July 27th, 2016

Re: Theta Xi Fraternity House
503, 509, and 515 1st Street
Davis, CA 95616

To whom it may concern,

This letter is to document that a structural inspection was conducted at the above stated addresses on July 27th, 2016 at 9:30 am. The primary purpose of this inspection was to structurally evaluate the existing framing and foundations for the three primary buildings on the lot, and to identify structural fixes to help extend the useful life of the buildings. In addition, the structural feasibility of adding a library/study room between two of the buildings was also evaluated. The inspection was done using nondestructive methods. As a result, much of the framing of the buildings was not directly observable. A fourth separate small garage structure was not included in the inspection. For the purposes of this report the houses are labeled as follows:

- TX House: 515 1st Street
- Bryson: 509 1st Street
- Jackson: 503 1st Street

Existing Configuration:
The three buildings are located in a row along 1st street, taking up most of the southern portion of the city block bounded by D Street, E Street, 1st Street, and 2nd Street. All three structures are two-story wood framed buildings built approximately 100 years ago. Each building has a covered front porch with a balcony above, and a partial basement. The buildings are set up dorm style, each having several bedrooms and community bathrooms. The 1st floor of TX House has a large kitchen and a large community dining hall. Each building also appears to have at least one addition and/or remodel.

- **Roof:** The roofing for all three buildings is composed of composite shingles supported by roof sheathing over rafters. A description of the roof framing is outlined below:
  - **TX House:** The roof is composed of a central relatively flat area with sloped edges along the perimeter. There is also a relatively flat portion along the rear that is likely an addition built after the original construction. The flat portions of the roof have a modified bitumen roofing material. The roof framing is composed of 2x4 redwood (RW) rafters spaced 24 inches apart. The rafters are supported by 2x4 cripple walls that follow the perimeter of the flat portion of the roof. The ceiling is composed of 2x6 rough sawn RW joists spaced 16 inches apart.
  - **Bryson:** The roof is composed of a large gable section (ridge running east-west) with a large dormer along the front and two smaller dormers along the rear. The roof sheathing is composed of plywood which has likely replaced the original planking. The roof framing is composed of original 2x4 rough sawn RW rafters spaced approximately 32 inches apart with newer 2x4 douglas fir (DF) rafters installed between each original rafter. A few newer 2x4 DF
braces have been added in some areas likely in an effort to stiffen areas which were sagging. The rafters are tied together towards the ridge with 1x6 collar ties spaced approximately 32 inches apart. The rafters are also spliced approximately half way from the ridge to the front and back. The rafters are supported by beams along this splice in some areas, and by cripple walls in other areas. The ridge board is composed of a 1x6 which is braced at one intermediate location. The ceiling is composed of 2x4 rough sawn RW joists spaced 16 inches apart.

- **Jackson:** The roof is composed of a large gable section (ridge running east-west) with a large dormer along the front. The roof sheathing is composed of a combination of original RW planks and newer plywood. The roof framing is composed of a combination of original 2x4 rough sawn RW rafters spaced 32 inches apart with two newer DF rafters installed between each original rafter. These were likely installed to stiffen the roof. The rafters are supported approximately at the mid-span by orthogonal site built roof trusses. These trusses are composed of 1x4 RW framing and have been reinforced with newer DF 2x4 framing. The ridge board is a 1x6 with several 1x6 and 2x4 scabs likely installed to stiffen the ridge and to support the newer rafters. The ceiling is composed of 2x4 rough sawn RW joists spaced 16 inches apart.

- **Walls:** The walls of all three buildings are composed of 2x4 rough sawn RW studs likely spaced 16 inches apart. These walls would have originally been sheathing on the inside with lath and plaster. Most if not all of this plaster has been replaced with gypsum board. The exterior walls of TX House are sheathed with stucco. The exterior walls of Bryson and Jackson are sheathed with wood lap siding.

- **Floors:** The second-story floors of all three buildings are composed of wood planking supported by rough sawn RW joists likely spaced 16 inches apart. These joists are supported by bearing walls and beams. The ground level floors are composed of floor planks supported by floor framing as described below:
  - **TX House:** The ground level floor framing is composed of 2x10 rough sawn RW joists spaced 16 inches apart. The floor joists are supported by a perimeter foundation wall, basement walls, and by periodic 4x6 girders running orthogonal to the joists. The girders are supported by periodic piers and pad footings. The girders are also supported by posts which extend down into the basement. There is a glulam beam supporting a portion of the floor framing that appears to be much newer than the other framing. This beam was likely installed in an effort to stiffen the floor or as part of a remodel.
  - **Bryson & Jackson:** The ground level floor framing is composed of 2x6 rough sawn RW joists spaced 16 inches apart. The joists are supported by a perimeter foundation wall, basement walls, and by periodic 4x6 girders running orthogonal to the joists. The girders are supported by periodic piers and pad footings. The girders are also supported by posts which extend down into the basement.

- **Foundations:** The foundation for each building is similar; there is a perimeter concrete foundation wall, pad footings at the piers, and concrete basement walls. The basement wall thicknesses are all approximately 8 inches. The basement of TX House is located towards the central portion of the building, while the basements of Bryson and Jackson are located below the back half of the buildings. The perimeter foundation walls are approximately 8 inches thick at the top and widen as they extend down to grade. The footings extend between 4 and 12 inches below grade.

**Observations:**
The following observations were made during the inspection:
- **TX House:** The roof was paced and found to be excessively spongy in the relatively flat areas. The roof appears to have been patched several times in the past. The roof framing was examined from within the attic and found to be in overall good condition. The flat rafters appear to be over-spanned based on current California Building Code (CBC) standards, but seem at least adequate for the existing
dead load. Several of the rafters show signs of water staining. It is unclear if these are active leaks or leaks that have been previously patched. The attic vents along the eaves have been partially obstructed with paint. Two downspouts appear to be missing, the gutters are clogged, and at least one downspout is discharging directly into the soil adjacent to the foundation. The floors were paced and found to be warped, sloped, and uneven in several areas. There is also a general crown to the floor. The interior wall and ceiling sheathing appear to be in overall good condition, but show signs of past patching in several areas. The stucco siding was inspected and found to be heavily cracked in a few areas. Most of the distress occurs at corners of door and window openings; however, there is substantial cracking along the west side of the covered front porch where it appears the foundation is separating from the framing above. The basement walls were inspected and found to be in overall good condition. No signs of any significant cracking, spalling, or material degradation were observed. What appears to be active mold was observed in the southwest corner of the basement along the lower portion of the wall. Some of the drywall which has been applied to the underside of the joists in the basement also shows signs of mold and water intrusion. Some of this material has dislodged from the ceiling as a result. The stairs leading down to the basement appear to be poor condition. The treads feel spongy and the connections feel loose. The foundation walls were examined from the exterior and a portion from the crawlspace as access was limited. The foundation walls are cracked in some areas, and limited material degradation was observed. The largest foundation crack was observed at the transition between the building and the porch. A gap measuring approximately 1 inch has opened up along this joint. The footing in this area extends below grade only approximately 4 inches. The front porch slab and concrete steps were found to be cracked towards the center adjacent to this area. The framing below the kitchen was found to be covered with water stains. This portion of the crawlspace was found to be infested with insects, some of which appeared to be termites. There is an exterior set of stairs along the north side of the building with the following issues:

- The stucco siding for the guard-walls is cracked and appears to be trapping water inside the framing cavity.
- The assembly appears to be separating from the building. A gap measuring 1 inch was measured between the guard-wall and building.
- Most of the supporting stringer and tread framing show signs of significant water staining and mold growth.
- The guard-wall cap rail has separated approximately 1 inch at the outside corner at the top landing.
- The guard-wall assembly can be laterally moved with ease.

**Bryson:** The roof framing was examined from within the attic and found to be in overall good condition. Several of the rafters show signs of water staining. It is unclear if these are active leaks or leaks that have been previously patched. The front porch beams show signs of significant deflection. It was estimated these beams have deflected at least an inch. The floors were paced and found to be warped, sloped, and uneven in several areas. There is also a general crown to the floor. The stairs also have at least one tread which appears to be failing as evidenced by excessive deflection when stepped on. The interior wall and ceiling sheathing appear to be in overall good condition, but show signs of patching in several areas. The foundation wall was inspected and found to be cracked in at least four locations. The cracks measure up to 1/8" of an inch in maximum width. The cracks appear to extend completely through the foundation wall. Several exposed steel retrofit plates were observed securing the wall framing down to the foundation and basement walls. These plates were likely installed as part of a seismic upgrade. The floor framing at the ground level was not directly observable because the basement ceiling is sheathed with gypsum and/or Masonite and the adjacent crawlspace does not appear to have an access opening. There appears to be an addition along the northeast corner of the building. The floor dips down towards the exterior wall along the transition between the two. The foundation also appears to be settling to a high degree at the southwest corner of the front porch. A crack measuring approximately 1/4 of an inch in width was observed within the
foundation wall adjacent to the brick column base in this area. The basement walls were inspected and found to be in overall good condition. No signs of any significant cracking, spalling, or material degradation were observed. The exterior wall siding has separated in areas and the corners do not appear to be weather proof.

- **Jackson:** The roof framing was examined from within the attic and found to be in overall good condition. Several of the rafters show signs of water staining. It is unclear if these are active leaks or leaks that have been previously patched. The floors were paced and found to be warped, sloped, and uneven in several areas. There is also a general crown to the floor. The interior wall and ceiling sheathing appear to be in overall good condition, but show signs of patching in several areas. The foundation wall was inspected and found to be cracked in at least two locations. The cracks measure up to 1/8th of an inch in maximum width. The cracks appear to extend completely through the foundation wall. Several exposed steel retrofit plates were observed securing the wall framing down to the foundation and basement walls. These plates were likely installed as part of a seismic upgrade. The floor framing at the ground level was not directly observable because the basement ceiling is sheathed with gypsum and/or Masonite and the adjacent crawlspace does not appear to have an access opening. There is an exterior wood staircase that provides an additional access to the second floor. This staircase is consistent with typical wood deck stairs and appears to be less than ten years old. There appears to be an addition along the northwest corner of the building. The floor slopes heavily down towards the exterior wall along the transition between the two. The basement walls were inspected and found to be in moderate condition. There was at least one full-height crack observed. Limited signs of surface scaling were also observed; however, the material below the scaling appears to be fairly sound. Several mud tunnels were observed extending between the basement walls to the floor framing. These tunnels are evidence of paste termite infestation. The exterior wall siding has separated in areas and the corners do not appear to be weather proof. At least one corner trim piece is also missing entirely. One of the front porch beams appears to be deflecting excessively and/or the trim is failing in this area.

**Structural Evaluation:**
The sloped floors, interior wall and ceiling distress, and cracked foundations are all evidence of differential settlement. This settlement is likely the result of a combination of soil consolidation and the presence of expansive soils. Soil consolidation typically does not continue past the first few years after construction. Expansive soils, however, can cause ongoing settlement issues. Expansive soils expand and contract proportionately to the amount of moisture present. Seasonal soil moisture content fluctuations can cause some degree of foundation movement; however, poor drainage can also heavily influence the effects imposed by expansive soils. The settlement has heavily fractured and incrementally degraded the stiffness and strength of the foundation walls. These foundation walls appear to be nearing the end of their useful lives. The basement walls; however, appear to be in decent structural condition and could have many more decades of effective use. Other house specific structural evaluations are as follows:

- **TX House:** The following conditions are structurally concerning:
  - The 2x4 rafters with low slope appear to be severely over-spanned. Given the potential for people to congregate in this area, the roof is susceptible to collapse in this area.
  - The stairs extending down into the basement appear to be posing a safety threat.
  - The exterior stair case and guard-wall are not structurally sound and are posing an immediate life safety threat.
  - The settlement at the western portion of the front porch is excessive and may eventually compromise the structural integrity of the porch roof.
  - The insect infestation is structurally concerning in that if left unchecked, insect damage can be excessive.
  - The mold in the basement is structurally concerning because mold breaks down the host material in the process of growing. The framing above this area may have been affected. In
addition, mold can cause various health issues to exposed occupants. Depending on the type of mold, some of these issues can be serious.

- **Bryson:** The following conditions are structurally concerning:
  - The porch beams have more than typical deflection. These beams could be in a state of progressive failure.
  - The faulty interior stair tread may be posing a safety threat.
  - The stairs leading down to the basement may be posing a safety threat.
  - The excessive settlement at the addition may be compromising the framing spanning between the addition and the original building.
  - The excessive settlement at the southwest corner of the porch may also be compromising the structural integrity of the beam-to-column connection above this area.
  - The building corners may have allowed long term water intrusion. This may or may not have caused the framing in these areas to deteriorate as a result of rot.

- **Jackson:** The following conditions are structurally concerning:
  - The failing trim covering the porch beam could be the result of progressive failure of this beam.
  - The stairs leading down to the basement may be posing a safety threat.
  - The building corners may have allowed long term water intrusion. This may or may not have caused the framing in these areas to deteriorate as a result of rot.

**Recommendations:**
Much of the settlement issues are the result of the presence of expansive soils aggravated by poor drainage. For this reason it is recommended that the drainage around the perimeter of all three buildings be improved as noted below:

- Positive slopes should be established around the perimeter of the home. This would likely involve strategically re-grading areas, and/or introducing low-point drains and/or French-drains.
- All downspouts should be tapped directly into drainpipes which discharge towards the front of the property.
- The gutters should be cleared of debris and tested to see if they are functioning properly.
- Landscaping and associated irrigation systems should be relocated further from the foundations.
- Provide new flatwork with a positive slope (down and away from the buildings) in areas which may now be trapping water against the foundation wherever feasible. New flatwork should have the following:
  - Positive slope (1/4:12 down and away from the foundation)
  - Rebar reinforcing in both directions
  - Crack control joints creating sections with length to width ratios of 1.5 or less.

Providing and maintaining proper drainage can help minimize the effects of the expansive soils.

Additional house specific recommendations are listed below:

- **TX House:**
  - The exterior stair case and guard-wall should be removed and replaced with a new staircase meeting the standards as set forth in the current CBC as soon as possible. Tenant access should be restricted through the use of caution tape, while still allowing for emergency egress until a new set of stairs is installed.
  - The basement stairs should also be removed and replaced. This staircase is not as critical, but should be replaced fairly soon.
  - A pest control expert should be consulted regarding the insect infestation. Left unchecked, insect damage can be excessive. Consideration should be made for opening up the wall cavities in the infested area to inspect the condition of the framing.
A mold specialist should be consulted regarding the mold within the basement. Consideration should be made for exposing the surrounding framing to inspect for any potential associated rot damage.

Consideration should be made for introducing steel retrofit plates as exist at Bryson and Jackson. These plates can drastically improve the seismic performance of the building.

The flat portion of the roof should be reinforced. The rafters are heavily over-spanned in this area and may pose a safety threat to any potential live loads.

- **Bryson:**
  - The porch beams should have all siding removed and be inspected for any structural damage.
  - The framing should be exposed at the building corners for evaluation of the structural integrity of the wall framing.
  - The faulty interior stair tread should be replaced.
  - The stairs leading down to the basement should be replaced at some point.
  - The foundation below the southwest corner of the porch should be replaced or repaired to help prevent additional settlement.
  - Consideration should be made for removing the existing siding and inspecting the wall framing for water intrusion damage. Building paper should be installed prior to reinstalling the siding. Providing stucco in place of wood siding would better protect the wall framing and extend the useful life of the building.

- **Jackson:**
  - The porch beams should have all siding removed and be inspected for any structural damage.
  - The framing should be exposed at the building corners for evaluation of the structural integrity of the wall framing.
  - The stairs leading down to the basement should be replaced at some point.
  - The foundation below the addition should be repaired or replaced to help prevent additional settlement.
  - The foundation below the southwest corner of the porch should be replaced or repaired to help prevent additional settlement.
  - Consideration should be made for removing the existing siding and inspecting the wall framing for water intrusion damage. Building paper should be installed prior to reinstalling the siding. Providing stucco in place of wood siding would better protect the wall framing and extend the useful life of the building.

The foundations of all three buildings appear to be nearing the end of their useful lives. Consideration should be made for preparing to replace these foundations over the next few decades. If these foundations are not replaced, the potential for structural damage of the framing above is high.

**Proposed Library/Study Room:**
The proposed addition between Jackson and Bryson is structurally feasible provided the addition does not rely on either adjacent building for gravity or lateral support. This would likely involve building a new foundation alongside the existing foundation and providing walls to support the new roof on all four sides. Structural ties would also likely be necessary to lock the new roof diaphragm into the existing adjacent floor diaphragms. The services of a licensed structural engineer should be rendered to provide the necessary structural evaluation and construction documents. Construction should be done by a licensed contractor familiar with this type of specialized work.

**Conclusion:**
It is my professional opinion that interior wall and ceiling distress, sloped floors, and cracked foundations are all the result of differential settlement. This settlement is likely the result of soil consolidation and ongoing movement caused by moisture content fluctuations within the expansive soil. Poor drainage is likely also influencing this often seasonally cyclic movement. The progressive degradation of the foundation has finally
brought the foundations close to the end of their useful lives. Preparations for replacing these foundations over the next few decades should be started now. As an alternative, stabilizing the foundations with underpinning may also be an option; however, that strategy would likely not be a long term solution. Most of the framing inspected appears to be in good structural condition; however, some localized structural concerns are listed above. By following the above stated recommendations, the useful life of each building can be extended. The proposed library/study between Jackson and Bryson is structurally feasible provided the new section can support all of the CBC level loads independently as noted above.

If you have any questions or comments, please contact me at the number given above.

Sincerely,

Mark Pemberton, S.E.
Principal Engineer