SCOPE OF WORK
LOCAL STRUCTURAL ENGINEER ASSISTANCE FOR
SEISMIC ASSESSMENT OF HOUSING PROPERTIES
U.S. EMBASSY – DJIBOUTI, DJIBOUTI

A. BACKGROUND

The U.S. Embassy in Djibouti, Djibouti has a need to assess residential properties for seismic risk. The assistance of a local structural engineer who has in-depth knowledge of indigenous housing design and construction practices and is well versed in seismic engineering is being sought for this effort. The services to be performed are prescribed in this scope of work (SOW).

B. GENERAL

1. The intent is to retain a qualified engineering company able to perform a qualitative seismic assessment of properties at post on an as need basis. As an example, the request will list properties as shown in Table 1 below. This includes the identification and evaluation of structural and non-structural seismic hazards in and around these properties. This does not include retrofitting design to mitigate the identified seismic deficiencies.

Table 1 – List of Properties to be Surveyed for Seismic Adequacy

Property I.D.	Address	Building Type/Construction
TBD	Four selected Djibouti Area houses between 300 and 1000gsm with addresses TBD at the time of the assignment	

2. The Embassy considers Djibouti, Djibouti to be in a very high seismic zone, per USGS designation, which is equivalent to Zone 4 of the 1997 Uniform Building Code (UBC). The Engineer shall base his/her assessment(s) on a large future earthquake is defined as an earthquake occurring in UBC 1997 Seismic Zone 4, with a Modified Mercalli Intensity Scale (MMI) rating of IX (See Attachment B).
   a. If the Engineer determines the building is designed by a more recent/stringent building seismic code, provide a narrative explanation of the design code requirements and how these requirements are addressed in the building design documents and as-built construction.

3. The engineering professionals conducting the surveys must demonstrate education and experience in building structural engineering design and construction in high seismic areas, as

well as experience with conducting conditions assessments of existing buildings. Engineers must have experience in designing to codes with reputable earthquake design provisions. Professional credentials, a list of relevant experience, and educational background shall be submitted with the proposal for evaluation by the Embassy and must meet these requirements:

- Well educated
- An American university is ideal, but not required
- Master's level degree is ideal
- English speaking and writing
- Professional licensure
- 7 to 10+ years of experience designing and assessing building structures
- The experience should be with designing and assessing buildings, not bridges, pipelines, etc.
- The design portfolio should be diverse and capture the building types and materials typical in post's inventory (for example we don't necessarily want just an engineer who only designs high-rise reinforced concrete buildings if we will be having them assess single family wood houses)
- Their design experience should be per reputable codes (e.g. International building code (IBC) or other international codes (Eurocode)). Such codes address how to calculate seismic forces AND pay particular attention to detailing (e.g. how tightly are reinforced concrete beams reinforced)
- Experience in post-earthquake damage assessment is a plus (as they get to see how buildings respond firsthand), although not required
- Professional committee involvement is a plus (e.g. code committees), although not required

4. The Engineer's assignment is limited to the properties specifically identified in this SOW. However, similar services may be required by the Embassy on an intermittent basis in the future. Such requirements are based on the Embassy's fluctuating housing needs and the availability of properties being offered for lease in the local market. A separate work assignment would be issued by the Embassy if the Engineer's assistance is needed in the future.

C. WORK TASKS

The Engineer shall perform the following for each property:

1. Research and obtain available data such as architectural and structural drawings/floor plans, construction photographs, building permits, dates of construction, and records of construction inspections, from the appropriate source, such as the owner, real estate agent, city permitting office, architect, or builder.

2. Travel to the site and conduct a site and building survey. Take note of all visibly observable conditions and features that might influence its expected seismic performance. Take particular note of unfavorable conditions and features, such as: significant structural irregularities (weak or

soft story, significant torsion or mass imbalances, short columns, discontinuity of shear walls, etc.), building deterioration, adjacency to other buildings - potential for pounding, site issues (significant slopes, high retaining walls, power transmission towers), or strength and stiffness deficiencies evident in the building to resist the expected seismic forces.

3. Fill out, while on site, the Building Investigation Worksheet provided as **Attachment A** to this SOW. The following guidelines apply to this task:

    a. While it is understandable that not all the information on the worksheet will be available, the Engineer is expected to complete it as much as possible. Fill in, when available, the items necessary to support a recommendation as to whether the building is seismically acceptable for lease and occupancy.
    b. Section 6 (Summary of Observations) of the worksheet must be completed for each building surveyed, including the Professional Opinion portion.
    c. At least one photograph of the front of the building must accompany each worksheet. Additional photographs of the structure may be included with the final report, as necessary to adequately document the building and present observed details/deficiencies.

4. Verify the consistency between as-built conditions and existing drawings/floor plans.

5. Gather the following additional information during the field investigation if they are not available from the existing drawings:

    a. Overall building dimensions and story heights.
    b. Plans of structural system, noting shear wall lengths, beam and column locations and spacing.
    c. Typical beam and column sizes; typical shear wall dimensions; floor and roof construction; slab thicknesses; interior and exterior wall construction and thicknesses.
    d. Partition wall construction, including composition, typical thickness, and typical connection to the surrounding structure.

5. Meet with the building owner, architect/engineer, construction contractor, and/or building maintenance personnel as necessary to develop/gather as much of the following data as possible if they are still unavailable/missing:

    a. Reinforced concrete design information, including but not limited to typical concrete beam, column, and shear wall reinforcement detailing including reinforcing steel sizes and amounts, spacing of column ties and beam stirrups, location of column bar splices, reinforcement of joints, shear wall details, shear wall cross ties and boundary elements, whether or not 135º seismic hooks were used. Ductile reinforcement enhances structural performance during an earthquake and should be noted in documenting the information obtained.

b. Typical reinforcement detailing in the interior and exterior walls and partitions for reinforced masonry construction.
c. Foundation design and allowable soil bearing pressure.
d. Construction progress photos that might confirm design and construction process and quality.
e. Any record of inspection services or involvement during construction by architect or engineer.

6. Formulate an opinion on the expected seismic performance of the building, including a prognosis of potential damage level (i.e., minor damage, moderate damage, major damage, or partial/total collapse) and corresponding life safety risk to occupants. Engineer shall assign a Seismic Hazard Rating to the building in the final report see **Attachment B** for Seismic Hazard Rating classifications.

7. Prepare a report, one for each of the properties evaluated, in accordance with the report format and contents outlined in **Attachment C**. Highlight the major structural and non-structural deficiencies and discuss their influences on the seismic performance of the building. Also provide an opinion as to whether the structure complies with building code requirements of the local jurisdiction.

NOTE:

1. It is understood that architectural and structural drawings may not always be available. In such cases, after pursuing all reasonable sources, the Engineer shall proceed with the evaluation using his/her experience with local design and construction practices to complement their visual observations made during the survey.

2. It is important to note that the basis of this survey is not intended to equate to the local building code's minimum requirements. Compliance with local building codes is certainly of interest in this survey but does not necessarily equate to a 'Good' Seismic Hazard Rating, for instance. The expected seismic performance of the building shall be based on its actual conditions and features, performance of similar structures in past earthquakes of comparable magnitude, and in accordance with Seismic Hazard Rating classifications provided in Attachment B.

3. There is no testing (non-destructive or destructive) intended or required for this work. The use of hand-held metal/rebar scanners by the engineer, however, is often beneficial for verifying the existence of reinforcing steel in masonry walls and is strongly encouraged where the presence of steel is questionable and might significantly impact the qualitative assessment. Such scanning can be at the discretion of the Engineer, perhaps only for two to three representative locations; as such, the increase in level of effort is typically considered to be insignificant.

4. Computer modeling of the structures is not included in this SOW. Per paragraph B.1, the seismic assessment is to be qualitative in nature and, as such, the Engineer is expected to evaluate the structures based on other factors as described above, based on interviews, drawing reviews, and visual observations only.

DELIVERABLES

1. Submit one electronic (PDF format) copy of each report with digital photographs and completed worksheet for the building/property.
2. All deliverables shall be submitted in English.
3. Report re-submissions may be required if necessitated by review comments by the Embassy.

D. SCHEDULE

Assessment of prospective housing is often needed with very short advance notice due to the short-term availability of these properties. Timeline for the Engineer to mobilize, complete the research and surveys, and submit the deliverables shall be coordinated with the Embassy in advance of task order award.

E. ATTACHMENTS

Attachment A – Building Investigation Worksheet

(Note: if the Engineer has a similar worksheet that he/she uses for such evaluations, submit a copy of this worksheet to the Embassy for review before proceeding with the investigations. If the Embassy approves use of the Engineer's worksheet, it may be used for this effort in place of the attached worksheet.)

Attachment B – Seismic Hazard Ratings

For the purposes of evaluating buildings in DJIBOUTI, a large future earthquake is defined as an earthquake occurring in UBC 1997 Seismic Zone 4, with a Modified Mercalli Intensity Scale (MMI) rating of IX.

Attachment C – Residential Seismic Survey Report Format & Contents

Building Investigation Worksheet

(Fill in and provide as much information as possible.)

1. Basic Information

a. Date: ___/___/___ (Mo / Day / Year) **b. Time:** _____ ☐ AM ☐ PM **c. Inspector Name:** _____

d. City/District: _____

GPS Coordinates: _____ **Latitude** _____ **Longitude**
(Use Center of Front Door for coordinates)

e. Building Address: _____

_____

_____

f. Architect/Engineer (Name & Address): ☐ Unknown

_____

_____

g. Contractor (Name & Address): ☐ Unknown

_____

_____

h. Date of Construction: _____ **i. Drawings Available:** ☐ Yes ☐ No

Insert Building Photo here

2. General Building Observations:

a. Maintained ☐ **Well** ☐ **Poorly**

b. Quality of Construction ☐ **Good** ☐ **Poor**

c. Evidence of any settlement: ☐ **Yes** ☐ **No** If yes - explain: _____

_____

d. Evidence of structural distress: ☐ **Yes** ☐ **No** If yes - explain: _____

☐ Cracked Foundation ☐ Cracked Column(s) ☐ Cracked Wall(s) ☐ Cracked Beam(s) ☐ Roof/Soffit Damage

e. Evidence of damage or repair from previous earthquakes. ☐ **Yes** ☐ **No** If yes - explain:

_____

f. Evidence of additions and modifications since original construction: ☐ **Yes** ☐ **No** If yes - explain:

_____

g. Evidence of non-engineered modifications: ☐ **Yes** ☐ **No** If yes - explain: _____

_____

_____

3. Foundations & Soils:

a. Type

- ☐ **Spread footings**
- ☐ **Continuous footings**
- ☐ **Grade or tie beams**
- ☐ **Other:** (explain) _____

_____

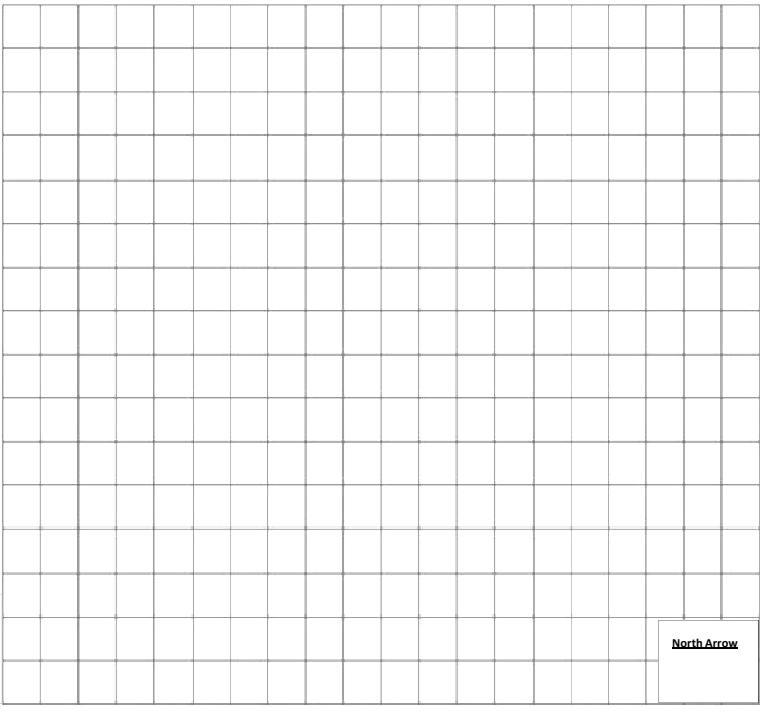
_____

_____

b. Allowable soil bearing _____ **(MPa)**

c. Proximity to liquefaction zone
☐ **Yes** ☐ **No**

d. Approximate Site Elevation:
_____ meters above sea level



Sketch Optional:
Show building footprint and sketch in shear walls in each direction - transverse and

Building Investigation Worksheet - continued

4. Structural & Seismic Observations:

a. Framing System: ☐ Reinforced Concrete Frame (beams & columns) with reinforced concrete shear walls.
☐ Reinforced Concrete Frame (beams & columns) with unreinforced masonry infill walls.
☐ Other (explain) _____

b. Number of stories: _____ **and story heights:** _____ **Feet.**

c. Below grade structure (basement, garage, mechanical room, etc.) ☐ Yes ☐ No Explain: _____

d. Porte-cocheres and carports ☐ Yes ☐ No

e. Floor and roof construction: ☐ Reinforced Concrete ☐ Steel Joists ☐ Wood ☐ Other (explain):

Floor Slab Thickness: _____ mm **Slab connection to Walls:** _____

f. Approx Wall Thickness: Exterior Walls: _____ mm Interior Walls: _____ mm Height/Thickness Ratio: _____

Wall Construction: Exterior Walls: _____ Interior Walls: _____
(insert applicable number) 1. Concrete 2. Reinforced Masonry 3. Unreinfroced Masonry 4. Other - explain

g. Typical Cross Section Dimensions (mm): Floor Beams: ____ x ____ Spandrel Beams: ____ x ____ Columns ____ x ____

h. Presence of a complete load path for seismic forces. ☐ Yes ☐ No

i. Number of shear walls parallel to front entrance. _____ ☐ Well Distributed ☐ Interrupted

j. Number of shear walls perpendicular to front entrance. _____ ☐ Well Distributed ☐ Interrupted

k. Shear walls aligned between floors. ☐ Yes ☐ No

l. Floor Diaphragm? ☐ Yes ☐ No **Roof Diaphragm?** ☐ Yes ☐ No

n. Redundancy in the lateral force resisting system. ☐ Yes ☐ No

o. Horizontal and vertical structural irregularities:
☐ Weak or Soft Story ☐ Geometric Shape - L or T shape footprint
☐ Short Columns ☐ Unusual Mass Concentrations / Torsional Irregualrities
☐ Diaphragm or Shear Wall Discontinuities ☐ Other (explain) _____

5. Other Building Observations:

a. Adjacency to other buildings - pounding/slapping potential: ☐ Yes ☐ No
- collapse/lean potential: ☐ Yes ☐ No

b. Presence of significant non-structural seismic hazards in and around the building. ☐ Yes ☐ No
☐ Loose Roof Tiles ☐ Rooftop Tanks ☐ Window Air Conditioners
☐ Unsecured Mechanical Equipment ☐ Chimney ☐ Parapets
☐ Other (explain) _____

c. Number of emergency escape routes from within building: _____ Routes

d. Presence of potential falling hazards along these routes: ☐ Yes ☐ No

e. Proximity of the building to natural and man-made hazards:
☐ Steep Hill/Slope Site ☐ High Perimeter Wall ☐ High Voltage Power Lines
☐ High Retaining Wall ☐ Dyke/Reservoir ☐ Water/Antenna Tower
☐ Industrial/Chemical Plant ☐ Other (explain) _____

6. Summary of Observations:

a. The quality of the design and construction of the building relative to local standard of upper-end residential construction: ☐ Below Average ☐ Average ☐ Above Average

b. A summary of observed deficiencies: (list & explain)

c. Expected seismic performance of the building, including a prognosis of potential damage level:
☐ minor damage ☐ moderate damage ☐ major damage ☐ partial/total collapse

d. Expected life safety risk to occupants during a future earthquake:
☐ low risk ☐ moderate risk ☐ high risk

e. Other observations identified by the Engineer: (list & explain) _____

f. Professional Opinion:
☐ Structurally Sound and Seismically Safe - better than average for the local area.
☐ Typical Design & Construction for the Area so expected to perform as good as most other buildings.
☐ Below the average quality of local design & construction.

ATTACHMENT B

Seismic Hazard Ratings

The Seismic Hazard Rating (SHR) is assigned to a building as a means of estimating how the building will perform during a large (see Note 1, below) future earthquake and the amount of damage the building is projected to sustain. The ratings are described below:

Good SHR
Damage Estimate: ***Minor Damage*** (Note 3)
Description: Some structural or non-structural damage and/or falling hazards may occur, but these would pose minimal life hazards to occupants.

Fair SHR
Damage Estimate: ***Moderate Damage*** (Note 3)
Description: Structural and non-structural damage and/or falling hazards are anticipated which would pose low life hazards to occupants.

Poor SHR
Damage Estimate: ***Major Damage*** (Note 3)
Description: Structural and non-structural damage are anticipated which would pose appreciable life hazards to occupants.

Very Poor SHR
Damage Estimate: ***Partial/Total Collapse*** (Note 3)
Description: Extensive structural and non-structural damage, potential structural collapse and/or falling hazards (Note 2) are anticipated which would pose high life hazards to occupants.

Notes:

1. A **"large"** future earthquake is defined for purposes of these ratings as an earthquake at the site that would be expected for the seismic zone and Modified Mercalli Intensity Scale (MMI) rating identified in the Scope of Work. A MMI scale follows on next page.
2. **"Falling Hazards"** are defined for the purposes of these seismic performance ratings as potential falling or sliding hazards such as interior and exterior building elements including parapets, ornamentation, chimneys, walls, and partitions, but excluding equipment, fixtures, ceilings, furniture, furnishings, and other contents. The falling hazards in the excluded list above should not be used in the determination of the seismic performance rating of a building or structure but should be abated.
3. **Damage Estimate**: It is impossible to predict the amount of damage and repairs buildings will require after a large earthquake event, based on a SHR. It is reasonable to assume that buildings rated Very Poor or Poor may not be repairable, and may have restricted access following a large earthquake event. Buildings rated Fair or Good may be repairable, but some disruption and limits on access can be expected after a large earthquake event.
4. A **"Life Safety Level of Performance"** is used as a basis for evaluating a building structure and establishing the SHR, following the ASCE 31-03 Standard for Seismic Evaluation of Existing Buildings.

Modified Mercalli Intensity Scale and Related Seismic Zone

UBC 1997 Zone *	Intensity	Description
2A	I	Not felt. Marginal and long-period effects of large earthquakes.
	II	Felt by persons at rest, on upper floors, or favorably placed.
	III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
	IV	Hanging objects swing. Vibration like passing of heavy trucks, or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of [intensity] IV, wooden walls and frames creak.
	V	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small, unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
	VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls, Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
2B	VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
3	VIII	Steering of motor cars affected. Damage to masonry C; partial collapse. Some to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
4	IX	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud ejected, earthquake fountains, sand craters.
	X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Railroad rails bent slightly.
	XI	Railroad rails bent greatly. Underground pipelines completely out of service.
	XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

* Correlation between Zone and Intensity is approximate to provide basis for defining a large future earthquake. Consult OBO seismic engineers for further clarification, if needed.

Definition of Masonry A, B, C, D:

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B. Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at the corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Residential Seismic Survey Report Format & Contents

I. Executive Summary

This is a one paragraph summary of the effort and findings. Repeat the Professional Opinion as to the expected response of the building to a large future earthquake along with the Seismic Hazard Rating.

II. Report

A. Introduction

Briefly state the purpose of the study, which can be lifted from Section A and Section B.1 of the Scope of Work. Include a statement on the seismic risk being considered for this location – from Section B.2. Note: the contract Statement of Work should be included as an appendix to this report and can be referenced here.

B. Building Location & Description

Identify the country and region and city where the property is located. Show the location of the property – either a city street map or a satellite image of the city from Google Map – provide a figure. Include GPS coordinates of the property. Show the relation of the property with respect to the US Embassy/Consulate.

Describe the property and building(s). Include basic features such as slope of the lot; retaining walls; major intersections; and other site related observations. Describe the building – dates of design/construction; number of stories; basement or crawl space; roof height above grade; floor heights; construction materials; and, overall condition and maintenance. Include information on design engineer/architect, and construction contractor.

C. Local Practices – Design & Construction

Provide an overview of the country's national building design and construction code, specifically as it relates to seismic design requirements. Are buildings such as the one being evaluated designed by and engineer or architect?

Briefly describe construction practices – materials, sources of material, quality control – inspection and testing. Has construction improved over recent years? Note any key dates that mark specific periods of construction practices – i.e., events that may have forced improvements, etc.

D. Interviews & Drawing Availability/Reviews

Provide a summary of interviews conducted with the building owner, the architect/engineer, contractor, and/or building maintenance personnel.

Describe the availability of design drawings, specifically structural, and the review conducted of these drawings. Were copies made, and where do these copies reside – were they shared with the Embassy/Consulate? Indicate whether construction photographs are available or whether construction inspection took place to ensure compliance with design concepts. Indicate what was learned from the review of these drawings with respect to materials, typical concrete beam, column, and shear wall reinforcement detailing including reinforcing steel sizes and amounts, spacing of column ties and beam stirrups, location of column bar splices, shear wall details, shear wall cross ties and boundary elements, whether or not 135º seismic hooks were used, etc.

Discuss typical reinforcement detailing in the interior and exterior walls and partitions, if of reinforced masonry construction.

Discuss foundation design and allowable soil bearing. Is the site located in a liquefaction-prone area?

E. Building Evaluation

This is the main section of the report. This section is not intended to be a copy of the Building Investigation Worksheet. Data gathered and recorded on the worksheet should be explained in the text of this section. Expand on the observations and findings from the actual site inspection. Note: the Building Investigation Worksheet should be included as an appendix to this report and can be referenced here.

Explain important facts or deficiencies noted during the survey and/or review of available construction documents. Use the itemized list in the Scope of Work as a basis for this discussion.

Include copies of drawings or sketches or photographs as appropriate, or reference them in an Appendix, to demonstrate the topic(s) being discussed.

F. Summary of Findings & Professional Opinion

Summarize the building positives and deficiencies – specifically those of a seismic nature. Include site deficiencies, too. Provide a statement on the quality of design and construction relative to local standards for upper end residential construction.

Provide a professional engineering opinion on the expected seismic performance of the building, including a prognosis of potential damage level (i.e., minor damage, moderate damage, major damage, or partial/total collapse) and corresponding life safety risk to occupants – see Attachment B to the Scope of Work for Seismic Hazard Rating (SHR) classifications.

The Engineer shall assign a SHR to the building.

III. Appendices

A. Drawings

Reproduce specific drawings, sections, and details necessary to support the report and its findings.

B. Photographs

Include representative photographs of the property, site features, adjacent structures, and the building itself (exterior and interior). Include photographs that demonstrate building seismic deficiencies. Annotate the photographs appropriately to provide reader with sufficient information to understand the view/orientation of the photograph, the important aspects of the intended picture, etc.

C. Building Investigation Worksheet

Include the Building Inspection Worksheet (the original field sheet or a clean reproduction). There is no need to spend a great deal of time re-typing this worksheet – a scanned copy will be accepted.

D. Scope of Work with Attachments

Include a copy of the contract scope of work and its attachments. It is not necessary to include another copy of the Building Inspection Worksheet since the completed one appears in Appendix C.