FPL

L-2016-108
10 CFR 52.3

May 6, 2016

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Voluntary Revised Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) – Standard Review Plan Section 02.05.04 – Stability of Subsurface Materials and Foundations

References:

1. NRC Letter to FPL dated October 18, 2011, Request for Additional Information Letter No. 040 (eRAI 6006) Related to SRP Section 02.05.04 – Stability of Subsurface Materials and Foundations for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application
2. FPL Letter L-2011-500 to NRC dated November 16, 2011, Response and Response Schedule to NRC Request for Additional Information Letter No. 040 (eRAI 6006) SRP Section – 02.05.04 Stability of Subsurface Materials and Foundations (ML11321A318)
3. FPL Letter L-2011-518 to NRC dated December 2, 2011, Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) SRP Section – 02.05.04 Stability of Subsurface Materials and Foundations (ML11340A003)
4. FPL Letter L-2011-552 to NRC dated December 16, 2011, Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) SRP Section – 02.05.04 Stability of Subsurface Materials and Foundations (ML11355A057)
5. FPL Letter L-2012-024 to NRC dated January 19, 2012, Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) SRP Section – 02.05.04 Stability of Subsurface Materials and Foundations (ML12023A070)
6. FPL Letter L-2014-111 to NRC dated April 29, 2014, Revised Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) – SRP Section 02.05.04 – Stability of Subsurface Materials and Foundations
7. FPL Letter L-2014-152 to NRC dated June 18, 2014, Submittal of Part 2, Chapter 2, Section 2.5

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8. FPL Letter L-2014-285 to NRC dated October 3, 2014, Voluntary Revised Response to NRC Request for Additional Information Letter No. 040 (eRAI 6006) – Standard Review Plan Section 02.05.04 - Stability of Subsurface Materials and Foundations

FPL and NRC Staff have been engaged in interactions concerning the information provided in References 2 through 8.

As a result of these interactions, Florida Power & Light Company (FPL) is providing, as an attachment to this letter, a revised response for the Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) for RAI 02.05.04-16 (Reference 1). The attachment identifies changes in the body of the response to provide clarification. The changes are identified by revision bars. There are no additional COLA changes as a result of these clarifications.

If you have any questions, or need additional information, please contact me at 561-904-3794.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 6, 2016.

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/RFB

Attachment: FPL Revised Response to NRC RAI No. 02.05.04-16 (eRAI 6006)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

NRC RAI Letter No. PTN-RAI-LTR-040

SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations

QUESTIONS from Geosciences and Geotechnical Engineering Branch 1 (RGS1)

NRC RAI Number: 02.05.04-16 (eRAI 6006)

Section 2.5.4.7.3.3 "Shear modulus and Damping for Rock", indicates that the damping for rock is taken as 1%. The damping shown in Figure 2.5.2-249, which describes the soil properties used to develop the GMRS, indicates that a damping value of 0.5% was used in the analyses. In accordance with NUREG-0800, Standard Review Plan, Chapter 2.5.4, "Stability of Subsurface Materials and Foundations," please provide clarification as to the actual level of damping used in the analyses and provide a basis for its selection considering the large variability in RQD shown in Figure 2.5.4-215.

FPL RESPONSE:

As part of the supplemental field investigation (2013), as discussed in the revised response to RAI 02.05.04-03, four resonant column torsional shear (RCTS) tests were conducted on the Key Largo and Fort Thompson formations. Three samples were extracted from initial borings B-615, B-714, B-728, and one sample was extracted from supplemental boring R-6-1b. The sample descriptions are provided in Table 1. The sample locations are shown in Figure 1 of the revised response to RAI 02.05.04-03. The supplemental field investigation also involved three additional RCTS tests on soil.

This response provides clarification on the actual levels of damping used in the analysis. In addition, this response outlines if the additional test results on the rock and soil samples impact the conclusions of the previously conducted site response analysis.

Table 1

RCTS Tests on Rock Samples

Boring Number	Sample Designation	Material Type	Specimen Midpoint Depth (Feet)
B-728	728-CS-04	Fort Thompson Limestone	54.0
B-615	615-CS-01	Key Largo Limestone	32.9
B-714	714-CS-01	Key Largo Limestone	29.7
R-6-1b	R-6-1b-SC-3	Fort Thompson Limestone	47.9

The following discussion provides a basis for the selection of damping ratio values for the various rock strata considering the large variability in rock quality designation (RQD).

The variability in RQD within each stratum is generally random in nature and does not have directional trends (e.g., high RQD at the top of the stratum and low RQD at the bottom), thus, the strata are not sub-divided within each formation. Figure 1 shows vertical RQD variability in the boreholes of cross-section A-A (see Figure 2). The lateral variability for the Key Largo and Fort Thompson formations is presented in Figures 3 and 4. The natural variability, which is evident in Figures 1, 3 and 4, is addressed through a randomization process for site response analysis as described in FSAR Subsection 2.5.2.5.2.

Figure 1 Vertical RQD Variation

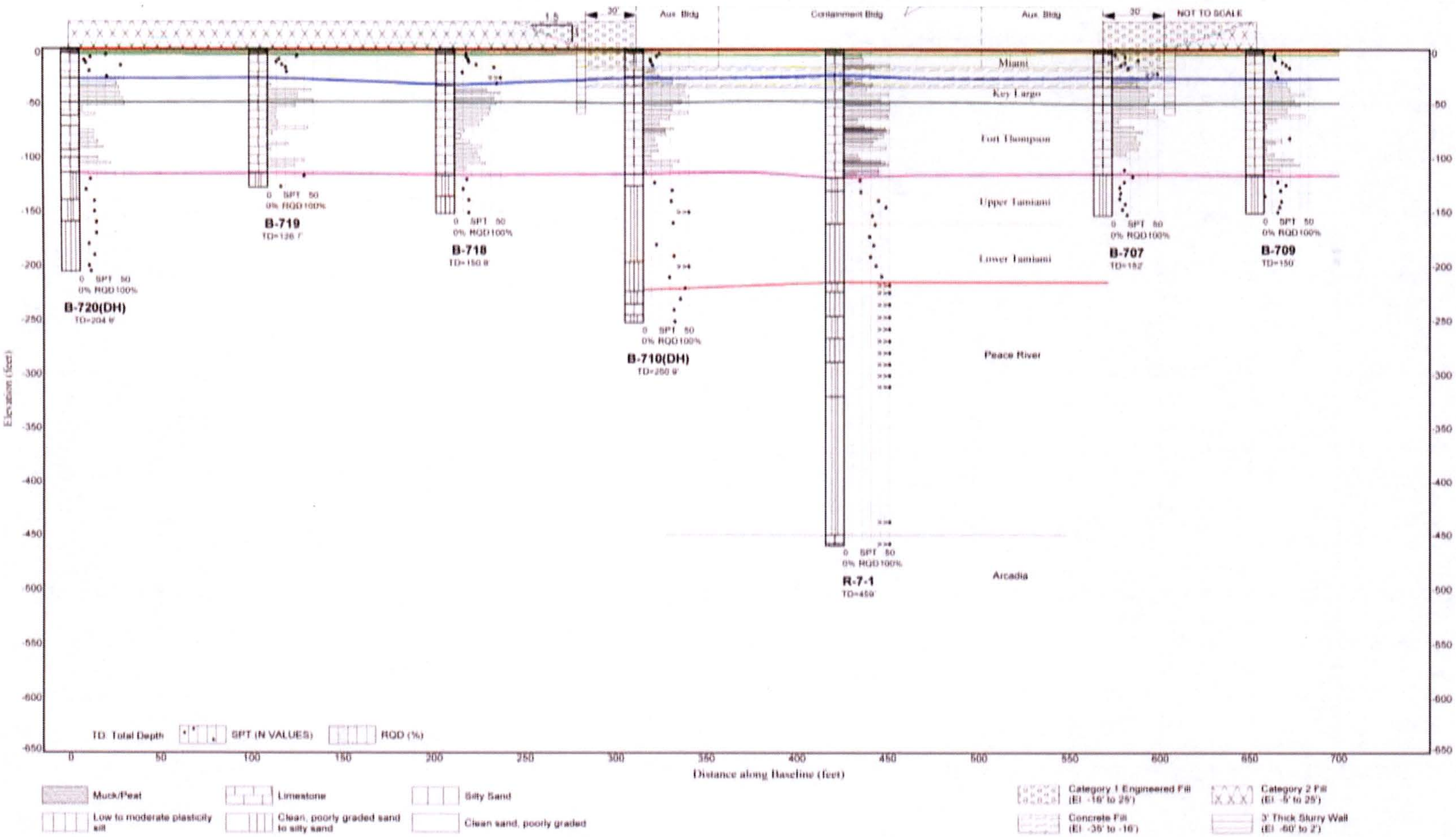


Figure 2 Plan Showing Geotechnical Cross Section Locations

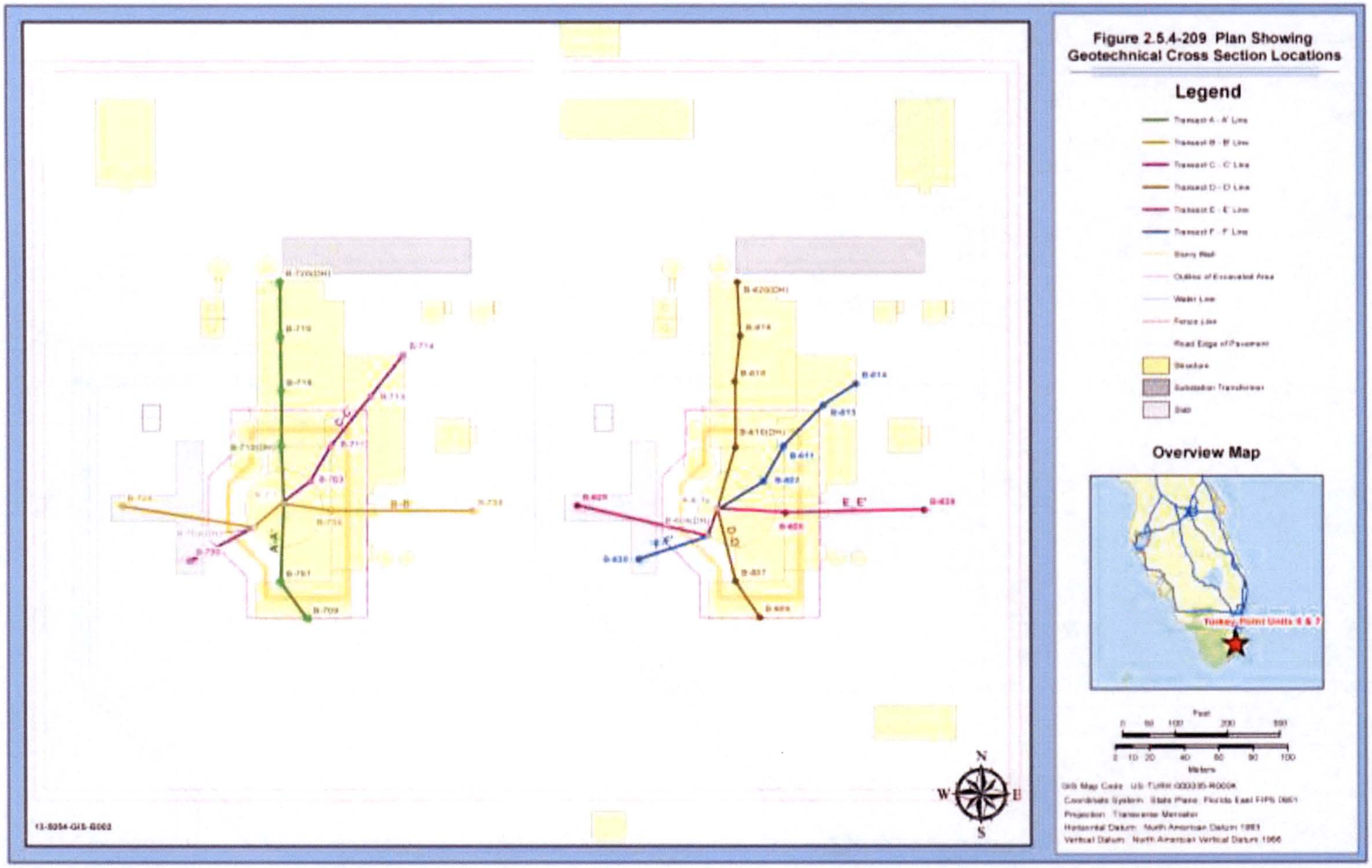


Figure 3 RQD Variation from South to North

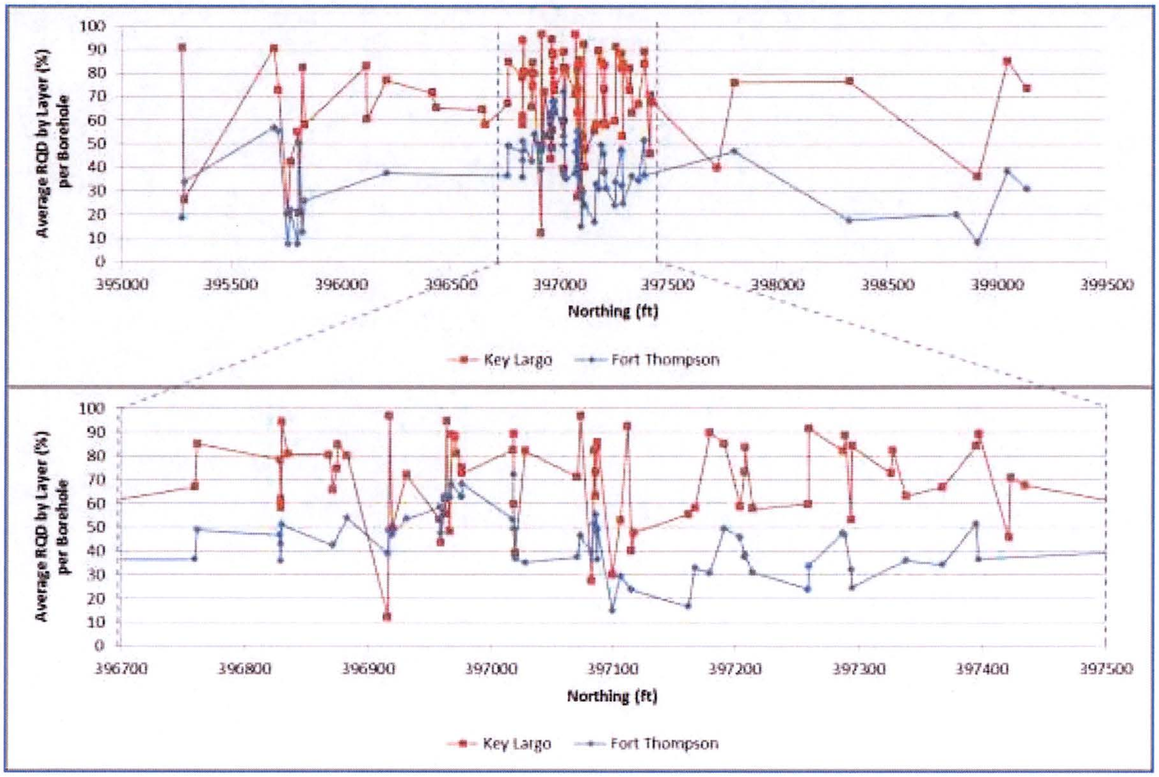
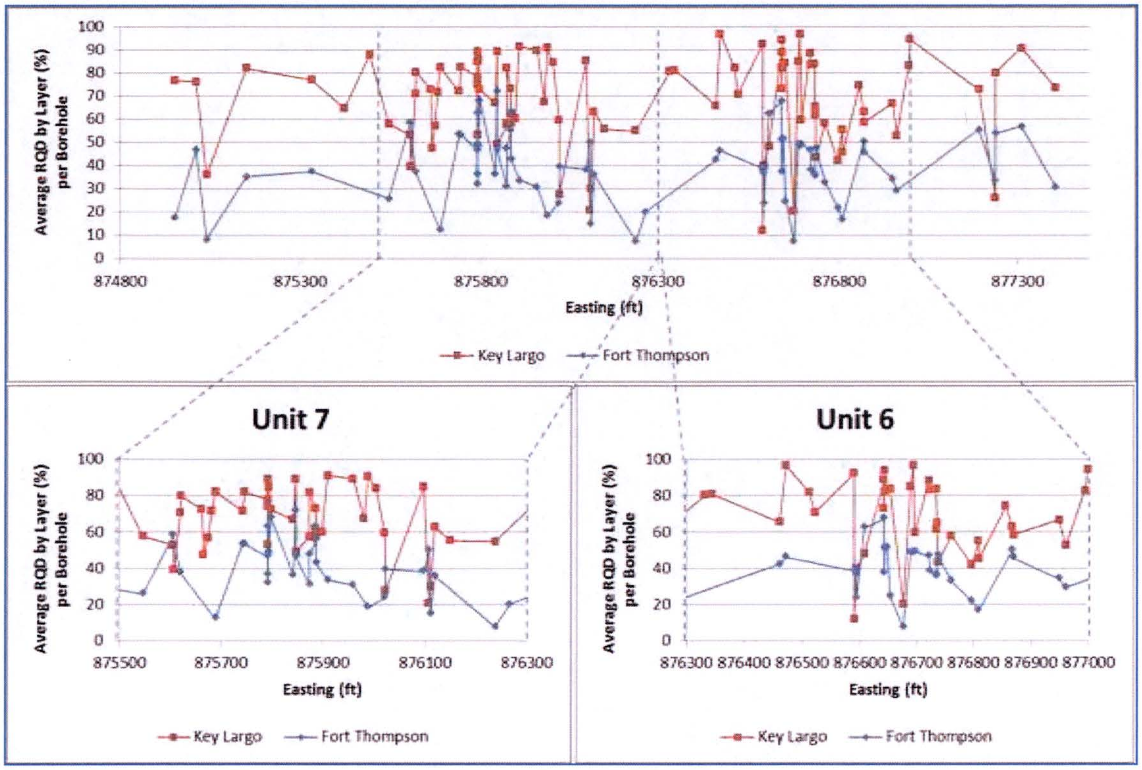


Figure 4 RQD Variation from West to East



For the purpose of this response, the rock strata will be classified as either "strain dependent" or "not strain dependent." The strain dependent strata have a variable G/G_{max} and damping ratios as a function of shear strain.

<u>Key Largo and Fort Thompson Formations:</u>

During the initial investigation (2008,) the Key Largo and Fort Thompson formations were assumed not to be strain dependent with a constant damping ratio of 1 percent (Figure 5).

The RCTS results, as obtained from the supplemental field investigation testing, are used to create the best fit damping curve labeled "Damping Curve for Key Largo and Fort Thompson (Initial & Supplemental Investigations)" in Figure 5. The maximum shear strain that these strata experience is much smaller than 0.005 percent (Figure 6). For this strain interval, the damping ratio is first constant around 0.8 percent, and then increases towards 1 percent as the shear strain approaches 0.005 percent. Even though the assumed damping ratio of 1 percent from the initial investigation is slightly higher than the best fit curve from the initial and supplemental investigation, the test results can be considered in good agreement with the assumptions made for this layer and the difference is within the uncertainty involved in determining the damping ratio from the test results.

Figure 5 Recommended Damping Curves

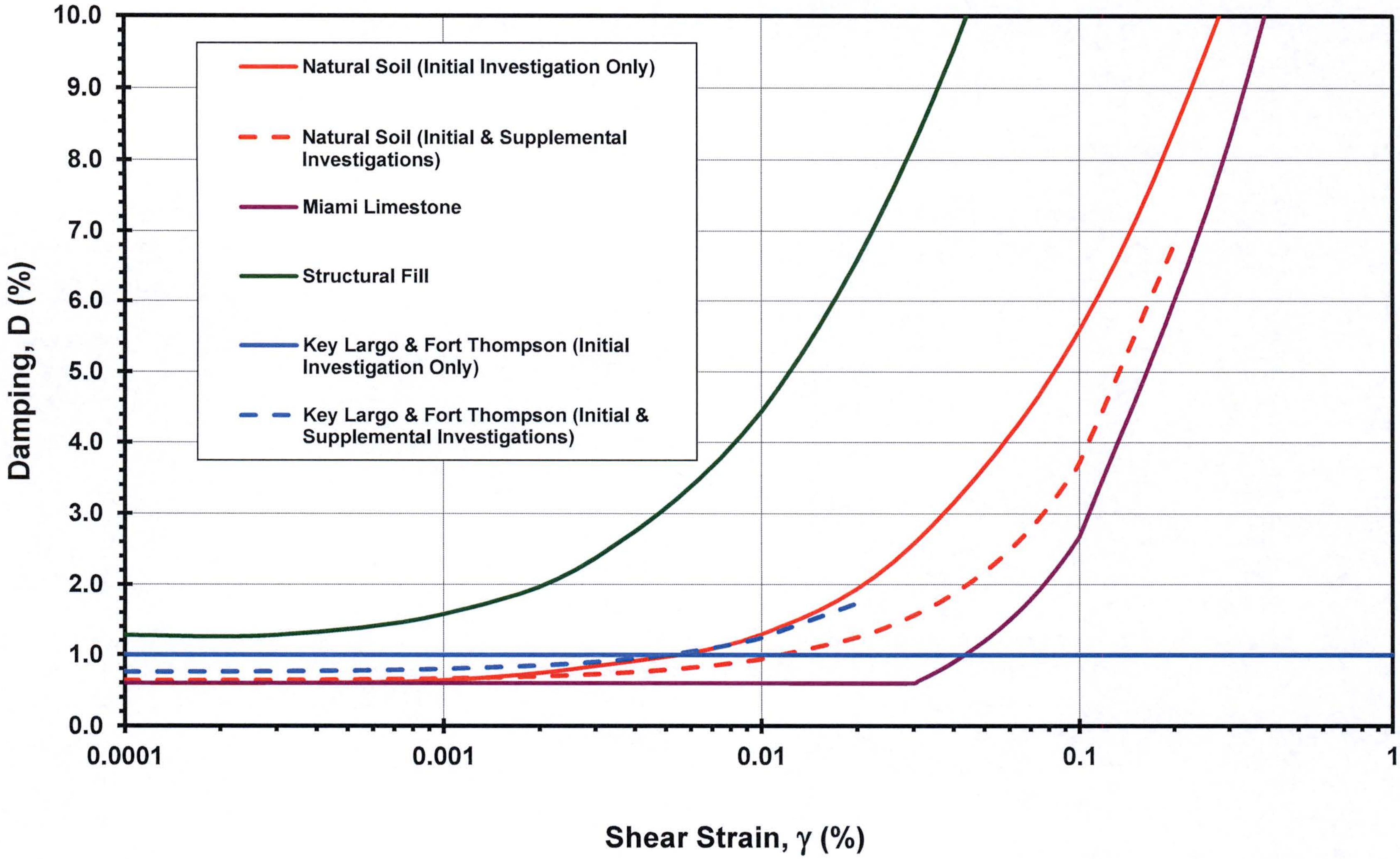
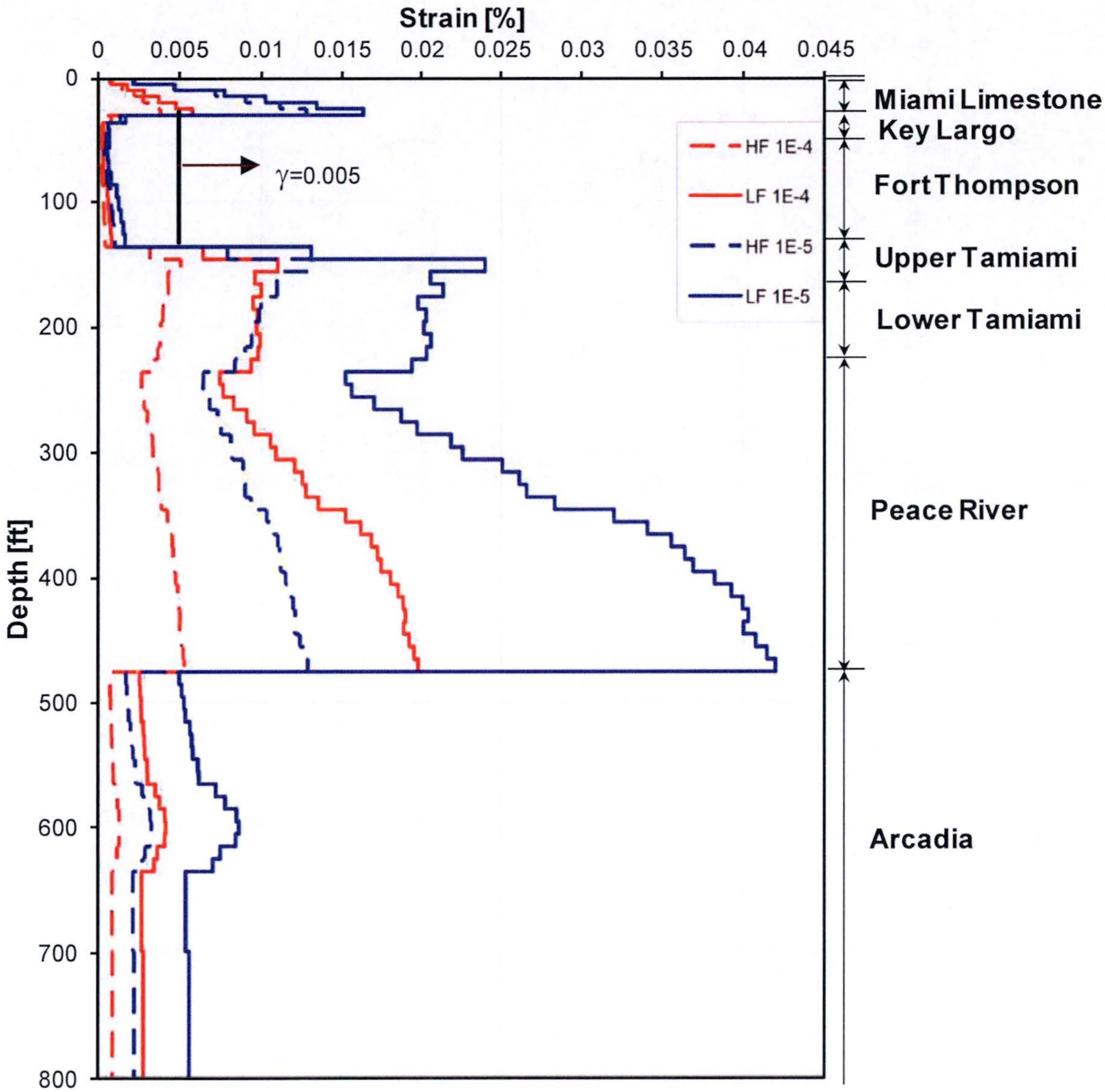


Figure 6 Median Strain-Compatible Soil Profiles (Upper 800 feet)



Miami Limestone:

In FSAR Subsection 2.5.4.7.3.3 the Miami Limestone is designated as strain dependent. The recommended damping curve in Figure 5, labeled "Miami Limestone," shows that damping remains constant at 0.6 percent from 0.0001 to 0.03 percent shear strain. The recommended damping curve for the Miami Limestone did not change from the initial investigation to the supplemental investigation.

Arcadia Formation:

Although the Arcadia Formation is reported in FSAR Subsection 2.5.4.2.1.1 along with the Miami Limestone, Key Largo, and Fort Thompson formations as being rock strata, the Arcadia Formation is much weaker than the Key Largo and Fort Thompson formations as indicated by the unconfined compressive strengths in revised FSAR Table 2.5.4-209 provided in the revised response to RAI 02.05.04-04. Additionally, the strain-dependent Miami Limestone has double the strength of the Arcadia Formation. Thus, for the Arcadia Formation, the recommended damping curve from the overlying Peace River Formation (Natural Soil) was used, as they both belong to the Hawthorn Group (FSAR Subsection 2.5.1.1.1.2.1.1).

The uncertainties and variation in the damping ratios (reflected in the variations in parameters such as RQD) were taken into account in the randomization process. FSAR Figure 2.5.2-238 shows the variation assumed in the randomization process for the damping ratio versus strain for the Arcadia Formation.

The constant damping ratio of the material below the Arcadia Formation, i.e., below about 640 feet depth in FSAR Figure 2.5.2-249, is 0.32 percent based on the median value of kappa and associated uncertainty.

Recommended Shear Modulus Degradation and Damping Curves:

A summary of the shear modulus degradation and damping curves based on data from just the initial investigation and the combination of the initial and the supplemental investigations is provided in Table 2. A summary of the recommended damping curves is provided in Figure 5. Damping curves with associated RCTS data for the Key Largo and Fort Thompson formations and for natural soil are presented in Figures 7 and 8, respectively. A summary of the recommended shear modulus degradation curves is provided in Figure 9. Shear modulus degradation curves with associated RCTS data for the Key Largo Limestone, Fort Thompson Formation, natural soil (Depth < 150 ft), and natural soil (Depth > 150 ft) are presented in Figures 10, 11, 12, and 13, respectively. The curves for the Structural Fill and the Miami Limestone are unchanged from the initial investigation.

Table 2
Recommended Shear Modulus Degradation and Damping Curves

		Shear Strain, γ (%)	0.0001	0.0003	0.001	0.003	0.01	0.03	0.1	0.3	1
Initial Investigation Only	G/G_{max}	Natural Soil (Depth > 150 ft)	1.00	1.00	1.00	1.00	0.95	0.87	0.65	0.42	0.19
		Natural Soil (Depth < 150 ft)	1.00	1.00	1.00	0.99	0.93	0.81	0.56	0.33	0.14
		Miami Limestone	1.00	1.00	1.00	1.00	1.00	0.98	0.87	0.63	0.33
		Key Largo	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Fort Thompson	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Structural Fill	1.00	0.96	0.87	0.74	0.55	0.37	0.21	0.11	0.05
	Damping (%)	Natural Soil	0.6	0.6	0.6	0.8	1.3	2.6	5.6	10.4	17.0
		Miami Limestone	0.6	0.6	0.6	0.6	0.6	0.6	2.7	8.2	17.0
		Key Largo & Fort Thompson	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		Structural Fill	1.3	1.3	1.6	2.4	4.4	8.2	14.3	20.6	27.9
Initial & Supplemental Investigations	G/G_{max}	Natural Soil (Depth > 150 ft)	1.00	1.00	1.00	0.99	0.95	0.88	0.68	0.41	0.17
		Natural Soil (Depth < 150 ft)	1.00	1.00	0.99	0.97	0.92	0.79	0.52	0.27	0.10
		Miami Limestone	1.00	1.00	1.00	1.00	1.00	0.98	0.87	0.63	0.33
		Key Largo	1.00	1.00	0.99	0.98	0.95	0.85	0.64	0.37	0.15
		Fort Thompson	1.00	1.00	0.99	0.96	0.89	0.73	0.45	0.21	0.07
		Structural Fill	1.00	0.96	0.87	0.74	0.55	0.37	0.21	0.11	0.05
	Damping (%)	Natural Soil	0.6	0.6	0.7	0.7	0.9	1.6	3.7	-	-
		Miami Limestone	0.6	0.6	0.6	0.6	0.6	0.6	2.7	8.2	17.0
		Key Largo & Fort Thompson	0.8	0.8	0.8	0.9	1.2	-	-	-	-
		Structural Fill	1.3	1.3	1.6	2.4	4.4	8.2	14.3	20.6	27.9

Figure 7 Damping Curves for Key Largo and Fort Thompson

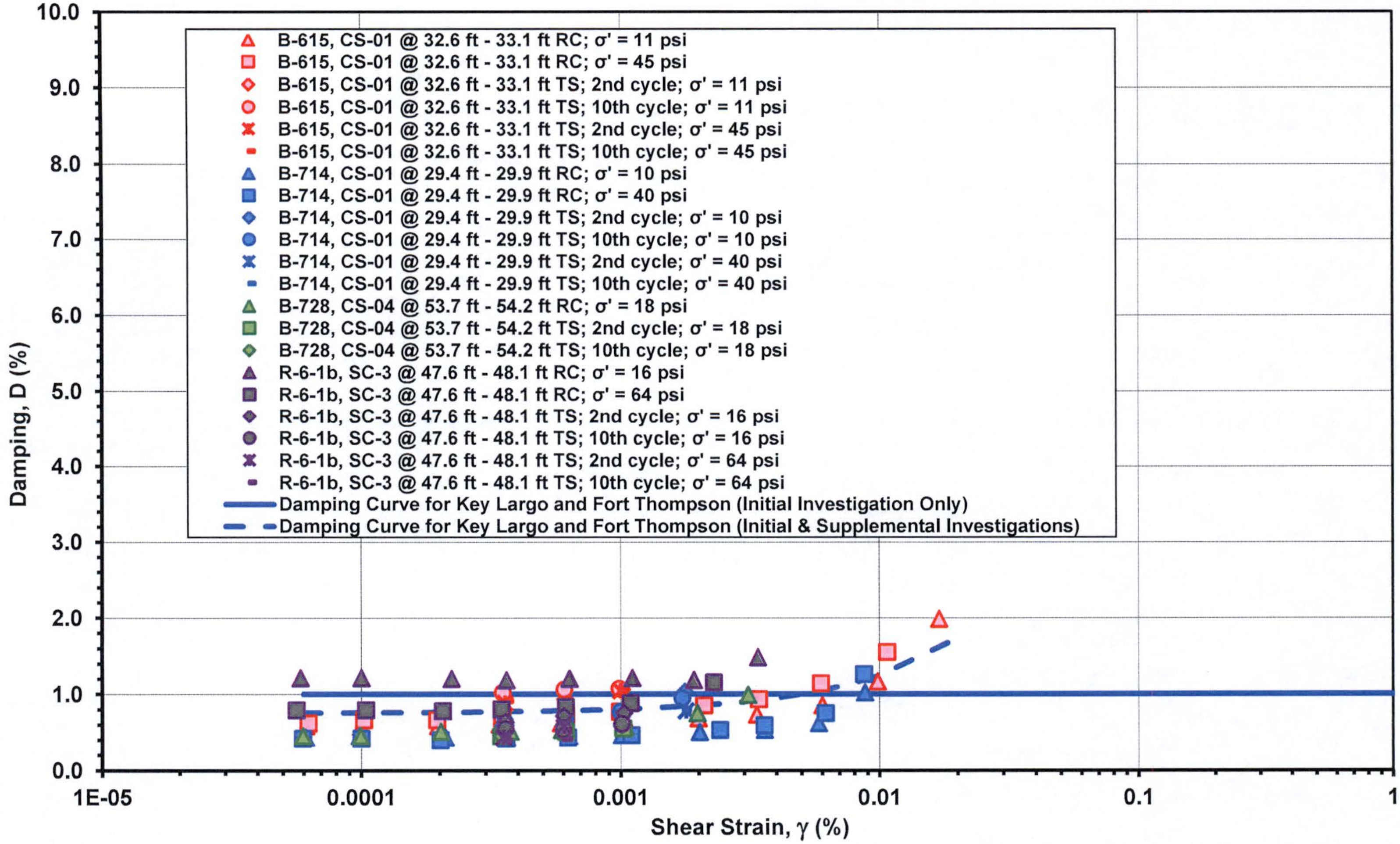


Figure 8 Damping Curves for Natural Soil

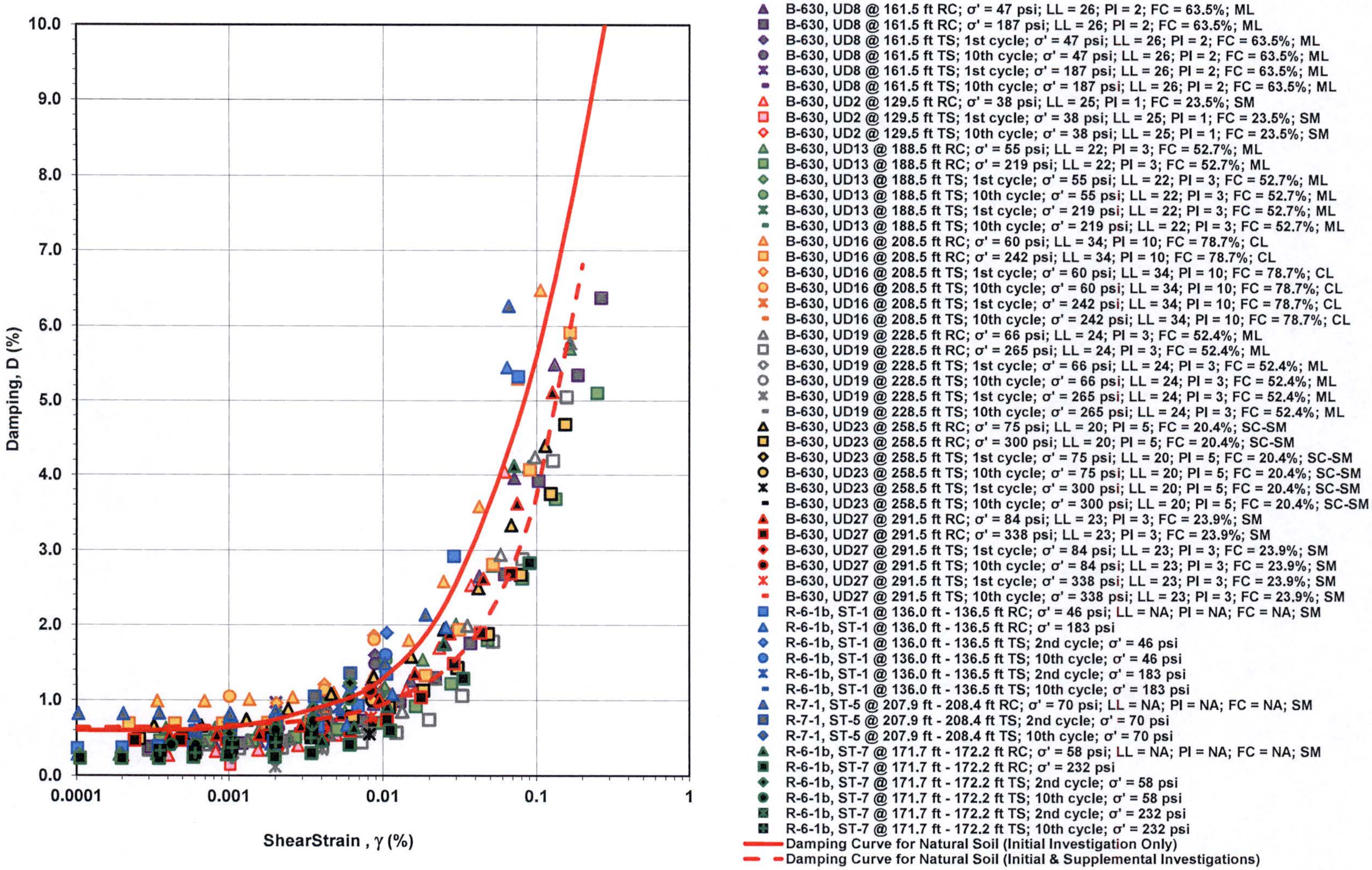


Figure 9 Recommended Shear Modulus Degradation Curves

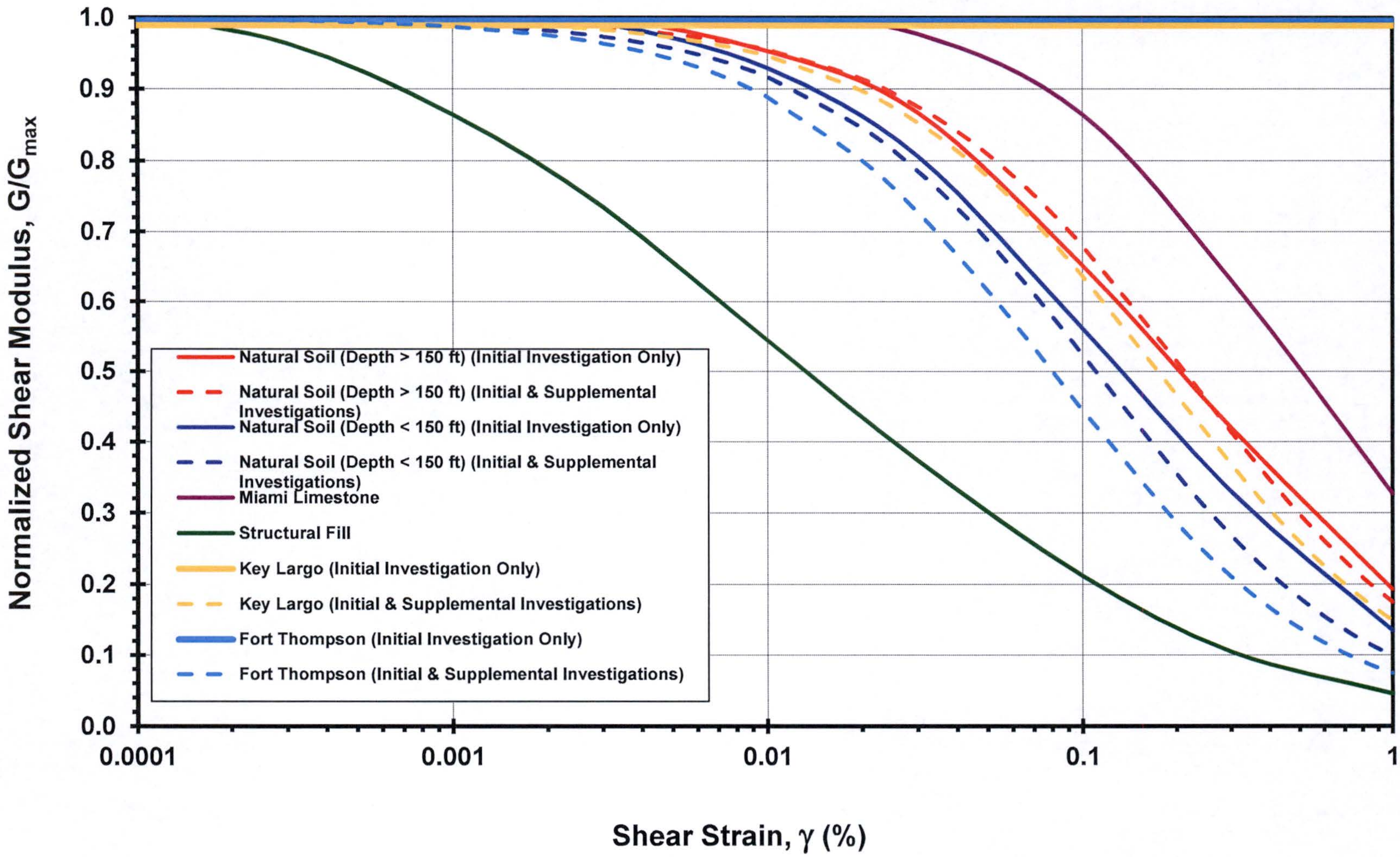


Figure 10 Shear Modulus Degradation Curves for Key Largo

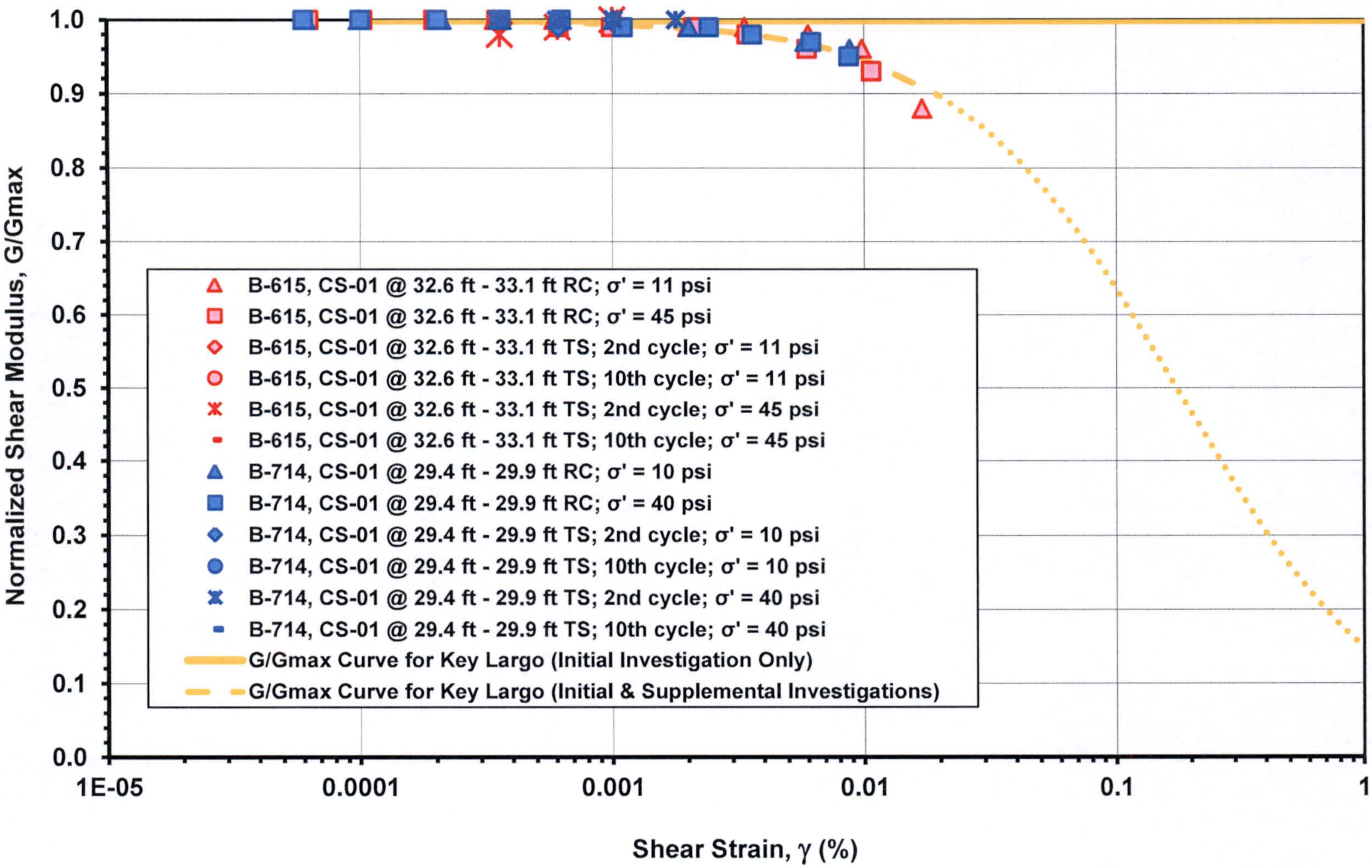


Figure 11 Shear Modulus Degradation Curves for Fort Thompson

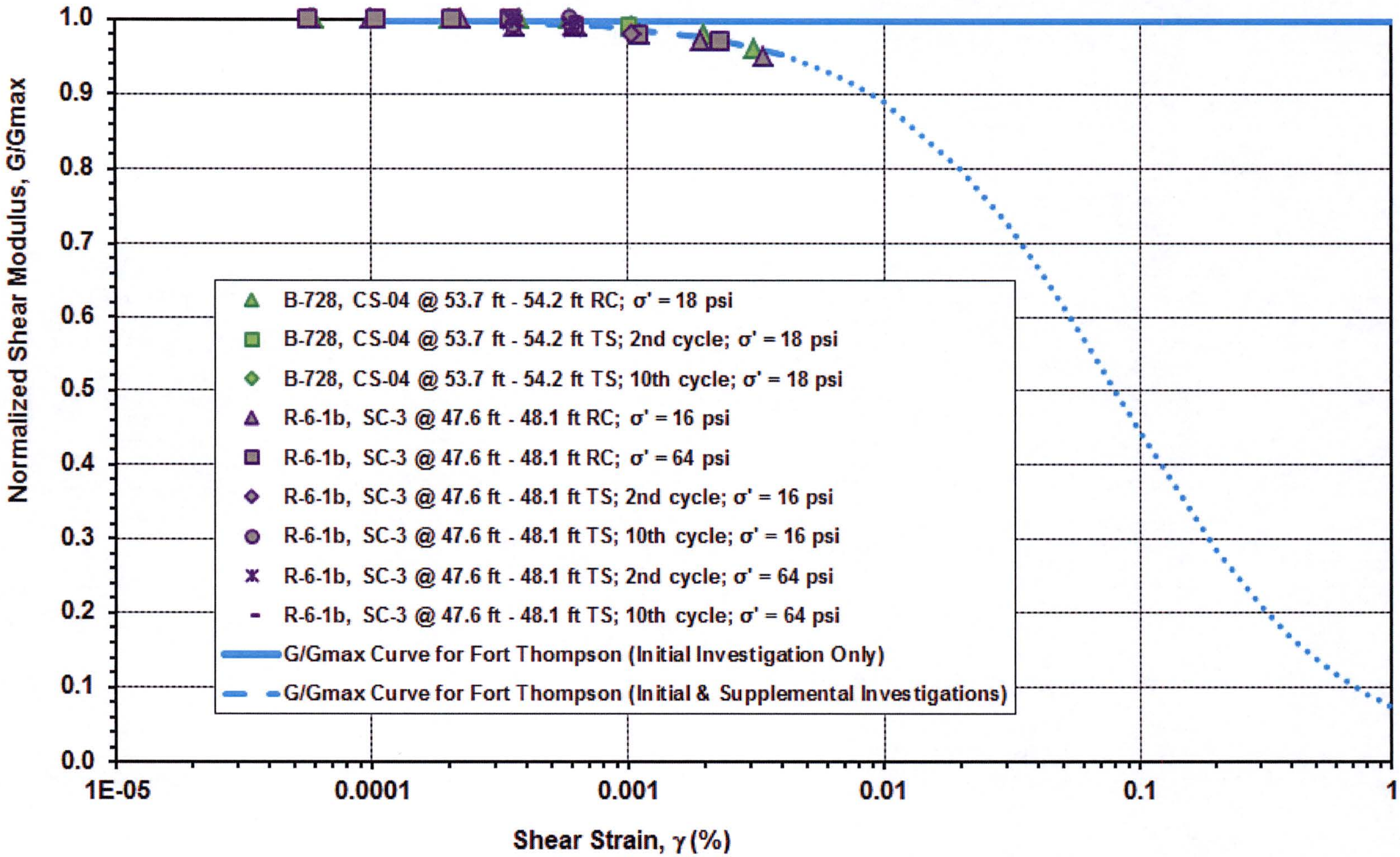


Figure 12 Shear Modulus Degradation Curves for Natural Soil (Depth < 150 ft)

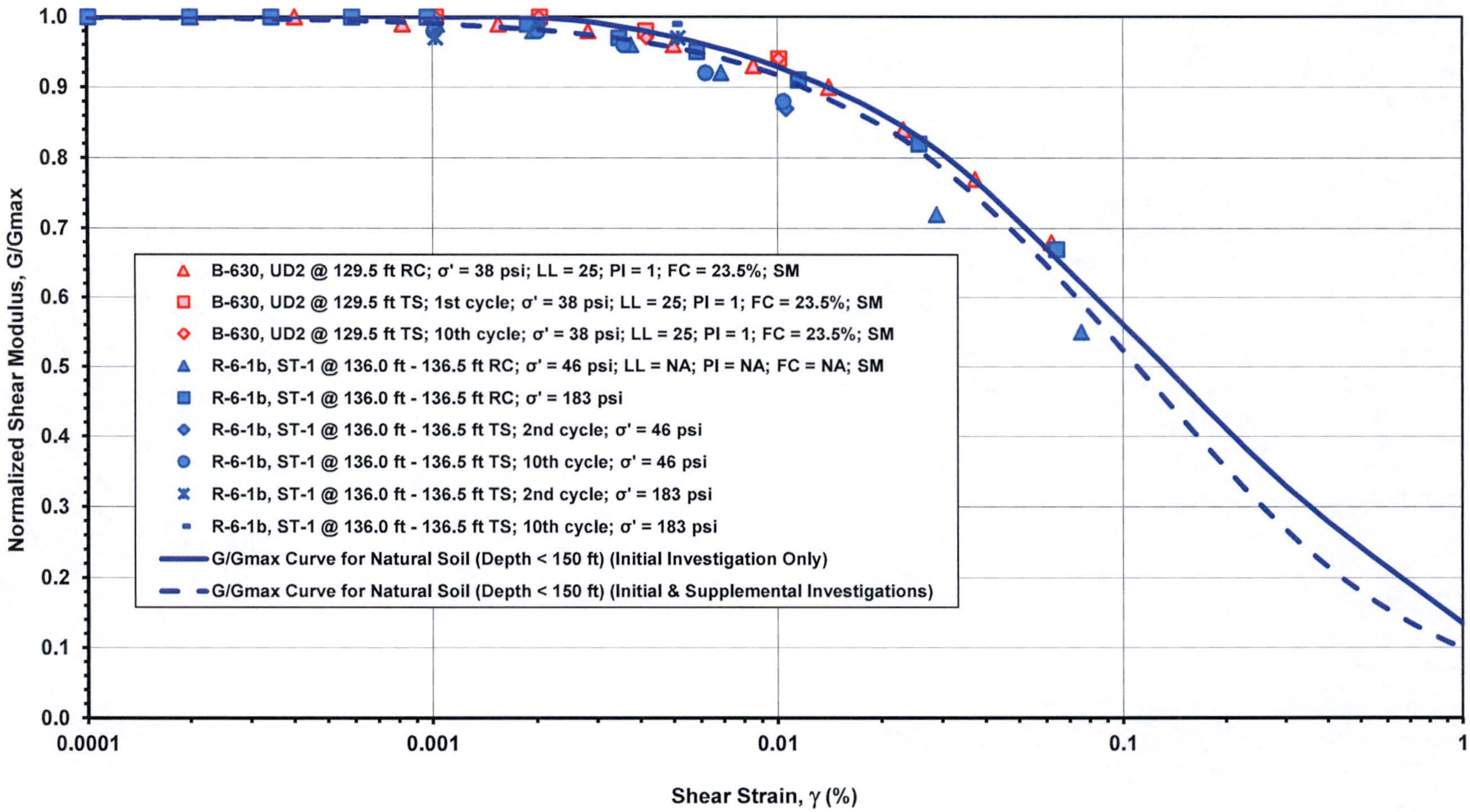
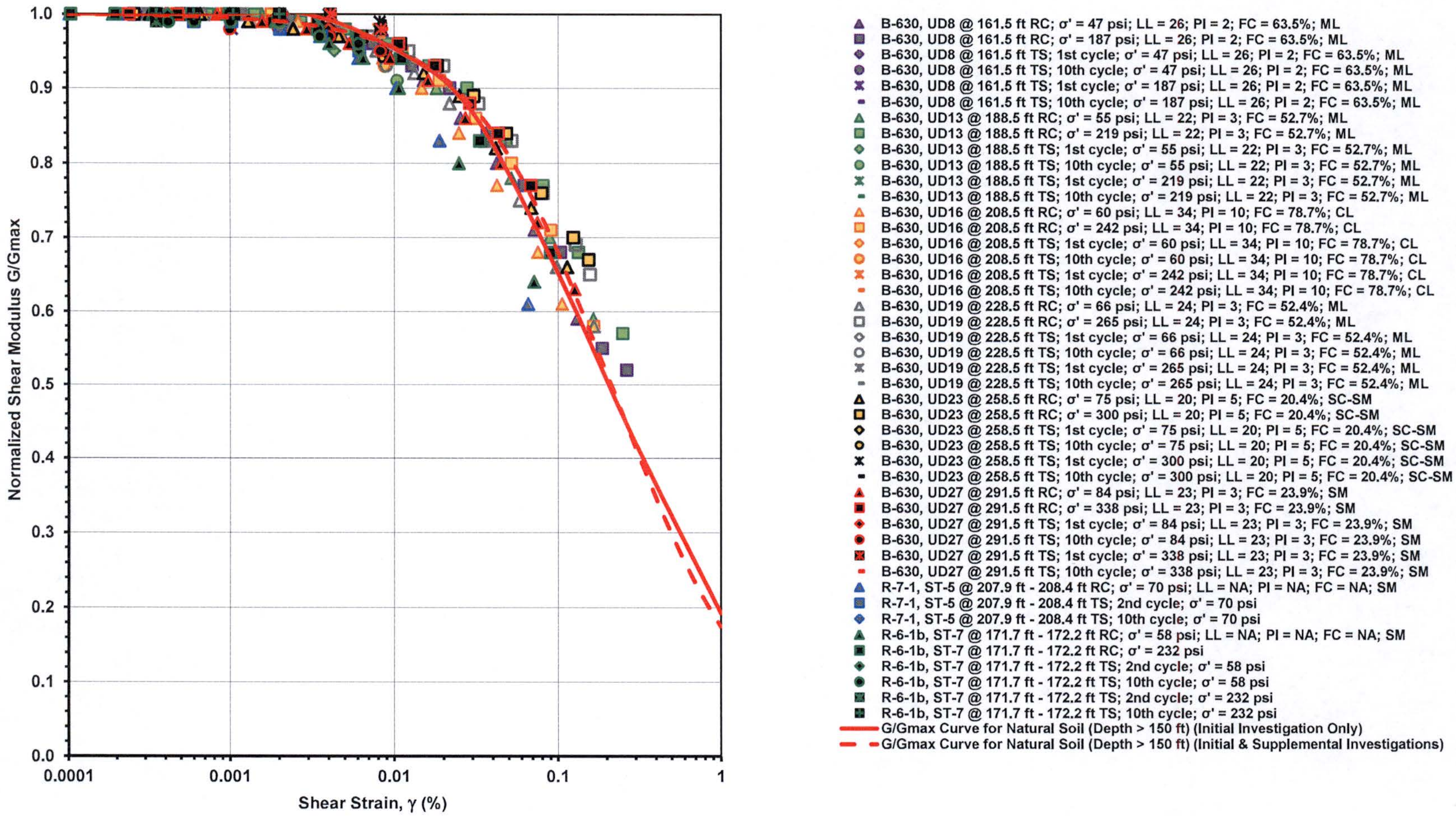


Figure 13 Shear Modulus Degradation Curves for Natural Soil (Depth > 150 ft)



Sensitivity Assessment for New (2013) RCTS Test Results:

As seen in Figures 6 through 13, as a result of the supplemental investigation, dynamic soil and rock properties changed slightly. To determine the impact of the updated properties, a sensitivity assessment was performed. The methodology used and the results of the sensitivity assessment are presented in FSAR Appendix 3JJ.7.

As described in FSAR Appendix 3JJ.7.1, the sensitivity assessment is not limited to changes in G/G_{max} and damping curves but also includes updates to the unit weight, layer thickness, and shear wave velocity.

Conclusions of the sensitivity assessment are given in FSAR Appendix 3JJ.7.4 and include the following:

1. The RG 1.60 spectrum with a PGA of 0.1g motion envelopes the sensitivity NI FIRS. Thus, the previously established SSE is still valid, which was partially based on the RG 1.60 spectrum with a PGA of 0.1g motion.

2. The sensitivity horizontal GMRS (developed using the updated site characteristics) was found to be slightly higher than the initial GMRS. At a frequency of 100 Hz, the sensitivity horizontal GMRS increased from 0.058g to 0.062g (a ratio of 1.07); with a maximum ground motion change from 0.0635g to 0.0698g (a ratio of 1.10) at 45 Hz. Although the ratio of these differences may indicate a significant change due to the updated site properties, the difference of 0.004g at a frequency of 100 Hz and 0.006g at a frequency of 45 Hz is well within the confidence bounds of PSHA and seismic site response. Therefore, the GMRS developed based on either the initial or updated site properties both characterize the Turkey Point Units 6 & 7 site as a site with low seismic hazard.

REFERENCES:

None.

ASSOCIATED COL APPLICATION REVISIONS:

Previous COLA updates provided in earlier revisions of RAI Question No. 02.05.04-16 (eRAI 6006) have been incorporated into a previous COL Application revision. There are no additional changes as a result of this RAI revision.