APPENDIX B: GEOTECHNICAL / GEOLOGICAL REPORT REQUIREMENTS

1.0 Introduction

ASCE 41-13 geotechnical/geological report requirements for seismic evaluation and retrofit design varies greatly based on the amount of as-built information obtained and type of existing foundation system. The following document is intended to help clarify geotechnical / geological requirements of Ordinance 17-1011 for Non-Ductile Concrete and Pre-Northridge Steel Moment Frames. It is noted that all geotechnical / geological reports shall be signed and stamped by a California licensed Geotechnical Engineer and by a California licensed Geologist (if applicable).

2.0 Seismic Site Hazard

The following frequently asked questions and answers are intended to clarify the scope and requirements of the seismic site hazard requirements of Ordinance 17-1011.

2.1 When is a site-specific seismic hazard determination required?

A site-specific seismic hazard procedure is required when:

a. The building is located on Site Class E soils and the mapped BSE-2N Sxs>2.0 or

b. The building is located on Site Class F soils, unless Ss<0.20.

In addition, a site-specific hazard is required to scale records when performing a non-linear dynamic time-history analysis.

[Ref. ASCE 41-13 Section 2.4].

2.2 When developing the site-specific response spectra, is there a required or preferred scaling method?

A Site specific response spectra shall be developed per ASCE 41-13 Section 2.4.2.1 requirements. As per ASCE 41-13, there are no requirements for which scaling method must be used.

2.3 When performing a non-linear time history analysis how many ground motion records are required?

Section 7.2.5.1 and Table 7-1 from ASCE 41-13 should be used to determine the required number of ground motions and response characteristics. Generally, it expected that the average response from a suite of 10 or greater ground motions is used, given most sites in West Hollywood are near-field.

2.4 Is Peer Review of the site-specific spectra or ground motion records required?

Yes, it is required, see Appendix C: Peer Review requirements for further information on the Peer Review process used by the City of West Hollywood.

3.0 Geologic Site Hazard

The following frequently asked questions and answers are intended to clarify the scope and requirements of the geologic site hazard requirements of Ordinance 17-1011.

3.1 When is a geological report required?

Where geologic hazards such as fault rupture, liquefaction, lateral spreading, landslide, or differential settlement are identified based on published maps, literature research, historical knowledge, or by any other assessment a geological report is required.

[Ref: ASCE 41 Section 8.2.2]

3.2 What geologic site hazards need to be investigated?

Fault Rupture, Liquefaction, Differential Settlement, Compaction, Land sliding and Earthquake Induced Flooding/Inundation are the geologic site hazards listed in ASCE 41-13 which require investigation.

[Ref. Section 8.2.2]

3.3 What happens if my site is on a Geologic Site Hazard?

Mitigation of the site hazard shall be accomplished through modification of the structure, foundation, soil conditions or other means as approved by the City of West Hollywood. The geologic site hazard mitigation approach shall be submitted to the City and a building permit obtained prior to the mitigation being performed. A peer review will be required if this condition occurs. (See Appendix C: Peer Review Requirements).

[Ref. ASCE41 Section 8.3].

3.4 When is a site-specific fault investigation required and who should perform the investigation?

Under the Alquist-Priolo Earthquake Fault Zoning Act (A-P Act), if the parcel is located within the boundary encompassing an active fault (see https://maps.conservation.ca.gov/cgs/EQZApp/) then the project is regulated by the A-P Act and a site-specific fault investigation is required unless one of the exceptions below is applicable:

Exceptions:

1. Alterations (including retrofit) cost does not exceed 50% of the value of the building.
2. Alterations (including retrofit) cost exceeds 50% of the value of the building, the building was constructed prior to May 4, 1975, and the building is classified as a “Concrete Moment Frame” building.

The fault investigation should be conducted by a California State Licensed Geologist. The purpose of the site-specific investigation is to determine the presence or absence of existing faults and evaluate the regency of their past activity.

[Ref: Special Publication 42 Earthquake Fault Zones – A Guide for Government Agencies, Property Owners/Developers and Geoscience Practitioners for assessing Fault Rupture Hazards in California, Department of Conservation, California Geological Survey]

3.5 What information should be included if the building is located on an active fault or fault trace (based on the A-P Act or previously determined)?

Where a fault or fault trace is identified to be within the footprint of the building the following information shall be provided in the report:

1. The degree of activity based on the age of the most recent movement and earthquake rate.
2. Fault type (ie strike-slip, normal, reverse, or oblique).
3. Width and distribution of the fault-rupture zone.
4. The orientation of slip with respect to the building geometry.
5. Magnitudes of vertical and/or horizontal displacements consistent with the BSE-2E.

[ASCE 41 Section 8.2.2.1]

4.0 Geotechnical Engineering and Foundations

The following frequently asked questions and answers are intended to clarify the scope and requirements of the geotechnical engineering and foundations requirements of Ordinance 17-1011.

4.1 When is a geotechnical report required?

A geotechnical report is required when a geological report is required per section 3.1 and/or site specific information is needed, e.g. a site-specific sub-surface exploration, a site-specific response spectra, or ground motions for non-linear response history analysis.

4.2 What information should a geotechnical report include?

The geotechnical report shall include, at a minimum:

- A summary of all sub-surface exploration data, including subsurface soil profile, exploration logs, laboratory or in situ test results, and ground water information.
- Interpretation and analysis of the sub-surface data including soil strength and stiffness characteristics. Load deformation characteristics of the foundation in vertical, lateral and rocking directions shall be included.
- Specific engineering recommendations for analysis and design including capacities of existing foundation elements and recommended foundation types for new foundation elements.
- Discussion of conditions for solution of anticipated problems such as large settlements or expansive soils.
- Recommended geotechnical special provisions such as mitigation for geologic hazards.
- Construction means and methods recommendations such as setbacks, permissible soil cuts, shoring loads, surcharges, excavation requirements etc., if needed.

4.3 When is a geotechnical sub-surface site exploration required?

A site-specific sub-surface Investigation is required:

- Where an Enhanced Performance Objective is selected or
- Where insufficient data is available to quantify foundation capacities or
- Where insufficient data is available to determine the presence of geologic site hazards identified in Section 8.2.2 or
- Where historic information indicates geologic site hazards have occurred in the vicinity. [Ref. ASCE41-13 Section 3.2.4].
- Where geologic hazards are not identified via maps, literature or other assessment, an in-situ geotechnical investigation shall be performed to identify that characteristic and to determine soil stiffness and strength characteristics. [Ref. ASCE41-13 Section 8.2.2].

- For buildings where the prescriptive methods specified in ASCE 41-13 Section 8.4.1.1 do not apply, a sub-surface geotechnical investigation shall be conducted to determine expected ultimate foundation capacities. Prescriptive methods are only permitted when construction documents or previous geotechnical reports for the existing building are available and provide information on foundation soil design parameters. [Ref. ASCE41-13 Section 8.4.1.1/2].
- The sub-surface site exploration, when performed, shall include all of the information required in ASCE 41-13 Section 8.2.1.1.2 based on the Performance Objective. In addition, the design foundation loads for dead and live loading and foundation load-deformation characteristics under seismic loading shall be determined per Sections 8.2.1.2 and 8.2.1.3.

4.4 Where a Geotechnical Report is not required, can I use as-built drawing geotechnical information or original geotechnical reports for the analysis and evaluation of the existing foundation? How about for the design of new foundation elements part of a retrofit?

Yes, the use of applicable existing foundation capacities available for the site is permitted to be used for both the evaluation of existing foundation elements and design of new foundation elements. Original design information, foundation capacities included on the drawings, previous geotechnical reports etc. may be used for the analysis, evaluation and design. [Ref. ASCE41-13 Section 8.4.1.1].

In cases where new retrofit components are used in conjunction with existing components, the effects of differential foundation stiffness on the modified structure shall be demonstrated to meet the acceptance criteria. [Ref. ASCE41-13 Section 8.7].

4.5 Can prescriptive foundation capacities be used for evaluation? For new design?

Yes, prescriptive expected foundation capacities can be used for both evaluation and design where construction documents or previous geotechnical reports for the existing building are available and provide information on foundation soil design parameters. Prescriptive foundation capacity equations for shallow and deep foundations and an alternative approach for both types can be found in equations 8-1, 8-2 and 8-3 of ASCE41-13 Section 8.4.1.1, respectively.

4.6 What is the difference between the stiffness of foundation elements, soil stiffness, foundation flexibility and soil structure interaction?

Stiffness of foundation elements – the stiffness of foundation components such as footings, grade beams, pile caps and piles.

Soil stiffness – the load deformation characteristics of the supporting soil.

Soil-Structure Interaction (SSI) – Interaction between the structure and the supporting soil consists of the following:

1. Foundation Flexibility – introduction of flexibility and strength at the foundation-soil interface. This overall foundation property includes the combined effects of the foundation component stiffnesses, base fixity assumptions and soil load-deformation properties collectively.
2. Kinematic effects – filtering of the ground motions transmitted to the structure based on the geometry and properties of the foundation; and
3. Foundation damping effects – dissipation of energy through radiation and hysteretic soil damping.

SSI accounts for the various ways in which the soil and soil structure interface react to seismic ground motions and dissipate energy. Foundation flexibility is addressed directly through the analysis assumptions and analysis model while kinematic effects and damping effects are accounted for in development of the hazard, I.e. spectra, ground motions etc.

4.7 Is the stiffness of the foundation elements and soil required to be considered when performing a structural analysis?

The foundation system shall be modeled considering the degree of fixity provided at the base of the structure per Sections 7.2.3.4 and 7.2.3.5 of ASCE 41-13. Rigid or flexible based assumptions shall be permitted in accordance with the requirements for soil-structure interaction in ASCE 41-13 Section 7.2.7 and foundation acceptability in Section 8.4. Foundation modeling shall also consider movement caused by geologic site hazards, if present, and foundation-soil load-deformation characteristics specified in Section 8.4.

Section 8.4 contains procedures to account for the foundation stiffness in relation to the soil, including rigid and flexible base assumptions, and the stiffness of the soil-structure interface.

Soil-Structure Interaction (SSI) shall be included in the structural analysis model per the requirements in Section 7.2.7. SSI shall be evaluated for those buildings in which an increase in fundamental period caused by SSI effects results ion an increase in spectral accelerations. Typically, this only occurs due to near-field or soft-soil sites.

4.8 How can foundation flexibility be included in the analysis model?

Shallow foundation flexibility can be modeled per the recommendations contained in ASCE 41-13 Section 8.4.2. This section describes various modeling options for shallow foundation systems that account for foundation stiffness, soil stiffness and building base fixity. Section 8.4.3 provides similar recommendation for deep foundation systems such as pile foundations. For additional information on proper modeling of foundation elements and how to apply ground motions when you are performing a Response History Analysis, the reader is referred to the National Institute of Science and Technology (NIST) Technical Brief *GCR 12-917-21 - Soil-Structure Interaction for Building Structures*.

4.9 How can soil-structure interaction (SSI) be accounted for in the structural analysis model?

SSI effects shall be included in the analysis model using the explicit modeling procedure found in ASCE 41-13 Section 7.2.7.2. A simplified procedure found in Section 7.2.7.1 may be used when the Linear Static analysis procedure is used.

4.10 When soil structure interaction is required per ASCE 41-13 Section 7.2.7, how can kinematic interaction and radiation damping effects be accounted for?

Section 8.5.1 of ASCE 41-13 provides recommended procedures to account for base slab averaging and embedment kinematic interaction effects that reduce the shaking input to the structure relative to free-field motion. Section 8.5.2 of ASCE 41-13 provides recommended procedures to account for the effects of a building embedded into the soil, such as a building with a basement. Both procedures to account for kinematic interaction

effects have limitations that need to be checked against the existing building and soil properties.

4.11 What are acceptance criteria for the foundation soil and foundation elements?

Foundation soil acceptance criteria for linear and non-linear analysis procedures are contained in ASCE 41-13 Section 8.4.2 for shallow foundations and 8.4.5 for deep foundation systems. Individual structural components of the foundation shall meet the appropriate requirements for the material per Chapters 9 through 12 of ASCE 41-13. The foundation soil and structural components of the foundation shall be evaluated to support all actions, including vertical loads, moments and seismic forces.

4.12 Are seismic earth pressures required to be used in the analysis, evaluation and design of building walls that retain soil?

Yes, the additional earth pressure caused by seismic shaking shall be added to the un-factored static active earth pressure to obtain the total design earth pressure on building retaining walls. The wall shall be checked as a force-controlled element. See equation 8-30 of ASCE 41-13 for the seismic earth pressure for unsaturated level soil above the groundwater table. For other conditions, a site-specific geotechnical investigation shall be performed to determine the seismic earth pressures.

[Ref. ASCE41-13 Section 8.6].

4.13 Does the City need to review and approve Geotechnical Reports?

Yes, site specific Geotechnical Reports are required to be reviewed and approved by the City of West Hollywood prior to the start of construction. It is advisable that the Geotechnical Report is submitted to the City and approved prior to completing and submitting construction documents for a retrofit design.

4.14 Does the city need to review geotechnical recommendations for construction means and methods i.e. deep excavation shoring that would be part of retrofit construction?

Yes, shoring needs to be reviewed and approved by the City of West Hollywood if an excavation is impacting adjacent buildings or public right of way such as roads, railways, sidewalks etc. The shoring recommendations may be submitted as a separate report or be included as part of a building geotechnical report and is required to be approved prior to the start of construction.