	1.09E-04
23	10.00	185.00	137.28	2238.30	4256.00	21379.3	0.31	3.060	55842.2	0.706	0.59	5.90	1.06E-04
24	10.00	195.00	137.28	2271.50	4333.60	22018.2	0.31	3.061	57515.0	0.744	0.56	5.60	9.74E-05
25	12.50	206.25	137.28	2270.70	4356.30	22002.7	0.31	3.831	57491.7	0.787	0.53	6.63	1.15E-04
26	12.50	218.75	137.28	2300.20	4397.00	22578.1	0.31	3.835	59009.2	0.835	0.51	6.38	1.08E-04
27	12.50	231.25	137.28	2301.60	4444.30	22605.6	0.31	3.837	59090.1	0.883	0.49	6.13	1.04E-04
28	12.50	243.75	137.28	2343.30	4520.40	23432.1	0.31	3.837	61250.7	0.930	0.47	5.88	9.59E-05
29	12.50	256.25	137.28	2415.80	4584.90	24904.5	0.31	3.826	65054.6	0.978	0.45	5.63	8.65E-05
30	12.50	268.75	137.28	2419.30	4594.80	24976.7	0.31	3.830	65259.2	1.026	0.42	5.25	8.04E-05
31	12.50	281.25	137.28	2458.60	4669.50	25794.8	0.31	3.829	67394.0	1.073	0.40	5.00	7.42E-05
32	12.50	293.75	137.28	2456.60	4669.50	25752.8	0.31	3.834	67303.0	1.121	0.38	4.75	7.06E-05
33	15.00	307.50	137.28	2517.40	4779.90	27043.4	0.31	4.595	70653.5	1.174	0.36	5.40	7.64E-05
34	15.00	322.50	137.28	2535.10	4815.30	27425.0	0.31	4.597	71659.3	1.231	0.35	5.25	7.33E-05
35	15.00	337.50	137.28	2637.20	4998.80	29678.5	0.31	4.583	77493.0	1.288	0.33	4.95	6.39E-05
36	15.00	352.50	137.28	2692.70	5100.70	30940.8	0.31	4.579	80773.5	1.345	0.32	4.80	5.94E-05
37	15.00	367.50	137.28	2753.80	5212.70	32360.9	0.30	4.574	84458.1	1.403	0.30	4.50	5.33E-05
38	15.00	382.50	137.28	2783.70	5269.10	33067.5	0.30	4.574	86300.8	1.460	0.29	4.35	5.04E-05
39	15.00	397.50	137.28	2795.70	5293.90	33353.2	0.31	4.576	87057.8	1.517	0.28	4.20	4.82E-05
40	15.00	412.50	137.28	2794.10	5293.90	33315.0	0.31	4.580	86975.5	1.574	0.25	3.75	4.31E-05
41	15.00	427.50	137.28	2792.60	5293.90	33279.3	0.31	4.584	86898.8	1.632	0.24	3.60	4.14E-05
42	15.00	442.50	137.28	2791.20	5294.10	33245.9	0.31	4.588	86827.7	1.689	0.22	3.30	3.80E-05
43	15.00	457.50	137.28	2869.30	5436.80	35132.4	0.31	4.580	91718.8	1.746	0.20	3.00	3.27E-05
44	15.00	472.50	137.28	2885.70	5468.30	35535.2	0.31	4.581	92774.5	1.803	0.19	2.85	3.07E-05
45	15.00	487.50	137.28	2909.90	5511.10	36133.7	0.31	4.579	94329.2	1.861	0.17	2.55	2.70E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.323	Σ= 159.94			Σ=	264.77	1.80E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 14703 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 5556 ksf
Vel = SQRT(32.17*1000*G/p 1261.5 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p 1141.1 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 5556 ksf : 1E-4 Event : 100' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 8

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS [1] H (FT)	DEPTH TO MIDPOINT [1] Z (FT) Depth = 0' is at soil surface.	DENSITY [1] Den (PCF)	SHEAR WAVE VELOCITY [1] Vs (FT/S)	COMPR. WAVE VELOCITY [1] Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO [2] μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' [3]	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT [4] Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	781.96	1948.40	2134.9	0.38	1.538	5911.2	0.008	1	4.00	6.77E-04
2	4.00	6.00	112.32	750.30	2150.00	1965.5	0.41	1.639	5541.7	0.023	1	4.00	7.22E-04
3	4.00	10.00	112.32	786.00	2413.70	2157.0	0.42	1.665	6110.1	0.038	1	4.00	6.55E-04
4	4.00	14.00	112.32	859.52	2682.20	2579.4	0.42	1.666	7307.5	0.053	1	4.00	5.47E-04
5	4.00	18.00	112.32	1073.60	3464.90	4024.3	0.41	1.650	11368.8	0.069	1	4.00	3.52E-04
6	8.00	24.00	112.32	996.25	3529.50	3465.3	0.42	3.354	9836.7	0.092	1	8.00	8.13E-04
7	8.00	32.00	112.32	1023.90	3579.50	3660.3	0.41	3.272	10314.8	0.122	1	8.00	7.76E-04
8	8.00	40.00	112.32	1058.00	3637.40	3908.2	0.40	3.183	10926.6	0.153	1	8.00	7.32E-04
9	8.00	48.00	112.32	1177.60	3899.30	4841.7	0.39	3.141	13485.3	0.183	1	8.00	5.93E-04
10	8.00	56.00	112.32	1446.90	3937.30	7309.4	0.38	3.029	20153.5	0.214	0.98	7.84	3.89E-04
11	10.00	65.00	112.32	1543.50	4133.60	8318.0	0.38	3.795	22948.6	0.248	0.96	9.60	4.18E-04
12	10.00	75.00	112.32	1606.00	4349.90	9005.3	0.38	3.787	24831.7	0.286	0.93	9.30	3.75E-04
13	10.00	85.00	112.32	1747.30	4652.90	10659.6	0.38	3.756	29325.6	0.324	0.90	9.00	3.07E-04
14	10.00	95.00	112.32	1688.60	4649.00	9955.4	0.38	3.797	27470.6	0.363	0.88	8.80	3.20E-04
15	10.00	105.00	137.28	2624.80	4957.20	29400.1	0.30	3.035	76648.4	0.401	0.85	8.50	1.11E-04
16	10.00	115.00	137.28	2624.00	4965.90	29382.2	0.30	3.045	76656.9	0.439	0.81	8.10	1.06E-04
17	10.00	125.00	137.28	2641.50	4980.60	29775.4	0.30	3.030	77597.0	0.477	0.78	7.80	1.01E-04
18	10.00	135.00	137.28	2702.00	5098.80	31154.9	0.30	3.034	81212.8	0.515	0.75	7.50	9.23E-05
19	10.00	145.00	137.28	2758.80	5209.10	32478.6	0.30	3.036	84680.0	0.553	0.72	7.20	8.50E-05
20	10.00	155.00	137.28	2787.60	5267.50	33160.2	0.30	3.040	86481.1	0.592	0.68	6.80	7.86E-05
21	10.00	165.00	137.28	2798.50	5292.60	33420.0	0.30	3.044	87186.2	0.630	0.65	6.50	7.46E-05
22	10.00	175.00	137.28	2766.00	5241.90	32648.3	0.31	3.053	85230.3	0.668	0.62	6.20	7.27E-05
23	10.00	185.00	137.28	2746.10	5212.50	32180.2	0.31	3.060	84054.1	0.706	0.59	5.90	7.02E-05
24	10.00	195.00	137.28	2795.50	5307.50	33348.4	0.31	3.061	87111.4	0.744	0.56	5.60	6.43E-05
25	12.50	206.25	137.28	2807.60	5335.40	33637.7	0.31	3.831	87893.4	0.787	0.53	6.63	7.54E-05
26	12.50	218.75	137.28	2831.60	5385.20	34215.3	0.31	3.835	89423.7	0.835	0.51	6.38	7.13E-05
27	12.50	231.25	137.28	2860.50	5443.10	34917.3	0.31	3.837	91272.3	0.883	0.49	6.13	6.71E-05
28	12.50	243.75	137.28	2909.30	5536.30	36118.8	0.31	3.837	94413.1	0.930	0.47	5.88	6.22E-05
29	12.50	256.25	137.28	2958.80	5615.30	37358.3	0.31	3.826	97585.9	0.978	0.45	5.63	5.76E-05
30	12.50	268.75	137.28	2963.00	5627.40	37464.5	0.31	3.830	97887.1	1.026	0.42	5.25	5.36E-05
31	12.50	281.25	137.28	3011.20	5719.00	38693.3	0.31	3.829	101093.9	1.073	0.40	5.00	4.95E-05
32	12.50	293.75	137.28	3008.70	5719.00	38629.0	0.31	3.834	100953.9	1.121	0.38	4.75	4.71E-05
33	15.00	307.50	137.28	3083.10	5854.10	40563.1	0.31	4.595	105975.2	1.174	0.36	5.40	5.10E-05
34	15.00	322.50	137.28	3104.80	5897.50	41136.1	0.31	4.597	107485.4	1.231	0.35	5.25	4.88E-05
35	15.00	337.50	137.28	3229.90	6122.20	44517.9	0.31	4.583	116239.7	1.288	0.33	4.95	4.26E-05
36	15.00	352.50	137.28	3297.80	6247.10	46409.3	0.31	4.579	121155.1	1.345	0.32	4.80	3.96E-05
37	15.00	367.50	137.28	3372.80	6384.20	48544.2	0.30	4.574	126694.5	1.403	0.30	4.50	3.55E-05
38	15.00	382.50	137.28	3409.30	6453.30	49600.6	0.30	4.574	129449.5	1.460	0.29	4.35	3.36E-05
39	15.00	397.50	137.28	3424.10	6483.70	50032.1	0.31	4.576	130592.9	1.517	0.28	4.20	3.22E-05
40	15.00	412.50	137.28	3422.10	6483.70	49973.7	0.31	4.580	130466.4	1.574	0.25	3.75	2.87E-05
41	15.00	427.50	137.28	3420.20	6483.70	49918.2	0.31	4.584	130346.5	1.632	0.24	3.60	2.76E-05
42	15.00	442.50	137.28	3418.50	6483.90	49868.6	0.31	4.588	130240.9	1.689	0.22	3.30	2.53E-05
43	15.00	457.50	137.28	3514.20	6658.70	52699.8	0.31	4.580	137581.3	1.746	0.20	3.00	2.18E-05
44	15.00	472.50	137.28	3534.30	6697.30	53304.4	0.31	4.581	139166.1	1.803	0.19	2.85	2.05E-05
45	15.00	487.50	137.28	3563.90	6749.70	54201.0	0.31	4.579	141494.9	1.861	0.17	2.55	1.80E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.323	Σ= 159.94			Σ=	264.77	9.44E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 28048 ksf

Equivalent Shear Modulus G = E/(2*(1+Average μ) = 10599 ksf

Vel = SQRT(32.17*1000*G/p 1742.4 fps (density =112.32 pcf)

Vel = SQRT(32.17*1000*G/p 1576.0 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 10599 ksf : 1E-4 Event : 100' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 100' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 9

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	E_i=2(1+μ)G' (3)	Z/W		Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	1105.90	2755.50	4270.1	0.38	1.538	11823.3	0.008	1	4.00	3.38E-04
2	4.00	6.00	112.32	1061.10	2890.10	3931.1	0.41	1.639	11083.8	0.023	1	4.00	3.61E-04
3	4.00	10.00	112.32	1111.60	3218.30	4314.2	0.42	1.665	12220.8	0.038	1	4.00	3.27E-04
4	4.00	14.00	112.32	1215.50	3793.20	5158.4	0.42	1.666	14613.9	0.053	1	4.00	2.74E-04
5	4.00	18.00	112.32	1518.20	4593.40	8047.6	0.41	1.650	22734.7	0.069	1	4.00	1.76E-04
6	8.00	24.00	112.32	1408.90	4703.80	6930.5	0.42	3.354	19673.1	0.092	1	8.00	4.07E-04
7	8.00	32.00	112.32	1448.00	4690.90	7320.5	0.41	3.272	20629.3	0.122	1	8.00	3.88E-04
8	8.00	40.00	112.32	1496.20	4779.00	7816.0	0.40	3.183	21852.0	0.153	1	8.00	3.66E-04
9	8.00	48.00	112.32	1665.40	4992.30	9683.7	0.39	3.141	26971.3	0.183	1	8.00	2.97E-04
10	8.00	56.00	112.32	2046.20	5035.60	14618.5	0.38	3.029	40306.1	0.214	0.98	7.84	1.95E-04
11	10.00	65.00	112.32	2182.80	5062.60	16635.4	0.38	3.795	45895.5	0.248	0.96	9.60	2.09E-04
12	10.00	75.00	112.32	2271.30	5327.50	18011.7	0.38	3.787	49666.6	0.286	0.93	9.30	1.87E-04
13	10.00	85.00	112.32	2471.00	5698.60	21318.2	0.38	3.756	58648.6	0.324	0.90	9.00	1.53E-04
14	10.00	95.00	112.32	2388.10	5693.80	19911.8	0.38	3.797	54943.9	0.363	0.88	8.80	1.60E-04
15	10.00	105.00	137.28	3214.80	6071.30	44102.6	0.30	3.035	114979.0	0.401	0.85	8.50	7.39E-05
16	10.00	115.00	137.28	3213.80	6082.00	44075.2	0.30	3.045	114990.3	0.439	0.81	8.10	7.04E-05
17	10.00	125.00	137.28	3235.20	6100.00	44664.1	0.30	3.030	116398.2	0.477	0.78	7.80	6.70E-05
18	10.00	135.00	137.28	3309.20	6244.70	46730.7	0.30	3.034	121814.8	0.515	0.75	7.50	6.16E-05
19	10.00	145.00	137.28	3378.80	6379.80	48717.1	0.30	3.036	127018.1	0.553	0.72	7.20	5.67E-05
20	10.00	155.00	137.28	3414.10	6451.30	49740.3	0.30	3.040	129721.8	0.592	0.68	6.80	5.24E-05
21	10.00	165.00	137.28	3427.50	6482.10	50131.6	0.30	3.044	130783.2	0.630	0.65	6.50	4.97E-05
22	10.00	175.00	137.28	3387.60	6420.00	48971.2	0.31	3.053	127842.2	0.668	0.62	6.20	4.85E-05
23	10.00	185.00	137.28	3369.20	6384.00	48440.6	0.31	3.060	126526.0	0.706	0.59	5.90	4.66E-05
24	10.00	195.00	137.28	3440.30	6500.30	50506.7	0.31	3.061	131931.5	0.744	0.56	5.60	4.24E-05
25	12.50	206.25	137.28	3471.50	6534.50	51426.9	0.31	3.831	134375.5	0.787	0.53	6.63	4.93E-05
26	12.50	218.75	137.28	3485.80	6595.50	51851.5	0.31	3.835	135516.9	0.835	0.51	6.38	4.70E-05
27	12.50	231.25	137.28	3555.20	6666.40	53936.7	0.31	3.837	140988.3	0.883	0.49	6.13	4.34E-05
28	12.50	243.75	137.28	3612.00	6780.50	55673.9	0.31	3.837	145529.4	0.930	0.47	5.88	4.04E-05
29	12.50	256.25	137.28	3623.70	6877.30	56035.2	0.31	3.826	146372.8	0.978	0.45	5.63	3.84E-05
30	12.50	268.75	137.28	3628.90	6892.10	56196.1	0.31	3.830	146829.2	1.026	0.42	5.25	3.58E-05
31	12.50	281.25	137.28	3687.90	7004.30	58038.3	0.31	3.829	151636.6	1.073	0.40	5.00	3.30E-05
32	12.50	293.75	137.28	3684.90	7004.30	57943.9	0.31	3.834	151431.7	1.121	0.38	4.75	3.14E-05
33	15.00	307.50	137.28	3776.10	7169.80	60847.6	0.31	4.595	158970.3	1.174	0.36	5.40	3.40E-05
34	15.00	322.50	137.28	3802.60	7222.90	61704.6	0.31	4.597	161229.2	1.231	0.35	5.25	3.26E-05
35	15.00	337.50	137.28	3955.80	7498.10	66776.7	0.31	4.583	174359.3	1.288	0.33	4.95	2.84E-05
36	15.00	352.50	137.28	4039.00	7651.10	69615.2	0.31	4.579	181736.0	1.345	0.32	4.80	2.64E-05
37	15.00	367.50	137.28	4130.80	7819.00	72815.6	0.30	4.574	190040.0	1.403	0.30	4.50	2.37E-05
38	15.00	382.50	137.28	4175.60	7903.60	74403.6	0.30	4.574	194181.5	1.460	0.29	4.35	2.24E-05
39	15.00	397.50	137.28	4193.60	7940.90	75046.5	0.31	4.576	195884.8	1.517	0.28	4.20	2.14E-05
40	15.00	412.50	137.28	4191.20	7940.90	74960.6	0.31	4.580	195699.6	1.574	0.25	3.75	1.92E-05
41	15.00	427.50	137.28	4188.90	7940.90	74878.3	0.31	4.584	195522.3	1.632	0.24	3.60	1.84E-05
42	15.00	442.50	137.28	4186.70	7941.10	74799.7	0.31	4.588	195352.9	1.689	0.22	3.30	1.69E-05
43	15.00	457.50	137.28	4304.00	8155.20	79049.8	0.31	4.580	206372.1	1.746	0.20	3.00	1.45E-05
44	15.00	472.50	137.28	4328.60	8202.50	79956.0	0.31	4.581	208747.6	1.803	0.19	2.85	1.37E-05
45	15.00	487.50	137.28	4364.90	8266.70	81302.7	0.31	4.579	212245.5	1.861	0.17	2.55	1.20E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.323	Σ= 159.94			Σ=	264.77	5.01E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus	E=sum(Nq*H)/sum(Nq*H/E_i)	52854 ksf
Equivalent Shear Modulus	G = E/(2*(1+Average μ) =	19973 ksf
	Vel = SQRT(32.17*1000*G/p	2391.8 fps (density =112.32 pcf)
	Vel = SQRT(32.17*1000*G/p	2163.4 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 19973 ksf : 1E-4 Event : 100' Alluvium : Upper Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : LOWER BOUND SHEAR WAVE VELOCITY: CASE 10

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT) Depth = 0' is at soil surface.	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF) (Den * Vs ^2)/(32.17*1000)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO H*μ	YOUNG'S MODULUS E_i (KSF) E_i=2(1+μ)G' (3)	Ratio of Depth to Midpoint to Width of Bldg Z/W	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness Nq*H	Influence Coeff. X Layer Thickness / Young's Modulus Nq*H/E_i
1	4.00	2.00	112.32	542.84	1359.50	1028.8	0.38	1.534	2846.9	0.008	1	4.00	1.41E-03
2	4.00	6.00	112.32	545.64	1608.10	1039.5	0.41	1.630	2926.0	0.023	1	4.00	1.37E-03
3	4.00	10.00	112.32	571.25	1828.40	1139.4	0.41	1.659	3223.8	0.038	1	4.00	1.24E-03
4	4.00	14.00	112.32	608.41	1908.20	1292.4	0.42	1.663	3659.5	0.053	1	4.00	1.09E-03
5	4.00	18.00	112.32	722.69	2216.30	1823.5	0.41	1.650	5151.8	0.069	1	4.00	7.76E-04
6	8.00	24.00	112.32	696.21	2306.80	1692.3	0.42	3.356	4804.4	0.092	1	8.00	1.67E-03
7	8.00	32.00	112.32	732.81	2314.00	1874.9	0.41	3.260	5278.1	0.122	1	8.00	1.52E-03
8	8.00	40.00	112.32	754.40	2305.00	1987.1	0.40	3.174	5550.7	0.153	1	8.00	1.44E-03
9	8.00	48.00	112.32	861.07	3061.60	2588.7	0.39	3.127	7201.2	0.183	1	8.00	1.11E-03
10	8.00	56.00	112.32	1037.00	3098.40	3754.6	0.38	3.016	10340.5	0.214	0.98	7.84	7.58E-04
11	10.00	65.00	112.32	1103.10	3390.90	4248.5	0.38	3.781	11710.0	0.248	0.96	9.60	8.20E-04
12	10.00	75.00	112.32	1144.50	3559.30	4573.4	0.38	3.781	12604.7	0.286	0.93	9.30	7.38E-04
13	10.00	85.00	112.32	1233.20	3782.30	5309.7	0.38	3.760	14612.7	0.324	0.90	9.00	6.16E-04
14	10.00	95.00	112.32	1187.60	3775.40	4924.3	0.38	3.805	13595.8	0.363	0.88	8.80	6.47E-04
15	10.00	105.00	112.32	1330.00	3842.00	6176.0	0.37	3.739	16970.7	0.401	0.85	8.50	5.01E-04
16	10.00	115.00	112.32	1296.30	3847.20	5867.0	0.38	3.774	16162.6	0.439	0.81	8.10	5.01E-04
17	10.00	125.00	112.32	1274.10	3856.30	5667.8	0.38	3.805	15648.9	0.477	0.78	7.80	4.98E-04
18	10.00	135.00	112.32	1319.90	3987.90	6082.6	0.38	3.800	16787.6	0.515	0.75	7.50	4.47E-04
19	10.00	145.00	112.32	1342.50	4078.00	6292.7	0.38	3.800	17367.5	0.553	0.72	7.20	4.15E-04
20	10.00	155.00	112.32	1347.30	4132.20	6337.7	0.38	3.806	17499.9	0.592	0.68	6.80	3.89E-04
21	10.00	165.00	112.32	1313.30	4114.60	6021.9	0.38	3.832	16658.9	0.630	0.65	6.50	3.90E-04
22	10.00	175.00	112.32	1273.70	4077.50	5664.2	0.39	3.860	15701.0	0.668	0.62	6.20	3.95E-04
23	10.00	185.00	112.32	1257.00	4081.70	5516.7	0.39	3.877	15310.7	0.706	0.59	5.90	3.85E-04
24	10.00	195.00	112.32	1289.40	4160.00	5804.7	0.39	3.872	16104.9	0.744	0.56	5.60	3.48E-04
25	12.50	206.25	137.28	2278.10	4366.20	22146.3	0.30	3.808	57787.3	0.787	0.53	6.63	1.15E-04
26	12.50	218.75	137.28	2307.60	4421.30	22723.6	0.31	3.814	59315.0	0.835	0.51	6.38	1.07E-04
27	12.50	231.25	137.28	2311.50	4447.80	22800.5	0.31	3.818	59530.2	0.883	0.49	6.13	1.03E-04
28	12.50	243.75	137.28	2358.80	4543.30	23743.2	0.31	3.819	61994.8	0.930	0.47	5.88	9.48E-05
29	12.50	256.25	137.28	2427.70	4625.00	25150.5	0.30	3.811	65637.2	0.978	0.45	5.63	8.57E-05
30	12.50	268.75	137.28	2439.80	4637.20	25401.8	0.31	3.816	66312.4	1.026	0.42	5.25	7.92E-05
31	12.50	281.25	137.28	2435.70	4637.20	25316.5	0.31	3.822	66112.5	1.073	0.40	5.00	7.56E-05
32	12.50	293.75	137.28	2431.80	4637.20	25235.5	0.31	3.827	65923.2	1.121	0.38	4.75	7.21E-05
33	15.00	307.50	137.28	2503.10	4748.20	26737.0	0.31	4.587	69827.9	1.174	0.36	5.40	7.73E-05
34	15.00	322.50	137.28	2520.30	4783.40	27105.7	0.31	4.591	70802.8	1.231	0.35	5.25	7.41E-05
35	15.00	337.50	137.28	2620.80	4965.70	29310.6	0.31	4.579	76516.9	1.288	0.33	4.95	6.47E-05
36	15.00	352.50	137.28	2672.80	5059.30	30485.2	0.30	4.575	79565.2	1.345	0.32	4.80	6.03E-05
37	15.00	367.50	137.28	2733.00	5170.50	31873.9	0.30	4.571	83173.1	1.403	0.30	4.50	5.41E-05
38	15.00	382.50	137.28	2762.30	5226.30	32561.0	0.30	4.571	84968.6	1.460	0.29	4.35	5.12E-05
39	15.00	397.50	137.28	2774.00	5251.10	32837.4	0.30	4.574	85703.1	1.517	0.28	4.20	4.90E-05
40	15.00	412.50	137.28	2772.20	5251.10	32794.8	0.31	4.579	85611.5	1.574	0.25	3.75	4.38E-05
41	15.00	427.50	137.28	2770.40	5251.10	32752.3	0.31	4.583	85518.8	1.632	0.24	3.60	4.21E-05
42	15.00	442.50	137.28	2768.80	5251.10	32714.4	0.31	4.587	85438.3	1.689	0.22	3.30	3.86E-05
43	15.00	457.50	137.28	2846.20	5392.70	34569.0	0.31	4.580	90248.0	1.746	0.20	3.00	3.32E-05
44	15.00	472.50	137.28	2862.30	5424.00	34961.2	0.31	4.581	91278.1	1.803	0.19	2.85	3.12E-05
45	15.00	487.50	137.28	2886.00	5466.40	35542.6	0.31	4.580	92790.3	1.861	0.17	2.55	2.75E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.338	Σ= 167.44			Σ=	264.77	2.08E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 12703 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 4746 ksf
Vel = SQRT(32.17*1000*G/p 1165.9 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p 1054.6 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 4746 ksf : 1E-4 Event : 200' Alluvium : Lower Bound Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : MEDIAN SHEAR WAVE VELOCITY: CASE 11

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

LAYER	LAYER THICKNESS (1) H (FT)	DEPTH TO MIDPOINT (1) Z (FT)	DENSITY (1) Den (PCF)	SHEAR WAVE VELOCITY (1) Vs (FT/S)	COMPR. WAVE VELOCITY (1) Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO (2) μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT (4) Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		H*μ	E_i=2(1+μ)G' (3)	Z/W		Nq*H	Nq*H/E_i
1	4.00	2.00	112.32	767.70	1922.60	2057.7	0.38	1.534	5693.9	0.008	1	4.00	7.03E-04
2	4.00	6.00	112.32	771.66	2177.30	2079.0	0.41	1.630	5852.1	0.023	1	4.00	6.84E-04
3	4.00	10.00	112.32	807.87	2455.90	2278.7	0.41	1.659	6447.7	0.038	1	4.00	6.20E-04
4	4.00	14.00	112.32	860.43	2698.60	2584.9	0.42	1.663	7319.1	0.053	1	4.00	5.47E-04
5	4.00	18.00	112.32	1022.00	3107.30	3646.8	0.41	1.650	10302.9	0.069	1	4.00	3.88E-04
6	8.00	24.00	112.32	984.58	3198.50	3384.6	0.42	3.356	9608.7	0.092	1	8.00	8.33E-04
7	8.00	32.00	112.32	1036.40	3242.60	3750.3	0.41	3.260	10557.3	0.122	1	8.00	7.58E-04
8	8.00	40.00	112.32	1066.90	3259.70	3974.2	0.40	3.174	11101.8	0.153	1	8.00	7.21E-04
9	8.00	48.00	112.32	1217.70	3928.40	5177.1	0.39	3.127	14401.5	0.183	1	8.00	5.55E-04
10	8.00	56.00	112.32	1466.50	3966.70	7508.8	0.38	3.016	20679.8	0.214	0.98	7.84	3.79E-04
11	10.00	65.00	112.32	1560.10	4153.00	8497.9	0.38	3.781	23422.4	0.248	0.96	9.60	4.10E-04
12	10.00	75.00	112.32	1618.60	4359.20	9147.1	0.38	3.781	25210.4	0.286	0.93	9.30	3.69E-04
13	10.00	85.00	112.32	1744.00	4632.40	10619.4	0.38	3.760	29225.2	0.324	0.90	9.00	3.08E-04
14	10.00	95.00	112.32	1679.60	4623.90	9849.6	0.38	3.805	27194.1	0.363	0.88	8.80	3.24E-04
15	10.00	105.00	112.32	1880.90	4705.50	12352.0	0.37	3.739	33941.3	0.401	0.85	8.50	2.50E-04
16	10.00	115.00	112.32	1833.30	4711.90	11734.7	0.38	3.774	32327.1	0.439	0.81	8.10	2.51E-04
17	10.00	125.00	112.32	1801.80	4723.00	11334.9	0.38	3.805	31296.0	0.477	0.78	7.80	2.49E-04
18	10.00	135.00	112.32	1866.60	4884.10	12164.9	0.38	3.800	33574.4	0.515	0.75	7.50	2.23E-04
19	10.00	145.00	112.32	1898.60	4994.50	12585.6	0.38	3.800	34735.7	0.553	0.72	7.20	2.07E-04
20	10.00	155.00	112.32	1905.30	5060.90	12674.6	0.38	3.806	34997.2	0.592	0.68	6.80	1.94E-04
21	10.00	165.00	112.32	1857.20	5039.30	12042.7	0.38	3.832	33314.6	0.630	0.65	6.50	1.95E-04
22	10.00	175.00	112.32	1801.20	4995.50	11327.4	0.39	3.860	31399.1	0.668	0.62	6.20	1.97E-04
23	10.00	185.00	112.32	1777.60	4999.00	11032.5	0.39	3.877	30619.2	0.706	0.59	5.90	1.93E-04
24	10.00	195.00	112.32	1823.50	5094.90	11609.6	0.39	3.872	32210.2	0.744	0.56	5.60	1.74E-04
25	12.50	206.25	137.28	2834.30	5363.80	34280.6	0.30	3.808	89449.6	0.787	0.53	6.63	7.41E-05
26	12.50	218.75	137.28	2858.20	5415.00	34861.1	0.31	3.814	90997.3	0.835	0.51	6.38	7.01E-05
27	12.50	231.25	137.28	2888.70	5477.10	35609.1	0.31	3.818	92972.5	0.883	0.49	6.13	6.59E-05
28	12.50	243.75	137.28	2941.20	5578.00	36915.2	0.31	3.819	96387.8	0.930	0.47	5.88	6.10E-05
29	12.50	256.25	137.28	2992.00	5664.50	38201.4	0.30	3.811	99697.3	0.978	0.45	5.63	5.64E-05
30	12.50	268.75	137.28	2997.30	5679.40	38336.9	0.31	3.816	100079.9	1.026	0.42	5.25	5.25E-05
31	12.50	281.25	137.28	2994.20	5679.40	38257.6	0.31	3.822	99907.4	1.073	0.40	5.00	5.00E-05
32	12.50	293.75	137.28	2991.30	5679.40	38183.5	0.31	3.827	99747.6	1.121	0.38	4.75	4.76E-05
33	15.00	307.50	137.28	3065.70	5815.30	40106.6	0.31	4.587	104744.7	1.174	0.36	5.40	5.16E-05
34	15.00	322.50	137.28	3086.80	5858.50	40660.5	0.31	4.591	106209.4	1.231	0.35	5.25	4.94E-05
35	15.00	337.50	137.28	3209.90	6081.70	43968.3	0.31	4.579	114781.8	1.288	0.33	4.95	4.31E-05
36	15.00	352.50	137.28	3273.50	6196.40	45727.9	0.30	4.575	119347.9	1.345	0.32	4.80	4.02E-05
37	15.00	367.50	137.28	3347.20	6332.50	47810.1	0.30	4.571	124757.6	1.403	0.30	4.50	3.61E-05
38	15.00	382.50	137.28	3383.10	6400.90	48841.1	0.30	4.571	127452.0	1.460	0.29	4.35	3.41E-05
39	15.00	397.50	137.28	3397.40	6431.20	49254.9	0.30	4.574	128551.4	1.517	0.28	4.20	3.27E-05
40	15.00	412.50	137.28	3395.20	6431.20	49191.1	0.31	4.579	128414.5	1.574	0.25	3.75	2.92E-05
41	15.00	427.50	137.28	3393.00	6431.20	49127.4	0.31	4.583	128275.6	1.632	0.24	3.60	2.81E-05
42	15.00	442.50	137.28	3391.10	6431.30	49072.4	0.31	4.587	128159.5	1.689	0.22	3.30	2.57E-05
43	15.00	457.50	137.28	3485.90	6604.70	51854.5	0.31	4.580	135374.3	1.746	0.20	3.00	2.22E-05
44	15.00	472.50	137.28	3505.60	6643.00	52442.2	0.31	4.581	136918.2	1.803	0.19	2.85	2.08E-05
45	15.00	487.50	137.28	3534.60	6695.00	53313.4	0.31	4.580	139184.3	1.861	0.17	2.55	1.83E-05
Σ=	495.00					Average μ = SUM (H*μ)/SUM H	0.338	Σ= 167.44			Σ=	264.77	1.06E-02

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus E=sum(Nq*H)/sum(Nq*H/E_i) = 24883 ksf
Equivalent Shear Modulus G = E/(2*(1+Average μ) = 9297 ksf
Vel = SQRT(32.17*1000*G/p 1631.8 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/p 1476.0 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 9297 ksf : 1E-4 Event : 200' Alluvium : Median Shear Wave Velocity.

CALCULATION OF EQUIVALENT SHEAR MODULUS : 1E-4 EVENT : 200' ALLUVIUM : UPPER BOUND SHEAR WAVE VELOCITY: CASE 12

See Ref. DTN MO0801SCSPS1E4.003 (Ref. 2.2.10) - Strain Compatible Soil Properties for the Surface Facilities Area at 1E-4 Annual Probability of Exceedance.

See Ref. 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., (Eq 20-15), for Dynamic Shear Modulus of Soil (G' = Mass Density * Velocity ^ 2).

WIDTH OF BUILDING (W) = 262 FT, See Ref. 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs, attachment 1 for CRCF ground floor plan.

CRCF Soil Springs - 2007 Strain Compatible Soil Properties

LAYER	LAYER THICKNESS [1] H (FT)	DEPTH TO MIDPOINT [1] Z (FT)	DENSITY [1] Den (PCF)	SHEAR WAVE VELOCITY [1] Vs (FT/S)	COMPR. WAVE VELOCITY [1] Vp (FT/S)	DYNAMIC SHEAR MODULUS G' (KSF)	POISSON'S RATIO [2] μ	LAYER THK X POISSON'S RATIO	YOUNG'S MODULUS E_i (KSF)	Ratio of Depth to Midpoint to Width of Bldg	INFLUENCE COEFFICIENT [4] Nq	Influence Coeff. X Layer Thickness	Influence Coeff. X Layer Thickness / Young's Modulus
		Depth = 0' is at soil surface.				(Den * Vs ^2)/(32.17*1000)		$H*\mu$	$E_i=2(1+\mu)G'$ [3]	Z/W		Nq*H	$Nq*H/E_i$
1	4.00	2.00	112.32	1085.70	2719.00	4115.5	0.38	1.534	11387.9	0.008	1	4.00	3.51E-04
2	4.00	6.00	112.32	1091.30	2948.00	4158.1	0.41	1.630	11704.3	0.023	1	4.00	3.42E-04
3	4.00	10.00	112.32	1142.50	3298.80	4557.4	0.41	1.659	12895.3	0.038	1	4.00	3.10E-04
4	4.00	14.00	112.32	1216.80	3816.40	5169.5	0.42	1.663	14637.4	0.053	1	4.00	2.73E-04
5	4.00	18.00	112.32	1445.40	4356.60	7294.3	0.41	1.650	20607.9	0.069	1	4.00	1.94E-04
6	8.00	24.00	112.32	1392.40	4435.00	6769.1	0.42	3.356	19217.2	0.092	1	8.00	4.16E-04
7	8.00	32.00	112.32	1465.60	4543.80	7499.6	0.41	3.260	21111.9	0.122	1	8.00	3.79E-04
8	8.00	40.00	112.32	1508.80	4609.90	7948.2	0.40	3.174	22202.9	0.153	1	8.00	3.60E-04
9	8.00	48.00	112.32	1722.10	5040.60	10354.3	0.39	3.127	28803.3	0.183	1	8.00	2.78E-04
10	8.00	56.00	112.32	2074.00	5078.30	15018.4	0.38	3.016	41361.9	0.214	0.98	7.84	1.90E-04
11	10.00	65.00	112.32	2206.30	5086.40	16995.5	0.38	3.781	46844.1	0.248	0.96	9.60	2.05E-04
12	10.00	75.00	112.32	2289.10	5338.90	18295.1	0.38	3.781	50423.2	0.286	0.93	9.30	1.84E-04
13	10.00	85.00	112.32	2466.40	5673.50	21239.0	0.38	3.760	58450.9	0.324	0.90	9.00	1.54E-04
14	10.00	95.00	112.32	2375.20	5663.10	19697.3	0.38	3.805	54383.0	0.363	0.88	8.80	1.62E-04
15	10.00	105.00	112.32	2659.90	5763.00	24702.3	0.37	3.739	67877.9	0.401	0.85	8.50	1.25E-04
16	10.00	115.00	112.32	2592.70	5770.90	23469.9	0.38	3.774	64655.3	0.439	0.81	8.10	1.25E-04
17	10.00	125.00	112.32	2548.20	5784.50	22671.1	0.38	3.805	62595.4	0.477	0.78	7.80	1.25E-04
18	10.00	135.00	112.32	2639.80	5981.80	24330.3	0.38	3.800	67150.3	0.515	0.75	7.50	1.12E-04
19	10.00	145.00	112.32	2685.00	6117.00	25170.7	0.38	3.800	69470.0	0.553	0.72	7.20	1.04E-04
20	10.00	155.00	112.32	2694.50	6198.30	25349.1	0.38	3.806	69994.4	0.592	0.68	6.80	9.72E-05
21	10.00	165.00	112.32	2626.50	6171.90	24085.8	0.38	3.832	66630.4	0.630	0.65	6.50	9.76E-05
22	10.00	175.00	112.32	2547.30	6120.20	22655.1	0.39	3.860	62799.1	0.668	0.62	6.20	9.87E-05
23	10.00	185.00	112.32	2514.00	6122.50	22066.7	0.39	3.877	61242.9	0.706	0.59	5.90	9.63E-05
24	10.00	195.00	112.32	2578.80	6240.00	23218.9	0.39	3.872	64419.4	0.744	0.56	5.60	8.69E-05
25	12.50	206.25	137.28	3526.40	6589.30	53066.4	0.30	3.808	138468.2	0.787	0.53	6.63	4.78E-05
26	12.50	218.75	137.28	3540.20	6632.00	53482.5	0.31	3.814	139604.3	0.835	0.51	6.38	4.57E-05
27	12.50	231.25	137.28	3610.10	6744.60	55615.3	0.31	3.818	145207.2	0.883	0.49	6.13	4.22E-05
28	12.50	243.75	137.28	3667.30	6848.40	57391.7	0.31	3.819	149853.2	0.930	0.47	5.88	3.92E-05
29	12.50	256.25	137.28	3687.50	6937.60	58025.7	0.30	3.811	151434.3	0.978	0.45	5.63	3.71E-05
30	12.50	268.75	137.28	3682.20	6955.80	57859.0	0.31	3.816	151043.2	1.026	0.42	5.25	3.48E-05
31	12.50	281.25	137.28	3680.80	6955.80	57815.0	0.31	3.822	150980.4	1.073	0.40	5.00	3.31E-05
32	12.50	293.75	137.28	3679.40	6955.80	57771.0	0.31	3.827	150916.5	1.121	0.38	4.75	3.15E-05
33	15.00	307.50	137.28	3754.70	7122.30	60159.8	0.31	4.587	157117.1	1.174	0.36	5.40	3.44E-05
34	15.00	322.50	137.28	3780.50	7175.20	60989.4	0.31	4.591	159310.5	1.231	0.35	5.25	3.30E-05
35	15.00	337.50	137.28	3931.30	7448.50	65952.1	0.31	4.579	172171.9	1.288	0.33	4.95	2.88E-05
36	15.00	352.50	137.28	4009.20	7589.00	68591.7	0.30	4.575	179021.6	1.345	0.32	4.80	2.68E-05
37	15.00	367.50	137.28	4099.50	7755.70	71716.3	0.30	4.571	187139.4	1.403	0.30	4.50	2.40E-05
38	15.00	382.50	137.28	4143.40	7839.50	73260.5	0.30	4.571	191174.8	1.460	0.29	4.35	2.28E-05
39	15.00	397.50	137.28	4161.00	7876.60	73884.2	0.30	4.574	192831.9	1.517	0.28	4.20	2.18E-05
40	15.00	412.50	137.28	4158.20	7876.60	73784.8	0.31	4.579	192616.7	1.574	0.25	3.75	1.95E-05
41	15.00	427.50	137.28	4155.60	7876.60	73692.6	0.31	4.583	192417.2	1.632	0.24	3.60	1.87E-05
42	15.00	442.50	137.28	4153.20	7876.70	73607.5	0.31	4.587	192236.2	1.689	0.22	3.30	1.72E-05
43	15.00	457.50	137.28	4269.30	8089.10	77780.3	0.31	4.580	203057.9	1.746	0.20	3.00	1.48E-05
44	15.00	472.50	137.28	4293.40	8136.00	78660.9	0.31	4.581	205371.0	1.803	0.19	2.85	1.39E-05
45	15.00	487.50	137.28	4329.00	8199.70	79970.8	0.31	4.580	208778.1	1.861	0.17	2.55	1.22E-05
Σ=	495.00					Average μ = SUM ($H*\mu$)/SUM H	0.338	Σ= 167.44			Σ=	264.77	5.46E-03

(1) Layer Thickness, Depth to Midpoint of Layer, Density and Shear Wave Velocity values are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(2) Poisson's Ratio at each soil layer are from DTN MO0801SCSPS1E4.003 (Ref. 2.2.10).
(3) Young's Modulus is from reference 2.2.5, Bowles Foundation Analysis and Design, 5th Ed., page 121.
(4) Influence Coefficients are interpolated from figure 3 of reference 2.2.4, Canister Receipt and Closure Facility (CRCF) Soil Springs.

Young's Modulus $E=sum(Nq*H)/sum(Nq*H/E_i)$ 48449 ksf
Equivalent Shear Modulus $G = E/(2*(1+Average\ \mu))$ = 18102 ksf
Vel = SQRT(32.17*1000*G/ρ 2277.0 fps (density =112.32 pcf)
Vel = SQRT(32.17*1000*G/ρ 2059.6 fps (density =137.28 pcf)

Use Equiv. Shear Modulus G = 18102 ksf : 1E-4 Event : 200' Alluvium : Upper Bound Shear Wave Velocity.

Summary of Equivalent Dynamic Shear Modulus

For values of equivalent dynamic shear modulus, see pages B-2 through B-13.

SUMMARY OF EQUIVALENT DYNAMIC SHEAR MODULUS G_s (KSF) FOR 5E-4 SEISMIC EVENT

TABLE B-1

100' Alluvium			200' Alluvium		
Lower Bound	Median	Upper Bound	Lower Bound	Median	Upper Bound
CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
8233 KSF	15333 KSF	28121 KSF	7212 KSF	13751 KSF	25996 KSF
(Page B-2)	(Page B-3)	(Page B-4)	(Page B-5)	(Page B-6)	(Page B-7)

SUMMARY OF EQUIVALENT DYNAMIC SHEAR MODULUS G_s (KSF) FOR 1E-4 SEISMIC EVENT

TABLE B-2

100' Alluvium			200' Alluvium		
Lower Bound	Median	Upper Bound	Lower Bound	Median	Upper Bound
CASE 7	CASE 8	CASE 9	CASE 10	CASE 11	CASE 12
5556 KSF	10599 KSF	19973 KSF	4746 KSF	9297 KSF	18102 KSF
(Page B-8)	(Page B-9)	(Page B-10)	(Page B-11)	(Page B-12)	(Page B-13)

TABLE B-3 SHEAR MODULUS COMPARISION: 5.00E-04						
SHEAR MODULUS, G (KSF)						
	NE 100' ALLUVIUM			NE 200' ALLUVIUM		
	LOWER BOUND	MEDIAM	UPPER BOUND	LOWER BOUND	MEDIAM	UPPER BOUND
MO0706SCSPS5E4.002	8255	15354	28124	7250	13744	25823
MO0801SCSPS5E4.003 (REF.2.2.9)	8233	15333	28121	7212	13751	25996
% CHANGE	-0.27	-0.14	-0.01	-0.52	0.05	0.67

TABLE B-4 SHEAR MODULUS COMPARISION: 1.00E-04						
SHEAR MODULUS, G (KSF)						
	NE 100' ALLUVIUM			NE 200' ALLUVIUM		
	LOWER BOUND	MEDIAM	UPPER BOUND	LOWER BOUND	MEDIAM	UPPER BOUND
MO0706SCSPS5E4.002	5675	10816	20359	4763	9329	18162
MO0801SCSPS5E4.003 (REF.2.2.9)	5556	10599	19973	4746	9297	18102
% CHANGE	-2.10	-2.01	-1.90	-0.36	-0.34	-0.33

As seen in tables B-3 and B-4 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 about 2% . The effect of this change in soil stiffness on the seismic analysis results is even less since the fundamental frequency of a system is a function of stiffness (*k*) and mass (*m*) given by: $f = \sqrt{k/m}$. Thus a 2% change in stiffness will result in a 1.0% shift in frequency. Given the broad band nature of the YMP input ground spectra (Ref. 2.2.13), the effect of this % 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 Canister Receipt and Closure Facility.