Stevens Ferrone & Bailey
Engineering Company, Inc

Geotechnical Engineering
Engineering Geology
Storm Water Management
Construction Observation & Testing Services

November 25, 2019

Mr. Peter Giles
DeNova Homes
1500 Willow Pass Court
Concord, CA 94520

Re: Geotechnical Engineering Assessment
20455 5th Street East – Sonoma, California
SFB Project No.: 155-87

Mr. Giles:

Stevens, Ferrone & Bailey Engineering Company, Inc. (SFB) performed a geotechnical engineering assessment of the property located at 20455 5th Street East in Sonoma, California. It is our understanding that the project will consist of developing the 2.96-acre property for a new residential development. Nominal grading is anticipated and associated underground utilities and roadways will be constructed.

Our geotechnical assessment included the following scope of work:

- Review available published and unpublished geological and geotechnical literature relevant to the project area and surrounding vicinity;
- Review available aerial photographs and images of the site;
- Perform a visual reconnaissance of the site and immediate surrounding area to evaluate the geotechnical conditions that impact the development of the site;
- Geotechnical engineering analyses and evaluation of the research and reconnaissance data in order to provide general geotechnically related development recommendations for the project; and
- Preparation of this report.

1.0 SUMMARY OF GEOTECHNICAL AND GEOLOGICAL CONDITIONS

1.1 Surface Description

SFB performed a reconnaissance of the site and surrounding area on November 22, 2019. The site was generally level with minor grade changes. A single-story, concrete block residence with a wood-frame garage, shed, and associated facilities was built in approximately 1950 and occupied the middle portion of the site. A gravel covered driveway provided access to the residence from

5th Street East. The residence was surrounded by various concrete and paver walkways. Another concrete block structure, likely used for storage, and an abandoned wood-frame chicken coop were located behind the residence and along the western boundary of the site. Both concrete block structures are likely supported by shallow foundation systems. Two wooden well and pump enclosures were observed slightly north and behind the residence. It is our understanding that the well behind the residence is not used anymore, but still functional. The rest of the site consisted of large vacant areas with moderate to heavy growths of grasses and weeds. Several small and large diameter trees and shrubs were generally observed surrounding the residence and along the site boundary. The site was surrounded and sectioned off with fencing throughout.

A seasonal drainage swale with two culverts bordered the eastern and southern property lines. The eastern portion was approximately 4 to 5 feet deep with 2:1 slopes (vertical to horizontal) and the western portion was approximately 2 to 3 feet deep with 1:2 slopes. The drainage swale was dry during our reconnaissance, but the soils within the drainage swale are potentially weak and compressible. Evidence of soil desiccation was observed in the drainage swale and animal burrows were observed throughout the site. It is likely that these surficial soils will require over-excavation and re-compaction to estimated depths of about 2 feet.

Based on our review of historical aerial photographs and topographic maps of the site and vicinity, it is our understanding that the site was previously occupied by an orchard that had possibly been removed in 1950 when the residence was built.

1.2 Subsurface Conditions, Geology, and Seismicity

According to Wagner, et al (2004)[1] and Wagner and Gutierrez (2017)[2], the site is underlain by old Pleistocene alluvial fan deposits consisting of sand, gravel, silt, and clay, deeply dissected. It has been our experience that these deposits are strong and capable of supporting the proposed development.

Earthquake intensities will vary throughout the San Francisco Bay Area, depending upon numerous factors including the magnitude of earthquake, the distance of the site from the causative fault, and the type of materials underlying the site. The U.S. Geological Survey (2016)[3] indicated that there is a 72 percent chance of at least one magnitude 6.7 or greater earthquake striking the

[1]Wagner, Clahan, Randolph-Loar, and Sowers, 2004, *Geologic Map of the Sonoma 7.5' Quadrangle, Sonoma and Napa Counties, California: A Digital Database*, Version 1.0.

[2]Wagner and Gutierrez, 2017, *Preliminary Geologic Map of Napa and Bodega Bay 30' x 60' Quadrangles, California*, Plate 1 of 2.

[3]Aagaard, Blair, Boatwright, Garcia, Harris, Michael, Schwartz, and DiLeo, *Earthquake Outlook for the San Francisco Bay Region 2014–2043*, USGS Fact Sheet 2016–3020, Revised August 2016 (ver. 1.1).

San Francisco Bay region between 2014 and 2043. Therefore, the site will probably be subjected to at least one moderate to severe earthquake that will cause strong ground shaking.

According to the U.S. Geological Survey's Unified Hazard Tool and applying the Dynamic: Conterminous U.S. 2014 (v4.2.0) model (accessed 11/20/19), the resulting deaggregation calculations indicate that the site has a 10% probability of exceeding a peak ground acceleration of about 0.54g in 50 years (design basis ground motion based on stiff soil site condition; mean return time of 475 years). The actual ground surface acceleration might vary depending upon the local seismic characteristics of the underlying bedrock and the overlying unconsolidated soils.

1.3 Geologic Hazards

The site is not located in an earthquake fault zone as designated by the State of California[4]. According to the U.S. Geological Survey, the site is located in an area that has been characterized as having very low liquefaction susceptibility[5,6].

2.0 GEOTECHNICAL ENGINEERING OPINIONS AND CONCLUSIONS

From a geotechnical engineering standpoint, it is our opinion that the site can be developed for the proposed project. Below are our preliminary earthwork and foundation recommendations. We recommend a geotechnical investigation (including exploratory borings, soil sample retrieval, laboratory testing, and detailed geotechnical engineering analyses) be performed to supplement and confirm these preliminary recommendations. The results of the investigation should be summarized in a comprehensive report providing detailed geotechnical design and construction criteria for the project.

3.0 PRELIMINARY EARTHWORK RECOMMENDATIONS

The site should be cleared of all obstructions including existing structures and their entire foundation systems, existing utilities and pipelines and their associated backfill, designated trees and their associated entire root systems, and debris. Holes resulting from the removal of underground obstructions extending below the proposed finish grade should be cleared and backfilled with compacted fill materials. Existing tree roots may extend to depths of 3 to 4 feet. Foundations likely extend to depths of about 1-1/2 to 2 feet. Wells and leach field systems should be removed/abandoned in accordance the county requirements.

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[4]Hart and Bryant, *Fault-Rupture Hazard Zones in California*, CDMG Special Publication 42, Interim Revision 2007.
[5]Witter, Knudsen, Sowers, Wentworth, Koehler, and Randolph, 2006, *Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California*, USGS Open File Report 2006-1037.
[6]Knudsen, Sowers, Witter, Wentworth, and Helly, 2000, *Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California*, USGS Open File Report 00-444.

From a geotechnical engineering standpoint, any existing trench backfill materials, clay or concrete pipes, gravel, pavements, and concrete that are removed can be used as new fill onsite provided debris is removed and it is broken up. Portions of the site containing vegetation that is not removed during clearing should be stripped to an appropriate depth to remove these materials.

All existing fill materials should be over-excavated to a depth where competent soil is encountered. In addition, existing surface soils will require over-excavation and re-compaction; we estimate based on our visual observation only that over-excavation depths of approximately 2 feet will be required.

From a geotechnical and mechanical standpoint, onsite soils and fills having an organic content of less than 3 percent by volume can be used as fill. Fill should not contain rocks or lumps larger than 6 inches in greatest dimension with not more than 15 percent larger than 2.5 inches.

Fill materials will likely require compacting to about 90 percent relative compaction and moisture conditioned approximately 3 to 5 percent over optimum water content. Fill material should be spread and compacted in lifts not exceeding approximately 8 to 12 inches in uncompacted thickness.

Pipeline trenches should be backfilled with fill placed in lifts of approximately 8 to 12 inches in uncompacted thickness. Thicker lifts can be used provided the method of compaction is approved by SFB and the required minimum degree of compaction is achieved. Backfill should be placed by mechanical means only. Jetting is not permitted. The upper 3 feet of trench backfill in foundation, slab, and pavement areas should be entirely compacted to at least 95 percent relative compaction.

We recommend that exterior slabs (including patios, sidewalks, walkways, and driveways) be placed directly on the properly compacted fills. We do not recommend using aggregate base, gravel, or crushed rock below these improvements. If imported granular materials are placed below these elements, subsurface water can seep through the granular materials and cause the underlying soils to saturate or pipe. Prior to placing concrete, subgrade soils should be moisture conditioned to increase their moisture content to approximately 3 to 5 percent above laboratory optimum moisture (ASTM D-1557). We recommend reinforcing exterior slabs with steel bars in lieu of wire mesh.

4.0 PRELIMINARY FOUNDATION & RETAINING WALL RECOMMENDATIONS

The proposed residential buildings can be supported on a post-tensioned slab foundation that is designed for the expansion potential of the onsite soils. The slab foundation should bear entirely on properly prepared, compacted structural fill. The post-tensioned slab thickness should be determined by the Structural Engineer; however, we recommend the post-tensioned slabs be at

least 10 inches thick. A vapor retarder must be placed between the subgrade soils and the bottom of the slabs-on-grade. We recommend the vapor retarder consist of a single layer of Stego Wrap Vapor Barrier 15 mil Class A or equivalent.

In order to reduce the potential for vapor transmission through the concrete slab, we recommend the concrete mix design for the slabs have a maximum water/cement ratio of 0.45. If a higher water/cement ratio is being considered, we recommend higher vapor transmission be taken into account in the design and construction of the homes. The actual water/cement ratio may need to be reduced if the concentration of soluble sulfates or chlorides in the supporting subgrade is detrimental to the concrete and/or reinforcing steel.

Where walls retain soil, they must be designed to resist both lateral earth pressures and any additional lateral loads caused by surcharging such as building and roadway loads. For retaining walls that need to resist earthquake induced lateral loads from nearby foundations, walls that are to be designed to resist earthquake loads, and any retaining walls that are higher than 6 feet (as required by the 2019 CBC), we recommend the walls also be designed to resist seismic pressures developed from a design basis earthquake. Some movement of the walls may occur during moderate to strong earthquake shaking and may result in distress as is typical for all structures subjected to earthquake shaking. Walls should be fully-back drained to prevent the build-up of hydrostatic pressures.

Retaining walls and soundwalls can be supported on drilled, cast-in-place, straight shaft friction piers that develop their load carrying capacity in the materials underlying the site. Alternatively, some walls can be supported by footing foundations.

5.0 PRELIMINARY PAVEMENT RECOMMENDATIONS

The soils are likely expansive which can result in R-values of about 5. We anticipate that roadway sections will consist of approximately 3 inches of asphalt concrete over 9 inches of Caltrans Class 2 baserock.

6.0 ADDITIONAL RECOMMENDATIONS, CONDITIONS, AND LIMITATIONS

Exploratory borings, laboratory testing, and geotechnical engineering analyses will need to be performed in order to provide detailed geotechnical design and construction criteria for the project and to confirm the preliminary recommendations provided above. The future report should include detailed drainage, earthwork, foundation, and pavement recommendations for use in the design and construction of the project. Once the future, detailed investigation is complete, we recommend SFB review the project's design and specifications to verify that the recommendations presented in the future report have been properly interpreted and implemented in the design, plans, and specifications. We also recommend SFB be retained to provide consulting services and to perform

construction observation and testing services during the construction phase of the project to observe and test the implementation of our recommendations, and to provide supplemental or revised recommendations in the event conditions different than those described in our reports are encountered. We assume no responsibility for misinterpretation of our recommendations if we do not review the plans and specifications and are not retained during construction.

If you have any questions or need additional information, please call us.

Sincerely,

Stevens, Ferrone & Bailey Engineering Company, Inc.

Kenneth C. Ferrone, P.E., G.E., C.E.G.
Civil/Geotechnical Engineer
Certified Engineering Geologist